Caste Discrimination, Land Tenure, and Natural Resource Management in Nepal

Kastediskriminering, jordeiendomsforvaltning og naturressursbruk i Nepal

Philosophiae Doctor (PhD) Thesis

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Summary of the thesis

This study investigates the issues related to land tenancy transactions, land productivity and land-related investment by farm households, with specific focus on caste discrimination. This study also explores the factors influencing the participation of households in renting livestock and the possible interlinkages between land rental and livestock rental markets. Paper I assesses the caste-related land productivity differential and its possible explanations. Results show that low-caste households (Dalits) have higher land productivity than high-caste households (non-Dalits). One of the possible explanations is that low-caste households are land-poor and have less access to off-farm labor markets, particularly the regular off-farm jobs. Due to traditional caste discrimination, low-caste households have high levels of illiteracy and poverty, and thus they tend to participate in agricultural labor in the village rather than to seek outside jobs. It is therefore clear that they concentrate their labor on farming and achieve higher land productivity in rural agriculture where no farm mechanization has taken place yet. Paper II assesses the existence of Marshallian inefficiency in sharecropping, allocative inefficiency in land tenancy transactions, and an inverse farm size–productivity relationship by indicating how these phenomena are associated with caste discrimination. The results show that the inverse farm size–productivity relationship is more readily explained by the inefficiency of land tenancy markets and caste discrimination. Marshallian inefficiency is found to be at a significant level only in the case of high-caste tenants. This raises the question: Why do high-caste landlords rent their land to other high-caste tenants if low-caste tenants are more efficient? One of the possible reasons for this is the past land-to-the-tiller policy which had a provision that tenants could claim ownership rights for a certain portion of tenanted land. Therefore, in order to avoid land loss, landlords may seek tenants with less social distance from them who only require informal tenancy. Paper III examines the factors driving livestock

rental market participation by farm households, despite the fact that livestock renting is associated with the problem of moral hazard. Results show that differences in resource endowments and in the access to factor markets between high-caste and low-caste households are the important reasons for the emergence of livestock rental market. Paper IV assesses whether the investment and intensity of production differ between high-caste and low-caste households in rural Nepal. This paper relates the caste issue to poverty, because low-caste households are poorer not only in terms of income but also in terms of asset holding. Results show that low-caste households are more likely to apply manure as compared to high-caste households. However, no difference is observed between high-caste and low-caste with regard to conservation investment. Low-caste households are found to use the land intensively. Access to off-farm employment is found to have negative effect on the likelihood to invest in conservation.

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1. Introduction

In the rural areas of developing countries, land is not only the main source of livelihood but also the primary asset for investment, accumulation and transfer of wealth (Deininger and Binswanger, 1999). In addition, most of the poor in developing countries depend heavily on the agricultural sector for their livelihood which creates a strong link between poverty and natural resource management, especially land management. In this context, unequal access to opportunities due to skewed distribution of land assets can be detrimental for sustainable growth (World Bank, 2005). Therefore, the ways in which access to land are instituted and distributed have broader implications beyond the sphere of agricultural production (Deininger and Binswanger, 1999; World Bank, 2003). Moreover, in rural areas of developing countries, where market imperfections are rules rather than exceptions, the distribution of assets will have an impact on the efficiency of resource usage (Janvry, et al., 1991; Holden, et al., 2001). Therefore, distribution of land and the land tenure system may significantly affect farm households' land management which, in turn, influences land productivity.

Although low agricultural productivity, increasing food insecurity and poverty have been the major challenges for the development of Nepal, land issues have been a much debated topic for a long time. Despite several land reform measures in the past, land distribution is still highly skewed and the land tenure system is still semi-feudal in nature (Wily, et al., 2008; Land Watch Asia, 2009). Past land policies could not adequately address the problem of unequal distribution

of land. Furthermore, by relying on a 'land-to-the-tiller'[1] program, past land policies distorted the rural land rental market (Yadav, 1999; Bhandari, 2006). Almost all political movements that have sprung up in Nepal so far have included land reform as one of their major agendas. For example, the first democratically elected government of Nepal, the Nepali Congress Government in 1959, started broad land reform measures including commitment to the land-to-the-tiller program (Shrestha, 2001). However, these measures could not be instituted because King Mahendra executed a Royal coup in 1960, dismissed the Nepali Congress Government and established a party-less Panchayat system that ruled the nation until 1990. The issue, nonetheless, remained alive and the Land Act 1964 was passed in response to it. This was the first comprehensive land reform measure undertaken until then. However, due to weak implementation, it was not able to achieve the stated goals. After the re-instatement of multi-party democracy in 1990, land reform once again became a high priority on the government's agenda. Finally, it took a more radical direction when the Maoist war (Maoists called it a 'People's War') was initiated in 1996, with radical land reform as one of its key demands. The Maoists' war ended in 2006 when they signed a peace agreement, with the end of feudal land ownership and scientific land reform at the top of the agenda. Despite political differences, all major political parties in Nepal state land reform as a key agenda in their manifesto. More importantly, the 2007 interim constitution of Nepal clearly stated as a goal the implementation of scientific land reform by doing away with feudal land ownership (Wily, et al., 2008).

Access to land and its distribution are not only governed by market forces, as it has been closely associated with the power relations that existed in the society throughout history. In Nepal,

[1] The 'land-to-the-tiller' refers to the idea that only the tiller should own the land. This favors the self-cultivation of land. Following this philosophy, the Land Act of 1964 provided legal authority to a registered tenant to claim the ownership rights to one-fourth of the total land rented. The amendment of the Land Act in 1996 further increased the tenants' claim to one-half of the land rented.

access to land and other resources are found to have a strong correlation with caste[2] (Wily, et al., 2008). History shows how economic, political and cultural institutions can reinforce each other to sustain certain configurations of exclusive power. In Nepal, power was consolidated by interlinking it with the Hindu caste system (Bennett, 2005; Haug, et al., 2009) and, therefore, the caste-based hierarchy is deeply rooted in society despite the abolition of caste-based discrimination by law. Caste is an institutional set up which affords some groups more opportunity to realize their agency than others, even when the legal set-up supports equal agency for all (Bennett, 2005; DFID and World Bank, 2006). As the low-caste (Dalits) lies at the bottom of the Hindu caste hierarchy, they have been facing economic, political and even spiritual and psychological barriers to access, voice and mobility.

This study covers issues such as land tenancy transactions, land productivity and land-related investment; as well as the interlinkages between land and livestock rental markets with specific focus on caste differences existing in Nepalese society. The question arises: Why is caste differential so important when analyzing the land productivity, inefficiency of land tenancy markets, farm size–productivity relationship, and investment and intensity of input use in rural Nepal? Firstly, because low-caste households have historically been excluded from land holding (Haug, et al., 2009). They used to work as agricultural laborers and cleaners for high-caste households (Banerjee and Knight, 1985). Even after the establishment of democracy in 1990 and constitutional provision of no discrimination based on caste, low-caste households remained extremely land-poor (World Bank, 2006). Moreover, 75 percent of low-caste households in the

[2] A caste system exists in the Hindu religion. Caste refers to hierarchically ranked categories based on hereditary membership. It fixes the social status of individuals at birth and prevents movements from one category to another. The major caste groups are: *Brahmins* (the highest caste); *Chhetries* (the second highest caste); Baishyas (the third highest caste); and *Sudras* (often called *Dalits* or *Scheduled castes* – the lowest caste). Dalits face severe discrimination due to the practice of untouchability, which prevents their participation in many religious functions and even entering the houses of other caste groups. This study classified all households into two broad groups: low -caste (*Dalit* households only) and high-caste (all other categories except *Dalits*).

hills of Nepal are functionally landless (Wily, et al., 2008). Secondly, low-caste households are often deprived of other resources, such as education and social networks, which are primary factors that influence access to high-paying, off-farm regular employment. As the proportion of low-caste household members who hold regular jobs in Nepal is extremely low compared to the high-caste, they are highly dependent on their small land holding and working as agricultural laborers for their living (DFID and World Bank, 2006). Studies in India (Banerjee and Knight, 1985; Kijima, 2006; Madheswaran and Attewell, 2007; Ito, 2009) also showed that low-caste households face severe discrimination in regular off-farm employment. Thirdly, despite the existence of a land sales market, poor low-caste households are unable to increase their access to land through land purchase. This is because land sale markets are beyond their reach due to imperfections in the credit market. Another reason might be that inheritance is the main mechanism through which land ownership changes hands in rural Nepal, where more than 85 percent of land has been obtained through inheritance (World Bank, 2006). Therefore, the effects of historical exclusion have remained until today as past land reform measures in Nepal were largely unsuccessful (Wily, et al., 2008). The land reform programs implemented so far have not effectively addressed the issue that low-caste households had suffered from lack of access to land (Hatlebakk, 2007). Fourthly, as caste differences in Nepal correspond to social and economic differences, it can have important implications for land-related investment in both the short and long-terms.

Against this backdrop, this dissertation aims at providing empirical evidence to clarify the following research questions:

- To what extent do caste-related land productivity differentials still exist and, if they do, what factors explain them?

- Is there an inverse farm size–productivity relationship in Nepal, or is it counteracted by caste discrimination and Marshallian inefficiency?
- Why is there an active livestock rental market in rural Nepal and how is it related to the land rental market and caste differentiation?
- How does poverty and caste affect farmers' decisions to invest in and intensity of use of productivity-enhancing investments?

These questions are addressed in separate papers in this dissertation by applying several empirical models. While addressing these questions, caste is included in all the analyses. This is done because the caste system is one of the major social institutions in rural areas of Nepal, which, to a larger extent, determines an individual's role and access to resources. Though several studies (Hachhethu, 2003; Bennett, 2005; Gurung, 2005; DFID and World Bank, 2006; Hatlebakk, 2008; UNDP, 2008; Wily, et al., 2008; Haug, et al., 2009) highlight the issues of caste-based social exclusion and inequalities in the distribution of resources in Nepal, most of them present a descriptive analysis of the socio-political implications of it. A systematic empirical analysis of this issue using economic theories still remains a virgin area and that is what this dissertation attempts to bring into broader economic analyses.

The rest of this introductory chapter is organized as follows. Section 2 provides a brief introduction to the caste system, focusing on why it is important in analyzing poverty and natural resource management in rural Nepal. Section 3 presents land issues in Nepal, including possible explanations for why and how the land distribution relates to the caste system. The theoretical framework for the study is presented in section 4, while section 5 gives an overview of the data issues and empirical methods. The major research findings are summarized in section 6, with

section 7 presenting the conclusions and policy recommendations. The last section highlights some areas of future research.

2. Why caste still matters in Nepalese society

While analyzing why even today caste matters in Nepalese society, it is necessary to explore the history of Nepal. The problem of caste discrimination is an age-old phenomenon in Nepal and thus is a very broad and complex topic to deal with. To give a brief overview, we start with the unification of Nepal by King Prithivi Narayan Shah in 1768. After the unification of Nepal, King Prithivi Narayan Shah wanted to make it a pure Hindu kingdom (Hachhethu, 2003) and Hinduization turned out to be the *raison d'être* of the Nepalese state (Gurung, 1997). For the successors of the Shah dynasty, who ruled Nepal until 2006, Hinduism had been the major philosophy for guiding the nation.

The Hindu polity assumed the king as a sovereign lord, who was protector of his territory and subjects, a guardian of the moral order, an upholder of traditions, and a source of all spiritual and temporal power (Sharma, 1997). Therefore, the king was able to maintain the *Varna* model of the Hindu religion, which provided the grounding for social stratification based on birth. The caste system used religious and cultural justifications to distinguish people, based exclusively on their birth into a particular social group (Pasipanodya, 2008). The *Manusmriti*, a Hindu religious scripture, divided human beings into four Varna: *Brahmans*, *Chhetries*, *Vaishyas* and *Sudra* (UNDP, 2008). *Brahmins* had priestly roles and were considered pure or holy, while *Chhetries* were considered warriors and rulers. *Vaishyas* were regarded as traders (business group) while *Sudras* were impure or untouchable (Dalits), which meant they were destined for manual labor. Water was not accepted from Dalits and physical contact with them required purification through sprinkling water (Hofer, 2004). As a result, ritual pollution and spatial restriction became part of

the Dalits' social identity (DFID and World Bank, 2006). Traditionally, it was illegal for Dalits to receive education, own land and use public services (Haug, et al., 2009). Due to these institutional regulations, Dalits were historically severely discriminated against in Nepalese society.

During the Shah-Rana regime (1846-1951), the Hindu polity was further enacted by the state and this was used as the basis for a more rigid social order (Hachhethu, 2003). The first Civil Code of Nepal – the *Muluki Ain* – was promulgated in 1854, which provided the legal framework for the Vedic prescription of social order in a hierarchical caste system. The Civil Code placed non-caste ethnic groups, such as *Magar*, *Gurung* and *Bhote*, into the fold of the Hindu-based hierarchical caste system and categorized them as middle caste group in the touchable category. The Civil Code accorded differential privileges and obligations to each caste and even discriminated between them in the judicial system by imposing different levels of punishment for crimes and in the distribution of state resources according to the caste hierarchy (Gurung, 1997; Hachhethu, 2003; Bennett, 2005). In general, penal provisions in the Civil Code replicated the caste hierarchy by enforcing the rule, such as the lower the caste, the higher the severity of punishment for the same offence (DFID and World Bank, 2006). In the case of distribution of state resources, the most devastating in this period was the confiscation of traditional *Kipat*[3] land and its redistribution to state elites, who mostly belonged to high castes, particularly *Brahmin* and *Chhetris*. This was made effective through the *Birta*[4] and *Jagir*[5] land tenures which exploited the other ethnic groups (Regmi, 1976). This Civil Code was in practice until 1963.

[3] Customary land tenure system related to the collective right to the land. It also includes land recognized/granted by Ranas to an indigenous group.
[4] Land granted by the state to individuals, usually on an inheritable basis, which was tax exempt.
[5] State land assigned to government employees in lieu of salaries.

The Civil Code of 1854 was replaced by a new Civil Code in 1963. Some radical changes could be seen in the new Code as it recognized the principle of equality of people. It also proposed the legal abolition of caste discrimination. This, however, was hardly translated into practice as it was inconsistent with the value system supported by the constitution and other existing laws in the nation (Dahal, et al., 2002). Moreover, it also contradicted with the 1962 Constitution of Nepal which mentioned that Nepal was a Hindu Kingdom and retained the concept that kingship and the Hindu religion were the core components of Nepali nationalism. From 1962 to 1990 the king directly ruled the nation under the auspices of a party-less *Panchayat* system. Up to 1990, Nepal was under an absolute monarchy, which placed the king above the laws of the nation and, therefore, his decisions remained the overall guiding principle for the nation. Although some improvements were made during this period, the transformation of Nepali people from mere subjects to citizens remained incomplete (DFID and World Bank, 2006).

After the People's Movement of 1990, Nepal entered into a multiparty democratic system under a constitutional monarchy, and a new constitution was promulgated for the Kingdom of Nepal in 1990. This constitution was more inclusive in nature and described Nepal as "a multi-ethnic, multi-lingual and democratic" nation. It also declared that all citizens are equal irrespective of their religion, race, gender, caste, ethnicity or belief. Despite several changes to the system, the constitution of Nepal of 1990 retained the notion of Nepal as a Hindu kingdom and explicitly supported the protection of traditional practices. Even the amendment of the Civil Code in 1992 did not consider traditional practices in religious places as discriminatory. This allowed discrimination against Dalits (untouchables, or 'low-caste') in religious places and other spheres as legal practices. For example, Dalits were excluded from entering temples and shrines, hotels, and from sharing the water sources used by high-caste households. Dalits were discriminated

against at all levels – from the local to the national level. Perpetuation of these types of activities has led to the exclusion of millions of Dalits from the benefits of development achieved in Nepal so far.

