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Migration, Remittances, and Forest Cover Change in Rural Guatemala and Chiapas, Mexico

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Received: 28 January 2020; Accepted: 11 March 2020; Published: 17 March 2020

Abstract: This article investigates how migration and remittances affect forest cover in eight rural communities in Guatemala and Chiapas, Mexico. Based on household surveys and remote sensing data, we found little evidence to support the widespread claim that migration takes pressure off forests. In the Chiapas sites, we observed no significant changes in forest cover since 1990, while in the Guatemalan sites, migration may have increased demand for agricultural land, leading to an average annual forest loss of 0.73% during the first decade of the millennium. We suggest that when attractive opportunities exist to invest in agriculture and land expansion, remittances and returnee savings provide fresh capital that is likely to increase pressure on forests. Our study also has implications for the understanding of migration flows; in particular, migration has not implied an exodus out of agriculture for the remaining household members nor for the returning migrants. On the contrary, returning migrants are more likely to be involved in farming activities after their return than they were before leaving.

Keywords: remittances; forest transition; agriculture

1. Introduction

Study of the environment-migration nexus has gained traction in recent decades [1–3], and the current climate concerns have become a "wake-up call to migration scholars" [4] (p. 473). While there is a vigorous debate on migration caused by climate change and associated vulnerabilities, as well as on environmental impacts of migration in destination areas, much less work examines the outcomes of migration on the environment in migrants' places of origin [5–9].

In this article, we examine how international migration affects tropical deforestation, which is responsible for about 10% of global greenhouse gas emissions [10]. Does international migration lead to an abandonment of existing agricultural land, which could lead to a forest recovery? Or, does the cash injection associated with remittances and returnee savings stimulate investments in new agricultural land by clearing natural forests? We answer these questions through an analysis of household and spatial data from eight rural communities: four in Guatemala and four in the Mexican state of Chiapas.

Close to 10% of Guatemala's population lives abroad, mainly in the United States, and remittances comprise about 10% of Guatemala's Gross Domestic Product (GDP) [11]. Data from Chiapas show that

about 3% of the population migrated to the United States in 2007 and remittances composed 6% of the state's GDP that year [12] (This is the most recent year for which we have census data on migration and remittances.) Thus, both migrants and their remittances have the potential to impart significant change on the local economy, which could lead to major land use changes in the sending region [5,6].

Migration and remittances—key aspects of globalization—are part of a changing rural economy and landscape throughout the global South. Hecht [13] argues that globalization is linked to "extensive processes of forest resurgence throughout the tropics and many rural areas reveal the expansion of numerous types of anthropogenic and successional forests" (p. 161). However, relationships between migration and forest cover are far from uniform, and cases studies across the Americas illustrate varied outcomes. Taylor et al. [14], for example, reported that remittances permit the conversion of rainforest into cattle pasture, while Aguilar-Støen [15] linked remittances with the expansion of coffee production in Eastern Guatemala. Gray and Bilsborrow [16] found that rural out-migration alone did not lead to a forest transition in their Ecuadorian study areas. Similarly, in a sample of four Central American countries, Davis and Lopez-Carr [17] found no significant correlation between agricultural land expansion and migration/remittances, although returning migrant savings (but not remittances) were linked to more pasture land purchases.

All of these case studies use different methods to examine the relationship between migration and forests. Thus, we developed and employed a migration–forest framework that can be employed by future studies to enable easier comparison and understanding of diverse outcomes [18]. Our framework investigates how migration may affect land use through two channels: i. reduced labor supply in migrant home areas, which might lead to abandoning farmland and/or to less labor-intensive agricultural practices, and ii. a cash injection through remittances to the family left behind and returning migrants' savings. This cash injection can have multiple effects on land use. Households may substitute their own food production with purchased food, thereby reducing their local agricultural footprint; they may buy more land or intensify agriculture, thereby increasing that local footprint; or, they may buy consumption goods or invest in other sectors, with minor direct impact on land use.

We contribute to the migration-environment literature in three ways. First, our migration–forest framework offers a theoretical contribution. Second, a comparison of sites in two countries with different settlement and migration histories illustrates the complexity and changing nature of relationships between migration (and associated remittances and savings) and the environment, which can be used to assess how the maturity of migration affects land use. Third, we compare the land-use impact of family members living abroad and remitting, and land-use impact of returnees and their savings, finding significant differences between the two.

The article is outlined as follows. Section 2 develops the migration–forest framework. Section 3 presents the eight study communities in Chiapas and Guatemala, describes the data used from satellite images and a survey of 728 households, and presents our empirical strategy: i. estimate aggregate change in forest cover at the community level, ii. analyze—by descriptive statistics and regression analysis—how migration and remittances affect household demand for agricultural land (Section 4), and iii. relate and discuss the different forest outcomes to four contextual factors: stage in migration, land tenure, market access, and policies (Section 5).

2. A Migration–Forest Framework

International migration is a central element of what has been termed "the new rurality" [13]. New rurality thinking holds that rural occupations and livelihoods are diversifying, household income is shifting from farm to non-agriculture, and remittances play a growing role in rural economies. Additionally, rural lives are becoming more mobile, farmers are aging, and new information technologies are making ideas flow faster, impacting aspirations and consumption [13,19]. Yet even with these transformations, a large share of people in developing countries continue to live in the countryside, and agriculture persists as the economic backbone in low-income rural regions [20]. Despite the popularity of "new rurality" thinking, the literature examining the relationship between migration and land use

in migrants' places of origins is far from consensus. Remittances might also allow non-migrating household members to continue living in rural communities, and combine agriculture with other activities to improve their material living standards [21]. Migration and remittances can also provide incentives and means for households to carry out changes in their land use [14,22,23].

To address the relationships between migration and land use systematically, we developed a migration–forest framework and build on three theoretical discussions: the forest transition, the livelihoods approach, and the "new economics of labor migration" school. The forest transition (FT) approach describes a sequence over time where forest cover first declines before it stabilizes and slowly increases [24]. This pattern occurred in Europe and North America over the past two centuries, and signs of diminishing deforestation and emerging reforestation are now observed in a number of tropical areas, particularly in South and East Asia and Central America, signaling a process of forest transition [13,25,26]. Several factors can accelerate FT and make the region or country enter a stage of forest stabilization and recovery [27]. Two dominating drivers are the forest scarcity path (shrinking forest areas provide incentives to better forest management, conservation, and tree planting) and the economic development path (higher labor costs in agriculture, due to economic development and urbanization, reduces agricultural profitability and acreage) [26]. Migration's potential role in FT is linked to the latter path: migration reduces labor available in sending communities and can therefore make agricultural expansion into forests less attractive; and remittances can make communities less reliant on agricultural income.

In creating the migration–forest framework, we also made use of the (sustainable) livelihoods approach, which investigates how households combine their assets or capitals (such as human (labor), natural (land), financial capital and social capital) into a set of activities, given the socioeconomic (markets, institutions, etc.), agroecological and policy context. These activities form household livelihoods strategies and yield a set of livelihoods outcomes (such as food security, income, and land use) [28–33]. Because migration and remittances influence household assets, this livelihoods approach must be incorporated into a model examining the relationships between migration and forests.

The third approach we employed in the creation of the framework is the new economics of labor migration [17,34–37]. This approach conceptualizes migration as part of household diversification and risk management strategies to cope with local income shortfalls and imperfect capital, labor, credit, and insurance markets [37]. The livelihoods and new economics of labor migration approaches overlap and provide frameworks to incorporate both the local and broader contexts in analyzing how migration and remittances impact household decisions and the local land use and economy.

Our framework seeks to combine a macro-level theory (forest transition) with two theories at the micro (household) level (the livelihoods and the new economics of labor migration approaches). In a comprehensive review of how demographic factors (including migration) affect the livelihoods-environment interaction, De Sherbinin, et al. [9] note that "much of the research on the impact of migration [is] at the aggregate or societal level, divorced from household livelihood strategies" (p. 45). Different scales of analysis, however, can be combined fruitfully, as evidenced in a review of migration and livelihoods in Southeast Asia [19]. Combining theories at the macro and micro level into our migration–forest framework helps scholars to include both macro level and micro level variables in their analyses of the impact of migration on the environment.

The migration–forest framework presented in Figure 1 outlines potential causal links between migration and forest cover and presents key conditioning factors that co-determine forest outcomes. In this model, migration has two principal impact pathways on the sending household and local economy. First, migration removes one person from the family labor pool and local labor market. The impact on farm production depends on the local labor market [38,39]. In large, well-functioning labor markets, the effects of this removal are likely to be small. In localized and imperfect labor markets, migration will put upward pressure on wages. The most direct effect of this wage increase should be reduced labor use in agriculture and possible reduction in agricultural acreage, as suggested by the FT theory.

