


Article

What Determines Indigenous *Chepang* Farmers' Swidden Land-Use Decisions in the Central Hill Districts of Nepal?

Sharif A. Mukul ^{1,2,3,*}  and Anja Byg ⁴

¹ Tropical Forests and People Research Centre, University of the Sunshine Coast, Maroochydore DC, Queensland 4556, Australia

² Centre for Research on Land-Use Sustainability, Dhaka 1229, Bangladesh

³ Department of Earth and Environment, Florida International University, Miami, FL 33199, USA

⁴ Social, Economic and Geographical Science Group, The James Hutton Institute, Aberdeen AB15 8QH, UK; anja.byg@hutton.ac.uk

* Correspondence: smukul@usc.edu.au; Tel.: +61-041-664-8544

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Abstract: Swidden or shifting cultivation is a widespread yet controversial land-use in the tropical forest–agriculture frontier. In recent years, the extent of land under swidden and the people who rely on it for subsistence and income have declined. We report swidden land-use changes in two central hill districts of Nepal by indigenous *Chepang* communities—a stronghold of swidden cultivation in mountainous Nepal. Despite a common trend of swidden decline, as in other parts of South and Southeast Asia, we found that swidden is important in the life and livelihoods of smallholder rural *Chepang* farmers in the area. Swidden cultivation was found to be more important to farmers with limited off-farm opportunities and in areas where alternative land-uses were scarce. We discuss biophysical, socio-economic, institutional, and other key drivers affecting farmers' decision to shift away from or continue with swidden in the area. Using linear mixed effect models, we also examined households' attributes that may expedite swidden decisions in the area. Our study recommends greater access to alternative land-use(s) and other income-generating options for the wellbeing of smallholder indigenous *Chepang* farmers, as well as the sustainability of this age-old land-use practice.

Keywords: shifting cultivation; sedentary agriculture; smallholder; food security; rural livelihood; climate change

1. Introduction

Swidden, shifting cultivation or slash-and-burn is a traditional land-use common in forest–agriculture frontiers in tropical developing countries [1,2]. Ideally, swidden involves the cultivation of forest patches after the clearing and burning of indigenous vegetation for a few years, before shifting to another place to favor the regrowth of the secondary vegetation [3–5]. For centuries, swidden has been part of the life and livelihood of millions of smallholder rural farmers in tropical forested regions [1,6]. Swidden is also considered as one of the major contributors to forest degradation and loss [7–9], and a major source of greenhouse gas emissions in the tropics [10,11]. In many parts of South and Southeast Asia, swidden has traditionally been attacked by governments and policymakers due to its perceived negative impacts on the environment [2,12–14]. Local and regional land-use and development policies have accordingly sought to minimize swidden agriculture and encourage a shift towards other forms of agriculture and land-use [15,16].

In South and Southeast Asia, swidden farmers are now rapidly transitioning to other types of land-use due to a policy environment unfavorable to swidden agriculture, greater emphasis on

conservation that restricts smallholder farmers' access to additional land for swidden expansion, and large-scale commercial cultivation of cash crops like rubber and oil palm [1,4,6]. In some areas, swidden remains critical simply because intensification is not a viable option [6,16]. The extent of land under swidden and people involved in swidden cultivation are also projected to decrease in the coming decades, raising the issue of livelihood security and the resilience of smallholder farmers currently depending on swidden agriculture [1,6].

Being situated in the foothills of Himalaya, Nepal is one of the most vulnerable countries due to global climate change [17,18]. In recent years, extreme climatic events like drought and excessive rainfall have directly influenced the livelihoods and land-use of rural upland communities in the country [19–21]. At the same time, land scarcity and labor-intensive agricultural production systems are common throughout the country, challenging the life and livelihoods of thousands of smallholder rural farmers [22]. In Nepal, most of the people live in the country's middle hills with 95% of the population still engaged in subsistence agriculture for their living [23]. Swidden, locally termed as *bhasme* or *khorja-kheti*, is a common land-use practiced by at least ten indigenous communities in nearly twenty districts in Nepal [24]. Accordingly, many rural households largely depend on swiddening for food security and to meet local dietary needs [21]. Swidden cultivation in Nepal, however, is different from those prevailing in other countries of the humid tropics due to the country's unique geo-climatic conditions (Figure 1) [22]. Unlike other parts of South and Southeast Asia, in Nepal, seasonal rainfall combines with high elevation, steep terrains, and fragile soils characterized by frequent landslides, erosion, and a high amount of rocks in the soil [20].



Figure 1. A forest patch cleared for swidden agriculture in Dhading district in Nepal.