In broad terms, the caste-based discrimination suffered by low-caste (Dalits) can be summarized as follows: i) Denial of entry into the house of high-caste households. ii) Denial of services such as wearing a sacred thread and worship. iii) Denial of, or restricted access to, common resources such as water taps and ponds that are used by high-caste households. iv) Restricted access to, or denial of entry into public places such as hotels and restaurants, and participation in public activities like religious functions and government functions. v) Discriminatory practices in labor such as bonded labor (*Kamaiya) and Bista*[6]. vi) Domination over Dalits by requiring them to practice obeisance (*Jadau Pratha*). vii) Social atrocities such as beating Dalits if they deny the social rules. viii) Social boycott such as excluding members of "high-caste Hindu" or Ethnic Groups (considered as middle- caste group by the Civil Code 1854) from society if they marry with Dalits. ix) Attitudinal discrimination against Dalits, for example, non-Dalits believe that the day will be inauspicious if a low-caste person (especially *Kami*) is the first person they see in the morning (Bhattachan, et al., 2002). Moreover, various forms of forced/bonded labor practices like *Haliya*[7] still exist in rural areas, for example, it is tradition in Hindu society that only low-castes plough the land using oxen. Therefore, during the peak farming season, high-caste landlords use debt bondage to secure cheap labor from Dalit laborers. One study (Robertson and Mishra, 1997) stated that the reasons for the continuation of bonded labor include feudalism, landlessness, discrimination, and failure of land reform programs.

[6] *Bista* refers to a kind of patron-client relation between high-caste households and Dalits at the community level. Under this, a Dalit household is patronized by a high-caste household as their *Bista*. So, Dalits must do occupational works as and when the patron needs it. Dalits are paid mostly in kind for their services.

[7] It is a form of forced labor in which Dalits provide their services to high-caste households, especially by ploughing land with oxen. For such labor, Dalits receive wages in kind during harvesting season.

Despite severe discrimination due to the practice of untouchability, Dalits in Nepal were not able to organize themselves and to raise their voices against this discrimination until the mid-1940s (Bhattachan, 2003). The first Dalit Movement started in the 1940s when Dalits in Kathmandu demanded entry to Hindu temples. Since then, the Dalit movement has been continuing, but until 1990 it remained subsumed within the larger struggle for democracy (DFID and World Bank, 2006). In 1990 democracy was established in Nepal, which gave Nepalese people the right to express their opinions and assert their identities. After the establishment of democracy, the Dalit movement gained momentum and was able to obtain support from several international and national non-governmental organizations. The political transition of Nepal into a democratic state, however, failed to establish an inclusive polity because caste-based norms and networks were persistent in the political parties; similar to other institutions in Nepal. In this environment, the Communist Party of Nepal (Maoists) could capitalize on the grievances of the Dalits by setting up the Dalit Liberation Front within the party while starting the war in 1996. One of the major demands of this front was “removing all caste-based discrimination”. The Dalit movement is closely linked to its demand for removing all untouchability practices, sharing national resources and securing higher representation at the different level of government (Hachhethu, 2003; UNDP, 2008). Concerning the practice of untouchability, both the high-caste and non-caste ethnic groups are exploiters of Dalits (Hachhethu, 2003). It is because Dalits suffer indignities and injustices from those high-caste and non-caste ethnic groups such as Newar, Gurung, Magar, Madhesis, and others (Pariyar, 2010).

The social construction of Dalits is primarily related to the division of labor. Traditionally, Dalits were assigned menial jobs with the lowest social status such as cleaning, tailoring, and blacksmith and cobbler work. Considering the wellbeing indicators such as literacy, education

level attained, property, income, health, life expectancy, occupation, and representation in politics, even today Dalits fall far short of the high-caste groups (UNDP, 2008). Despite the fact that many Dalits own land, 80 percent of them only own less than one hectare of land (World Bank, 2006). Dalits comprise nearly 80 percent of Nepal's 'ultra poor' (Pasipanodya, 2008) and compared to high-caste groups (0.441), Dalits have a very low Human Development Index (HDI) of 0.239 (NESAC, 1998). Until 2000, no Dalits were in senior positions in constitutional bodies, cabinet, court or in a party's leadership. This illustrates how they were discriminated against at all levels of government, as well as in other institutions in Nepal. As a consequence, they were more engaged in subsistence agriculture and the informal wage labor market.

The 2007 Interim Constitution of Nepal states that Nepal is a secular nation and thus, there is no longer a legal basis for caste-based discrimination. Moreover, the constitution has also made several provisions to empower Dalits, such as a minimum requirement of Dalit candidates to be included in every political party for elections. The recent political situation also indicates that the Dalit Movement has achieved some success in Nepal. For example, in the Constituent Assembly election of 2008, Dalits were able to obtain a significant number of representatives in the legislature for the first time (Haug, et al., 2009). This has demonstrated their increased participation in politics, implying that their level of awareness has increased a lot.

Dalits are now more organized than ever before and, therefore, the authorities now pay attention to their demands. Several factors, such as the democratization of national politics, an international presence and gradual social changes have contributed to a stronger Dalit movement in Nepal (Haug, et al., 2009). A number of non-governmental organizations are working on improving the situation of Dalits by making them aware of their rights and uniting them to achieve the desired goal of social justice. Despite the official abolition of caste-based

discrimination in 1963, the caste-based social hierarchy has still been functioning in the country, especially in the rural areas. Therefore, the major challenge now is not merely amending the laws but changing the mindset of the people and the *modus operandi* of formal and informal institutions that perpetuate caste-based discrimination. The main requirements are to make society more inclusive and to empower Dalits by improving their access to education and other productive resources.

3. Land issues in Nepal

Land issues, particularly land distribution, land tenure and agrarian reform, have been debated at length in Nepal. In previous Nepalese land policies, agrarian reform was usually defined in a narrow sense and only referred to government-initiated land reform programs. However, agrarian reform is a broader concept which implies an overall redirection of the agrarian system of the nation. Therefore, it includes a broader set of issues such as the class character of the relations of production and distribution in farming and their connections to the wider class structure of the society (Cousins, 2007). As agrarian reform primarily focuses on the political economy of land, agriculture and natural resources, it is associated with economic and political power structures and their connections (Cousins, 2007).

In spite of the fact that the majority of the population earns their livelihood from agriculture, the distribution of land has largely remained unequal, the land tenure system is still feudalistic and agrarian reform is far from adequate. Wily et al. (2008) state that land poverty and socio-economic poverty correlate as expected in Nepal. Furthermore, they also indicate that caste strongly correlates with levels of land holding; and that high-caste households own more and rent less land. Land reforms have been a major agenda item for all political movements in Nepal, especially in the Maoist war which was started in 1996. In order to understand why land remains

such a critical issue, why its distribution is so unequal, and why certain caste groups, especially Dalits, are land-poor, a short journey in Nepalese history is called for.

After the unification of Nepal in 1768 until 1951, the land tenure system in Nepal was extremely exploitative and feudal (Ojha, 1983). Land was either owned by the state (*Raikar*) or by the ethnic communities (*Kipat*). State land was usually allocated to civil and military officials, and members of the nobility received *Birta* tenure, while government employees were paid through the assignment of land under *Jagir* tenure regulations (Regmi, 1971). Furthermore, chieftains of vanquished principalities (former kings of certain territories) were also provided with state land according to *Birta* tenure (Regmi, 1971; Ojha, 1983). In some settlements where strategic location is important due to the possibility of war with the British, *Jagir* tenure was often assigned to military officials (Regmi, 1971). Land was also allotted to a handful of elites such as priests (*Brahmins*), royal family members and their close relatives (*Chhetris* including *Rana* and *Thakuries*), military officers (mostly *Chhetris* and some members of ethnic groups), and tax collectors assigned by the government. Thereby the state forced the majority of cultivators to work as their tenants (Regmi, 1971; Regmi, 1976; Regmi, 1978).

During this period, people who controlled *Birta* land in the village were assigned the political or administrative authority in that village. They were the ones who held the authority to control peasants' access to agricultural land. They used to determine who were allowed to rent the *Birta* land in the village, the amount of land to be rented, rental terms, and the selection and eviction of the tenants (Pandey, 1993; Joshi and Mason, 2008). Land rent could be collected in cash or in kind during any season (Regmi, 1976). Land tax was levied on the basis of a contract and thus contractors were provided full rights to charge any amount that they could collect from the peasant (Regmi, 1976; Joshi and Mason, 2008). The overall system is feudalistic and, as a

consequence, poor tenants were forced to pay more land rent and provide free labor to the government, the local official and the local headman (Regmi, 1971). On the one hand, poor cultivators lacked the money to meet their basic needs and worked as bonded labor for their local masters, and on the other hand, land concentration was a problem with state land due to a lack of a land ceiling (Regmi, 1971; Ojha, 1983). Dalits, who were at the lowest stratum of society, depended on their patrons because they used to work as *Haliya* (a male who ploughs his master's field on an annual contract basis). In many instances, they were like bonded labor (Land Watch Asia, 2009).Their situation can best be explained by a patron-client dependency whereby landed patrons (high-caste households) provide them with access to small pieces of land and other basic requirements for subsistence living, and in return, they are bound to provide their services to the patron (Scott, 1976; Platteau, 1995).

Tenants were severely exploited by the *Birta* tenure system until 1951. Regmi (1976) stated that about 36 percent of the country's farm land was under *Birta* tenure before the 1950s. However, growing dissatisfaction among cultivators led to the peasant's movement in 1950. In several districts, tenants refused to pay land rent in the form of grain payments and started a movement against landlords, particularly against the *Birta* tenure system (Land Watch Asia, 2009). *Birta* tenancy was abolished by the *Birta* Land Abolition Act of 1957 which converted all *Birta* land into *Raikar*. It became effective after the formation of the first democratically elected government of Nepal, the Nepali Congress Government, came into power in 1959. Following this, the interim Constitution of Nepal, 1951 had a provision for guaranteed property rights. This provision made the *Birta* and *Jagir* land holders that had been in place into permanent land holders by securing their private property rights. Although the primary intention of this provision was to strengthen private property rights, it resulted in a highly unequal distribution of land by

institutionalizing the hierarchical relationship between landed elites and peasants (Regmi, 1976; Joshi and Mason, 2008). This was because people who had previously acquired *Birta* and *Jagir* land consisted of government officials, military officers, Brahmins and members of ruling classes (Joshi and Mason, 2008). Increasingly, land tenure security in such cases resulted in the highly unequal distribution of land holding ownership and thereby further aggravated the need for agrarian reform in Nepal.

The peasant's movement forced the government to enact the Tenancy Rights Acquisition Act in 1951. This Act had a provision that tenants would be provided with title to the land on which they paid land tax. However, this provision did not serve its original purpose because the land tax, although collected from tenants, was registered officially in the name of landlords. Therefore, it had just the opposite effect than intended and gave permanent legal title of land ownership to the landlords who managed to pay the land tax (Regmi, 1976). In such circumstances, the land tenancy reform measures that were used in the past remained largely ineffective (Yadav, 1999; Joshi and Mason, 2008; Wily, et al., 2008).

The Land Act of 1964 was the most comprehensive of all measures that had been taken and occupies the central place in land reform legislation in Nepal even today (Wily, et al., 2008). Initially, the Act was implemented over three consecutive years, starting from 1964, and was revised several times. The main objectives were to achieve more equitable land distribution and poverty reduction by redistributing land to small farmers, tenants and agricultural workers. The main components of the Land Act 1964 were: i) abolishing land tax collection by intermediaries (called '*Zamindari Pratha'* in Nepali); ii) imposing fixed ceilings on ownership landholdings, whereby a family could hold an area of 16.93 hectare in *Terai*, 4.07 hectare in the *Hills* and *Mountains*, and 2.54 hectares in Kathmandu valley; iii) fixing land rent as one half of the output

of the main crop; iv) providing compulsory saving by and credit to farmers; v) imposing measures to improve farming practices; and vi) imposing a ceiling on tenancy holdings of land, whereby a family could hold an area of 2.67 ha in the Terai, 1.51 ha in the Hills and Mountains, and 1.02 ha in the Kathmandu valley. The abolition of intermediaries was used as an instrument to reduce the feudal and semi-feudal tenure system. There was also provision to distribute land acquired through the landlord possessing land above the ceiling fixed by the Act. In addition, several supporting laws were enacted to improve the registration of land and tenants.

However, the Land Act 1964 was only partially implemented. As the full implementation thereof took several years, many large landowners were able to circumvent the land ceiling fixed by the Act – either by selling their surplus land or distributing it among close relatives (Yadav, 1999). As a result the government was not able to acquire the amount of land it expected when the program was initiated. Yadav (1999) reported that by implementing the new ceilings on land, as defined in the Land Act 1964, only 31800 hectares of land were acquired, of which only 29100 hectares were distributed among the landless and small landholders. The total land acquired for distribution was therefore less than two percent of total agricultural land in the country (Yadav, 1999; Bhandari, 2006). In addition, all the redistributed land was not received by the intended beneficiaries due to corrupt land administration and the strong alliance between the landed class and bureaucracy (Regmi, 1976; Bhandari, 2006). While assessed in terms of actual land acquired and redistributed to landless and poor, the land reforms program of 1964 did not seem to be effective. However, the program was successful in abolishing the local intermediary (*Zamindars*) system for collecting land tax and as a result cultivators were no longer subjugated to these local intermediaries (Kuhnen, 1971).

Another major area where the land reform program of 1964 had a lot of influence was the tenants' and tenancy regulations. Government initiated a program to identify the real tenants (real cultivators of the land) and grant them formal tenancy certificates. Only 300,000 could be identified and granted tenancy certificates due to the lack of a proper registration system, although there were more than 600,000 tenants in the nation (IDS, 1986). After the implementation of the Land Act 1964, both the number of recorded tenants and the area under tenancy declined. Table 1.1 shows the proportion of tenant households as a portion of the total farm households and area under tenancy as a portion of the total area under cultivation.

Table 1.1 Proportion of Tenants and Area under Tenancy (in percentage)

Description	Year				
	1961	1971	1981	1991	2001
Tenant households	40.4	19.0	9.5	15.9	12.2
Area under tenancy	25.5	15.9	6.2	8.5	8.7

Source: Ministry of Land Reform and Management (2006)

In the first two decades from 1964, the percentage of formal tenant households had substantially declined from 40.4 to 9.5 percent, while it increased slightly after 1981. This decrease was mainly due to the provision of dual ownership of rented land by both landlord and tenant if the formal written tenancy was adopted. Furthermore, this law was later interpreted to mean that the tenant will receive half the tenanted land. The land reform law not only prohibited the eviction of tenants but also restricted the landowner from selling the land under tenancy because it would be under shared ownership of the landlord and tenant. Landlords attempted to circumvent the implementation of the land-to-the-tiller program and the share tenancy contracts of poor tenants became even more insecure than before. This gave rise to informal tenancy, as landlords would make personal agreements with their tenants to not claim tenancy rights through oral contracts (Acharya and Ekelund, 1998). Another reason for the decline in formal tenancy was that most of the tenants were illiterate and thus they were not able to register as a formal tenant within the

time provided by the government. About 560,000 tenants failed to register as formal tenants and lost any claim to their tenancy rights (Land Watch Asia, 2009).

Generally, the provision of sharing the rented land between landlord and tenant increased landlords' tenure insecurity which resulted in them not being amenable to enter into formal tenancy contracts. This forced them to rely on short-term, informal (mostly verbal) contracts due to a for fear that the tenants might claim tenancy rights. This fear has even caused the landlords to keep their land fallow or only partially cultivated and also increased disputes between landlords and tenants. Although figures are contested, it is estimated that nearly 25 percent of cultivable land is reported to be left fallow due to land ownership disputes (Land Watch Asia, 2009). There are no exact records on how much land is under informal tenancy in the country (Yadav, 1999). Recent studies claim that numbers of informal tenants may surpass the number of formal tenants in Nepal (CSRC, 2007; Wily, et al., 2008). This has discouraged both landlords and tenants from investing in land improvements. Studies (Pandey, 1993; Yadav, 1999; Wily, et al., 2008) show that the land reform in 1964 was largely ineffective in achieving its objectives. In essence, there was no significant improvement in land distribution and the land tenure system before 1990 as the country was under an absolute monarchy where the King was above the law; and his close relatives and ardent supporters were often the feudal landlords.