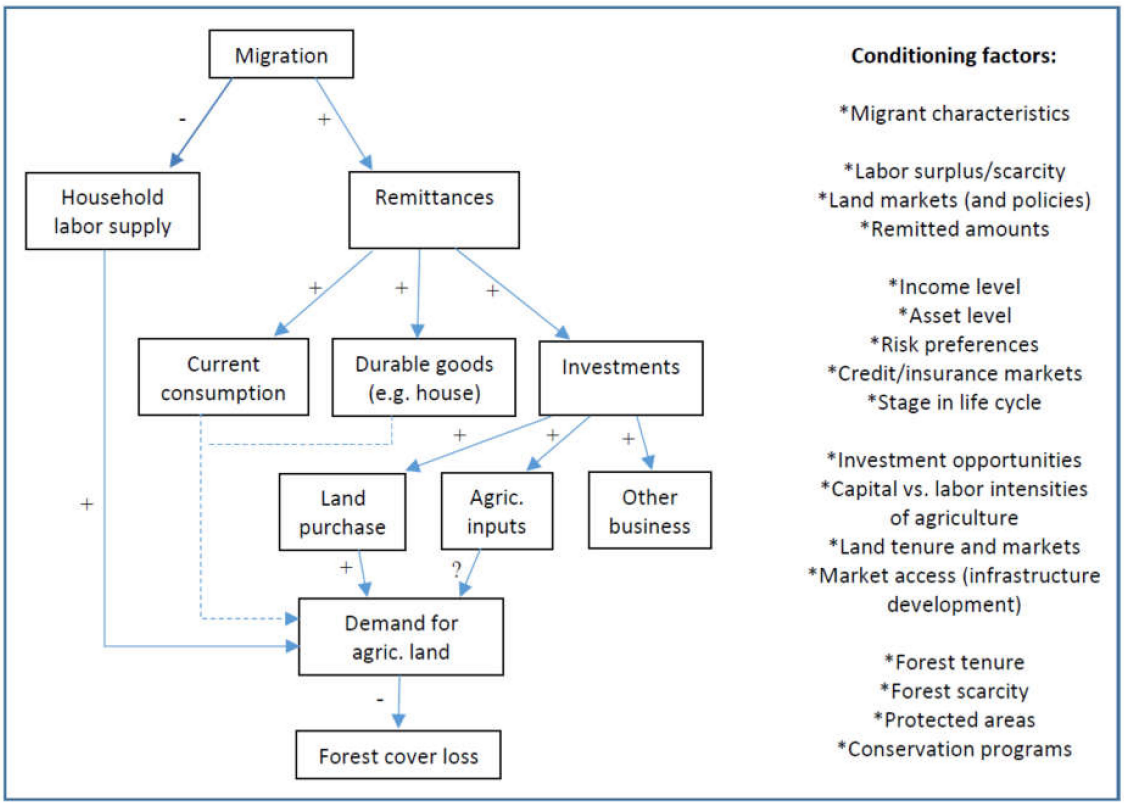

Figure 1. The migration–forest framework. Note: Dotted lines indicate potentially important channels of impact, which are not discussed further in this paper. Conditioning factors are grouped based on their relevance to the decisions or outcomes to the immediate left in the figure.

Migration's second effect on the local economy is through remittances and migrant savings, which have three principal uses: current consumption, durable consumption goods (e.g., new/improved house or car), and productive investments in agriculture or other sectors. Each use has complex land-use implications which can result in more or less forest cover. Remittances can, for example, be used to buy food, reducing a household's subsistence production and local demand for agricultural land. Remittances can also provide funds for diversification away from agriculture and forestry, spurring FT.

The most direct forest impact is when remittances or savings are used to convert forests to agriculture or to buy agricultural land, increasing overall land demand. This is more likely to happen when farmers are linked to regional, national or even international markets, and when family or hired labor is available at low costs [40]. If agricultural production is capital- (rather than labor-) intensive, as in cattle raising, remittances can help capital-constrained farmers buy more cattle and expand their operations at the expense of forests [14,17,23].

Further, remittances might be used to adopt new agricultural technologies and increase agricultural input use (intensification, rather than extensification). Although agricultural intensification is often promoted as a way to spare forests (the Borlaug hypotheses) [40], its impact on forests is debated [41]. Again, which use of remittance and savings dominate is an empirical question. For example, Jokisch [21] found that remittances have not been used for agricultural improvements in highland Ecuador, but that low-return agriculture is continued for cultural reasons and to diversify risk.

Household decisions are strongly influenced by policies. Land policies in the study areas (including the tenure regime, and opportunities and transactions costs related to land sales and purchases) matter for how feasible and attractive land investments are. Infrastructure development, agricultural price policies, and output market regulations more generally are also critical for land-use decisions [42]. Further, government support programs (pensions and cash transfer programs such

as *Oportunidades* in Chiapas and *Mi Familia Progresa* in Guatemala), and credit and insurance policies influence how important risk considerations are in migration decisions, and in the use of remittances and savings [6,15].

The conditions shaping households' land use decisions change over time, and land use and forests impacts may change as migration from a community matures over decades and generations. Inspired by Massey, et al. [43], we hypothesize a systematic change in the use of remittance and savings over time. Early in a household's or community's migration history, remittances and savings are used to meet basic consumption needs. Later, migrant incomes are increasingly used to purchase houses or other durable goods. During the final stage of this transformational history, a higher share of remittances and savings are used for productive investments in agriculture or other sectors. Thus, we hypothesize remittance use progresses over time from consumption to durable goods to investments, as visible in Figure 1.

Our framework is a simplification of a complex migration–forest nexus. Social remittances, a form of cultural diffusion where sending communities receive ideas, behavior, identities, and social capital from returning migrants [44], may also be important in shaping how migrants view and use their land. Analyzing this aspect of migration, however, is beyond the scope of this study.

3. Study Areas, Data, and Methods

3.1. Characteristics of the Eight Study Communities

About half the population in both Chiapas and Guatemala live in rural areas, and agriculture is their main source of income [45,46]. Land ownership in Guatemala is highly unequal, with most arable land in the hands of a few large landholders [47,48]. Partly due to the end of the global regulatory mechanism in the 1990s, lower coffee prices resulted in the collapse of many large coffee estates in the late 1990s and early 2000s and left thousands of landless peasants without seasonal work [49], providing both a migration push and a cheap source of labor for agricultural expansion.

For our study, four communities were selected in Guatemala (La Estancia, Javillal, Santa Teresa, and San Lucas) and four in the Mexican state of Chiapas (El Aguila, La Competencia, Miguel Avila Camacho, and 24 de Febrero) (Figure 2). We purposefully selected these eight communities to provide variation in two key variables: the age of the settlement and the start of major, international migration. Community characteristics, including poverty levels, forest cover, agricultural practices, and migration histories, are shown in Table 1. With the exception of San Lucas and Santa Teresa in Guatemala, all study sites have common property land regimes. In practice, however, individual families in communities with common property land regimes have usufruct (use and keep profit) rights to a piece of land where they cultivate subsistence or cash crops. These rights are often traded in monetary or in-kind transactions among local residents. Forests in these six communities are governed by a communal land committee, while two have private property regime for forests.

3.2. Surveys and Data Sources

Data for this article come from a household survey and satellite image analysis. The household survey sampled 401 households in Guatemala and 327 households in Chiapas, between October 2010 and April 2011. In addition to the quantitative data collection, we undertook qualitative fieldwork in the form of structured interviews, focus-group discussions, and participant observation. The use of multiple methods, both quantitative and qualitative, enriched our understanding of site dynamics, and were used to enlighten and nuance the interpretation and discussion of our quantitative results.

Table 1. Key figures for the eight study communities.

	Guatemala				**Chiapas (Mexico)**			
	Santa Teresa	**La Estancia**	**San Lucas**	**El Javillal**	**El Aguila**	**La Competencia**	**Miguel Avila Camacho**	**24 de Febrero**
Start of major, international migration	1960s	1970s	1980s	1990s	1970s	1990s	1990s	1990s
Population (rincet. households)	300	600	200	158	287	245	440	127
Poverty (% living in poverty/HDI score)	63/0.65	43/0.70	88/0.58	57/0.71	70/0.71	93/0.56	77/0.73	85/0.67
Cash crops	Coffee, cattle, sugarcane	Vegetables	Oil palm, cattle, cardamom, maize	Maize (very little)	Coffee	Cattle, coffee	Maize	Maize
Subsistence crops (own consumption)	Maize, beans	Maize, beans	Maize, beans	Maize, beans	Maize, beans, vegetables	Maize, beans, vegetables	Maize, beans	Maize, beans
Land tenure	Private	Private (agric.) and common (forest)	Private	Common	Common	Common	Common	Common
Forest vegetation	Tropical moist forest	Tropical lower montane moist forest	Tropical wet forest	Tropical moist forest and subtropical dry forest	Cloud (montane) forest	Tropical wet forest	Mangroves	Tropical deciduous forest
Total land area (ha)	11,942	387	4708	2206	986	3,113	3014	2,021
Forest area, 2010 (ha)	2479	141	2448	188	313	698	975	1,088
Forest area share, 2010 (%)	20.8	36.4	52.0	8.5	31.8	22.4	32.3	53.8
Annual forest cover change, 1990–2000 (%)	0.15	0.05	−1.82	0.91	−0.74	2.62	−1.15	1.82
Annual forest cover change, 2000–2010 (%)	−1.30	−0.93	−0.47	−0.22	0.10	0.41	0.28	1.89

Sources*:* Data from our own survey and analysis of satellite images [48,50].

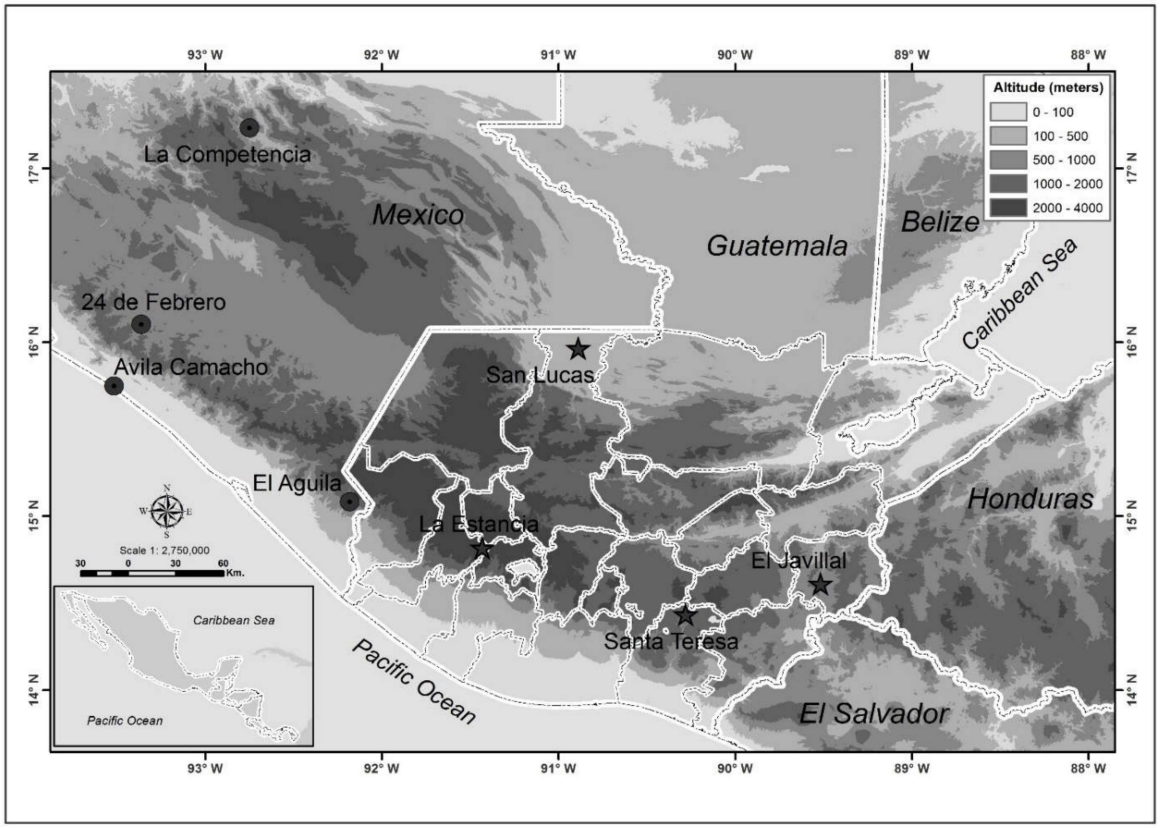

Figure 2. Map of the study area and the eight communities in the survey.