Smallholder swidden farmers in Nepal, as in other parts of the developing tropics, have been deserting their traditional swidden land-use due to the unfavorable policy environment as well as changing social, ecological, and institutional context [25]. The traditional view of swidden as an environmentally unsustainable land-use, which prevails in many parts of the developing tropics, also perseveres in Nepal, and negatively impacts swiddening in the country [2,21]. Here, we report swidden land-use and drivers of swidden change in two central hill districts of Nepal. We also investigate households' characteristics that may influence smallholders' decisions to shift away from or continue with swidden in the area. Our study specifically focused on the indigenous *Chepang* community—the largest practitioner and last stronghold of swidden agriculture in the country [26]. The *Chepang* are amongst the 59 indigenous communities living in Nepal who live mostly in the upper slope of the hilly terrain [26,27]. As per the latest available estimate, there are about 52,237 *Chepang*

people, representing approximately 0.03% of the country's total population [28]. Our study is therefore also important for understanding how small and marginal communities in tropical countries may respond to changing contexts and what influences the abandonment versus retention of their age-old and/or traditional practices.

2. Materials and Methods

2.1. The Study Area

We conducted our study in Dhading and Chitwan districts located in the central part of Nepal (Figure 2). Our study area falls in a seasonally dry tropical monsoon climate with three distinct seasons: a hot dry season (April–June), a warm monsoon (July–September), and cold winter (November–February). The March and October are transition periods, between winter and dry season, and between monsoon and winter season, respectively. The mean monthly minimum and maximum temperature varied from 7.3 °C to 25.4 °C and 25.6 °C to 35.6 °C, respectively [29].



Figure 2. Location map of the study area (in red box) in central hill districts of Nepal.

2.2. Site Selection

We purposively selected the Dhading and Chitwan districts for the present study because of their high *Chepang* population density. Together, they are home to about 60% of the total *Chepang* population in Nepal [30,31]. Through a stratified random sampling approach, we selected Jogimara and Shaktikhar village within Dhading and Chitwan district for the final survey. The general characteristics of our study villages are given in Table 1.

Table 1. General characteristics of our study villages in central hill districts of Nepal.

	Jogimara	Shaktikhar
Vegetation type	Tropics to sub-tropics	Humid tropics
Elevation	375 m–1000 m	125 m–300 m
Slope	35°–60°	25°–40°
Climate	Dry and humid	Dry
Annual rainfall	~580 mm	~2000 mm
Soil type	Sandy loam to silty clay	Sandy loam to silty clay

2.3. Field Surveys

Field surveys were undertaken between April to June 2011. We interviewed 24 *Chepang* farmers in Jogimara and 27 farmers in Shaktikhar (Table 2). We organized two focus group discussions (FGD) prior to the household (HH) survey in each village with the help of a local facilitator (cum translator). Persons involved during the FGD exercise were elderly people, local farmers, and representatives from the local institutions such as the Village Development Committee (VDC) and Community Forestry User Groups (CFUG). The purpose of the FGD was to identify individual *Chepang* farmers engaged in swidden agriculture, either presently or in the recent past (within the last 3 years). They were subsequently approached for the interviews. We had a 100% response rate (i.e., *Chepang* farmers who agreed to give interviews) in Jogimara and a 92% response rate in Shaktikhar. In Jogimara, all the households were engaged in swidden agriculture during the time of our survey, while in Shaktikhar HHs were engaged in a variety of activities and not everybody practiced swidden cultivation. We therefore specifically focused on HHs active in swidden agriculture during the time of our survey and/or in the recent past in Shaktikhar. While our study only covers a small percentage (9.1%) of the total population in Shaktikhar, it does cover a larger percentage of the sub-population of *Chepang* farmers in the area.

Table 2. Information on the households and study villages in central hill districts of Nepal.

	Jogimara	Shaktikhar
Total households (N)	27	297
Interviewed households (n)	24	27
Sampling intensity	88.9%	9.1%
Major ethnic groups	Chepang, Gurung	Chepang, Gurung
Major livelihood activity	agriculture	agriculture, business
Major land-use(s)	swiddening, sedentary agriculture	leasehold forestry, agroforestry, sedentary agriculture, swiddening
Distance from the highway	2–6 h	2–4 h
Distance from the nearby forest	2–5 min	20–30 min

Source: field survey.

Where possible, household heads were interviewed for the survey. In the absence of the household head, a senior member of the family was interviewed. We used a semi-structured questionnaire to collect household information (Supplementary Materials 1). This included information about households' landholdings under different land-uses/cover, demography, livestock and other assets, and their perspective on swidden farming. In addition, smallholder *Chepang* farmers were asked about government policies and local changes, which may have influenced their traditional swidden practices in the area. For each topic, participants were encouraged to express their own views and/or opinion.