After the people's movement of 1990, Nepal adopted a multi-party democracy system with a constitutional monarchy and thus, the power of the king was substantially reduced. This change created an opportunity to readdress land reform and in 1995 a High Level Land Reform Commission (HLRC) was formed. This commission proposed new provisions for tenancy reform with a target to abolish tenancy by handing over a share of the rented land to tenants to enhance more equitable distribution of land (Wily, et al., 2008). Some of the major recommendations

made by the commission in relation to land tenure were: i) Given that both parties are farmers, land under tenancy will be equally divided between them so that registered tenants should get 50 percent of rented land immediately. ii) If the landlord is not farming the entire land, then all the tenanted land will be handed over to the tenant. In this case, landlords will receive the market value of their share of the land. If the tenant cannot buy the landlord's share of the land, they are allowed to sell it to a third party. iii) Lowering the ceiling of maximum size of landholding ownership. iv) Not permitting the sub-division of land below a minimum farm size by fixing floors (minimum size of landholding) which would apply even when transferring land to tenants. v) Tenancy rights, including the right to receive fifty percent of rented land, would be given to any farmer who had tilled the land for three consecutive years. vi) Tenancy rights would be inheritable. vii) Tenancy rights would be mostly granted to marginal farmers.

The HLRC (1995) also addressed the problem of land fragmentation. In Nepal, private land is equally distributed among all male heirs and land fragmentation has resulted mainly due to this inheritance system. This type of social norm has a significant impact on the rural landscape in many countries (Platteau and Baland, 2001). The Agriculture Perspective Plan of Nepal, initiated in 1996, also recognized agricultural land fragmentation as one of the major constraints to agricultural development and recommended taking action toward consolidating land. Although several reforms had been initiated, the governments from 1996 to 2007 were not able to implement most of the policies as the country was engulfed by the Maoist war.

One of the major demands of the Maoists when they initiated the so-called 'People's war' was scientific land reform. However, during the decade-long war Maoists used force to confiscate land from local landlords and, in many cases, the political ideology of the land owners rather than the size of land they possessed became the grounds for confiscating their land. Many of

these landlords were threatened and intimidated (in the worst cases, they were killed), and many of these households were forced to migrate to urban centers where they could be safer than in the village. The Maoist supreme leader, Prachanda, stated that poor peasants took the initiative in capturing land from different feudal landowners of the country (Karki and Seddon, 2003). During the Maoist war, some poor peasants forcefully seized the land from landlords in many districts across the country. The total amount of land seized was estimated to be about 33,000 ha (Tiejun and Kinchi, 2008).

In the areas where Maoists had overall control during the Maoist war, they embarked on land distribution and collective farming. Maoists did not distribute land to the peasants after they seized land from landowners, as they wanted it to be collectively owned. They focused more on a policy of collectivization, which was similar to the policy adopted in China during the 1950s. However, Maoists need to understand that the policy of collectivization, which requires farm households to surrender their land to collectives, had a negative effect on agricultural production and rural welfare in China (Putterman and Skillman, 1993; Yao, 1999; Lin and Yang, 2000). In order to overcome this problem, China adopted the Household Responsibility System in 1978 that made farm households the residual claimants to output and this policy enormously increased agricultural output and productivity in China (McMillan, et al., 1989; Lin, 1992).

In 2006 the Maoists signed the Comprehensive Peace Accord and joined the multi-party democratic system. Returning the seized land and property was one of the clauses in the Comprehensive Peace Accord. The Maoists, however, have to date not returned the seized land and properties to the respective owners, denying the basic rights of the citizens guaranteed by the Interim Constitution of Nepal. If such illegal activities of the Maoists and their atrocities committed against non-Maoists cannot be stopped, these problems might hinder the

implementation of the all-desired scientific land reform (Pyakurel, 2007). Recently, the Maoists led a forceful land-grabbing movement of both public and private land across the country (Himalayan Times, 2009; Jolly, 2009). This has not only raised the issue of secure individual property rights as stated in the recent constitution of Nepal, but also cast doubt on the Maoists' commitment to democracy, peace, rule of law and basic human rights. Furthermore, it undermined the interim constitution of Nepal 2007 which mentioned that the country would implement a scientific land reform program. The difficult question now facing Nepal is: what constitutes scientific land reform?

In the interim, several non-governmental organizations, such as the Community Self-Reliance Centre (CSRC), the Informal Sector Service Centre (INSEC) and Land Watch Asia, have been working on this issue. It is surprising to see that most of them advocate the 'land-to-the-tiller' policy as a basic objective and consider tenancy transactions as inefficient and feudal. However, recent studies in India (Deininger, et al., 2008; Deininger, et al., 2009) and China (Kung, 2002; Deininger and Jin, 2005; Jin and Deininger, 2009) showed the importance of rural land rental markets and claimed that rental restrictions negatively affect productivity and equity by reducing the scope for efficiency-improving rental transactions. Deininger and Jin (2005) showed that rural land rental markets are more effective in reallocating land than administrative reallocation and thus improving land rental markets has a higher productivity-enhancing effect.

An extensive review of land rental markets in Asia showed that suppression of land tenancy transactions lead to significantly inefficient land allocation among farming households (Otsuka, 2007). Furthermore, the inefficiency of share tenancy is likely to be caused by land reform regulations rather than the inherent difficulties of contract enforcement under share tenancy (Otsuka, et al., 1992; Otsuka, 2007). Removing government's restrictions on land tenancy

transactions only may not lead to equitable operational holding, given that the traditional institution in the form of the caste system prevails (Otsuka, 2007). Therefore, policy makers in Nepal need to design a new land policy focusing on the possible impacts on future land tenancy transactions, land use efficiency and social equity. Acting in a radical fashion and blaming market institutions are not a good basis for designing scientific land reform in Nepal.

Land reform should be viewed from the broad perspective of agrarian reform rather than simply as a 'land-to-the-tiller' program. For a peasant, land reform may simply mean 'land-to-the-tiller', but for a country it refers to a fundamental institution-building instrument to strengthen the overall national economy. The success of land reform in East Asia showed that land reform is not part of any political philosophy like most of the extreme left-wing parties in Nepal used to rely on (Tiejun and Kinchi, 2008). Therefore, the formation of appropriate land policies to improve the efficiency of markets, enhance agricultural investment and increase productivity, requires a more critical understanding of the specific land-market imperfections, their effects on the access to land, and the way they interact with tenure security (Holden, et al., 2009a).

4. Theoretical framework

The theoretical framework of this dissertation is fundamentally microeconomic in nature and, therefore, it studies the behavior of individual economic agents in a given technological, institutional and resource environment (Kreps, 1990). In addition, the overall conceptual framework of the analysis interlinks the political economics-related issues such as land policy reforms and the land tenure system, as well as other institutional issues such as the caste system. Agricultural farm household models are applied as the basic analytical tools for the analyses of land productivity, the farm-size productivity relationship, interrelationships between land and livestock rental markets, and the farm households' investment decisions. Farm households in the

rural areas of developing countries are both producers and consumers of their own products and they therefore have to make decisions regarding their production, consumption and labor supply (Singh, et al., 1986; Sadoulet and de Janvry, 1995). In addition, factor markets in rural areas of developing countries are imperfect (Janvry, et al., 1991; Hoff and Stiglitz, 1993). High transaction costs, which may arise from high transportation costs, search, negotiation, screening, recruitment, monitoring, coordination and enforcement, and imperfect information are the basic factors behind market imperfections (Bardhan, 1989; Hoff and Stiglitz, 1990; Hoff and Stiglitz, 1993; Sadoulet, et al., 1996; Holden, et al., 2001). Under market imperfections, farm households' consumption and production decisions become non-inseparable and have to be made simultaneously (Singh, et al., 1986; Janvry, et al., 1991; Sadoulet and de Janvry, 1995). Production and land-related investment depend on a wide variety of factors, including agro-climatic and land quality variables. However, under factor market imperfections, households' initial resource endowments and household characteristics also affect their production, investment, and market participation decisions (Sadoulet and de Janvry, 1995; Pender and Kerr, 1998; Holden, et al., 2001). Under labor market imperfections, households with more labor endowments are more likely to use labor-intensive farming practices and technologies. A study by Pender and Kerr (1998) in India showed that labor market imperfections lead to differences in land conservation investment among farm households and, thus, households with more male labor endowment invest more in soil and water conservation.

Under perfect markets, efficiency is not affected by the distribution of asset ownership. If not all markets are functional, transaction costs establish a linkage between asset ownership and efficiency in resource use (Sadoulet and de Janvry, 1995). Under such circumstances, redistribution of assets can be an important policy tool in improving efficiency of resource use.

Small and big farmers confront different factor prices due to imperfections in factor markets (Ellis, 1993) and, thus, in the absence of capital intensive farming systems labor-rich small farmers may cultivate their limited land more intensively than land-rich farmers leading to a productivity differential between small and large farms (Otsuka, et al., 1992). This justifies the land reform program that redistributes land to small family farms as a tool for enhancing both efficiency of resource use and equity in resource distribution. Several empirical studies showed that small, family-owned farms have efficiency advantages over large farms (Sen, 1962; Berry and Cline, 1979; Bhalla, 1979) because large farms usually face high transaction costs in managing hired labor (Eswaran and Kotwal, 1985; Feder, 1985).

Imperfect information and high transaction costs may also give rise to the interlinkage of markets, such as share tenancy (Stiglitz, 1974). A sharecropping contract is considered a mechanism for risk sharing (Cheung, 1969), a way for screening tenants (Newbery and Stiglitz, 1979) and a mechanism to overcome market imperfections other than that of land (Eswaran and Kotwal, 1985). An analysis of the type of contract between landlord and tenant elucidates the unequal relationship of the principal to the agent (Sadoulet and de Janvry, 1995). Sharecropping is thus assumed to be a second-best solution. In theory, sharecropping is associated with Marshallian inefficiency which indirectly calls for government intervention to improve efficiency. In practice, efficiency losses due to sharecropping were found to be relatively small, implying that efficiency improvement through government action is questionable (World Bank, 2003).

Poverty may also influence a household's production and investment decisions. Empirical evidences from several studies (Pender, 1996; Holden, et al., 1998; Yesuf, 2004) show that the poor discount the future at higher rates than wealthier people, and thus the results are consistent

with the downward spiral hypothesis. In addition, some studies in Ethiopia (Shiferaw and Holden, 1998; Holden and Shiferaw, 2002) show that higher discount rates and lower willingness to pay for conservation are closely associated. While responding to transitory income shocks the rural poor in developing countries, who often lack access to liquid savings and access to credit, are more likely to compromise their future income prospects which they might achieve by conserving resources (Barrett, et al., 2002). However, high discount rates are not the only factor through which poverty might affect land-improving investments and overall environmental degradation (Nkonya, et al., 2008).

Poverty may affect decisions on land investment by influencing on households' attitudes toward risk (Ekbom and Bojo, 1999). The possible impact of differences in risk aversion on land investments rests on whether land investments are risk increasing or risk decreasing. Studies show mixed results on whether poor people are more risk averse or not. Some studies (Binswanger, 1980; Cardenas and Carpenter, 2005) found no relationship between households' degree of partial risk aversion and wealth. In northern Ethiopia, poorer households are found to have higher risk aversion which is associated with less investment in soil and water conservation (Hagos and Holden, 2006). Furthermore, a household that is not poor according to the traditional definition of welfare poverty can be poor in terms of investment. Investment poverty prevents the households from investing in resource conservation (Reardon and Vosti, 1995).

Imperfection in nonland factor markets creates the potential for land markets to enhance production efficiency (Holden, et al., 2009a). Even if the labor market fails, well-functioning land markets can promote efficiency-enhancing land transfers (Deininger and Binswanger, 1999). However, missing or imperfect capital and insurance markets lead to unfavorable conditions for participation in land sales market and, therefore, potential benefits from land

transfers through land sale may not be realized in rural areas of developing countries (Sadoulet, et al., 2001). As credit markets are highly imperfect in rural areas, poor farmers may be rationed out from credit transactions due to lack of collateral. This limits the possibility of poor households to participate in the land sale market. Moreover, as land can be used as collateral to obtain credit, its price often exceeds the present value of future farm profits accrued to land by the amount of benefit accrued using the land as collateral (Otsuka, 2007). That is why imperfections in other markets increase the value of land, which is higher than the capitalized value of the stream of farm profit (Binswanger, et al., 1995) and thus limits the possibility of the poor buying land. As land sale transactions are predominantly governed by wealth difference rather than relative factor endowments of farm households, poor small farmers may not be able to purchase land, even if they are more efficient than large ones (Otsuka, 2007).

The land rental market is therefore an alternative arrangement for enhancing efficiency in the context of missing or imperfect markets. Land rental markets are less affected by credit market imperfections and may have lower transaction costs than private land sale markets (Deininger and Binswanger, 1999). Land rental markets also provide flexibility in the adjustment of land holding by temporarily transferring land from land-rich to land-poor households without the landlord risking the loss of land (Sadoulet, et al., 2001). The dominance of land tenancy transactions can be attributed to the relatively less efficient functioning of land sales and labor market transactions than that of the land tenancy market (Skoufias, 1995). Due to high cost of supervision and enforcement of hired labor in certain critical tasks in spatially dispersed and ecologically diverse agricultural environments, labor market transactions are unlikely to lead to efficient resource allocation (Hayami and Otsuka, 1993; Otsuka, 2007).

The efficiency and equity advantages of the land rental market can be questioned when transaction costs in these markets are sufficiently high (Coase, 1960). High transaction costs cause land rental market imperfections and, in these circumstances, adjustments through the land rental market cannot compensate for the imperfections in other factor markets (Bliss and Stern, 1982; Skoufias, 1995). In the study of the land rental market in rural India, Skoufias (1995) found high transaction costs. The allocative inefficiency of the land rental market may therefore partly explain the inverse relationship between farm size and farm productivity (Carter, 1984; Otsuka, 2007; Holden, et al., 2009b; Yamano, et al., 2009) because in the absence of capital intensive farming systems labor rich small farmers may cultivate their limited land more intensively than land rich farmers (Otsuka, et al., 1992).

Another issue which is often debated is the efficiency of land use under sharecropping tenancy. Disincentive effects of output sharing (Marshallian inefficiency) and tenure insecurity are the most frequent reasons cited for the inefficiency of share tenancy. The Marshallian inefficiency view of share tenancy assumes that it is prohibitively costly for a landlord to observe and enforce a tenant's work and, consequently, there is the possibility of labor shirking by the tenant (Otsuka, 2007). Given the nature of agricultural production, monitoring and enforcing a tenant's work effort is not an easy task for a landlord. If this can be done without cost, the landlord can observe and enforce a tenant's work effort at the desired level (Otsuka and Hayami, 1988; Otsuka, 2007). In a real world situation, the Marshallian assumption of prohibitively costly enforcement seems too restrictive and Cheung's assumption of costless enforcement is far from realistic. Monitoring efficiency depends on several factors such as the landlord's ability, farming experience, size of the holding, residential proximity and technology of production. Likewise, the probability of detecting a tenant who shirks work increases with the degree of shirking and a landlord's

supervision time (Otsuka, et al., 1993). In many cases, threat of eviction can be a weapon which forces the tenant to provide maximum work effort and produce more. Therefore, theoretical arguments are on both sides consider the efficiency of share tenancy as an empirical issue. Empirical studies are also mixed.

In the theoretical framework adopted by this study, ideas are drawn from the review of Otsuka (2007) and the existence of Marshallian inefficiency, allocative inefficiency of land rental market and an inverse farm size–productivity relationship are assessed concurrently. Because the reason is that if share tenancy is inefficient, it is more likely that the land rental market is inefficient in allocating land among farm households. This is due to the presence of high transaction costs and, as a result, an inverse farm size–productivity relationship may appear. Investment decisions about land may also be affected if the inefficiency of share tenancy is due to tenure insecurity. The theoretical framework for this dissertation is primarily developed on the basis of the above-mentioned issues. Figure 1.1 below summarizes the discussion presented so far.