The household survey sample included approximately 30% of households in each community. A household was defined as a group of people living under the same roof, pooling labor and income. We deployed random sampling at the community level, using maps to list all households. There was no need for stratified sampling as the sample size is large, and sub-groups of households with migrants, with returnees, and without migrants are well represented. The questionnaire design was inspired by instruments produced by the Mexican Migration Project at Princeton University (http://mmp.opr.princeton.edu/) and the International Organization of Migration (http://www.iom.int/). Our survey, however, placed greater emphasis on land-use change and agriculture. It collected information on demographic characteristics, education, migration and remittances, income-generating activities, land and other tangible assets, savings, expenditures and consumption, investments, credit and agriculture, participation in communal projects, and coping strategies [45].

Satellite data of the study areas were collected and analyzed for changes in forest cover. For all sites, we used satellite data from LANDSAT TM and ETM to analyze forest cover change, examining data from 1990, 2000, and 2010. The procedure of forest cover change analysis was developed as part of a larger effort to produce National Forest Cover maps for Guatemala [51]. We used an unsupervised classification procedure, followed by a visual analysis, to classify each category of pixels as forest or non-forest. This work was complemented by ground information (on vegetation cover in randomly selected points) and by high-resolution Google Earth images. The final product was a set of classified images with five categories: forest, non-forest, water, urban centers, and no information (areas with cloud cover) for all given years.

3.3. Empirical Strategy and Methods

Directly connecting spatial land cover/use data to household level socioeconomic data has remained a major challenge in deforestation research, basically because different units of analysis (pixels and households) need to be matched [52]. One option is to collect georeferenced land use data

at the household level (which we did not collect) and match those with spatial data on land cover/use. While time consuming and full matching is hard to achieve, this is increasingly done. However, with full matching, domino effects are hard to detect. For example, a migrant household might purchase land, which raises the local land price and stimulates non-migrant households to convert more forests to agricultural land [e.g. 14].

The empirical approach taken in this study is as follows. We first looked at medium-term (1990–2010) forest cover change at the community level (Table 1). Tropical deforestation is mainly due to agricultural land expansion, both globally (ca. 80%) [53] and in our study communities. The second step was therefore to investigate how migration (including remittances and returnee savings) affects the demand for agricultural land at the household level, as proxied by two variables: farm size and number of plots. In addition, migration might spur an intensification of land use that is potentially land sparing [54], although that claim is also contested [40]. Finally, we related the findings of the spatial and household data analyses to broader contextual factors in the discussion Section 5.

In the household analysis, we first made simple comparisons of key characteristics between households with and without migrants. While useful as a first step to understand differences between groups, such comparisons may also be deceptive in an analysis of migration's true impacts. In particular, we might have bias due to the non-random selection of migrants; the same variables can affect both the migration decision and the outcomes of interest (farm size, number of plots, and agricultural intensification). To check for potential self-selection biases, we applied the following identification strategy. We first used a Probit model to identify which household characteristics influence the decision to migrate. Second, we estimated migration's effect on the outcome variables, while controlling for confounding factors to identify causal relationships. One option is instrumental variable estimation [55], as is done in the switching regression approach employed by Taylor and López-Feldman [39]. We faced a challenge, however, in identifying a reasonably valid instrument. To overcome this problem, we utilized the control function estimator of Klein and Vella [56], which does not require instrumental variables. Using this approach, in all six estimations (three outcomes and two countries), the control function's coefficient was not significant. This situation implies that unobserved migration effects appear not to explain any significant variation in the dependent variables. In other words, migration is not endogenously determined in estimating farm size, number of plots, or intensification. Consequently, we proceeded with a simpler regression model, using a standard OLS regression for the continuous dependent variables (farm size, number of plots) and Probit regression for the binary variable (chemical input use). The regression results with control functions are available upon request.

Wealth (physical assets) and social indices were estimated using predicted factor scores, generated using the principal-component factor method [57]. The wealth index includes a number of assets: home ownership, house walls with bricks and plaster, cement floor, roof with iron sheets or tiles, refrigerator, stove, washing machine, iron, television, radio, and microwave. The social capital index included any household member with membership in at least one community association or cooperative; any household member having a bank/cooperative savings account; and any household receiving support from social programs.

While we believe our methodological approach is appropriate given the data sets at hand, three limitations should be noted. First, we only have cross-sectional data (although some recall questions were included, such as pre-migration occupation). Time series (panel data) would enable a better understanding of migration dynamics. Second, as noted above, directly matching spatial land-cover/use data and geo-referenced socioeconomic data would yield additional insights. Third, data are from only eight communities in the two countries. Future studies will benefit from scaling up to cover households and communities in larger areas with more diverse socio-economic and ecological circumstances, especially in Mexico.

4. Results

4.1. Household Characteristics

There is relatively little variation in most household characteristics across communities in both countries (Table 2). Between 40% and 72% of household heads have attained primary education, slightly more so in Guatemala than in Chiapas. However, average farm size varies dramatically from 0.15 ha in La Estancia to 6.45 ha in San Lucas (both located in Guatemala).

We define a migrant household as a household with a current or former member who lives or has lived abroad and engaged in gainful employment. Overall, the Chiapas communities have a higher proportion (46%) of households with migrants than the Guatemalan ones (37%). La Estancia (Guatemala) had the smallest share (20%), and households there are less dependent on both agriculture and farm-labor employment and have the smallest average farm size (0.15 ha). The La Estancia community is heavily involved in non-agricultural activities such as petty trade and craft making, explained by its proximity to two important tourism destinations (Quetzaltenango and Atitlán Lake). In contrast, in El Javillal (also in Guatemala), 34% of households have a migrant living abroad, and 20% of households reported remittances as the major income source.

In Chiapas, Manuel Avila Camacho has a low share of migrant households (35%) and very low dependence on farm income. The community of 24 de Febrero offers a contrasting case; almost half of households include at least one migrant, but none reported remittances as a major income source. The community is land rich, and 92% of households report either self-employment on their own farm or agricultural wage as the major income source.

Migration from both countries is strongly male-dominated. As shown in Figure 3, among households with a migrant currently living abroad, male adult children make up 73% (Guatemala) and 67% (Chiapas) of migrants. Only 19% and 11 %, respectively, have an adult female child abroad. Among households with returnees, in more than 60% of cases in both countries, the male household head is the return migrant. This gendered pattern of migration can be explained by the expectations placed on young men to accumulate capital before establishing their own family, and migration is an attractive option for achieving that. Field interviews with returnees also suggested that employment was more available for males than for females. Finally, it was considered less safe for young women to migrate.

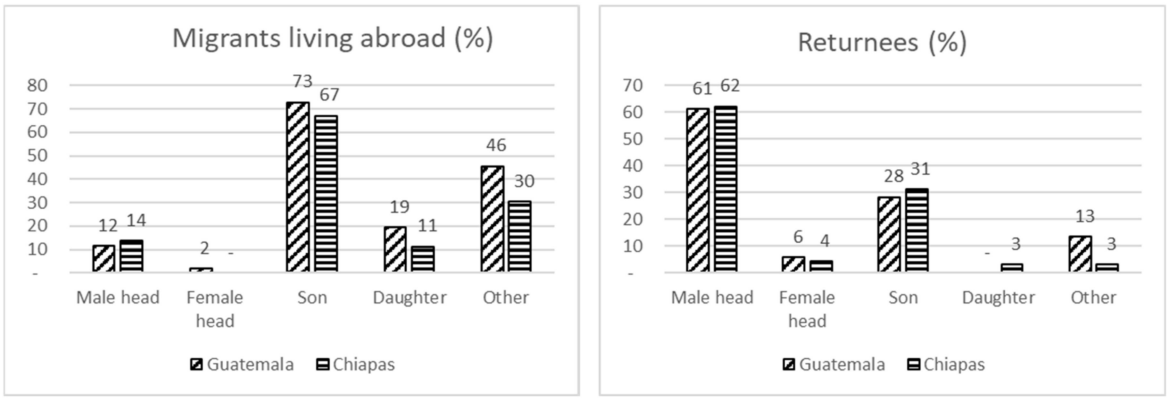

Figure 3. Migration by household member.

Table 3 presents differences in key characteristics between non-migrant and migrant households. We divided migrant households into two (partly overlapping) groups: those with a member living abroad and those with return migrants (returnees). As seen from Table 2, some households were in both groups, but we did not include them as a separate group as it would be very small (3%) in Chiapas.

Table 2. Basic household characteristics in the eight communities.

	Guatemala				Chiapas (Mexico)			
	Santa Teresa	**La Estancia**	**San Lucas**	**El Javillal**	**El Aguila**	**La Competencia**	**Manuel Avila Camacho**	**24 de Febrero**
Number of households (sample)	115	175	61	50	102	102	102	38
Migration status (%):								
Households with migrants	57	20	43	42	54	48	35	47
-migrants living abroad	24	13	13	34	19	21	17	21
-return migrants (returnees)	20	6	15	6	30	25	14	24
-migrants living abroad and returnees	12	2	15	2	2	2	4	3
Household (hh) and farm characteristics:								
Age of hh head (years, mean)	50	42	48	51	51	47	48	45
Male-headed hh (%)	84	89	93	66	95	91	94	95
hh with primary education (%)	72	68	61	56	52	58	48	40
hh with post-primary education (%)	14	27	8	24	36	21	32	29
hh size (persons, mean)	5.1	5.2	6.1	5.5	5.1	4.8	4.4	4.0
Farm size (ha, mean)	1.9	0.2	6.5	1.7	1.2	3.0	0.6	5.5
Major income sources[1] (%):								
Farming	23	9	53	44	60	70	5	68
Agricultural wage	31	10	33	34	13	4	1	24
Non-agric. Activities	32	47	13	6	30	29	96	16
Craft making	0	27	0	0	0	0	0	0
Remittances[2]	13	7	10	20	5	9	3	0

[1] A household may have more than one major income source, thus the shares add up to more than 100%.[2] Some non-migrant households may receive remittances from migrants who are not (former) household members.