2.4. Data Analysis and Interpretation

We collected both quantitative and qualitative data during the survey. To analyze the data, we mostly used descriptive statistics. Households in each village were categorized as small (below 0.15 ha), medium (more than 0.15 ha but less than 0.40 ha) or large (more than 0.40 ha) farmers based on their total landholdings, including swidden, sedentary agriculture and other land-uses/cover. We collected both

present and recall data regarding households' land holdings under different land-uses/cover. Local land units were recorded during the survey and were later converted to standard international units.

To examine the effect of different demographic and socio-economic factors (see Appendix A Table A1) on households' decision to continue with or shift away from swidden, we developed linear mixed-effect models (also referred to as LMEM) in the R statistical environment (version 3.1.3) [32]. In our LMEM, respondent's age, education, HH size, house type, total livestock resources, number of years active in swidden cultivation, access to other land-cover/use(s) in the area, land area under swidden, sedentary agriculture and other uses were used as explanatory variables (i.e., fixed factors), and households' decision to continue with or shift away from swidden was the response variable. We used HH number nested in land-holding categories (i.e., small, medium, or large) as the random effect in our models. We considered the Akaike Information Criterion corrected for small sample sizes (AICc) for the selection of our top models, where the best models had the lowest AICc scores. R-package 'MuMin' was used for our model selection, and to evaluate the contribution different fixed effects had on explaining the variation in the response variables [33]. In our analysis, models within four AICc units were equivalent models [34].

3. Results

3.1. Demography of the Chepang Farmers

About 61% of the respondents were engaged in swidden cultivation in the area. In Jogimara, total numbers of family members among the survey households were 121 (adult male—35, adult female—42, and children—44) while it was 146 in Shaktikhar (adult male—39, adult female—47 and children—60). The household size ranges from two to 11 people in both study villages. The average age of the respondents in Jogimara was 43.6 years, while it was 40.3 years in Shaktikhar. The oldest *Chepang* farmer we interviewed during the study was 88 years old and was from Jogimara. The literacy rate (i.e., those who can read and write) amongst the survey *Chepang* farmers was higher in Shaktikhar (51.85%) than in Jogimara (45.83%).

Major livelihood activities in Jogimara were swidden cultivation, sedentary agriculture, and wage labor in nearby areas. In addition, in Shaktikhar, households were found to be engaged in small businesses like selling stationery goods and operating tea stalls and restaurants in their vicinity. The options for permanent wage labor, however, were found to be limited in both study villages. In Jogimara, swidden cultivation was the primary income source for about 58.33% respondents, whilst in Shaktikhar, only 29.63% respondents reported swidden as their primary income source (Table 3). The collection of forest products, mainly firewood and fodder, was also common among our survey households but only for the purpose of self-consumption.

Table 3. Major income sources of our respondents in the study villages in Nepal.

Activity/ Occupation		Importance as Per Contribution to Total Income		
		Primary	Secondary	Tertiary
Swidden cultivation	Jogimara (n = 24)	14	6	3
	Shaktikhar (n = 27)	8	10	6
Sedentary agriculture	Jogimara (n = 24)	5	9	10
	Shaktikhar (n = 27)	11	8	3
Small business	Jogimara (n = 24)	1	-	-
	Shaktikhar (n = 27)	5	1	-
Others	Jogimara (n = 24)	4	2	-
	Shaktikhar (n = 27)	3	1	1

We found most (43.25%) of our respondents in the study villages living in small houses called semi building constructed with locally available materials, like rock, wooden frame, and corrugated

metal sheet as roof (Figure 3). Only few households in both study villages lived in larger houses called building (Figure 4). All the survey households in both villages were found to own at least some livestock resources (Figure 4), which provided them with additional income or back up during times of emergencies (e.g., crop failure due to extreme weather events like drought or heavy rainfall) by providing a source of cash.



Figure 3. A typical *Chepang* house in the area.