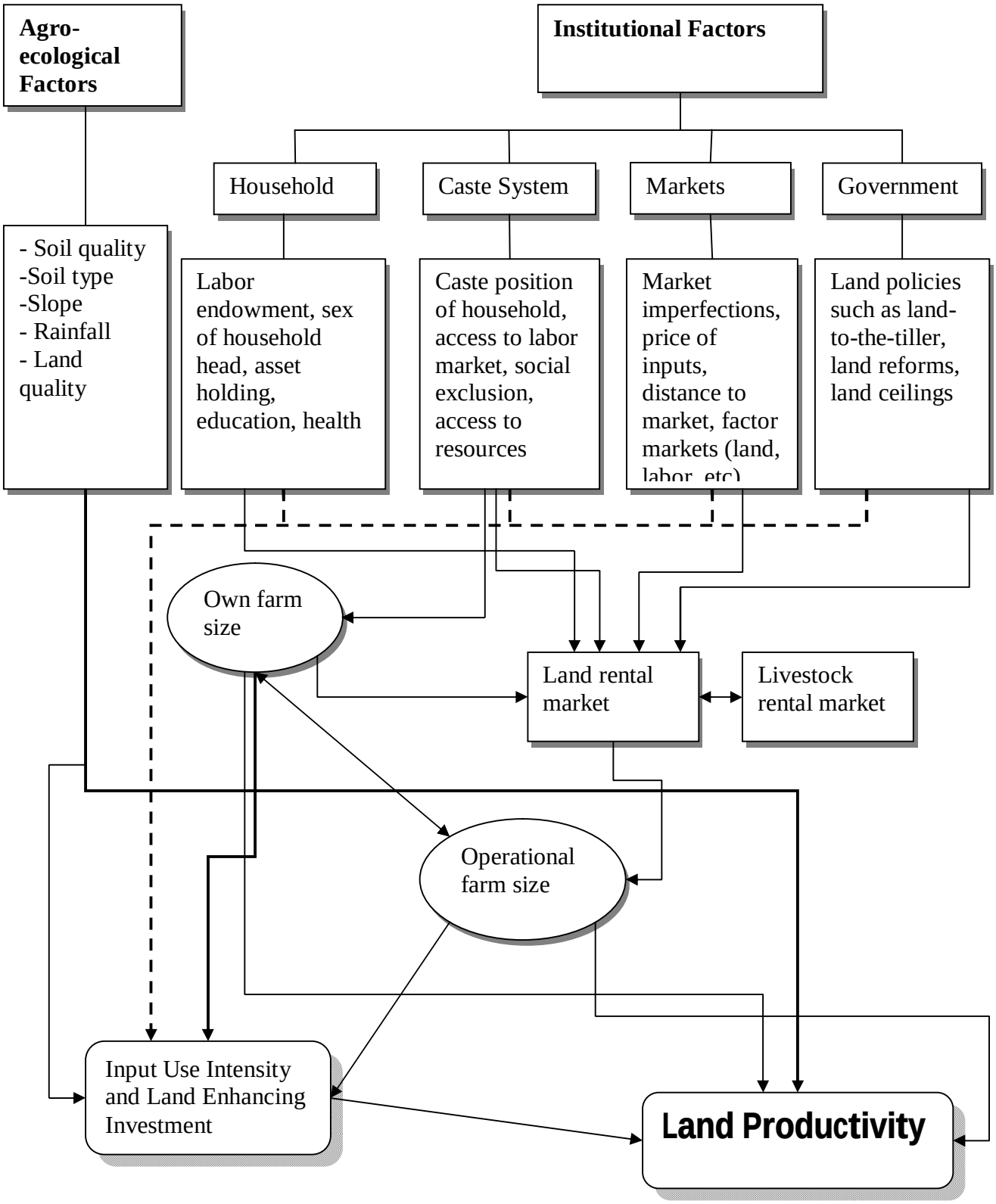

Figure 1.1: Schematic presentation of factors influencing land productivity, input use intensity and investment

5. Data and methods

Data for this study were collected from 500 households in the Mardi watershed area of the western hills region of Nepal in 2003. In the watershed area, three Village Development Committees (VDCs), namely Lwang Ghalel, Rivan and Lahachok, were selected as the field area for the study. Of the 500 households, this dissertation used information from 489. The information from the remaining 11 sample households was discarded due to inconsistency. Table 1.2 below presents the total households, population, and caste distribution in sample villages, and the sample size of this study.

Table 1.2: Population and sample selection for the study

	Total households		Total population		Caste distribution		Sample size	
VDC	Number	Percent	Number	Percent	High (%)	Low (%)	Number	Percent
Lahachok	721	36.2	3801	34.8	77.8	22.2	177	35.4
Rivan	334	16.8	1749	16.0	85.5	14.5	83	16.6
Lwang-Ghalel	935	47.0	5375	49.2	77.0	23.0	240	48.0
Total	1990	100	10925	100	80.1	19.9	500	100

Source Annapurna Conservation Area Project Report (1999)
Note that we have divided all households into high-caste and low-caste for the analysis. High-caste households include Brahmins, Chhetries, and Ethnic groups (Gurung and Magar), whereas low-caste households include all Dalits (Damai, Sarki, Gandharva and Kami).

Based on the study carried out by the Annapurna Conservation Area Project (Annapurna Conservation Area Project (ACAP), 1999) and the list of all households that were obtained from the Village Development Committee offices, a complete list was compiled of all households in the selected VDCs. Using that list, the sample households for this study were selected randomly. Of the total households in the sample villages, about 25 percent were sampled. The sample size is assumed to be representative of the study area.

A structured questionnaire was designed in order to record the required information (see Appendix 1). The questionnaire was pre-tested in Rivan and changes were made following the

testing. Local school teachers, who were employed as enumerators, were trained and also participated while pre-testing the questionnaire, which was intended to enable them in understanding the real intentions of the questions and the objectives of the survey. Using local teachers as enumerators helped to improve the quality of data as they had more knowledge of the local farming system, local measurement units and the socio-cultural norms.

The data were collected both at household and at plot levels. The household level data covered a wide range of household characteristics such as household composition, consumption expenditure, income from different sources, sales and purchases, credit, and household preferences. The plot level data included the biophysical characteristics of the plot, plot trade information, input applied in the plot, type of crop, and production at plot level. Therefore, at the household level the sample size is 489 households, whereas the plot level sample size is 1131 plots operated by 489 households. The major characteristics of the sample households by caste are presented in Table 1.3 below:

Table 1.3 Major characteristics of sample households by caste

Household Characteristics variables	High-caste HHs	Low-caste HHs	All sample HHs	Test
Male head dummy (%)	20	65	30	82.72***
Literate head (%)	35	19	31	10.40***
Ownership land holding (in hectare)	0.64	0.17	0.53	8.83***
Operational land holding (in hectare)	0.63	0.35	0.56	5.86***
Net land leased-in (in hectare)	-0.01	0.17	0.03	4.96***
Farm income (in Rs.)	32034.9	15312.3	28375.83	5.57***
Remittance income (in Rs.)	20126.9	3448.6	17365.03	4.41***
Total income (in Rs.)	72360.3	30928.85	63294.4	8.02***
Value of asset (in Rs.)	38581.22	15173.4	33459.3	8.29***

Note: Test shows the difference between high-caste and low-caste households. We used t-test for continuous variables and chi-square test for categorical variables.
Significance levels: *: 10% level, **: 5% level, ***:1% level

From Table 1.3 it is clear that low-caste households in the study area are land poor households compared to high-caste households. Similarly, average farm income of high-caste households is

more than double that of low-caste households. Although the difference in operational land holding is smaller than with ownership land holding, it is still highly significant. An overall comparison of asset holding and total household income per annum shows that low-caste households are poorer both in terms of income and major asset holding such as land.

Both non-parametric and parametric methods were employed in the empirical analysis. The non-parametric methods included stochastic dominance analysis, matching methods, and local polynomial regressions, while the varieties of parametric methods such as fixed and random effects regression models, bivariate ordered probit models, and Tobit and variants of Tobit models (double hurdle and selection models) were applied. Since there are multiple plots per household, panel data methods were applied. Random effects (RE) models were used for most of the empirical analysis where the variable 'caste' was analyzed. This was necessary as caste is a plot invariant variable and fixed effects (FE) models cannot be estimated; such models could otherwise have been used for controlling the intra-group correlation which may arise due to unobserved cluster effects (Udry, 2000; Wooldridge, 2002). However, in the econometric analyses where separate models for high-caste and low-caste households were estimated, household fixed effects models were applied. Furthermore, the analysis is done within the limitations set by cross-section data. For example, historical patterns in caste discrimination were not taken into account, which could have been done by including lagged dependent variables in the case of panel data; this would also have helped to control for some omitted variables (Wooldridge, 2003). For similar reasons, dynamic issues such as the impact of risk or shocks on productivity and productivity enhancing investment could not be captured in the analysis.

In the case of plot level analysis, selection biases that might arise due to unobservable plot characteristics were controlled for. A Heckman-type selection model was used to achieve this.

First, in the case of plot selection for tenancy, the Inverse Mills Ratio (IMR) was estimated from probit models run on the rental status of the plots, and then the IMR was included as an RHS variable in the second-stage models. The Heckman-type selection models rely on the normality and homoskedasticity assumptions and are sensitive to any violation of these. While doing this, some variables from the first stage were excluded at the second stage in order to satisfy the exclusion restriction. This is done because relying only on nonlinearities for identification has become less acceptable practice recently. For all models with IMR and other predicted variables, bootstrapped standard errors were generated using 500 replications and by re-sampling households to obtain corrected standard errors.

This study used the household as basic unit of analysis. A household is comprised of a group that shares the same abode or hearth and who reside and eat in one house and work in the same group. A household, rather than an individual, is thought to be the decision-making unit in this case. In defining a household, the key element is to identify the decision-making unit which sets the strategy with regard to income generation and allocation of income for consumption and reproduction (Sadoulet and de Janvry, 1995). However, the resource allocation inside the household was not dealt with in this study and, therefore, it does not explain any intra-household resource allocation decisions, bargaining between household members and their possible impacts on resource use decisions.

The data were collected during the period when the Maoist war was at its peak. Therefore, questions related to Maoists' influence and other political issues were avoided for security reasons. In addition, many other surveys had been carried out in the same area and this might have had some negative influence on the households. Some households even enquired about the benefits of this study and complained that there were several similar studies but that those studies

had neither changed their lives nor appreciably helped to develop the area. This might have reduced the motivation to provide comprehensive information. Often it is difficult to obtain reliable information of income and expenditure as the households in rural areas do not keep account of it. Therefore, in many cases, there were no alternative than to rely on what they could recall from memory. This could lead to under- or over-valuation of the property or the asset holding. Despite this, the strength of the survey is that the researcher is fully acquainted with the area as fieldwork in the same area was done while collecting data for an MSc dissertation. Moreover, all households were very cooperative, none refused to be interviewed and none demanded anything in return for providing the information.

6. Summary of the research findings

This section presents a summary of the papers highlighting their objectives, methodology, empirical findings and main contributions.

Paper I: Caste, Land and Labor Market Imperfections, and Land Productivity in Rural Nepal

This paper assessed the caste-related land productivity differential in rural Nepal and looked for its possible explanations. For the purpose of analysis, sample households were divided into two major groups: high-caste households and low-caste households. High-caste households comprised all castes/ethnic groups except the *Dalits* (former untouchables), whereas low-caste households consisted of all *Dalits*. This division is essential because the gap between high-caste and low-caste households with regard to access and ownership of resources is very wide in Nepal. Furthermore, as rural farm households face multiple market imperfections, the distribution of asset can have impact on efficiency of resource use.

For empirical analysis we used both non-parametric and parametric methods. Stochastic dominance analysis and propensity score matching were the main non-parametric methods while the household random effects regression methods were used for the parametric analysis.

We first tested whether the initial assumptions of the theoretical models are correct. The main theoretical assumption that were empirically tested in this paper are: i) Low-caste households have lower land endowment, poor access to skilled off-farm employment, and are more likely to rent in additional land and work as agricultural laborer. ii) High-caste households are more likely to rent out land and/or hire in agricultural labor to balance land and labor endowments. iii) Sharecropping is associated with Marshallian inefficiency. After this, we tested following hypotheses. i) Land productivity is higher on owner-operated land of low-caste households than on owner-operated land of high-caste households. ii) Land productivity is higher on rented-in land of low-caste households than on owner-operated land of high-caste households.

The results show that about 60 percent of high-caste households hired in agricultural labor while about 20 percent rented out land. Nearly 83 percent of low-caste households participated in the agricultural labor market (seller) while 50 percent of them rented in land. This indicates that the adjustment of land and labor endowments is common through the labor market than through the land rental market. Low-caste household were found to have significantly higher land productivity on their own land (28 percent higher) as well as on their rented in land (21 percent higher) as compared to own land of high-caste households. Another major finding is that there is no significant Marshallian disincentive effect in the case of low-caste tenants. This indicates that transaction costs in labor market dominate over the disincentive effects of sharecropping.

One of the major reasons for this difference in land productivity between high-caste and low-caste households is the existing agricultural production system. Agricultural production system

in the study area requires substantial labor for activities like tiling land, managing land, applying manure and fertilizer, carrying inputs to plots, water management, and harvesting. Given this, households with relatively more family labor endowment per unit of land are able to achieve higher land productivity by applying more labor to cultivate land intensively. Although households with less family labor endowment can hire in labor but in a spatially-dispersed agricultural setting, hiring labor is associated with search, monitoring and enforcement costs. This indicates that higher transaction costs in the labor market as a possible explanation for productivity differential. On the other hand, a household with less endowment of family labor can rent out land. However, the land rental market is not fully compensate for the labor market imperfections

Difference in the opportunity cost of labor is another major reason for the land productivity difference between low-caste and high-caste households. Due to discrimination in non-agricultural labor markets, especially in regular off-farm employment, low-caste households have lower opportunity cost of labor. As a result, they concentrate their labor in farming and in the seasonal agricultural labor market.

The persistence of a productivity differential even after participation in the land rental market is an indication of imperfections in the land rental market, as well as in other factor markets. The family labor endowment was found to have a significantly positive association with land productivity in all models, implying that family labor is a crucial factor in rural farming. This also indicates the imperfection in agricultural labor market. Therefore, improving markets, especially the land rental market, by enhancing tenure security could be an important policy for enhancing efficiency in production.

The major contribution of this paper is that this is the first empirical study which assesses the impact of caste on the land productivity differential. In addition, this paper contributes to theory by demonstrating how labor market imperfections affect land productivity.

Paper II: Caste, Marshallian Inefficiency and Farm Size–Productivity Relationship

This paper assessed the association between Marshallian inefficiency in sharecropping, allocative inefficiency in land tenancy transactions and an inverse farm size–productivity relationship, and indicated how these phenomena were associated with caste discrimination in Nepal.

The main hypothesis of the study were: i) Marshallian disincentive effects lower land productivity on rented (sharecropped) land than on owner-operated land of tenants, ii) low caste households have higher land productivity than high-caste households due to low opportunity cost of labor, iii) Marshallian disincentive effects in sharetenancy contracts is responsible for the inverse relationship between farm size and land productivity, and iv) The inverse relationship between farm size and land productivity is caused by high transaction costs in labor and land rental markets.

Both parametric and nonparametric methods were employed for the empirical analysis. Propensity scoring and matching methods (kernel matching and nearest neighbor matching), local polynomial regression (nonparametric regression), and household fixed effects and random effects models showed that Marshallian inefficiency was significant in the case of high-caste households only. There were significant transaction costs on both sides of the land rental market and the transaction costs were found to be higher for tenants than landlords. An inverse farm size–land productivity relationship was found using the farm level as well as plot level data. The inverse farm size–productivity relationship was significantly stronger for high-caste households

than for low-caste households. Although low-caste tenants are found to be more efficient than high-caste tenants, many high-caste households still rent land to other high-caste households. There are two possible reasons for this. Firstly, land-rich high-caste households feel insecure due to the past land-to-the-tiller policy. This tenure insecurity causes them to rent to those tenants who are close relatives in order to reduce the probability of land loss. Their main objective is to reduce tenure insecurity rather than to seek efficient tenants. Secondly, the Maoists did not only strongly lobby for the land-to-the-tiller policy, but also grabbed land by force from some of the landlords. Due to a fear for this, landlords rent land to less efficient high-caste households which results in less efficient land use. For the same reason, less land is available to low-caste households. Therefore, caste discrimination and allocative inefficiency of tenancy transactions, rather than Marshallian inefficiency, appeared to be a more important explanations for the inverse relationship.