Table 3. Characteristics of migrant and non-migrant households.

	Guatemala			Chiapas		
	Non- migrants	**Migrants abroad**	**Returnees**	**Non- migrants**	**Migrants abroad**	**Returnees**
Number of households	254	102	45	186	78	80
Household (hh) characteristics:						
Age of hh head (years, mean)	44[a]	52[b]	45[a]	48[a]	52[b]	47[a]
Male-headed hh (%)	88[a]	76[b]	93[a]	94[a]	91[a]	94[a]
hh with primary education (%)	66[a]	74[a]	53[b]	51[a]	46[a]	58[a]
hh with post-primary education (%)	19[a]	10[b]	29[a]	30[a]	26[a]	32[a]
hh size (persons, mean)	5.5[a]	4.7[b]	5.6[a]	4.5[a]	4.9[a]	4.9[a]
Wealth indicators:						
Physical asset index	−0.23[a]	0.37[b]	0.48[b]	−0.22[a]	0.21[b]	0.29[b]
Social capital index	−0.20[a]	0.32[b]	0.40[b]	0.12[a]	−0.06[ab]	−0.23[b]
Farm characteristics:						
Farm size (ha, mean)	1.1[a]	3.0[b]	3.2[b]	1.9[a]	2.5[a]	1.9[a]
Plots (number, mean)	1.1[a]	1.6[b]	1.4[b]	1.0[a]	1.3[a]	1.1[a]
Use of chemical inputs[1] (%)	72[a]	76[a]	91[b]	56[a]	65[a]	51[a]
Use of organic manure[1] (%)	20[a]	13[a]	12[a]	6[a]	13[a]	13[a]
Major income sources[2] (%):						
Farming	21[a]	26[ab]	33[b]	44[a]	45[a]	59[b]
Agricultural wage	26[a]	15[b]	22[ab]	6[a]	8[ab]	13[b]
Non-agric. activities	36[a]	22[b]	38[a]	54[a]	47[a]	34[b]
Craft making	17[a]	4[b]	4[b]	0[a]	0[a]	0[a]
Remittances[3]	2[a]	36[b]	2[a]	1[a]	21[b]	0[a]

[a],[b],[c] report significance levels at ≤10%. Different superscript letters between two categories report significant differences between those two categories, while same subscript letters on two categories indicate no significant differences between those categories. For example, in the case of age of household head in Guatemala, household heads with migrants abroad are significantly older than those heads with non-migrants and returnees; whereas the age of household heads with non-migrants and returnees are not significantly different. [1] The total number of observations used for these variables was 311 in Guatemala and 189 in Chiapas. [2] A household may have more than one major income source, thus the shares add up to more than 100%. [3] Some non-migrant households may receive remittances from migrants who are not (former) household members.

Migrant households in both categories were significantly wealthier than non-migrant households in both countries. In terms of social capital, migrant households in Guatemala scored higher, while the opposite was true in Chiapas. In both countries, heads of households with migrants abroad were significantly older. This finding might be explained by the fact that the children of young households were too young to become migrants and that most returnee households have male heads that have returned recently to the community (Figure 3).

4.2. Livelihood Strategies and Economic Activities

Differences between migrant and non-migrant households emerged regarding the major economic activities (Table 3). Overall, migration did not appear to be a way out of farming. On the contrary, a significantly higher share of households with returnees in both countries reported farming their own land as the main income source, compared with non-migrant households. Mirroring this finding, non-migrant households in Guatemala, which had less land than their migrant neighbors, relied more on other income sources such as agricultural wages and craft making. A related pattern was observed in Chiapas, where non-agricultural activities were significantly lower among migrant households compared with non-migrant households.

A complementary way of investigating the impact of migration on livelihood strategies is by comparing returnees' occupation before and after their stay abroad. Most returnees were engaged in farming activities before migrating: 40% in Guatemala and 52% in Chiapas (Figure 4), and that share increased upon migrants' return in both countries. An increase in self-employed farmers in Chiapas of about 10 percentage points (pp) was accompanied by a decline of 2 pp in agricultural wage-employment and 5 pp in other activities, indicating that after return, migrants were able to buy or rent land to cultivate (see below). In Guatemala, we observed a 3 pp higher involvement in farming after returning to the community and also more agricultural wages. These figures fit the picture depicted by Table 3 (Note the differences in the shares, as the Table 3 figures are at the household level while Figure 4 refers to individuals, and several returnee households have more than one returnee.) In conclusion, migration does not imply a farewell to agriculture; returnees tended to be more involved in agriculture than before they migrated, and households with a migrant abroad are more reliant on agriculture than non-migrant households.

Figure 4. Occupation of returnees, before and after migration.

Figure 5 depicts the link between economic activities and landholdings, revealing an agriculture-dependent local economy in Chiapas and more diverse local economy in Guatemala. In Guatemala, farming as the main occupation was closely associated with large landholdings, whereas non-agriculture activities dominated in households below the 40th percentile for landholdings. In Chiapas, farming was the dominant income source across all land categories. The contrasting patterns observed suggest more non-farm income opportunities for land-poor farmers in the Guatemalan communities.

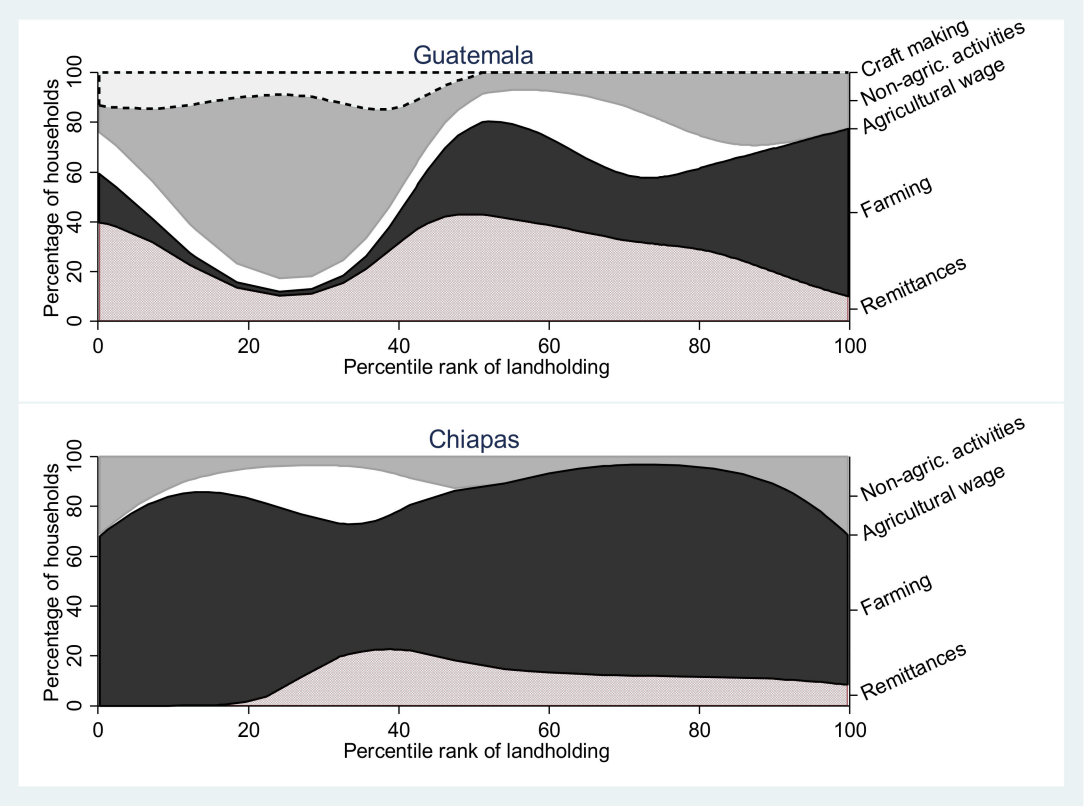

Figure 5. Landholding distribution by main income source for migrants.

We also noted that remittances played a negligible role for the land-poorest (bottom 20%) in Chiapas, whereas it played a larger role for the poorest in Guatemala. This pattern tentatively suggests that remittances helped reduce poverty more in Guatemala than in Chiapas, although this conclusion warrants further analysis with data from more than four communities in each country as well as analysis based on time series data.

4.3. Landholdings and Input Use

While changes in occupation are important to understand the land use implications of migration, changes in agricultural land expansion and intensification provide a more direct account of how migration affects the forest transition [see also 19]. Migrant household landholdings in the Guatemalan communities averaged about three times larger than those of non-migrants (Table 3), and migrants owned more land plots/parcels. In Chiapas, we observed slightly higher landholdings among households with a migrant living abroad, but the differences were not statistically significant.

Figure 6 depicts the distribution of the sampled households by landholdings and migration status and confirms the different patterns for the two countries. In Guatemala, both households with migrants abroad and returnees were in the upper end of land distribution. In the Chiapas sites, by contrast, migration households were more evenly distributed along the landholding gradient.