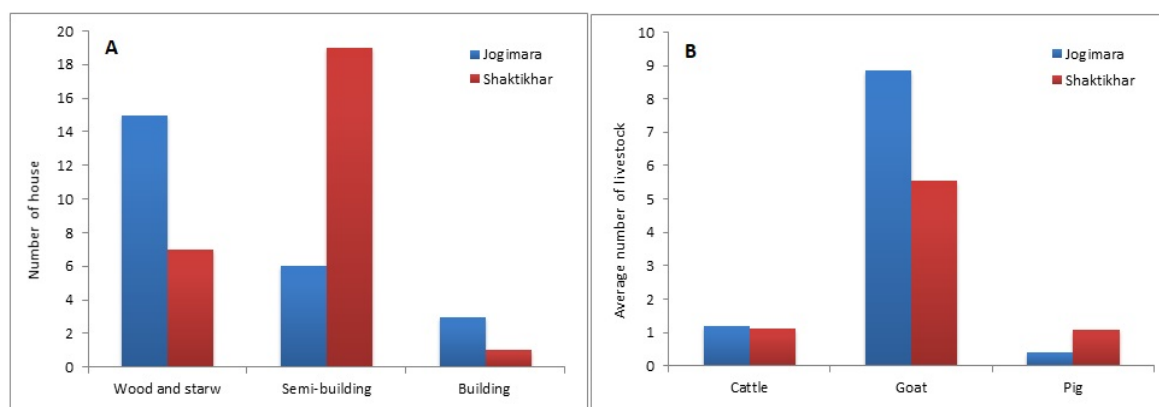


Figure 4. Housing condition (A), and livestock resources (B) of the *Chepang* farmers in the central hill districts of Nepal.

The average number of years that respondents had been involved in swidden cultivation was higher in Jogimara (about 23 years) than in Shaktikhar (about 19 years). Maize (*Zea mays*) was the major crop in swidden fields in both areas. Additionally, *Chepang* hill farmers in the area used to grow vegetables and some other perennial crops to supplement their dietary requirements (see Appendix A Table A2). In the area, fallow length (i.e., interval between two successive cropping season) was found to be shortened considerably due to the lack of land available to expand swidden area and limited manpower essential to provide physical labor during initial land preparation. In Jogimara, the fallow length was, however, found to be longer (7–10 years) than it was in Shaktikhar (3–5 years).

3.2. Swidden and Other Land-Uses in the Area

Table 4 shows the respondents' landholdings under major land-use categories in the area. In both areas, there had been a marked decrease in landholdings for swidden agriculture between 2000 and 2011. Landholdings for sedentary agriculture and other purposes (e.g., agroforestry under leasehold forestry programs) had, however, increased in both areas, although they were more pronounced in Shaktikhar.

Table 4. Landholdings by smallholder *Chepang* farmers during 2011 and 2000 in our study villages in central hill districts of Nepal.

Landholding by Household *		2011			2000		
		Min.	Max.	Mean \pm SD	Min.	Max.	Mean \pm SD
Land under swidden cultivation	Jogimara (n = 24)	0	6	2.81 \pm 1.37	0	6	3.33 \pm 1.71
	Shaktikhar (n = 27)	0	5	2.07 \pm 1.98	2	8	4.07 \pm 1.54
Land under sedentary agriculture	Jogimara (n = 24)	0	2	1.15 \pm 0.77	0	2	0.88 \pm 0.85
	Shaktikhar (n = 27)	1	5	2.81 \pm 1.10	0	5	1.43 \pm 1.45
Land under other land-uses/cover	Jogimara (n = 24)	0	1	0.35 \pm 0.40	0	1	0.21 \pm 0.36
	Shaktikhar (n = 27)	0	2	0.74 \pm 0.94	0	0	-

* Landholding by HH is expressed in local unit Ropani, where 19.9 ropani is ~1 ha.

In Jogimara, the average amount of land managed for swidden agriculture under usufructs rights was higher (~0.14 ha) than in Shaktikhar (~0.10 ha). In contrast, the average land owned for sedentary agriculture was higher in Shaktikhar (0.14 ha) than it was in Jogimara (0.06 ha). Sedentary agriculture in terraced fields and rain-fed plain lands were, in fact, the dominant forms of land-use in Shaktikhar. Sedentary agriculture in both villages only took place on lands to which households had the legal titles.

Figure 5, below, shows the number of *Chepang* farmers who fell into the small, medium, and large landholding categories, respectively, based on their total landholdings (i.e., the sum of land under swidden, sedentary agriculture and other land-uses/cover). Farmers did not hold any legal land titles of the areas they used for swidden agriculture in our study villages. Within the communities, however, informal usufruct rights were recognized in such a way that members from the community were aware of one another's swidden areas and did not infringe on or enter other people's swidden fields uninvited.

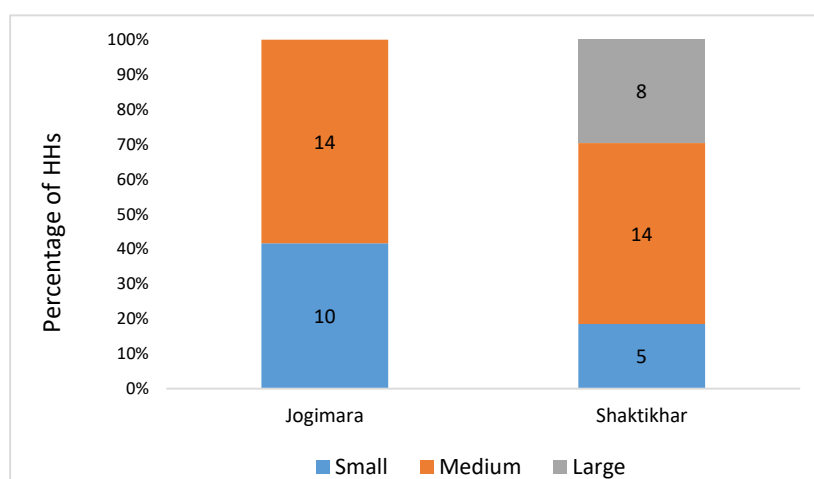


Figure 5. Classification of *Chepeng* farmers by landholdings in our study villages in central hill districts of Nepal.