The major contribution of the paper is that it provided a joint assessment of Marshallian inefficiency, allocative inefficiency and an inverse farm size–productivity relationship, and indicated how these phenomena were associated with caste discrimination in Nepal. This was a gap in research as most previous studies dealt with these issues separately (Otsuka, 2007). A joint study of these issues has led to a clearer understanding of the fact that an inverse farm size–land productivity relationship is possible when the land rental market does not work properly; given that the initial distribution of land was unequal due to caste discrimination. Due to the presence of transaction costs, land rental markets are inefficient and, thus, land transfer through the use of the land rental market is less than optimal. This means land-labor ratios, as well as other factor ratios, are not equalized across farm households even after adjustments made through the land rental market. This is one of the main reasons for the inverse correlation in

efficiency of farming between large and small farms driven by the difference in the endowed family labor-land ratio (Otsuka, 2007). In addition, it was also revealed that the promotion of tenancy transactions through improving tenure security can reduce the inefficiency of share tenancy. Fears of the past land-to-the-tiller policy and Maoist insurgency, which supported a similar land policy, have distorted the land rental market, hindered the possible land transfer to efficient low-caste farmers via the land rental market and led to an inverse relationship between farm size and land productivity.

Paper III: Caste Differentiation and Livestock Rental Market Participation in Rural Nepal

This paper examined the factors that drive the livestock rental market participation of farm households using data from rural Nepal. Despite problems such as moral hazard, making livestock rental markets missing or very rare, the data reveal that households in the study area have participated in livestock renting. This was a puzzle that needed to be solved. In addition, the paper also assessed whether a relationship existed between the livestock rental and land rental markets and what the nature of this relationship was.

One of the main hypotheses of the study was that amount of livestock rented in (out) decreases (increases) with ownership holdings of livestock and land. Furthermore, given that low-caste households are relatively poorer in land and livestock, they are more likely to rent in livestock (+rent in more) and less likely to rent out livestock (+rent in less). It was also hypothesized that labor-poor households are more likely to rent out their livestock holding (+rent out more) and less likely to rent in (+rent in less) than labor-rich households. The hypothesis that migration is positively correlated with renting out livestock (+rent out more) and negatively correlated with renting in livestock (+rent in less) was also tested.

Double hurdle models and bivariate ordered probit models were employed for the empirical analysis. Double hurdle models were separately applied on both sides of the livestock rental markets. Results show that low-caste households were more likely to rent in livestock than high-caste households; this is similar for male-headed households and households with more male labor. Caste, however, did not affect the likelihood to rent out livestock. The more the livestock owned the propensity to rent in livestock decreased. Owned livestock holding only affected the amount rented out but not the likelihood of renting. Larger ownership land holding was associated with a higher amount of livestock rented out. Households with migrated members were less likely to rent in and more likely to rent out livestock. Migration reduced the amount of livestock rented in and increased the amount rented out. This indicates that the livestock renting phenomenon is driven by inequality in land holding size and out-migration of high-caste adult males in particular. A bivariate ordered probit model showed a significant positive association between the decision to participate in livestock and land rental markets, respectively.

The rental markets for livestock and land were found to have improved resource access for resource-poor low-caste households that are also discriminated in labor markets and may also be rationed out of credit markets. The livestock rental market therefore serves as a substitute for the credit market, allowing low-caste households to benefit from crop-livestock interactions. Overall, differences in resource endowments and in the access to factor markets between high-caste and low-caste households are observed to be important reasons for the emergence of livestock rental markets. Therefore, while designing policies for promoting agricultural productivity in rural areas, the complementarities between factors of production, mainly livestock and land should not be ignored.

The paper contributes by analyzing jointly the decisions to participate in land rental and livestock rental markets.

Paper IV: Caste, Investment and Intensity of Production

This paper assessed whether investment and intensity of production differ between high-caste and low-caste households in rural Nepal. It related the caste issues to poverty as low-caste households are poorer than high-caste households in terms of income and assets (particularly land). The differences in short-term investments were analyzed in terms of fertilizer use and manure use, while the more long-term investments were analyzed in terms of terrace maintenance expenditure and intensity of cropping.

The study empirically tested the following hypotheses. i) Low-caste households are land-poor and less able to invest as compared to high-caste households, ii) Low-caste households depend more on agricultural production on limited land and therefore invest more per unit of land to increase their land productivity, iii) Access to off-farm income is associated with lower investment in conservation, iv) Low-caste households have lower opportunity cost of labor due to discrimination in the labor market and thus, invest more, and v) Lack of off-farm employment in combination with land poverty causes low-caste households to be less able to invest in intensification.

The probability and level of fertilizer use, manure use and terrace maintenance expenditure were analyzed using double hurdle models. Intensity of cropping was assessed using an ordered probit model. The results show that low-caste households are more likely to apply manure. Likelihood to use fertilizer and to adopt conservation investment is not significantly different between low-caste and high-caste households. However, amount of fertilizer used is significantly lower among the low-caste households. Households with access to off-farm employment are found to have

significantly lower likelihood to invest on land conservation. Caste was found to have a significant impact on cropping intensity. In addition, male-headed households, and households with more male labor endowment relative to ownership land holding, were found to invest more in land conservation.

The results of this paper have important policy implications: unlike in the conventional approach, poverty should not be taken to have a negative impact on land-improving investment. It rather reveals that while assessing the impact of poverty on land-improving investment, the focus should be on the type of asset poverty, because the relative endowment of different assets can have different effects on land-improving investment. Moreover, not only the type of asset poverty, but also the type of land-improving investment matters in explaining their impact. The possible effects of differences in resource endowment as well as access to markets need to be considered while designing policies and incentive structures for enhancing conservation investment.

This paper contributes to research by using broader concept of poverty in studying the impact of poverty on land-improving investment by farm households.

7. Conclusions and policy recommendations

7.1 Conclusions

The main conclusions of the study can be summarized as follows:

1. Caste still represents the main class hierarchy in rural Nepal. Low-caste households remain poorer than high-caste households in terms of income as well as holding of other economic assets such as land and livestock. Furthermore, due to a lack of education, family networks and the presence of caste-based discrimination, low-caste households participate less in regular off-farm employment. The initial distribution of land is not only

inequitable but also biased against the low-caste households. Moreover, the effect of caste on the land productivity differential is explained by historical socio-economic and political structure which has resulted in differences in access to land and regular off-farm employment outside agriculture. Limited opportunities outside the farming sector have forced low-caste households to concentrate their labor on farming on their own small plots or the limited land that they have been able to rent.

2. Empirical results show that low-caste households are more productive than high-caste households. The productivity differential between high-caste and low-caste households remains significant even after the participation of households in the land rental market. The major reasons for this are inequalities in the initial wealth distribution, and labor and land market imperfections. Low-caste households that are more subsistence constrained are found to have applied more labor per unit land and thus they are more productive.
3. An inverse farm size–productivity relationship is observed. High transactions costs in the land rental market and caste discrimination are the main identified causes of an inverse farm size–productivity relationship in the study area. This result also suggests that the land rental market needs to be improved and caste-based discrimination reduced in order to enhance land productivity. In addition, this result calls for land redistribution to enhance land productivity.
4. Many high-caste landlords are found to have rented out land to other high-caste households in spite of the fact that low-caste tenants are more efficient. This indicates that the inefficiency of share tenancy is more likely a consequence of the Maoist war and the land-to-the-tiller policy that they advocate rather than the inherent difficulty of enforcing contractual terms under share tenancy.

5. Availability of household male labor, less migration, land poverty, and male headship appeared to jointly drive the renting in of land and livestock in rural Nepal. Differences in resource endowment and in the access to factor markets between high-caste and low-caste households are found to be the important reasons for the emergence of livestock rental market in the study area.
6. Land-poor households were found to have invested more in conservation per unit of land. This may, however, be due to the labor-intensive nature of terrace maintenance and generalizing this conclusion could be dangerous. On the whole, the results contradicted the conventional downward spiral hypothesis which claims the poor invest less in conservation. Another reason why the poor may invest more in conserving the land is their higher dependency on it for their long-term livelihood. It means small farmers are not only more productive but also manage land more sustainably. In such a situation, land redistribution justified on the grounds of equity and efficiency is also justified in terms of better management of natural resources, especially land management. However, the results of the study need further scrutiny because the lack of a significant negative effect of poverty on investment could be due to the fact that it has been covered up by the negative effect of tenure insecurity on investment for high-caste households. The land-to-the-tiller policy and the Maoist's focus on a similar policy have created tenure insecurity among landlords.

7.2 Policy recommendations

Based on the findings of the study, the following policy recommendations can be suggested:

1) **Design a new land policy**: Due to past land policies which give a tenant the legal authority to claim ownership rights on 50 percent of the rented land, many landlords are not willing to

rent out land to efficient tenant households. The land reform policies of 1964 and subsequent policies did not focus on making the land rental market efficient or how to improve agricultural productivity. Those policies were focused on how to benefit a tenant through the expropriation of land in tenancy and to gain access to ownership. As a result of this policy, tenant households are not able to gain access to more land because landlords fear renting out land. Therefore, land rental market participation alone cannot increase access to land for the land-poor households. In addition, given that the initial distribution of land is not only inequitable but also favors high-caste households due to traditional restrictions faced by low-caste households in ownership holding of land, there is a need for a new land policy which can properly address the distributional issues related to caste.

2) **Need to address overall agrarian reforms**: Almost all political parties in Nepal consider land reform a magic solution to deal with all the problems related to the distribution of land, disregarding the fact that the past land-to-the-tiller reform failed to achieve the stated goals. Nonetheless, land reform has once again become a political agenda for the government. None of the major political parties focus on how land reform can be addressed as a part of overall agrarian reform. Moreover, in order to understand the characteristics of agriculture in rural Nepal, the analysis of the relationship between caste groups, their power relations, their differential access to resources, and the opportunity structures are integral. Without a proper analysis of these factors, the complete picture of agrarian relations in Nepal cannot be painted. Any land policies which disregard these issues are more likely to fail.

3) **Improving the land rental market**: Land tenancy transactions have been considered a feudal and inefficient system in the previous land policies in Nepal and, thus, past land

reform measures have not achieved the intended effect in the form of more equitable land distribution. Even now the pro-communist parties in Nepal still focus on similar land policies and disregard the changing context of the Nepalese economy. As the share of remittance in the total economy has been increasing over time, the efficient operation of the land rental market is absolutely crucial to enhancing land productivity. Given that it is not possible to relocate all family members when the principal member of the household migrates temporarily to the cities or abroad in order to earn off-farm income, suppressing the land rental market does more harm in the rural context. Furthermore, reallocation of land by the government is a time-consuming and a costly process, which cannot address the need of short-term nonland factor adjustments by the farm households. This also calls for an efficient land rental market. In order to improve the land rental market, the following reformations are necessary:

Remove dual ownership of land

The land rental market in Nepal has been severely distorted by the implementation of the Land Act 1964, which provides for dual ownership of rented land for landlord and tenant. This provision has increased tenure insecurity among landlords which, in turn, restricts the efficient functioning of the land rental market. There is a need to end the system of dual ownership of land.

Remove the provision that a tenant can claim ownership rights on rented land

According to the past land-to-the-tiller program, tenants can claim half of the rented-in land if they till the land for three consecutive years under a formal contract. This made long-term land rental contracts more insecure for landlords and they preferred informal, short-term

contracts. On the other hand, short-term rental contracts provide fewer incentives for users to undertake land-related investment. In order to make long-term contracts feasible, providing a higher level of tenure security is critical. Therefore, finding ways to ensure such tenure security is a key policy requirement.

Remove restrictions on the amount of land involved in tenancy transactions

Another major constraint facing the land rental market in Nepal is that there is a legal restriction on the amount of land that can be rented out. For example, according to the Land Act 1964, a tenant household can rent in only 2.7 ha in the Terai region, 1.5 ha in the hills and 1.02 ha in the Kathmandu valley. There is a need to remove such restrictions to enhance enable more efficient functioning of the land rental market. These restrictions have a negative effect on the ability of landless households to obtain land through the land rental market.

Increasing tenure security

Past land reform measures weakened the property rights of landowners by the provision that rented land should be divided between landlord and tenant. There is a need to draft rules for tenancy contracts in such a way that tenure security can be ensured for the landlord. For example, a tenant should not be able to claim ownership rights on rented-in land.

4) **Land redistribution**: The inverse relationship between farm size and land productivity clearly shows a need for land redistribution policies to improve productivity. The redistribution of land, which increases access to land for poor low-caste households, is better in this case because merely improving the land rental market cannot rectify the fundamental inequity arising from the unequal distribution of land ownership throughout history. As land redistribution is a complex issue, the following measures could be implemented:

Changing ceilings of ownership land holding

In those cases where a household possesses more land than the ceiling fixed by the Land Act 1964, the land over the ceiling should be taken by the government without any compensation. This land then can be distributed to the landless or land-poor farmers. It means that if a household has land up to the ceiling fixed by the Land Act 1964, the household can rent out land without any fear of losing ownership of such rented land. The provision that tenants can claim ownership rights should be removed. Those who are in favor of this provision should understand that this will not lead to the equitable distribution of land as it distorts the land rental market severely and will increase conflicts between landlords and tenants. If a household possesses land that are within the provisions of the Land Act 1964 but more according to the new land policy, the household must be compensated at a given rate for its loss of land due to the new regulation. It means government needs to buy the excess land from the landlord and distribute it to land-poor households. However, before distributing land to poor households, a complete list of landless households must be made and verified by the special committee. If this is not done, the fear exists that members of political parties will be able to get access to the distributed land by using their political influence. Major political parties, especially Maoists, will be able to capture the land easily by using their youth wing called the 'Young Communist League'. Therefore, land redistribution requires strong and clear rules. There must be transparency and accountability in the land allocation process so that the possibility of political or elite land-grabbing can be fully checked.

Progressive land tax

Land tax in Nepal is not high and many households own land just for social status rather than for farming. The low tax rate has therefore encouraged the unproductive holding of

agricultural land. Increasing land tax may induce land sales by large landowners. A more peaceful approach could be to promote the redistribution of land through the market rather than an administrative redistribution without compensation. Such an approach would help to achieve socially desirable land distribution without sacrificing efficiency in production.

Establish a land bank

As village land sales markets are still very thin and credit markets are highly imperfect, it is not possible to achieve allocative efficiency through a land sales market. The introduction of a 'land bank' providing loans for land-poor households to buy land could be an option. Instead of paying 50 percent of the output to the landlord, they can pay it to the bank as a down payment on their loan.

5) **Improve land administration system**: Corruption and politico-bureaucratic inertia were some of the reasons why past land reform measures failed in Nepal (Devkota, 2005). Before implementing the new land policy, the land administration system needs to be strengthened. Institutional reforms are essential to reduce the gap between program design and implementation (Aryal, 1997). The following measures can be taken to improve land administration:

Set up a land authority at village level

There is a need to set up a village level authority which keeps a record of all landlords and tenants, their contract period and all regulations regarding land tenancy transactions. This not only improves land rental arrangements but also reduces land-related conflicts between tenant and landlord.

Comprehensive computer-based land registry system

Before the implementation of a new land reform program, a comprehensive computer-based land registry system should be implemented. This is required to record detail information of an individual's land ownership. Although there are data on individual land ownership, consolidated data showing land ownership by individuals in the whole country are still lacking. In the absence of such a coordinated data system, there is the possibility that an individual can have land in different parts of the country and thus possesses more land than prescribed without the land administration having any knowledge thereof. To achieve this, land administration should be modernized and strengthened. As a computer-based land accounting system is not possible in all villages of Nepal due to a lack of basic infrastructure such as electricity, the government can initiate it in those districts where it is feasible and coordinate with the centre to establish a comprehensive national land registry system. In addition, the government can rule that an individual must inform the district land authority of where he/she permanently resides, and about the land he/she owns in different parts of the country. Overall, less corrupt and more accountable land administration is a basic requirement for the success of any land policy.

6) **Reduce caste-based discrimination**: Caste-based discrimination is an age-old practice in Nepalese society. Several measures have been taken in the past, but the provision of no discrimination by caste in the present constitution is a major step forward. In this context, a major challenge is to address the sources of discriminations, such as caste discrimination, at society level. The constitution has already made provision that nobody can be discriminated on according to caste. Therefore, awareness in the society should be heightened by providing free education to the poor, especially for low-caste households. Setting up a reservation fund

in education for low-caste households may improve their overall situation. This would also improve their access to land through the land rental markets. To achieve this, the following measures could be taken:

Special provisions for low-caste households

As low-caste households are mostly poor, increasing their access to education and other training programs can improve their long-term income and, hence, enable them to buy more land and improve their access to off-farm income through the labor market. Improving their access to public schools is an option because poor households can afford to send their children to those schools.