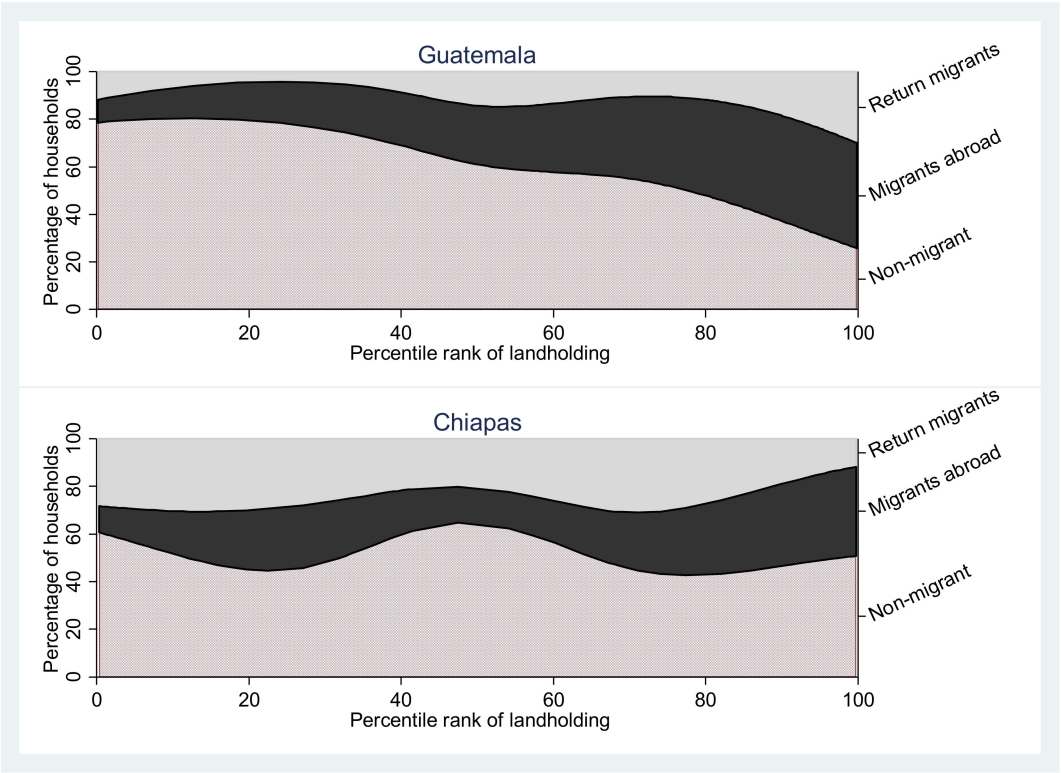

Figure 6. Landholding distribution by migration status.

To isolate the impact of migration on land use, Table 4 reports the regression results for the three outcome variables: farm size, number of plots, and use of chemical inputs, the latter being used as a proxy for agricultural intensification. While farm size was not significantly related to the migration status of the household, number of plots owned was positively and significantly related to having migrants living abroad in the Guatemalan communities but is not significant in the Chiapas communities. These findings were consistent with results reported in Table 3 and Figure 6.

As a complement to the regression analysis, we also asked the households how remittances and savings were spent. The primary uses of remittances in Guatemala were equally divided between agricultural investments (e.g., buying farmland), housing, and various forms of consumption (Figure 7). In Chiapas, almost 6 out of 10 households with migrants reported "house" as the primary use of remittances, while only a quarter reported using remittances on agricultural investments. The use of returnee savings showed a similar pattern between the two countries. Investing in a house was the primary use of savings for half the returnees in Guatemala and almost two-thirds in Chiapas. Using savings to buy farmland was reported by 12% and 6% of households in Guatemala and Chiapas, respectively. An interesting observation, and consistent with the regression results, is that compared with remittances, savings were more likely to be spent on a house or house improvements and less likely to be spent on agricultural investments.

Table 4. Regression models for farm size, number of plots, and crop diversification.

	Guatemala			Chiapas		
Variable	**Farm size (OLS)**	**No. of plots (OLS)**	**Chemical inputs[1] (Probit)**	**Farm size (OLS)**	**No. of plots (OLS)**	**Chemical inputs[1] (Probit)**
Migration status:						
Household with migrant abroad[2]	0.027	0.488***	0.131	0.090	0.173	0.202
	(0.086)	(0.155)	(0.179)	(0.098)	(0.156)	(0.219)
Household with return migrant[2]	0.099	0.170	0.376*	−0.013	-0.075	−0.051
	(0.132)	(0.179)	(0.229)	(0.099)	(0.157)	(0.212)
Household (hh) characteristics:						
Age of hh head	0.004	0.036	0.041	0.050***	0.077***	−0.002
	(0.015)	(0.024)	(0.030)	(0.017)	(0.027)	(0.039)
Age of hh head squared*10^{-2}	0.004	−0.029	−0.029	−0.037**	-0.063**	0.014
	(0.017)	(0.024)	(0.031)	(0.016)	(0.026)	(0.037)
Male-headed hh (1/0)	0.199***	0.406***	0.403**	0.500***	0.288	0.705*
	(0.073)	(0.127)	(0.192)	(0.161)	(0.255)	(0.383)
Primary education[3]	0.016	-0.234	−0.012	0.154	0.085	−0.215
	(0.116)	(0.240)	(0.216)	(0.115)	(0.183)	(0.248)
Post-primary education[3]	−0.016	-0.149	0.066	0.198	0.132	−0.201
	(0.162)	(0.356)	(0.292)	(0.143)	(0.227)	(0.314)
hh size	−0.007	0.042	0.006	0.006	0.009	−0.028
	(0.014)	(0.026)	(0.031)	(0.020)	(0.031)	(0.046)
Wealth indicators:						
Physical asset index	0.248***	0.280***	0.224**	−0.074*	−0.082	0.028
	(0.047)	(0.077)	(0.094)	(0.043)	(0.069)	(0.094)
Social capital index	0.048	0.109*	0.018	−0.032	0.004	0.078
	(0.030)	(0.061)	(0.078)	(0.048)	(0.076)	(0.123)
Community dummies:						
La Estancia [El Aguila][4]	−0.198***	0.613***	0.453**	−0.529***	−0.840***	−1.572***
	(0.067)	(0.157)	(0.178)	(0.105)	(0.167)	(0.231)
El Javillal [24 de Febrero][4]	0.598***	0.833***	0.987***	0.228*	−0.532**	−0.011
	(0.098)	(0.180)	(0.259)	(0.135)	(0.214)	(0.258)
San Lucas [Manuel Avila Camacho][4]	1.004***	0.853***	0.185	−0.869***	−1.724***	−2.166***
	(0.150)	(0.156)	(0.230)	(0.123)	(0.195)	(0.306)
Constant	−0.131	−0.780	−1.814**	−1.024**	−0.681	−0.195
	(0.306)	(0.492)	(0.728)	(0.487)	(0.773)	(1.127)
F (Chi square) value	13.187***	7.405***	39.431	11.330***	11.265***	125.773***
Number of observations	401	401	401	327	327	327

Notes: [1] Chemical inputs are inorganic fertilizers, pesticides, and herbicides. [2] Dummy variable: Default category is household with no migrant. [3] Dummy variable: Default category is "No education". [4] Dummy variable: Default community is Santa Teresa for Guatemala and La Competencia for Chiapas. Community names in square brackets for Chiapas. Figures in parentheses are standard errors. ***, **, * report significance levels at 1%, 5% and 10%, respectively

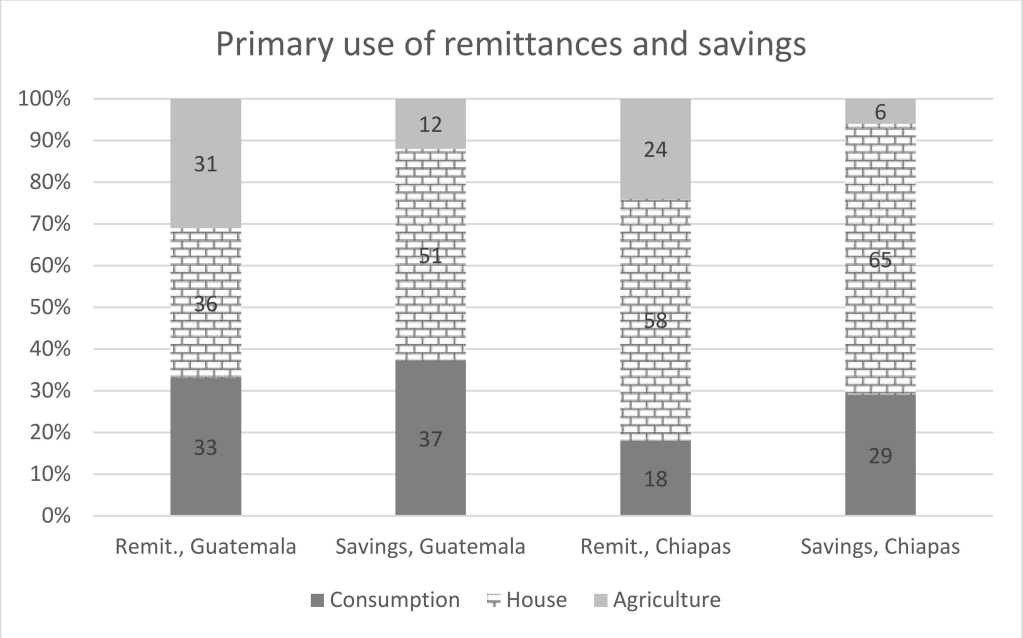

Figure 7. Primary use of remittances and savings by returnees.

Can migration also spur agricultural intensification, which potentially may take pressure off forests? Table 3 showed higher use of chemical inputs like fertilizers and pesticides among households with returnees in Guatemala. This positive effect of migration on agricultural intensification was confirmed in the regression analysis (Table 4). Besides savings having reduced cash-constraints and thus enabled returnees to apply more inputs on the farm, this result may also be due to social remittances. We found no significant correlation between migration and chemical input use in Chiapas.

Besides migration, we tested the effect of several other variables on land use. The regression analysis shows that wealthy (physical assets) households also had large farms, had a higher number of plots, and were more likely to adopt crop intensification technologies in Guatemala. In contrast, wealthy households in Chiapas were more likely to have smaller farms. This result was unexpected, but it aligns with the finding of fewer agricultural investments from remittances and savings in Chiapas compared to Guatemala (Figure 7). We found no significant relationship between assets for plot number and intensification in Chiapas. For social capital, we only found a positive relationship to the number of plots owned in Guatemala.