Smallholders in Jogimara used to grow rice (*Oryza sativa*) in their terraced fields and plain lands located near downstream riverbanks once a year. Other land-uses in the areas were agroforestry in lands issued under the leasehold forestry (LF) program and land managed as grazing fields for

livestock. The LF program operated by the Forest Department was, however, found to be limited in Shaktikhar, and only a few of the respondents were found to be involved in that program. Under the LF program, a limited number of community members were granted access to forest lands to cultivate agricultural crops under different agroforestry schemes, mainly during the early years of forest plantation development. The selection of the members for the LF program was, however, at the discretion of the local government and forest management unit, and sometimes did not reflect the needs of the households.

3.3. Households' Characteristics Affecting Swidden Decline in the Area

Smallholders' landholdings under swidden land-use and access to alternative land-uses were found to be the most influential household attributes determining *Chepang* farmers' decision to continue with or abandon swidden in the area (Table 5). Other factors that were also found to be important in households' swidden decision were (not in an order of importance) educational level of the respondent, housing condition, livestock resources, land under sedentary agriculture, and land area under other usages. Interestingly, demographic factors like the respondent's age and corresponding household size were found to be trivial in *Chepang* farmers' swidden decisions in the area.

Table 5. Summary of linear mixed-effect models (LMEM) between smallholder *Chepang* farmers' swidden decision with other variables in the area.

Model	Explanatory Variable *							df	LL	AICc	Δ AICc	Weight
	Ed	HC	Liv	AgL	SL	OL	AcL					
1					X		X	6	−100.49	214.89	0.00	0.24
2					X			5	−102.23	215.79	0.90	0.15
3	X				X		X	7	−100.10	216.80	1.91	0.09
4		X			X		X	7	−100.28	217.16	2.27	0.08
5			X		X		X	7	−100.33	217.27	2.38	0.07
6	X				X			6	−101.68	217.27	2.38	0.07
7					X	X	X	7	−100.36	217.32	2.43	0.07
8		X			X			6	−102.01	217.93	3.04	0.05
9					X	X		6	−102.07	218.04	3.15	0.05
10				X	X		X	7	−100.74	218.09	3.19	0.05
11			X		X			6	−102.38	218.67	3.78	0.04
12				X	X			6	−102.45	218.81	3.92	0.03

* Respondent's level of education (Ed), housing condition (HC), livestock resources (Liv), agricultural land (AgL), land area under swidden agriculture (SL), land area under other usage (OL), access to other land-uses/cover (AcL). Degree of Freedom (df), Log Likelihood (LL), Akaike Information Criterion (AIC). ** The most influential model is indicated in bold.

3.4. Farmers' Perspectives on Swidden Land-Use and Changes in the Area

The number and percentage of households who were found to be willing to continue (yes) or shift away (no) from swidden in our study villages in Nepal is shown in Figure 6. Interestingly, the number of farmers who wished to continue swidden were higher in Shaktikhar (66.7%) compared to in Jogimara (33.3%), although households in Jogimara were found to have practiced swidden longer than those in Shaktikhar.

Most of the respondents (92.16%) reported a decline in swidden in terms of area and people involved in our study villages. Smallholders' views about the factors that had led to the abandonment of swidden cultivation in the area are listed in Table 6. The major reasons most frequently cited by the respondents in Jogimara were labor intensiveness (37.50%), scarcity of labor (29.17%), and low economic returns (or high opportunity costs) from swidden cultivation when compared with other available income-generating activities in the area. In Shaktikhar, the most frequently cited factors were government policies and negative attitudes (40.74%) that considered swiddening as an environmentally unsustainable land-use, followed by the scarcity of land (29.63%), and low economic turnover

compared to other land-use(s) (25.93%). Swiddening was also viewed as a sign of primitiveness and/or backwardness amongst young *Chepang* members, as per our respondents in Shaktikhar.