Special land reforms targeting Dalits

Dalits in Nepal are among the very poor and landless people. However, for many years they have been working as agricultural laborers and tenants for other households. As Dalits have become more aware of their rights recently and may follow the Indian example. One cannot deny the possibility of a Dalit uprising for socio-economic change. Therefore, it is better to investigate feasible options for land reform, as was done in alleviating the *Kamaiya* (bonded labor) system in the Western Terai of Nepal (Hatlebakk, 2007).

7) **Market improvement and infrastructural development**: Improving credit facilities for land purchase and land conservation investment, factor market improvement and investment in basic infrastructure such as road, electricity, irrigation, and education can help improve land productivity. In the study area, as in most rural areas of Nepal, the road linking the village centre to the market centre is highly seasonal (only used during the winter season; in the rainy season it is out of use as there is no bridge over the river and the road is too muddy

for vehicles to pass). Therefore, improving infrastructure, irrigation facilities and input market access should contribute to agricultural intensification and, hence, productivity.

8) **Realize the changing structure of employment**: Unlike the assumption of past land policies in Nepal, this study showed that all landlords are not very large landlords. The change in household labor force can change a household's ability to operate land and create a need for rental transactions. For example, a households' participation in off-farm income-generating activities, especially earning remittance income, might change the availability of family labor for farming, which ultimately reduces the ability of households to cultivate farm land they possess. Under a situation that Nepalese are now more involved in remittance earning activities than before, restricting the land rental market leads to more fallowing or less intensive use of agricultural land. Therefore, setting clear rules for land tenancy transactions improves the efficiency of land use rather than abolishing land tenancy transactions. All major communist parties in Nepal that support the abolition of land tenancy transaction, assuming that it is a feudal institution, should learn from recent experiences in China and Vietnam. In these countries, the gradual removal of land tenancy restrictions in the land rental market contributed in transferring land to more productive and land-poor farmers in a way that is more effective than what could otherwise be achieved with administrative redistribution of land (World Bank, 2003).

Overall, there is a need for careful examination of how land reforms can be well integrated within the broader objective of agrarian reform, rather than just prioritizing radical measures. Furthermore, land reforms also need to be integrated with the overriding objective of poverty alleviation and increasing productivity. Therefore, issues such as structure of the society regarding caste-based discrimination, access to land and other markets and caste-related social

exclusion need to be analyzed carefully in order to design a policy to address caste discrimination, the land tenure system and natural resource management in Nepal.

8. Some areas of future research

A number of issues warrant further research. Firstly, there is a need to identify the major components of a new land policy as all major political parties in Nepal have already agreed to 'scientific land reform'. Land reform is not a new agenda for Nepal, but it should address the changing context of the Nepalese economy. For example, it should recognize the importance of land rental market as Nepalese are increasingly participating in remittance earning activities and this will expand if the Indian economy continues to grow apace. Higher growth in the Indian economy can have spillover effects in Nepal because Nepalese have no barriers to travelling and working in India. In addition, as the country has already decided to adopt a federal system, the effectiveness of land policies also depend on the level of power that the central government resumes with regard to the use of natural resources in each state. Secondly, as both land and livestock renting might be influenced by the Maoist insurgency, it is now the time to determine whether the major features seen in these markets are largely due to insurgency. This has allowed for further studies on what happens after the Maoist war is over. It is possible that some migrated household members have returned after the settlement of the conflict. Thirdly, a further study is required to identify whether an inverse farm size–productivity relationship is a general phenomenon in Nepalese agriculture or a feature of agriculture in the hills. Therefore, there is a need to compare it with the Terai region of Nepal, where differences between Dalits (low-caste) and non-Dalits (high-caste) are higher. For example, 54 percent of Dalits own less than 0.15 ha of land in the hills and mountains whereas almost all (100 percent) of them own less than 0.15 ha of land in the Terai region (UNDP, 2008). Unlike in the hills, the agriculture in Terai is more

mechanized. Fourthly, many researchers used to consider monarchy as a major contributing factor in protecting and promoting the caste system in Nepal, as this had a linkage with the Hindu religion. Therefore, it is appropriate to see how caste discrimination has recently been reduced when Nepal shifted from a Hindu kingdom to a secular state. In addition, Maoists and other communist parties of Nepal are in favor of ethnicity-based federalism. If ethnicity becomes the basis of federalism, it focuses more on ethnic groups such as Gurung, Newar, Rai, and Limbu. In such a situation, Dalits will not be able to have their own autonomous federal state because they are not considered a separate ethnic group. Dalits are assumed to be a caste group similar to *Brahmin* and *Chhetries* (the first and second highest ranks under the Hindu caste system) by groups who call themselves indigenous groups of Nepal. More importantly, Dalits have no traditional homeland they can claim for a separate state, but they constitute about 14 percent of the total population of the country. Therefore, further research is required to answer the question: How can Dalits secure their rights under ethnicity-based federalism given that they lack a traditional homeland, in contrast to other ethnic groups in Nepal?

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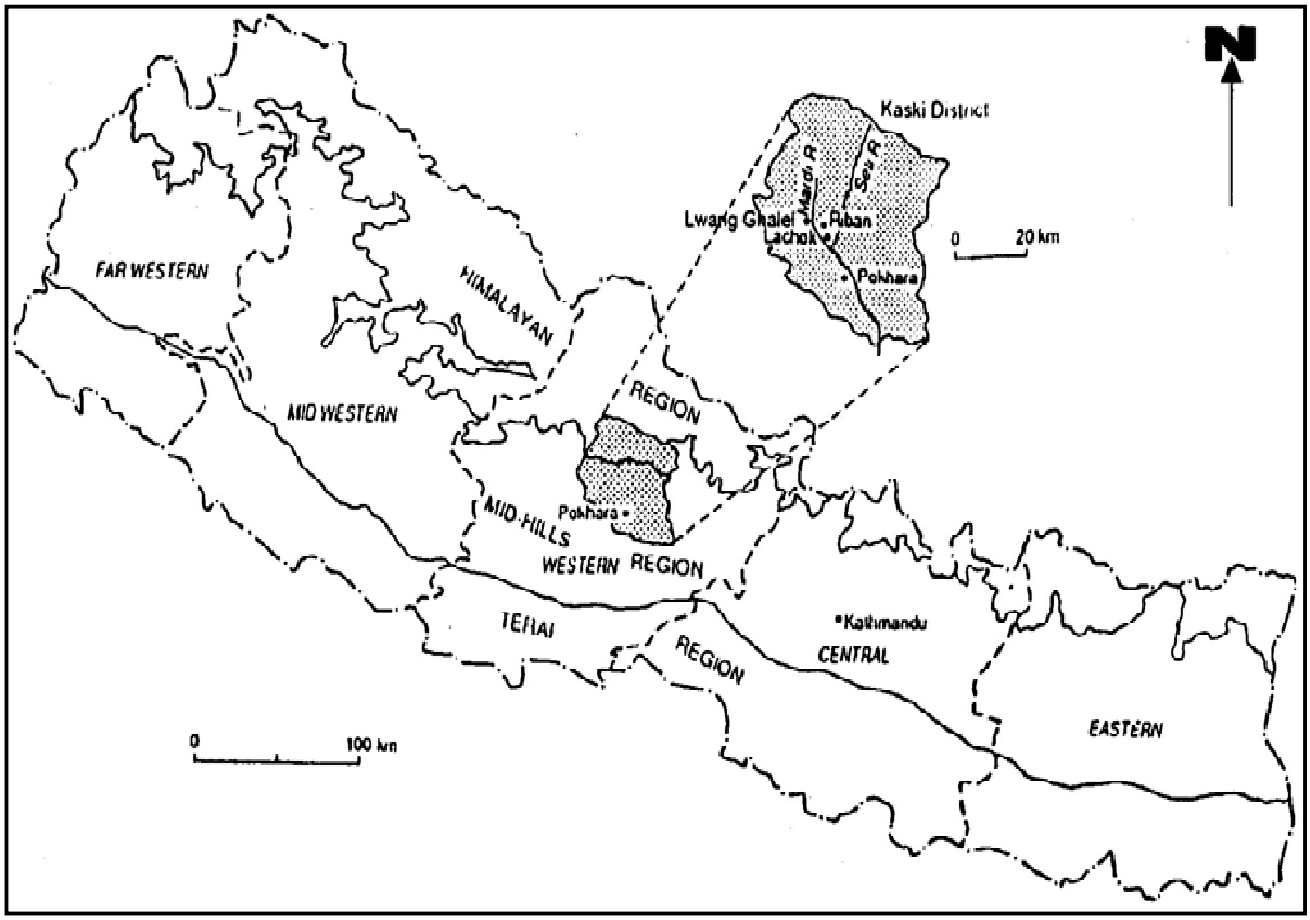

Figure 1.2 Map of the Study Area

Caste, Land and Labor Market Imperfections, and Land Productivity in Rural Nepal

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Abstract
This paper provides new evidence on the caste-related land productivity differential and its explanations in rural Nepal using household plot panel data. While comparing productivity in owner-operated plots, low-caste households are found to have significantly higher land productivity as compared to high-caste households. A comparison between the rented in land of low-caste and the owner-operated land of high-caste households showed that the former has significantly higher land productivity. We also found that there is no significant Marshallian inefficiency in the case of low-caste tenant households, which indicates that transaction costs in labor market dominate over the disincentive effect of sharecropping.

Key words: land productivity; low-caste; high-caste; Nepal

1. Introduction

Land productivity is a serious concern for rural households in the developing countries like Nepal as they are highly dependent on agriculture for their livelihood. In addition, rural farm households face multiple market imperfections and thus, the distribution of assets can influence their efficiency of land use (Sadoulet, et al., 1996). Recent studies show that farm household characteristics such as gender can also affect land productivity, implying that not only the physical factors but also the socio-economic and institutional factors influence land productivity.

In this context, the caste[1] system that is closely associated with the access to and the distribution of land and other economic resources (including labor market participation) in Nepal can influence land productivity in rural areas.

In Nepal there is wide difference between *Dalits* (low-caste) and Non-*Dalits* (high-caste) with regard to income poverty, land holding, participation in the job markets and social life. The incidence of income poverty is about 46 percent for *Dalits* whereas it is only 18 percent in the case of high-caste people (WB, 2006). In addition, *Dalits* are land-poor and commonly rent in (additional) land, typically from high-caste households with excess land (Wily, et al., 2008). In Hindu societies, differences in the average land holdings between high- and low-caste are not accidental but fundamental to the caste structure (Dahal, 1995; Hazari and Kumar, 2003).

In South Asian countries, climbing of the agricultural ladder is made difficult by the caste system and land reform legislation (Otsuka, et al., 1992) because land ownership in South Asia is largely hereditary and past land-to-the-tiller policy has contributed to land rental market imperfections. Under a situation where the land rental market is either institutionally repressed or highly imperfect, inefficiency is bound to arise (Otsuka, et al., 1992). In Indian villages, one's caste can make a difference in leasing behavior in the land rental market (Bliss and Stern, 1982; Skoufias, 1995). Recent studies in Nepal showed that caste has significant impact on the adoption of improved soil conservation technology (Tiwari, et al., 2008) and land management practices (Paudel and Thapa, 2004). Similarly, a study in India showed that caste is one of the significant variables affecting the soil and water conservation investment (Pender and Kerr, 1998).

Low-caste households also face severe discrimination in the labor market. National data in Nepal revealed that there were almost no *Dalits* in senior positions in constitutional bodies, cabinet, court or in a party leadership until 2000 (Gurung, 2005). Studies from India (Banerjee and

Knight, 1985; Munshi and Rosenzweig, 2006; Madheswaran and Attewell, 2007; Ito, 2009) showed that caste discrimination exists in the labor market and the low-caste faces considerable inconvenience in finding regular employment (Ito, 2009). In India, Madheswaran and Attewell (2007) found that low-caste individuals receive 15 percent lower wages as compared to equally qualified high-caste individuals due to caste discrimination. Their study also showed that caste discrimination is observed both in the public and private sector job markets, but is higher in the private sector. In Nepal, caste discrimination is observed in the labor market such that a high-caste individual is paid higher than a Dalit (Hatlebakk, 2002). Such discrimination is also found in the informal credit market as Dalits pay higher interest rates in the informal credit market as compared to others (Hatlebakk, 2009).

If caste affects several factors like land ownership, land rental market participation, labor market access and participation, and investment behavior such as on soil conservation technology adoption and land management, it is likely that caste-related differentiation also has impact on land productivity. However, to our knowledge there exist no such good studies related to land productivity in South Asia (Sen, 1962; Bardhan, 1973; Deolalikar, 1981; Acharya and Ekelund, 1998) . This study is a contribution to fill this research gap by assessing the impact of the caste differential on land productivity. Additionally, this paper contributes to theory by demonstrating how labor market imperfections affect land productivity. Particularly labor market conditions have not been fully examined in connection with land productivity in the literature before. Using data from rural Nepal the study furthermore assesses how caste-related productivity differences are associated with caste-related differences in endowments and in market access. As low-caste households have lower land endowment and poorer access to skilled off-farm employment, they are more likely to concentrate their labor on farms. Under such a condition we

put forth the hypothesis that low-caste households achieve higher land productivity as compared to high-caste households. On the other hand, if these low-caste households get access to land through sharecropping contracts, this may reduce their incentives to enhance land productivity. Parametric and nonparametric methods were used for analyzing the data. Low-caste households were found to have significantly higher land productivity as compared to high-caste households both on their own land and on the rented in land. The results indicate that transaction costs in the labor market are high and that dominates over the disincentive of sharecropping in the case of low-caste tenants.

The rest of the paper is organized as follows. The second part covers the theoretical framework of the study. A general introduction of the study area and data are provided in part three, followed by the empirical estimation methods in part four. The fifth part presents the major results and discussion, and the last part concludes the study.

2. Theoretical Framework

Consider that all sample households can be classified into two major caste groups: high-caste household *C* and low-caste household *c*. For simplicity, consider only two resources, land and labor and access to land and land rental market by these caste groups. The ownership land $\overline{A}$ distribution is such that $\overline{A}^{C} > \overline{A}^{c}$.

Assume that high-caste households have access to off-farm employment while this is not the case for low-caste households. There are labor market imperfections also such that hired labor is not a perfect substitute for family labor. There are transaction costs for hiring in labor such as supervision costs. Assuming linear transaction costs, cost of hiring in farm labor can be expressed as: $(\omega_a + \tau_a) L^h$ where ω_a, τ_a and L^h refer to wage, transaction costs of hiring in labor and units of labor hired respectively. There are also transaction costs in hiring out agricultural

labor. Therefore, the earnings obtained from hiring out agricultural labor can be expressed as: $(\omega_a - \upsilon_a) L_g$ where υ_a and L_g refer to transaction costs of hiring out agricultural labor and units of labor hired out respectively. Likewise, there are also transaction costs in the off-farm labor market such as search costs and costs involved in travelling. Therefore, wage income obtained by hiring out labor to the off-farm sector can be expressed as: $(\omega_o - \tau_o) L_o$ where subscript *o* refers to off-farm sector and all other symbols are as mentioned earlier. The total time endowment *T* of a household is divided into labor *L* and leisure L_e.

It is assumed that a farm household maximizes a utility function: $U = U(Y, L_e)$ subject to *Y*, the net income from both agricultural production and off-farm work and that the utility function is concave: $\frac{\partial U}{\partial Y} > 0$, $\frac{\partial U}{\partial L_e} > 0$, $\frac{\partial^2 U}{\partial Y^2} < 0$ and $\frac{\partial^2 U}{\partial L_e^2} < 0$. For agricultural production, the household uses two inputs: land *A* and farm labor L_a. The operational land *A* is the sum of the own land $\bar{A}$ and rented-in land A^{ri} minus the rented-out land A^{ro}. For simplicity, we assume uniform land quality. The production function is: $q = q(L_a, A)$; $\frac{\partial q}{\partial L_a} > 0$, $\frac{\partial q}{\partial A} > 0$, $\frac{\partial^2 q}{\partial L_a^2} < 0$ and $\frac{\partial^2 q}{\partial A^2} < 0$.