In both countries, male-headed households were associated with larger farm size and the use of chemical inputs. In Guatemala, male-headed households also had more plots than female-headed ones. We found a bell-shaped relationship between, on the one hand, farm size and number of plots and, on the other, age of the household head in Chiapas: households with both younger and older heads had smaller farm sizes and fewer plots, compared with households with middle-aged heads. This finding supports the life-cycle hypothesis [58] in Chiapas: households plan and invest in land in their early/middle years and then even out their consumption by disposing of their landholdings (including to their children) as they age. We did not observe a similar pattern in Guatemala. One explanation, based on the Chayanov-inspired agricultural household modeling tradition [e.g., 38], is that in more market-integrated rural economies (i.e., the Guatemalan sites relative to the Chiapas ones) households-specific factors are relatively less important than market factors to explain economic behavior.

4.4. Forest Cover Change: Guatemala–Chiapas Contrasts

The four Chiapas communities gained forest cover during the 2000–2010 period (on average 0.67% per year), while forest cover shrank in the four Guatemalan ones (−0.73% per year) (Table 1).

Additionally, looking at the preceding decade (1990–2000), and the decadal change in deforestation rates, the picture is more nuanced. For three of the Guatemalan communities, forest cover change went from positive in 1990-2000 to negative in 2000-2010. In the fourth, San Lucas, annual forest cover change was reduced from −1.82% to −0.47% between the two decades.

The Guatemalan study communities, except San Lucas, had low forest size before major, international migration started. Thus, while the relative figures of land use change are high (Table 1) the absolute changes are small. The annual forest loss in San Lucas was the highest among the eight communities from 1990 to 2010, and it followed a typical frontier dynamic [58]: high deforestation in the early years of settlement, before forest cover stabilized when settlers reached some sort of equilibrium between food and income needs, labor availability, market opportunities, and forest accessibility.

In Chiapas, three communities were established in the 1930s, whereas 24 de Febrero was established in the 1990s. Settlement history in these sites are, thus, shorter than in the Guatemalan ones and can be considered typical forest frontiers. Two communities (El Aguila and Miguel Avila Camacho) went from a relatively high forest cover loss (1990–2000) to a small gain in forest cover (2000–2010), while a third (La Competencia) had a significant reduction in the forest cover, and the fourth (the forest-rich 24 de Febrero) maintained a high forest cover gain in both decades.

5. Discussion and Synthesis

The overall contrast in forest cover change between the Guatemalan and Chiapas sites, particularly for the 2000–2010 period, is consistent with our household-level analysis. In Guatemala, migrant households were wealthier, had more land, and were more engaged in farming. About one third of remittances were invested in agriculture, mainly buying land, and this share is much higher than in Chiapas. In the four Chiapas communities, there were small and mostly insignificant differences between migrant and non-migrant households in both the descriptive and regression analyses.

Using the findings of Section 4, the next sub-sections seek to explain these differences in forest outcomes—both between and within the two countries—and relate them to four sets of conditioning factors laid out in our migration–forest framework (Figure 1): the stage in migration, income and investment opportunities in agriculture and other sectors, landholdings and land tenure, and government policies.

5.1. Stage in Migration

Migration from Guatemala is more mature than from Chiapas, and its impact on land use and land cover may follow a specific pattern over time. Our findings are largely consistent with the Massey et al.'s [43] hypothesis about how remittances and returnee savings use changes over time from current consumption to house building/improvement to productive investments (e.g., agricultural land). The share spent on building a house was significantly higher in Chiapas than in Guatemalan communities, while the opposite is true for agricultural investments (Figure 7). Massey et al. [43] concluded that home ownership "was a universal aspiration among families (in their study sites) and that migration is employed as a means to achieve this end." (p. 219). Our informants confirmed that house-building was a high priority and that they preferred to build a house before investing in production. Moreover, there are no public programs supporting house acquisition by poorer families in either Mexico or Guatemala, and our fieldwork revealed that access to credit for this purpose is limited.

We therefore suggest that many households in the Guatemalan sites had reached a stage with more focus on productive investments, while households in Chiapas were at the first stage in Massey's framework. Thus, the insignificant forest impact detected in Chiapas can, in part, be explained by their more recent migration history. This story resonates with findings from other Mexican studies with delayed entrance to migration circuits [23,59,60].

5.2. Landholdings and Land Tenure

Remittances have permitted some migrant families in Guatemala to increase landholding to a level at which they could produce a surplus for the market, whereas no such effect was observed in Chiapas. Farm size, however, remained small in the four Guatemalan communities (Table 2). The national census indicated no change with respect to land concentration between 1979 and 2003 [61], suggesting that widespread migration had not challenged long-standing unequal land distribution.

Yet in our study sites in Guatemala, remittances changed local land tenure patterns and improved migrants' access to land, while also creating new local forms of exclusion. In Santa Teresa, which has the highest annual forest loss during the 2000-2010 period (1.3%), our qualitative data showed migrants and remittances helped some households purchase land in a market previously dominated by a few local elite families. Additionally, in San Lucas, migrant households were accumulating land [15,45,62]. The land and forest outcomes in these two study communities were shaped by local institutions, including land tenure. Both San Lucas and Santa Teresa have private ownership of both agricultural and forest land, and the two sites have witnessed expansion of commercial agricultural activities: oil palm (mainly for production of cooking oil) in San Lucas and coffee in Santa Teresa. While other factors can explain the expansion (such as favorable agroecological conditions and market access), private ownership to converted forest land can incentivize agricultural land expansion [63]. The causality might, however, run both ways. According to the new institutional economics school of thought [64], the emergence of profitable investment opportunities is an important driver for privatization of land.

All Chiapas sites are ejidos in which land is held communally, with permanent individual usufruct rights. One might hypothesize that collective institutions in these sites inhibited agricultural expansion into the forest. The evidence from previous studies is, however, mixed [65,66] and the forest outcome depend on ejido characteristics [67]. We suggest that other factors than land tenure were more important in explaining forest outcomes in Chiapas.

5.3. Market Access and Income-Generating Opportunities

Better access to outside markets can be a key driver in the forest transition, but with two opposing effects: improved market access and higher prices for agricultural commodities can stimulate agricultural expansion into forests, while better non-farm employment and investment opportunities—often associated with improved market access—can help stabilize forest cover [27]. In most of our study communities, agriculture remains the main investment outlet for any migration-generated cash.

Compared with Chiapas, the Guatemalan sites have relatively better access to national or international markets, making the use of remittances and savings to invest in agriculture more attractive. The two communities where we observed significant investments in agriculture have well-established markets and institutional infrastructure (coffee in Santa Teresa) or crops for which new markets are opening (oil palm in San Lucas). In these two communities, 30–32% of households included returnees (Table 2), providing capital for such investments. These two also had the highest forest loss among the Guatemalan communities between 1990 and 2010 (Table 1). In Santa Teresa, a local cooperative offers credits for agricultural conversion and is involved in capacity building and commercialization. Through the cooperative, farmers can reach specialized markets and fetch higher prices for their coffee.

Guatemala's Ixcán region, where San Lucas is located, is increasingly connected to wider markets, especially with the recent construction of a major paved road in the region [62]. At the same time, the region has seen an explosion in Oil Palm plantations, created mainly by large land owners and transnational companies [68]. Several households in San Lucas have dedicated their land parcels to oil palm cultivation, but this practice has only taken place since roads improved and processing facilities opened in nearby regions. In both San Lucas and Santa Teresa, remittances and returnee savings have helped migrant families take advantage of the new opportunities created.

La Estancia is close to Guatemala's second largest city, and this location offers good opportunities to seek non-agricultural employment. In the fourth Guatemalan site, Javillal, most households only engaged in subsistence agriculture. Small farm size, poor market access, and lack of agricultural credits prevented the shift to more market-oriented forms of production. Not surprisingly then, El Javillal is the only Guatemalan study community with a net forest cover gain over the period 1990–2010.

A situation similar to El Javillal was observed for the Chiapas sites. Lack of market access and small farm size in these communities prevented the shift to potentially more profitable crops. According to Solís (2005), none of Chiapas's economic sectors seemed capable of providing workers with jobs in the 1990s after the crisis in the coffee sector. Migration became a way to cope with the crisis [46], while remittances and returnee savings found few profitable investment opportunities. These diverse land use and forest outcomes in our study communities are indicative of the key role played by access to larger agricultural markets in shaping the environmental impact of remittances and returnee savings.

5.4. Government Policies

The data analyses and field observations showed few signs of intensification of small-scale agriculture, reflecting that access to credit, technical assistance, and training is very limited for agriculturalists in our study communities. During the past 20 years, the policy and legal framework in Guatemala have favored plantation agriculture, particularly oil palm and sugarcane [69]. This agricultural sector is dominated by a landed elite who exercise considerable power in policy-making and legislation [70]. Thus, small-scale farmers, like the ones included in our study, appear to engage in land expansion rather than the intensification of existing cleared land, which is consistent with the observed changes in forest cover. Our finding on agricultural intensification corresponds well with a study from El Salvador; Damon [34] found weak evidence of migration and remittances contributing positively to land and livestock accumulation, while they have insignificant impacts on agricultural input use.

An interesting exception to high deforestation rates took place in San Lucas, where forest cover loss has slowed since 2006, in part because a government program pays landholders to replant or conserve forested lands [71]. Although the total amount of land is small, we observed that six farms in San Lucas participated in the PINFOR program (Guatemala's Forestry Incentive Program). Four of these parcels are included in the national register for conservation of existing forest, while the remaining two are listed under the reforestation program. Migration and the non-agricultural alternatives opened by remittances may permit more land in San Lucas to revert to forest if programs like PINFOR continue. The three other study sites are located outside the prioritized region defined by the government [71].

At the macro scale, changes to agricultural and energy policies beginning in the 1990s stimulated the growth of Guatemala's agro-industry (particularly sugarcane, palm oil, and non-traditional agricultural exports (NTAE)) [72]. These sectors are outside the reach of most small-scale producers [73], although some peasants have been able to engage in NTAE [74]. Changes in commodity prices and the regulation of international markets also affected agriculture, particularly in the coffee sector, which remains one of Guatemala's most important exports and employs close to 30% of the rural workforce [75]. However, historically low coffee prices in the early 2000s made the traditional landed elite abandon coffee production and move into biofuels or other economic sectors. With support from coffee cooperatives and the national coffee association, and, we argue, migrant remittances, small-scale producers have been able to occupy a niche left open when the landed elite turned away from coffee. Small-scale producers are now responsible for about 50% of Guatemala's coffee production (up from 16% in the 1970s) [75].