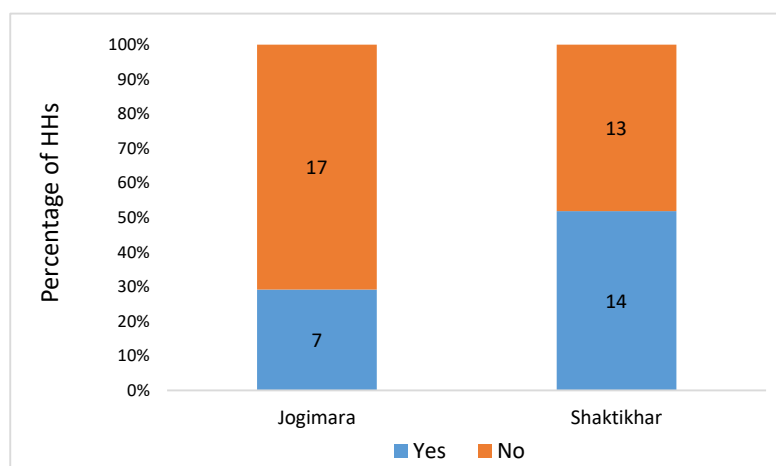


Figure 6. Smallholders' response regarding their intention to continue with or shift away from swidden in the central hill districts of Nepal.

Table 6. Smallholders' views of the factors causing swidden decline in our study area in Nepal.

Reason	Jogimara		Shaktikhar	
	n	%	n	%
Government's policy and attitude	3	12.50	11	40.74
Labor intensiveness	9	37.50	6	22.22
Lack of human resources	7	29.17	4	14.81
Land scarcity	2	8.33	8	29.63
Local attitudes	1	4.17	5	18.52
Low economic turnover	5	20.83	7	25.93
Others (e.g., wildlife, irrigation problem)	1	4.17	3	11.11

Number of respondents (n).

Respondents from both Jogimara and Shaktikhar identified land scarcity for swidden expansion as one of the major reasons why they considered discontinuing swidden. Water scarcity was another major cause mentioned by the respondents from Shaktikhar while people from Jogimara mentioned poor crop yield as one of the major reasons behind swidden abandonment.

4. Discussion

4.1. Drivers of Swidden Change in the Area

Because policymakers and forest managers do not recognize it, reliable estimates of land under swidden use and farmers who practice swidden are scarce [4]. Our study found that the extent of land under swidden and people who practiced swidden agriculture was declining in the area although swiddening forms part of the culture and traditional way of life of indigenous *Chepang* communities. The importance of swidden to smallholders' livelihoods, however, was found to remain critical. Swiddening was particularly important to those with limited access to other income-generating options including sedentary agriculture. The decline in swidden in the area, both in terms of area coverage and peoples' involvement can be expected to lead food insecurity, poverty, and greater vulnerability of rural smallholder farmers due to higher dependency on external market and institutions [31]. At the same time, the limited access to land for swidden due to unfavorable policy environment might lead to the shortening of fallow cycles, thus increasing the risk of environmental degradation and socio-political unrest due to landlessness and poverty.

Figure 7 illustrates the key drivers of swidden change in the area as mentioned by the indigenous *Chepang* households during our survey. Although most drivers were common, the extent to which they were pertinent differed between our two study villages. In Jogimara, for example, swidden was at the core of indigenous *Chepang* farmers' livelihoods due to their traditional lifestyles, remoteness, and limited access to alternative land-uses. The biophysical drivers included water scarcity, poor yields attributed to site factors, and land shortage while socio-economic drivers were limited off-farm income/opportunities, lack of communal labor, and low economic returns. The government's negative view towards swiddening, limited land-use options including access to leasehold forestry were the major institutional or policy drivers identified in the area, and attitudes towards swidden from young *Chepang* people were considered to be attitudinal drivers in the present study.

In many parts of the developing tropics, smallholder swidden farmers are now transitioning from traditional rice or maize-based farming system to more permanent sedentary agriculture or cash crop-based systems [35,36]. Such transition, however, does not follow a fixed pattern and usually occurs as a consequence of interplays and interactions between several biophysical, socio-economic, and institutional factors [37–39]. The government's land-use policy and major focus on conservation also make swidden agriculture particularly challenging in many parts of south and Southeast Asia [2,15]. Low productivity of swidden attributed to drought and water scarcity, losses in soil fertility, soil degradation as well as market constraints also making this age-old land-use highly vulnerable in the region [40].

In tropical Asia, classifying swiddeners as ethnic minorities, state control of traditional swidden practices with unfavorable policies, and the promotion of market-driven agriculture, are among the major causes leading to swidden abandonment [16]. Agrarian change due to transitions from rural to urban livelihoods are also becoming prominent in most parts of South and Southeast Asia [36,41]. In the case of Nepal, the outmigration of people is causing the abandonment of their farmlands, including swidden areas [22,42,43]. Greater access to regional job markets as a major reason for farmers' unwillingness to continue swidden is reported by Figueroa et al. [44] and Padoch et al. [45] in their studies. Paudel and Thapa [25] and Rasul and Thapa [46] provide evidence that smallholders' access to local institutions and support influence their land-use preferences and that farmers abandon swidden when they obtain access to such institutions and support.