Assuming constant returns to scale, the production function can be expressed in terms of farm productivity, $q = q(l_a) A$ where $q(l_a)$ refers to farm productivity per unit land and l_a is labor use per unit land.

The following market conditions are considered to first handle separately market issues in the labor market and the land rental market before these are combined:

1. Imperfect labor market and missing land market.
2. Land rental market (sharecropping) and missing agricultural labor market.
3. Imperfect labor market and land rental market (sharecropping).

Each market situation includes models for two types of households: one for high-caste and one for low-caste households, in which the key differences between these are differences in land and labor endowment, and labor market access. For empirical analysis, we focus on the third situation as it is closest to reality in the study area. However, we present all models because in Model 1, we are able to get unambiguous analytical solutions in comparative statics, which provide the basis for deriving hypotheses.

Case 1: Imperfect labor market and no land market

Case 1a: For high-caste households (C)

Under this case, land is given exogenously because we assumed no land market. The labor market is divided in two, a high-wage market for (skilled) labor outside agriculture, and a low-wage market for (unskilled) labor in agriculture. A high-caste household has access to better paid off-farm employment and is able to hire in additional labor from low-caste households to farm its land. There are transactions costs both in relation to working off-farm and in relation to hiring farm labor. A household's income constraint is obtained by subtracting cost of hired labor from the sum of its earning from the farm production on its own land and from the participation in off-farm employment. In addition, the household uses its time endowment on farm labor, off-farm labor and leisure. Hence, the households' problem can be expressed as:

Maximize $U^C = U(Y, L_e)$ subject to

$$Y^C = p_q\, q(l_a^f + l_a^h)\bar{A} + L_o(\omega_o - \tau_o) - l_a^h(\omega_a + \tau_a)\,\bar{A}$$
$$T^C = \bar{A} l_a^f + L_o + L_e;\ l_a = l_a^f + l_a^h;\ l_a \geq 0;\ L_o \geq 0$$

where p_q refers to price of agricultural goods; and superscripts f and h denote family and hired labor respectively. All other notations are as defined earlier. By substitution, we obtain:

$$\underset{\{l_a^f, l_a^h, L_o\}}{Max}\ U^C = U\left[\, p_q q(l_a^f + l_a^h)\bar{A} + L_o(\omega_o - \tau_o) - l_a^h(\omega_a + \tau_a)\bar{A}; T^C - L_o - l_a^f \bar{A}\right]$$

From the first order conditions, we obtain:

1.1) $\omega_o - \tau_o = \omega^{*C} = \dfrac{\partial U/\partial L_e}{\partial U/\partial Y} = \omega_a + \tau_a = p_q \dfrac{\partial q}{\partial l_a}$

where ω^{*C} represents the opportunity cost of labor for high-caste households who hire labor up to the point where the marginal cost of hired labor is equal to the marginal opportunity cost of family time off-farm and balances with the preferences for leisure and income, and the marginal return to labor in agriculture for own and hired labor. This shows how the adjustment takes place between family labor and hired labor in farming, off-farm engagement and leisure time.

Case 1b: For low-caste households (c)

In the case of low-caste households, we assume that they only have access to low-pay wage employment in agriculture and that they have a very limited land endowment causing a high labor-land ratio. They can hire out agricultural labor to high-caste households in the village. Hence, the income constraint for a low-caste household can be obtained by summing up its earning from own land (as we assumed no land market now) and from hiring out unskilled labor. The household allocates it's time for farming, hiring out unskilled labor and leisure. So, the household maximizes: $U^c = U(Y, L_e)$ subject to

$Y^c = p_q q(l_a^f)\bar{A} + L_g(\omega_a - \upsilon_a)$ and $T^c = l_a^f \bar{A} + L_g + L_e$

By substitution, the utility function becomes:

$$\underset{\{l_a^f, L_g\}}{Max}\ U^c = U\left[\, p_q q(l_a^f)\bar{A} + L_g(\omega_a - \upsilon_a); T^c - l_a^f \bar{A} - L_g\right]$$

From the first order conditions, we obtain:

1.2) $\omega^{*c} = \frac{\partial U/\partial L_e}{\partial U/\partial Y} = \omega_a - \upsilon_a = p_q \frac{\partial q}{\partial l_a^f}$

where ω^{*c} represents the net wage of labor for low-caste households. The household will allocate its labor off-farm (here it implies hiring out agricultural labor) up to the point that the marginal return to labor on farm falls to this low-caste net wage.

Given that high-caste households hire in labor from low-caste households, we have $\omega^{*c} < \omega^{*C}$ if the non-negative transaction costs $\tau_a > 0$ and/or $\upsilon_a > 0$. Comparing the high-caste and the low-caste households with respect to marginal return to labor, the net wage for low-caste households is lower than that of high-caste households. It implies that low-caste households apply more labor per unit of land and therefore, have higher land productivity if the land quality and management skills are the same. Households not participating in the labor market should have a shadow wage inside the price band due to the transaction costs in the labor markets and should have land productivity somewhere between those hiring in and hiring out labor because $\omega_a - \upsilon_a < \omega^* < \omega_a + \tau_a$.

In order to find out how the agricultural labor supply in farming varies with the change in key exogenous variables, comparative statics were carried out (see Appendix 1 Table A.1). Table A.1 has relevance in explaining the possible logics behind the caste-related land productivity differences because this shows how agricultural labor supply changes due to change in wages and transaction costs in farm and off-farm employment. From Table A.1, we see that increase in farm wage increases the family labor supply in agriculture in the case of high-caste households (to substitute for more expensive hired labor) while the effect is opposite in the case of low-caste households who will supply more labor in the labor market and reduce the intensity of their own production. This is basically because they operate on each side of the agricultural labor market.

This increased price of labor should result in a negative effect on land productivity on all types of land. On the other hand, increase in off-farm wage reduces the family labor supply to agriculture in the case of high-caste households with access to off-farm income. They will instead hire in more labor to maintain their agricultural production. An increase in the transaction costs in the agricultural labor market will lead to a larger gap between the opportunity costs of labor for high-caste and low-caste households and this will also increase the difference in land productivities between (high-caste) households that hire in labor and (low-caste) households that hire out labor.

Case 2: Sharecropping and missing agricultural labor market

It is assumed that high-caste households have more land than low-caste households. Contrary to low-caste households they also have access to off-farm employment, while they for those reasons have relatively less family labor available for farm production. They cannot hire labor because of the missing agricultural labor market but can instead rent out their land through sharecropping arrangement with low-caste households who demand additional land.

In this paper, contract choice per se is not the issue under consideration because the main objective is how caste-related differences in endowments and market access are related to imperfections in land and labor markets and consequently affect land productivity. Therefore, the paper does not highlight on the rationale of sharecropping and assumes that sharecropping is the only form of land rental contract. In other words, the market characteristics are taken as given, while their outcome implications are studied. We present parsimonious household models for high- and low-caste households as landlords and tenants with sharecropping as the only form of land contract while ignoring risk, and assume zero monitoring and enforcement costs for the landlord. While these restrictive assumptions could be relaxed they are not necessary for our

main point. The major purpose of the model is to demonstrate that it is ambiguous whether land productivity is higher or lower on sharecropped land of low-caste households as compared to on high-caste household owner-operated land even when Marshallian inefficiency is present. This is because the gap between ω^{*c} and ω^{*C} may more than compensate for the disincentive effect on sharecropped land due to $\alpha < 1$. The implication is that even inefficient sharecropping (due to Marshallian inefficiency) may be better for efficiency and equity than no sharecropping as it may enhance land productivity and improve land access of land-poor households when there are significant transaction costs in the labor market and no alternative land contracts exist.

Case 2a: For high-caste households (C)

With the possibility to rent-out land using sharecropping contract, the income constraint of the high-caste households consists of value of agricultural goods produced in owner-operated land, value of its share of agricultural produce in rented-out land and earning from the off-farm sector. Moreover, the household allocates its time to farming, off-farm employment and leisure. Hence, the household's constrained utility maximization problem can be expressed as:

$$\text{Maximize } U^C = U(Y, L_e) \quad \text{subject to}$$
$$Y^C = p_q\, q(l_a^f)(\overline{A} - A^{ro}) + (1-\alpha)\, p_q\, q(l_a^c) A^{ro} + L_o(\omega_o - \tau_o) \text{ and } T^C = l_a^f(\overline{A} - A^{ro}) + L_o + L_e$$

where A^{ro} denotes the amount of rented-out land, and α represents the output share of tenants. All other components without superscript *c* belong to the high-caste households here. Substituting the income and time constraints into the objective function, we obtain:

$$\underset{\{l_a^f,\, A^{ro},\, L_o\}}{Max} \quad U^C = U\left[p_q\, q(l_a^f)(\overline{A} - A^{ro}) + (1-\alpha)\, p_q\, q^{ro}(l_a^c)\, A^{ro} + L_o(\omega_o - \tau_o); T^C - L_o - l_a^f(\overline{A} - A^{ro}) \right]$$

Solving for the first order conditions, we get:

$$2.1)\ \frac{\partial U/\partial L_e}{\partial U/\partial Y} = \omega^{*C} = \omega_o - \tau_o = p_q \frac{\partial q}{\partial l_a^f} = p_q \frac{q\left(l_a^f\right)}{l_a^f} - (1-\alpha)\, p_q \frac{q^{ro}\left(l_a^c\right)}{l_a^f}$$

where ω^{*C} denotes the opportunity cost of labor for high caste households. The result shows that a household allocates its family labor to the farm and off-farm up to the point where the cost of labor is equal to the marginal value product of labor in agriculture and off-farm, taking into account the preferences for leisure. This formulation allows for Marshallian inefficiency.

Case2b: For low-caste households (c)

Given that there is a land rental market through sharecropping but no agricultural labor market, the low-caste household can rent in land from the high-caste household instead of hiring out labor. Now, the income constraint of the low-caste household comprises of value of produce in its own land and the value of its share of output from rented in land. So, the household allocates its labor time endowment for own farming, farming the rented in land and leisure. The low-caste households' utility maximization problem (still assuming constant returns to scale in agriculture) can be formulated as:

Maximize $U^c = U(Y, L_e)$ subject to

$Y^c = p_q\, q(l_a^f)\, \overline{A} + \alpha\, p_q\, q^{ri}(l_a^{ri})\, A^{ri}$ and $T^c = l_a^f\, \overline{A} + l_a^{ri}\, A^{ri} + L_e$

The factors with superscript *ri* relate to the rented-in components of land and household labor applied on rented in land. By substitution, the utility function of the household becomes

$$\underset{\{l_a^f, l_a^{ri}, A^{ri}\}}{Max} \quad U^c = U(p_q\, q(l_a^f)\, \overline{A} + \alpha\, p_q\, q^{ri}(l_a^{ri})\, A^{ri};\ T^c - l_a^f\, \overline{A} - l_a^{ri}\, A^{ri})$$

Solving for the first order conditions, we obtain:

$$2.2)\ \frac{\partial U/\partial L_e}{\partial U/\partial Y} = \omega^{*c} = p_q \frac{\partial q}{\partial l_a^f} = \alpha\, p_q \frac{\partial q^{ri}}{\partial l_a^{ri}} = \alpha\, p_q \frac{q^{ri}\left(l_a^{ri}\right)}{l_a^{ri}}$$

This implies that the low-caste household applies labor on own and rented in land till the marginal returns to its labor are the same on the two types of land for the household. When there is unrestricted access to land to rent in, the amount of land rented in adjusts to the point where average return to the household per unit labor on rented in land is equal to its marginal return to labor on the land. This implies that low-caste (tenant) households have higher marginal land productivity on their own land than on rented-in land. This is the standard Marshallian inefficiency result (Marshall, 1920) which has been widely debated and tested (Shaban, 1987; Otsuka and Hayami, 1988; Otsuka, et al., 1992; Otsuka, 2007).

The results of this model have following implications. From equation (2.1) we obtain,

2.3) $$l_a^f \frac{\partial q}{\partial l_a^f} - \alpha q^{ro}\left(l_a^c\right) = q\left(l_a^f\right) - q^{ro}\left(l_a^c\right)$$

Equation (2.3) indicates that if the product of labor intensity and the marginal return to labor per unit land is less than the gross return per unit of land to the tenant (low-caste household), then the land productivity of the landlord (high-caste household) on his owner-operated land is lower than that on rented out land (operated by the low-caste household).

We can also go further by comparing ω^{*c} and ω^{*C}. The gap between the opportunity costs of labor may explain why or when low-caste households achieve higher land productivity on rented in land despite Marshallian inefficiency. For this, we express the equation (2.1) as follows:

2.4) $$\Rightarrow q\left(l_a^f\right) - q^{ro}\left(l_a^c\right) = \frac{\left(\omega_o - \tau_o\right) l_a^f}{p_q} - \alpha q^{ro}\left(l_a^c\right)$$

We know $q^{ro}\left(l_a^c\right) = q^{ri}\left(l_a^{ri}\right)$ from tenant's side. Then, using equation (2.2) we have

2.5) $$\omega^{*c} = \alpha p_q \frac{q^{ri}\left(l_a^{ri}\right)}{l_a^{ri}} \Rightarrow \alpha q^{ri}\left(l_a^{ri}\right) = \frac{\omega^{*c}}{p_q} l_a^{ri}$$

Now substituting equation (2.5) into equation (2.4) we obtain the following:

$$2.6)\quad q\left(l_a^f\right)-q^{ro}\left(l_a^c\right)=\frac{\left(\omega_o-\tau_o\right)l_a^f}{p_q}-\frac{\omega^{*c}l_a^{ri}}{p_q}=\frac{\omega^{*C}l_a^f}{p_q}-\frac{\omega^{*c}l_a^{ri}}{p_q}$$

Equation (2.6) shows that the productivity difference between high-caste households (landlords) and low-caste households (tenants) is explained by their relative opportunity costs of time times labor intensities per unit land in farming. In this model the opportunity cost of labor for low-caste households is determined by their marginal (share) return to labor per unit rented in land and marginal return to labor on their own land. In the next model we introduce the agricultural labor market which also can influence this wage rate and the decisions to rent out and in land.

Model 3: Imperfect labor market and sharecropping

For this model, we assume that there are imperfect labor markets and land rental market through sharecropping. In order to keep the model simple, we still assume that the high-caste households as landlord and the low-caste households as tenants.

Case 3a: For high-caste households (C)

Now high- caste household can rent out its land, hire in labor for farming and sell its labor in the off-farm sector. Therefore, its income constraint is obtained by subtracting the cost of hired labor used in own land from the sum of the value of output from own land, value of its share of output in rented-out land and the earning from the off-farm jobs. The household allocates its labor time in farming own land, working off-farm and the leisure. Therefore, the households' utility maximization problem can be represented as:

$$\underset{\left\{l_a^f,\,l_a^h,\,L_o,\,A^{ro}\right\}}{Max}\ U^C=U(Y,L_e)\quad \text{subject to}$$

$$Y^C = p_q\, q(l_a^f + l_a^h)(\overline{A} - A^{ro}) + (1-\alpha)\, p_q q^{ro}\left(l_a^c\right) A^{ro} + L_o(\omega_o - \tau_o) - l_a^h(\omega_a + \tau_a)(\overline{A} - A^{ro})$$

$$T^C = l_a^f(\overline{A} - A^{ro}) + L_o + L_e$$

By substitution, the utility function can be written as:

$$U^C = U\begin{bmatrix} p_q\, q(l_a^f + l_a^h)(\overline{A} - A^{ro}) + \\ (1-\alpha)\, p_q q^{ro}\left(l_a^c\right) A^{ro} + L_o(\omega_o - \tau_o) - l_a^h(\omega_a + \tau_a)(\overline{A} - A^{ro}); \\ T^C - l_a^f(\overline{A} - A^{ro}) - L_o \end{bmatrix}$$

Solving for the first order conditions gives:

$$3.1)\ \omega_o - \tau_o = \omega^{*C} = \frac{\partial U^C / \partial L_e}{\partial U^C / \partial Y^C} = \omega_a + \tau_a = p_q \frac{\partial q}{\partial l_a} = \frac{p_q q(l_a^f + l_a^h) - (1-\alpha) p_q q^{ro}\left(l_a^c\right) - (\omega_a + \tau_a) l_a^h}{l_a^f}$$

where ω^{*C} denotes the price of labor for the high-caste household. The result shows that a high-caste household hires labor to the point where the marginal cost of hired labor is equal to the marginal opportunity cost of family time. It implies that a household that has better access to off-farm employment may divert its labor to the off-farm sector; given that wage rate in off-farm employment is higher and hires agricultural labor at a lower wage in the agricultural labor market. Transaction costs in relation to participation in the two labor markets determine whether and to what extent such households both hire out and hire in labor at the same time and/or rent out land instead of hiring in labor.