In Chiapas, as a consequence of the 1994 Zapatista uprising, the Mexican government granted property rights to small-scale farmers [76]. However, this change in access and control over land had little impact because small-scale agriculturalists did not have acreage or access to credits or technology and/or owned marginal lands, and hence were unable to capture even a portion of the indirect subsidies [77,78]. The North American Free Trade Agreement (NAFTA) became another

burden on peasant economies, particularly in the coffee sector, because NAFTA rules prevented the Mexican state from subsidizing coffee producers beyond the terms stipulated in the agreement [78].

6. Conclusions

A common assumption in the migration-environment debate is that migration lowers the pressure on environmental resources in the sending region by lowering population densities and, through remittances, providing alternative sources of livelihoods [13]. Yet, in our study sites in Guatemala and Chiapas, migration and remittances did not lead to an exodus from agriculture and subsequent reduction in the pressure on forests. In fact, returning migrants were more likely to be involved in agriculture than were non-migrants. Migrant savings and remittances raised demand for agricultural land – both as a productive investment and as a form of wealth accumulation – and did not seem to protect forests in the Guatemala sites, which all experienced forest loss from 2000 to 2010. Yet this conclusion is context specific, and we were not able to detect any significant forest impacts (positive or negative) in Chiapas.

Our migration–forest framework (Section 2) helps explain the different forest outcomes and provides a basis for investigating why researchers have reported diverse land use and forest implications of migration, depending on context. Our main conclusion is that favorable investment opportunities in agriculture—created primarily by access to larger markets—make the cash injection from remittances and returnee savings increase demand for agricultural land; and that forest access and the tenure regime co-determine whether this demand translates into more forest conversion. Government policies also matter and can enlarge the market forces, e.g., by providing subsidized inputs and credit, or by facilitating marketing of agricultural commodities. Proactive forest conservation policies can modify or reverse predicted outcomes, as exemplified by PINFOR in Guatemala [71].

Inspired by Massey, et al. [43], we also hypothesized that the impact of migration on forests depends on the length of the migration history. Our empirical findings are consistent with this hypothesis. Migration from Chiapas is more recent than in Guatemala, and a higher share of earnings in Chiapas was spent on current consumption and non-productive investments. This hypothesis has critical implications for the interpretation of case study evidence. If migration and remittance spending follow such phases, then an insignificant or reduced pressure on forests as observed might just be an early stage and temporary. At a later stage, remittances might be used to invest in agricultural land and increase pressure on forests. To fully test this hypothesis requires, however, longitudinal and geographically more diverse data than ours and presents an exciting avenue for future research.

Author Contributions: Conceptualization: A.A., M.A.-S., J.H.A., E.C. and M.T.; methodology: A.A., M.A.-S., J.H.A., E.C. and M.T.; software: J.H.A., A.A. and E.C.; formal analysis: J.H.A., A.A., M.A.-S. and E.C.; investigation: M.A.-S., Castellanos and M.T.; data curation: M.A.-S., J.H.A., A.A. and E.C.; writing original draft: A.A. and M.A.-S.; editing: A.A., M.A.-S., J.H.A., E.C. and M.T.; writing review: A.A., M.A.-S., J.H.A., E.C. and M.T.; project administration: M.A.-S. and E.C.: funding acquisition: M.A.-S. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the Research Council of Norway [Norges Forskningsraåd] under grant number 193710, for the project "Migration and Land Use Change in rural Guatemala and Mexico: Is there a forest transition? – MIRLU" led by Mariel Aguilar-Støen at SUM, UiO.

Acknowledgments: We acknowledge the support of Diego Incer at the GIS Laboratory, Universidad del Valle de Guatemala UVG, for the spatial analysis with satellite images. UVG students and researchers also helped with collecting field data in all Guatemalan sites. We are grateful to two anonymous reviewers and to special issue editor Lindsey Carte for useful comments.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Obokata, R.; Veronis, L.; McLeman, R. Empirical research on international environmental migration: A systematic review. *Popul. Environ.* **2014**, *36*, 111–135. [CrossRef]

2. Piguet, E.; Kaenzig, R.; Guélat, J. The uneven geography of research on "environmental migration". *Popul. Environ.* **2018**, *39*, 357–383. [CrossRef]
3. Berlemann, M.; Steinhardt, M.F. Climate change, natural disasters, and migration—A survey of the empirical evidence. *CESifo Econ. Stud.* **2017**, *63*, 353–385. [CrossRef]
4. Hunter, L.M.; Nawrotzki, R. Migration and the Environment. In *International Handbook of Migration and Population Distribution*; Springer: Berlin/Heidelberg, Germany, 2016; pp. 465–484.
5. Robson, J.P.; Klooster, D.J. Migration and a New Landscape of Forest Use and Conservation. *Environ. Conserv.* **2019**, *46*, 1–8. [CrossRef]
6. Radel, C.; Jokisch, B.D.; Schmook, B.; Carte, L.; Aguilar-Støen, M.; Hermans, K.; Zimmerer, K.; Aldrich, S. Migration as a feature of land system transitions. *Curr. Opin. Environ. Sustain.* **2019**, *38*, 103–110. [CrossRef]
7. Jokisch, B.D.; Radel, C.; Carte, L.; Schmook, B. Migration matters: How migration is critical to contemporary human–environment geography. *Geogr. Compass* **2019**, *13*, e12460. [CrossRef]
8. Lambin, E.F.; Meyfroidt, P. Global land use change, economic globalization, and the looming land scarcity. *Proc. Natl. Acad. Sci. USA* **2011**, *108*, 3465–3472. [CrossRef]
9. De Sherbinin, A.; VanWey, L.K.; McSweeney, K.; Aggarwal, R.; Barbieri, A.; Henry, S.; Hunter, L.M.; Twine, W.; Walker, R. Rural household demographics, livelihoods and the environment. *Glob. Environ. Chang.* **2008**, *18*, 38–53. [CrossRef]
10. IPCC. Climate change: The physical science basis. Working Group I contribution to the Fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC). In *Climate Change 2013*; Stocker, T.F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V., Midgley, P.M., Eds.; Cambridge University Press: Cambridge, UK; New York, NY, USA, 2013.
11. BANGUAT. *Ingreso de Divisas por Remesas Familiares, Años 2008–2014*; Banco de Guatemala: Guatemala City, Guatemala, 2014.
12. BANMEX. *Informe Anual*; Banco de Mexico: Mexico City, Mexico, 2007.
13. Hecht, S. The new rurality: Globalization, peasants and the paradoxes of landscapes. *Land Use Policy* **2010**, *27*, 161–169. [CrossRef]
14. Taylor, M.J.; Moran-Taylor, M.J.; Rodman Ruiz, D. Land, ethnic, and gender change: Transnational migration and its effects on Guatemalan lives and landscapes. *Geoforum* **2006**, *37*, 41–61. [CrossRef]
15. Aguilar-Støen, M. 'Con nuestro propio esfuerzo': Understanding the Relationships between International Migration and the Environment in Guatemala. *Eur. Rev. Lat. Am. Caribb. Stud.* **2012**, *93*, 25–40. [CrossRef]
16. Gray, C.L.; Bilsborrow, R.E. Consequences of out-migration for land use in rural Ecuador. *Land Use Policy* **2014**, *36*, 182–191. [CrossRef] [PubMed]
17. Davis, J.; Lopez-Carr, D. Migration, remittances and smallholder decision-making: Implications for land use and livelihood change in Central America. *Land Use Policy* **2014**, *36*, 319–329. [CrossRef] [PubMed]
18. Wiersum, K.F.; Gonzalez, I.C.G. *"Intermediate" Forest Types as Man-Nature Systems: Characteristics and Future Potential*; Forest management group, Wageningen University: Wageningen, The Netherlands, 2004.
19. Cole, R.; Wong, G.; Brockhaus, M. *Reworking the Land: A Review of Literature on the Role of Migration and Remittances in the Rural Livelihoods of Southeast Asia*; Center for International Forestry Research (CIFOR): Bogor, Indonesia, 2015; 29p.
20. Rigg, J. Land, farming, livelihoods, and poverty: Rethinking the links in the Rural South. *World Dev.* **2006**, *34*, 180–202. [CrossRef]
21. Jokisch, B.D. Migration and Agricultural Change: The Case of Smallholder Agriculture in Highland Ecuador. *Hum. Ecol.* **2002**, *30*, 523–550. [CrossRef]
22. Aguilar-Støen, M.; Angelsen, A.; Moe, S.R. Back to the forest: Exploring Forest Transitions in Candelaria Loxicha, Mexico. *Lat. Am. Res. Rev.* **2011**, *46*, 194–216. [CrossRef]
23. Schmook, B.; Radel, C. International Labor Migration from a Tropical Development Frontier: Globalizing Households and an Incipient Forest Transition. *Hum. Ecol.* **2008**, *36*, 891–908. [CrossRef]
24. Mather, A.S. The Forest Transition. *Area* **1992**, *24*, 367–379.
25. Southworth, J.; Nagendra, H.; Cassidy, L. Forest transition pathways in Asia–studies from Nepal, India, Thailand, and Cambodia. *J. Land Use Sci.* **2012**, *7*, 51–65. [CrossRef]
26. Rudel, T.K.; Coomes, O.T.; Moran, E.; Achard, F.; Angelsen, A.; Xu, J.C.; Lambin, E. Forest transitions: Towards a global understanding of land use change. *Glob. Environ. Chang.* **2005**, *15*, 23–31. [CrossRef]