4.2. Household Attributes Affecting Swidden Decline in the Area

We found smallholders' landholdings under swidden land-use and access to alternative land-uses such as agroforestry under an LF scheme to be the most influential household attributes determining *Chepang* farmers' decision to continue with or abandon swidden in the area. Several studies also reported households' characteristics such as education and household wealth status as primarily determined by households' income, land-holdings, livestock resources, housing condition as important factors influencing their land-use and other decisions [25,42,47–50]. Figueroa et al. [44] also found that greater access to alternative land-uses influenced farmers' unwillingness to continue with or abandon swidden agriculture in and around a biosphere reserve in Mexico. A study in Malaysia by Hansen and Mertz [51] showed that access to higher education influenced young people's motivation to abandon swiddening.

In Nepal, community forestry including leasehold forestry is highly regarded for their contribution to rural development particularly among forest-dependent livelihoods [52,53]. Our study also demonstrates that smallholder farmers who had access to such arrangements were unlikely to continue swiddening in the area. At the same time, forests remain a critical part of indigenous people's life and culture with their important role during emergencies as a safety net both in Nepal and elsewhere in the developing tropics [19,54–56].

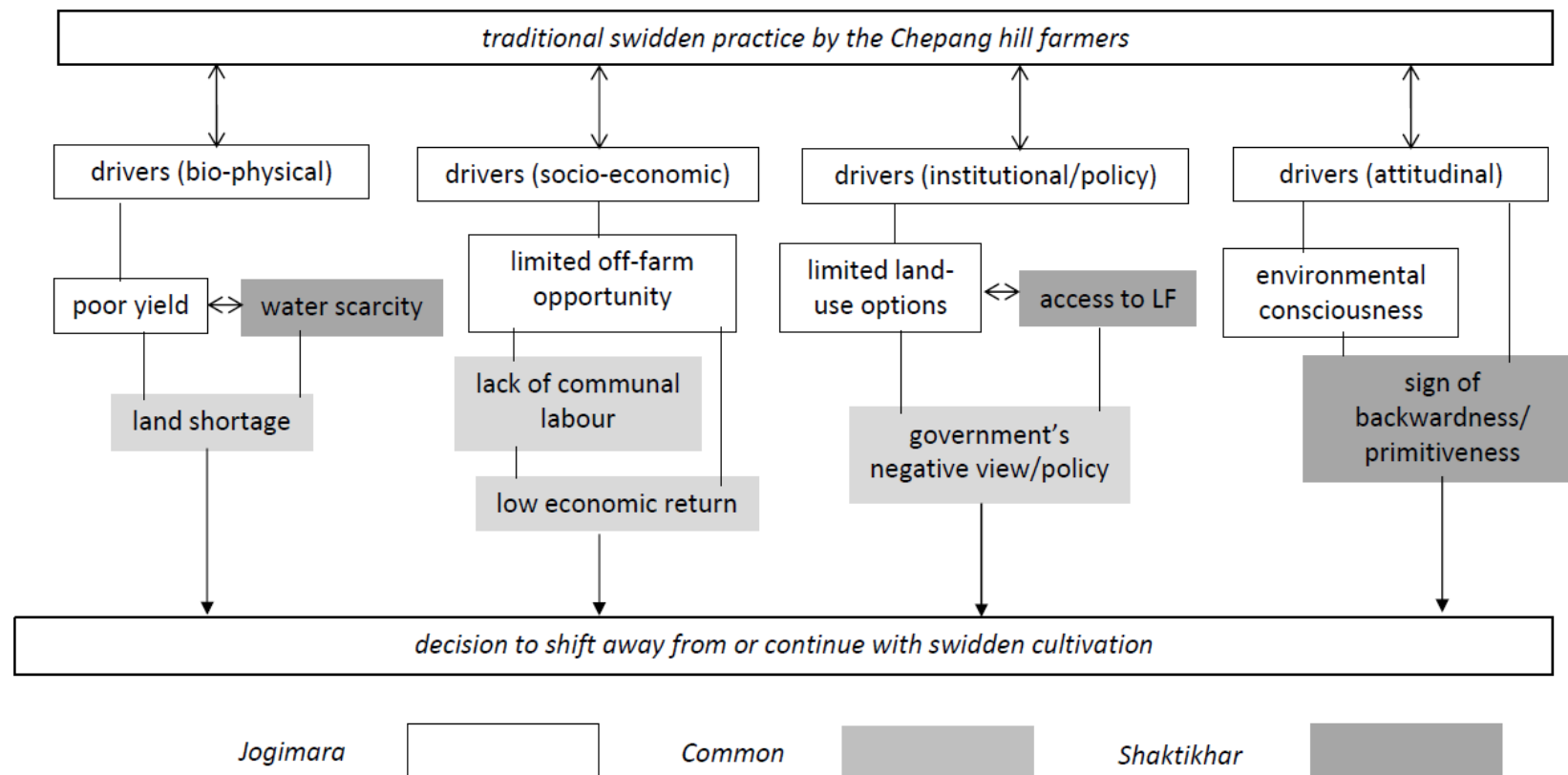


Figure 7. The interplay of different drivers affecting swidden change in our study sites in central hill districts of Nepal.

5. Conclusions

Although our study is based on field survey conducted in 2011, the findings of the study are still valid and highly relevant [42,43]. Despite the critical role of swidden cultivation in supporting smallholders' livelihoods in our study villages in Nepal, both the number of indigenous *Chepang* farmers who traditionally practiced swiddening and the land area under swidden cultivation was declining. It was also evident that, swidden land-use is likely to disappear in areas with greater exposure to certain socio-economic and institutional support such as access to other land-uses, while it is expected to remain important in rural livelihoods in areas where such factors are not available. Some household attributes (e.g., land area under swidden use) were also found to be important in smallholders' decision to shift away from or continue swidden agriculture.

Swidden forms an important part of indigenous peoples' traditional way of life, and their traditional right to continue this practice should be recognized in government policy. An increased focus on equity by the government and related agencies on providing more land-use options, secure land tenure, and access to certain facilities like micro-credits and training are, however, crucial to making the livelihoods of *Chepang* farmers less vulnerable to any environmental or economic changes and thereby ensuring they have more stable livelihoods.