27. Angelsen, A.; Rudel, T.K. Designing and Implementing Effective REDD + Policies: A Forest Transition Approach. *Rev. Environ. Econ. Policy* **2013**, *7*, 91–113. [CrossRef]
28. Preston, D.A. Too busy to farm: Under-utilisation of farm land in central Java. *J. Dev. Stud.* **1989**, *26*, 43–57. [CrossRef]
29. Ellis, F. *Rural Livelihoods and Diversity in Developing Countries*; Oxford University Press: Oxford, UK, 2000.
30. McCusker, B. Land Use and Cover Change as an Indicator of Transformation on Recently Redistributed Farms in Limpopo Province, South Africa. *Hum. Ecol.* **2004**, *32*, 49–75. [CrossRef]
31. Bebbington, A. Globalized Andes? Livelihoods, landscapes and development. *Cult. Geogr.* **2001**, *8*, 414–436. Available online: http://cgj.sagepub.com/content/8/4/.
32. Hecht, S.B.; Kandel, S.; Gomes, I.; Cuellar, N.; Rosa, H. Globalization, forest resurgence, and environmental politics in El Salvador. *World Dev.* **2006**, *34*, 308–323. [CrossRef]
33. Babigumira, R.; Angelsen, A.; Buis, M.; Bauch, S.; Sunderland, T.; Wunder, S. Forest Clearing in Rural Livelihoods: Household-Level Global-Comparative Evidence. *World Dev.* **2014**, *64* (Suppl. 1), S67–S79. [CrossRef]
34. Damon, A.L. Agricultural land use and asset accumulation in migrant households: The case of El Salvador. *J. Dev. Stud.* **2010**, *46*, 162–189. [CrossRef]
35. De Haas, H. Migration, remittances and regional development in Southern Morocco. *Geoforum* **2006**, *37*, 565–580. [CrossRef]
36. De Haas, H. Migration and development: A theoretical perspective. *Int. Migr. Rev.* **2010**, *44*, 227–264. [CrossRef]
37. Stark, O.; Bloom, D.E. The New Economics of Labor Migration. *Am. Econ. Rev.* **1985**, *75*, 173–178.
38. Janvry, A.D.; Fafchamps, M.; Sadoulet, E. Peasant household behavior with missing markets: Some paradoxes explained. *Econ. J.* **1991**, *101*, 1400–1417. [CrossRef]
39. Taylor, J.E.; López-Feldman, A. Does migration make rural households more productive? Evidence from Mexico. *J. Dev. Stud.* **2010**, *46*, 68–90. [CrossRef]
40. Angelsen, A.; Kaimowitz, D. (Eds.) *Agricultural Technologies and Tropical Deforestation*; CAB International: Wallingford, UK, 2001.
41. Ewers, R.M.; Scharlemann, J.P.W.; Balmford, A.; Green, R.E. Do increases in agricultural yield spare land for nature? *Glob. Chang. Biol.* **2009**, *15*, 1716–1726. [CrossRef]
42. Radel, C.; Schmook, B.; Carte, L.; Mardero, S. Toward a political ecology of migration: Land, labor migration, and climate change in northwestern Nicaragua. *World Dev.* **2018**, *108*, 263–273. [CrossRef]
43. Massey, D.S.; Alarcón, R.; Durand, J.; González, H. *Return to Aztlan. The Social Process of International Migration from Western Mexico*; University of California Press: Berkeley, CA, USA, 1987.
44. Levitt, P.; Lamba-Nieves, D. Social Remittances Revisited. *J. Ethn. Migr. Stud.* **2011**, *37*, 1–22. [CrossRef]
45. Aguilar-Støen, M.; Taylor, M.; Castellanos, E. Agriculture, Land Tenure and International Migration in Rural Guatemala. *J. Agrar. Chang.* **2016**, *16*, 123–144. [CrossRef]
46. Davis, J.; Eakin, H. Chiapas' delayed entry into the international labour market: A story of peasant isolation, exploitation, and coercion. *Migr. Dev.* **2013**, *2*, 132–149. [CrossRef]
47. Gauster, S.; Isakson, S.R. Eliminating market distortions, perpetuating rural inequality: An evaluation of market-assisted land reform in Guatemala. *Third World Q.* **2007**, *28*, 1519–1536. [CrossRef]
48. PNUD. *Informe Nacional de Desarrollo Humano 2009–2010*; PNUD: Guatemala City, Guatemala, 2010.
49. Eakin, H.; Tucker, C.; Castellanos, E. Responding to the coffee crisis: A pilot study of farmers' adaptations in Mexico, Guatemala and Honduras. *Geogr. J.* **2006**, *172*, 156–171. [CrossRef]
50. De la Torre, R.; Moreno, H. *Advances in sub-National Measurement of the Human Development Index: The Case of Mexico*; UNDP: Mexico City, Mexico, 2010.
51. Regalado, O.; Villagrán, X.; Pérez, G.; Castellanos, E.; Martínez, G.; Incer, D.; Ramos, V.H.; Molina, O.; Beltetón, C.; Gómez, J.M. *Mapa de Cobertura Forestal de Guatemala 2010 y Dinámica de la Cobertura Forestal 2006–2010*; National Forestry Institute (INAB), National Council for Protected Areas (CONAP), Universidad del Valle de Guatemala, Universidad Rafael Landívar: Guatemala City, Guatemala, 2012.
52. Liverman, D.M.; Cuesta, R.M.R. Human interactions with the Earth system: People and pixels revisited. *Earth Surf. Process. Landf.* **2008**, *33*, 1458–1471. [CrossRef]
53. FAO. *The Future of Food and Agriculture. Trends and Challenges*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2017.

54. Stevenson, J.R.; Villoria, N.; Byerlee, D.; Kelley, T.; Maredia, M. Green Revolution research saved an estimated 18 to 27 million hectares from being brought into agricultural production. *Proc. Natl. Acad. Sci. USA* **2013**, *110*, 8363–8368. [CrossRef] [PubMed]
55. Wooldridge, J.M. *Econometric Analysis of Cross Section and Panel Data*; MIT Press: Cambridge, USA, 2010; p. xxvii.
56. Klein, R.; Vella, F. Estimating a class of triangular simultaneous equations models without exclusion restrictions. *J. Econom.* **2010**, *154*, 154–164. [CrossRef]
57. Rabe-Hesketh, S.; Everitt, B.S. *Handbook of Statistical Analyses Using Stata*; Chapman and Hall/CRC: Boca Raton, FL, USA; London, UK; New York, NY, USA, 2007.
58. Walker, R.; Perz, S.; Caldas, M.; Silva, L.G.T. Land use and land cover change in forest frontiers: The role of household life cycles. *Int. Reg. Sci. Rev.* **2002**, *25*, 169–199. [CrossRef]
59. Radel, C. Becoming farmers: Opening spaces for women's resource control in Calakmul, Mexico. *Lat. Am. Res. Rev.* **2011**, *46*, 29–54. [CrossRef] [PubMed]
60. Radel, C.; Schmook, B. Male transnational migration and its linkages to land-use change in a southern Campeche ejido. *J. Lat. Am. Geogr.* **2008**, *7*, 59–84. [CrossRef]
61. INE. *IV Censo Agropecuario de Guatemala*; INE: Guatemala City, Guatemala, 2004.
62. Taylor, M.J.; Aguilar-Støen, M.; Castellanos, E.; Moran-Taylor, M.J.; Gerkin, K. International migration, land use change and the environment in Ixcán, Guatemala. *Land Use Policy* **2016**, *54*, 290–301. [CrossRef]
63. Angelsen, A. Agricultural Expansion and Deforestation: Modelling the Impact of Population, Market Forces and Property Rights. *J. Dev. Econ.* **1999**, *58*, 185–218. [CrossRef]
64. Ruttan, V.W.; Hayami, Y. Toward a Theory of Induced Institutional Innovation. *J. Dev. Stud.* **1984**, *20*, 203–223. [CrossRef]
65. Deininger, K.; Minten, B. Determinants of deforestation and the economics of protection: An application to Mexico. *Am. J. Agric. Econ.* **2002**, *84*, 943–960. [CrossRef]
66. Bonilla-Moheno, M.; Redo, D.J.; Aide, T.M.; Clark, M.L.; Grau, H.R. Vegetation change and land tenure in Mexico: A country-wide analysis. *Land Use Policy* **2013**, *30*, 355–364. [CrossRef]
67. Alix-Garcia, J.; De Janvry, A.; Sadoulet, E. A tale of two communities: Explaining deforestation in Mexico. *World Dev.* **2005**, *33*, 219–235. [CrossRef]
68. Hurtado Paz y Paz, L. *Dinámicas Agrarias y Reproducción Campesina en la Globalizacion: El Caso de Alta Verapaz. 1970–2007*; F&G Editores: Guatemala City, Guatemala, 2008.
69. Díaz, G. *Opciones de Política Para las Inversiones Agrícolas y la Gobernanza de los Mercados. En Apoyo a la Agricultura a Pequeña Escala en Guatemala*; Oxfam: Guatemala City, Guatemala, 2012.
70. Palencia-Prado, M. *Elites y Lógicas de Acumulación en la Modernización Económica Guatemalteca*; Instituto de Investigaciones y Gerencia Política, Universidad Rafael Landívar: Guatemala City, Guatemala, 2012.
71. Aguilar-Støen, M. Social forestry movements and science-policy networks: The politics of the forestry incentives program in Guatemala. *Geoforum* **2018**, *90*, 20–26. [CrossRef]
72. Aguilar-Støen, M. Beyond Transnational Corporations, Food and Biofuels: The Role of Extractivism and Agribusiness in Land Grabbing in Central America. *Forum Dev. Stud.* **2016**, *43*, 1–21. [CrossRef]
73. Krznaric, R. The limits on Pro-poor agricultural trade in Guatemala: Land, labour and political power. *J. Hum. Dev.* **2006**, *7*, 111–135. [CrossRef]
74. Fischer, E.F.; Benson, P. *Broccoli and Desire. Global Connections and Maya Struggles in Postwar Guatemala*; Stanford University Press: Stanford, CA, USA, 2006.
75. Fischer, E.F.; Victor, B. High-End Coffee and Smallholding Growers in Guatemala. *Lat. Am. Res. Rev.* **2014**, *49*, 155–177. [CrossRef]
76. Van Der Haar, G. Land reform, the state, and the Zapatista uprising in Chiapas. *J. Peasant Stud.* **2005**, *32*, 484–507. [CrossRef]
77. Cornelius, W.A.; Craig, A.L.; Fox, J. *Transforming State-Society Relations in Mexico: The National Solidarity Strategy*; Center for US-Mexican Studies, University of California: San Diego La Jolla, CA, USA, 1994.
78. Solís, D.V. Rural Chiapas ten years after the armed uprising of 1994: An economic overview. *J. Peasant Stud.* **2005**, *32*, 461–483. [CrossRef]