Reducing Emissions from Deforestation and Forest Degradation (REDD+) is an agenda of global interest nowadays, and is highly relevant in Nepal, where people of different Community Forest User Groups are being rewarded for carbon sequestration and conservation. The government, together with the Forest Department, could develop mechanisms to offer financial benefits to smallholder *Chepang* farmers who have already abandoned swidden practice (or wish to do so) to secure long term environmental benefits of such transitions. Beside REDD+, Payment for Environmental Services (PES) schemes could also be useful, taking into consideration the other environmental benefits like the avoidance of soil erosion and nutrient loss due to changes in swidden practices.

Supplementary Materials: The following are available online at <http://www.mdpi.com/2071-1050/12/13/5326/s1>, Checklist of information collected during the swidden farmer survey (Supplementary Material 1).

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Appendix A

Table A1. Variables Used in Our Preliminary Linear Mixed Effect Models.

Variable Type	Variable Name
Demographic	Respondent's age
	Respondent's education
	Household size
Socio-economic	Housing condition
	Total livestock resources
	Access to other land-uses/cover
	Year active in swidden agriculture
	Land area under swidden agriculture
	Land area under sedentary agriculture
	Land under other land-uses/cover

Table A2. Major Agricultural Crops in Swidden Fields in Our Study Villages in Central Nepal.

Common Name	Botanical Name	Abundance *		Type/Use
		Jogimara	Shaktikhar	
Bean	<i>Lablab</i> sp.	++	+	Vegetable
Bot	<i>Ficus</i> sp.	+++		Fodder
Cassava	<i>Manihot</i> sp.	+		Vegetable
Chilly	<i>Capsicum</i> sp.	++	+	Vegetable
Cucumber	<i>Cucumis sativus</i>	+		Vegetable
Garlic	<i>Allium sativum</i>	+		Vegetable
Rice	<i>Oryza</i> sp.		+++	Staple
Khoir	<i>Acacia catechu</i>	++		Other
Long bean	<i>Vigna</i> sp.	++		Vegetable
Maize	<i>Zea mays</i>	+++	++	Staple
Millet	<i>Echinochloa</i> sp.	+		Cereal
Okra	<i>Abelmoschus esculentus</i>	++	+	Vegetable
Onion	<i>Allium cepa</i>	+		Vegetable
Orange	<i>Citrus sinensis</i>	++		Fruit
Pineapple	<i>Ananas comosus</i>		++	Fruit
Potato	<i>Solanum tuberosum</i>	++	+	Vegetable
Pumpkin	<i>Cucurbita</i> sp.	+		Vegetable
Radish	<i>Raphanus sativus</i>	++	+	Vegetable
Tomato	<i>Solanum lycopersicum</i>	++		Vegetable
Mountain-ebony (Koiralo in local)	<i>Bauhinia variegata</i>	+++		Fodder; Vegetable
Wheat	<i>Triticum</i> sp.	+	++	Staple

* where, +++—common; ++—moderate; +—rare.

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