Case 3b: For low-caste households (c)

In this case, low-caste households can rent in land and can hire out its unskilled labor as agricultural worker. Therefore, the income of the low-caste households is given by the summation of value of agricultural output in its own land, value of its share of output in rented-in land and the earnings from the agricultural wage labor. In this case, low-caste household allocates the time for own farming, working in the rented-in land, working as agricultural labor

to other households and the leisure. Therefore, the utility maximization problem of the low-caste household can be expressed as:

$$\underset{\{l_a^f, l_a^{ri}, L_g, A^{ri}\}}{Max} U^c = U(Y, L_e) \quad \text{subject to}$$

$$Y^c = p_q\, q(l_a^f)\,\overline{A} + \alpha\, p_q\, q^{ri}(l_a^{ri})A^{ri} + L_g(\omega_a - \upsilon_a) \text{ and } T^c = l_a^f\,\overline{A} + l_a^{ri}A^{ri} + L_g + L_e$$

Hence, by substitution, the utility function becomes:

$$U^c = U\left[\, p_q\, q(l_a^f)\,\overline{A} + \alpha\, p_q\, q^{ri}(l_a^{ri})A^{ri} + L_g(\omega_a - \upsilon_a);\; T^c - l_a^f\,\overline{A} - l_a^{ri}A^{ri} - L_g \,\right]$$

Solving for the first order conditions, we get:

$$3.2)\ \omega^{*c} = \frac{\partial U^c / \partial L_e}{\partial U^c / \partial Y^c} = p_q \frac{\partial q}{\partial l_a^f} = \omega_a - \upsilon_a = \alpha\, p_q \frac{\partial q^{ri}}{\partial l_a^{ri}} = \alpha\, p_q \frac{q\left(l_a^{ri}\right)}{l_a^{ri}}$$

where ω^{*c} represents the net price of labor for low-caste households. Equation (3.2) implies that a household will allocate its labor off-farm (here, we mean hiring out of agricultural labor/unskilled labor supply by low-caste households to high-caste households) up to the point where the marginal return to labor on farm reaches to this low-caste net wage. Equation (3.2) implies that low-caste households have unrestricted access to land and allocate labor to rented land up to the point where its net opportunity cost of labor in the labor market is equal to the marginal value product of its share in output from rented in land. This has been referred to as the case of Marshallian inefficiency. However, the lower wage rate of low-caste households pulls up land productivity as they have incentives to work harder than high-caste households.

From cases 3a and 3b, one observes that the net wage for low-caste household is less than the net wage for high-caste households: $\omega^{*C} > \omega^{*c}$ when $\tau_a > 0$ and/or $\upsilon_a > 0$.

Using the results of this model, we can derive the following productivity related implications. Rearranging equation (3.1) we obtain,

$$3.4)\ q(l_a^f + l_a^h) - q^{ro}\left(l_a^c\right) = \frac{\partial q}{\partial l_a}(l_a^f + l_a^h) - \alpha q^{ro}\left(l_a^c\right)$$

By combining the high-caste and low-caste models, we know that $q^{ro}\left(l_a^c\right) = q^{ri}\left(l_a^{ri}\right)$. Therefore, equation (3.4) can be expressed in terms of the opportunity cost of labor for high-caste and low-caste households. In order to do this, we rearrange equation (3.2) as follows:

$$3.5)\ \omega^{*c} = \alpha p_q \frac{q\left(l_a^{ri}\right)}{l_a^{ri}} \Rightarrow \alpha q\left(l_a^{ri}\right) = \frac{\omega^{*c}}{p_q} l_a^{ri}$$

Substituting equation (3.5) into equation (3.4) we obtain:

$$3.6)\ q(l_a^f + l_a^h) - q^{ro}\left(l_a^c\right) = \frac{\omega^{*C}}{p_q} l_a - \frac{\omega^{*c}}{p_q} l_a^{ri} = \frac{(\omega_o - \tau_o)}{p_q} l_a - \frac{(\omega_a - \upsilon_a)}{p_q} l_a^{ri} = \frac{(\omega_a + \tau_a)}{p_q} l_a - \frac{(\omega_a - \upsilon_a)}{p_q} l_a^{ri}$$

Equation (3.6) shows the productivity difference between owner-operated land of high-caste households and the rented in land of low-caste households (alternatively, this can also be interpreted as the rented out land of high-caste household). From the equation, it is clear that the productivity difference is explained by their relative opportunity costs times labor intensities per unit land in farming. This also demonstrates that the transaction costs related to both farm and off-farm employment influence land productivity of both high-caste and low-caste households through the effects on opportunity costs of labor and labor intensity on owner-operated and rented land. Whether labor productivity is lower or higher on owner-operated land of high-caste households than on their rented out land remains theoretically ambiguous and will require empirical testing. High transaction costs in the agricultural labor market pull in direction of low-caste households having higher land productivity on both their owned and rented in land.

Marshallian inefficiency pulls in the direction that land productivity is higher on owner-operated land of high-caste households than on their rented out land. Empirically the paper aims to test the following hypotheses:

a) Test whether the initial assumptions of our theoretical models are correct:

H1: Low-caste households have lower land endowment, poor access to skilled off-farm employment, and are more likely to rent in additional land and work as agricultural laborers.

H2: High-caste households are more likely to rent out land and/or hire in agricultural labor to balance land and labor endowments.

H3: Sharecropping (the dominant land renting arrangement) is associated with Marshallian inefficiency.

b) Given that the above hypotheses are confirmed, the following theoretical implications are tested:

H4: Land productivity is higher on owner-operated land of low-caste households than on owner-operated land of high-caste households (due to high transaction costs in the labor market).

H5: Land productivity is higher on rented-in land of low-caste households than on owner-operated land of high-caste households (due to high transaction costs in the labor market that dominate over the Marshallian inefficiency effect on land productivity on rented land).

The hypotheses will first be assessed by a descriptive analysis of the survey data from the study area in western Nepal before they are further tested through non-parametric and parametric analyses of the data.

3. Study Area and Data

Data for this study were collected in 2003 from 500 households in the Mardi watershed area located in the western hills of Nepal. The data were collected both at the household level and at the plot level. This paper uses information from a subsample (see following tables) of a total sample of 489 households (data from the 11 households were not used due to inconsistency) and a total of 1131 plots. The household level data covered a wide range of household characteristics such as household composition, consumption expenditure, income from different sources, sales and purchases, credit, and household preferences. The plot level data included the biophysical characteristics, trade information, inputs applied, and outputs.

The settlements of the Mardi watershed are located 15-45 km from the district centre, Pokhara. Hills and mountains higher than 1200 m are the major topographical features of this region (Thapa and Weber, 1995). This area lies in the highest rainfall region of Nepal. As in other parts of Nepal, monsoon season starts in early June and lasts until mid-September.

Agriculture is the major economic activity in this area. The households practice traditional cropping systems for agricultural production and they cultivate a variety of crops. The most common crops in the valley are paddy and wheat while maize and millet are common in the terraced land. Farmers practice crop rotation systems, growing one to three crops per year. Livestock is a major component within the production system as oxen are essential to plough the land and manure is a major input to farm production.

Table 1 presents the basic characteristics of high-caste and low-caste households in the total sample of households.

Table 1 Major household characteristics variable by caste

Variables	High-caste	Low-caste	All sample	Test
Number of Households	382	107	489	-
Ownership holding (in hectare)	0.64	0.17	0.53	8.83***
Operational holding (in hectare)	0.63	0.35	0.56	5.86***
Male head dummy (%)	20	65	30	82.72***
Literate head (%)	35	19	31	10.40***
Standard labor unit	3.81	3.98	3.85	0.85
Standard consumer unit	4.93	5.2	4.99	1.09
Farm income (in Rs.)	32035	15312	28376	5.57***
Remittance income (in Rs.)	20127	3449	16478	4.41***
Total income (in Rs.)	72360	30928	63294	8.02***
Value of asset (in Rs.)	38581	15173	33459	8.29***
Agricultural wage employment (unskilled) (%)	12.3	69.8	24.94	7.16***
Non-agricultural wage employment (unskilled) (%)	34.2	25.6	32.31	3.78***
Regular salary jobs (at least one member) (%)	41.3	9.2	26.58	5.71***
At least one member earning pension (%)	26.7	5.6	22.09	3.96***

Notes:
1. Test shows the difference between high-caste and low-caste households; t-test is used for continuous variables and chi-square test for categorical variables.
2. Regular salary jobs include the jobs both in and outside the country

Regarding the hypothesis on the initial land distribution it is clear that average ownership land holding of high-caste households is more than three times as large as the land holding of low-caste households. The operational land holding of low-caste households is almost double of their own land holding implying that they are renting in land while surprisingly operational land holding is not much smaller than their own land holding for the high-caste households. Furthermore, low-caste households are more likely to earn income as agricultural workers while high-caste households are more likely to have other forms of off-farm employment.

Table 2 presents the combined picture of land rental and agricultural labor market participation for the sample households by caste. The categories marked in yellow are those that the theoretical models have attempted to capture.

Table 2 Land rental and agricultural labor market participation of sample households

	Land Rental Market											
	High-caste HHs						Low-caste HHs					
Agricultural Labor market	Landlord		Non-Participant		Tenant		Landlord		Non-participant		Tenant	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Net seller	0	0	21	5.5	22	5.7	4	3.7	37	34.6	48	44.9
Non-participant	48	12.6	50	13.1	13	3.4	2	1.9	8	7.5	5	4.7
Net buyer	28	7.3	171	44.8	29	7.6	0	0	3	2.8	0	0
Total	76	19.9	242	63.4	64	16.8	6	5.7	48	44.9	53	49.5

Table 2 shows that nearly 20 percent of the high-caste households are landlords while about 60 percent hire in agricultural labor and only about 7 percent rent out land as well as hire in labor. This implies that about 65 percent (high-caste households marked in yellow in Table 2) of the high-caste households fall in the three categories of households that we have modeled in the theory section that either hire in agricultural labor, rent out land or combine these responses, demonstrating the relevance of our models.

About 50 percent of the low-caste households are tenants while about 83 percent hire out agricultural labor. This implies that about 84 percent of the low-caste households fall within the three categories of households modeled in the theory chapter as either hiring out agricultural labor, renting in land or combining these responses. This also clearly demonstrates the relevance of the theoretical models as capturing a dominant pattern in the study area.

Land rental market participation has contributed to reducing the inequality in operational holding of land among sampled households. The gini-coefficient for the ownership land holding is 0.49 whereas it is 0.42 for the operational land holding.

The major objective of this paper is to see whether land productivity is different between these caste groups due to differences in opportunity costs of labor, Marshallian inefficiency and

transaction costs in the labor markets. Table 3 presents the major characteristics of high-caste households classified on the basis of theoretical models presented in section 2.

Table 3 Major characteristics of high-caste households classified on the basis of theoretical models

Relevant variables	Renting in agricultural labor but no land market participation	Renting out land but no agricultural labor market participation	Renting out land and hiring in agricultural labor
Number of households	171	48	28
Owned land holding (in ha)	0.59 (0.04)	0.89 (0.07)	1.14 (0.12)
Operated land holding (in ha)	0.59 (0.04)	0.76 (0.06)	0.73 (0.09)
Standard labor unit/operated land holding	12.22 (1.14)	5.61 (0.55)	7.13 (1.11)
Standard labor unit/owned land holding	12.22 (1.14)	5.44 (0.69)	5.22 (1.15)
Male head (%)	0.27 (0.03)	0.21 (0.06)	0.21 (0.08)
Literate head (%)	0.37 (0.04)	0.42 (0.07)	0.421(0.089)
Age of HH head (in years)	48.5 (0.89)	51.2 (1.49)	49.8 (1.91)
Value of Asset (in Rs.)	41683 (2187)	50348 (2051)	70550 (6770)
Household participating in off-farm employment (%)	39	31	67
Average annual income from off-farm employment (in Rs.)	23761 (5230)	27693 (3427)	45321 (6132)
Land productivity (in Rs. per hectare) on owner-operated land (not rented out)	66142 (3146)	47096 (3010)	43550 (3601)

Note: Standard errors in parentheses

From the table we can see that mean land productivity on owner-operated land of high-caste households, measured in output value per unit land, that households that rent in agricultural labor but do not rent out land, is 66,142 Rs./ha whereas it is only 43,550 and 47,016 Rs./ha in the case of high-caste households that rent out land and that do not hire or hire agricultural labor. It appears that the first group has significantly more family labor available on its farms and still hires additional labor that contributes to enhance labor productivity. Similarly, a significant difference can be seen in the ownership holding of land between the high-caste households that rent in agricultural labor but do not participate in the land rental market and the high-caste

households that rent out land and hire in agricultural labor, also pointing in direction of more labor intensive production in the first group.

Table 4 shows the major characteristics of the low-caste households that are classified on the basis of the theoretical models as defined earlier in section 3.

Table 4 Major characteristics of low-caste households classified on the basis of theoretical models

Relevant variables	Hiring out agricultural labor but no land market participation	Renting in land but no agricultural labor market participation	Renting in land and hiring out agricultural labor
Number of households	37	5	48
Owned land holding (in ha)	0.21 (0.03)	0.10 (0.04)	0.11 (0.03)
Operated land holding (in ha)	0.21 (0.03)	0.66 (0.26)	0.37 (0.04)
Standard labor unit/operated land holding	28.27 (7.73)	24.70 (11.59)	14.52 (1.36)
Standard labor unit/owned land holding	28.27 (7.73)	86 (38.79)	43.18 (7.94)
Male head (%)	0.57 (0.08)	0.80 (0.20)	0.73 (0.07)
Literate head (%)	0.24 (0.07)	0.20 (0.20)	0.17 (0.05)
Age of HH head (in years)	49.9 (1.93)	50.8 (4.95)	46.96 (1.69)
Value of Asset (in Rs.)	15279 (1552)	25282 (7440)	13123 (916)
Average annual income from hiring out agricultural labor (in Rs)	9475 (1031)	0	8733 (1735)
Land productivity (in Rs per ha) on owner operated land	82065 (10075)	71601 (40551)	80527 (7644)
Land productivity (in Rs. per ha) on rented in land	-	68287 (10419)	76891 (3974)

Note: Standard errors in parentheses

There are no significant differences in land productivity between the low-caste households that hire out agricultural labor but do not participate in land rental market and the low-caste households that rent in land and hire out labor as well. There is also no significant difference in land productivity between owner-operated land and rented in land. This implies that there is no significant Marshallian inefficiency related to land renting by low-caste tenants.

4. Empirical Methods and Variable Specification

We applied both non-parametric and parametric techniques in the analyses. Stochastic dominance analysis (SDA) and propensity score (PS) matching are the non-parametric methods used in the empirical analysis.

4.1 Stochastic Dominance Analysis

Using SDA, we compared the total value of output distribution between high-caste and low-caste households based on cumulative distribution functions, CDFs. There are two criteria for comparing the stochastic dominance- first order stochastic dominance (FSD) criterion and second order stochastic dominance (SSD) criterion.

Assume that *c(y)* and *C(y)* are cumulative distribution functions for low-caste and high-caste households respectively. Under FSD criterion, the distribution *c(y)* dominates *C(y)* if $C(y)-c(y)\geq 0,\ \forall_y \in \Re$, with strict inequality for some $y \in \Re$. It means the distribution with lower density function dominates the distribution with higher density function. In this case, *c(y)* dominates *C(y)* if the CDF of yield for high-caste *C(y)* is greater than the CDF of yields for low-caste *c(y)* for all level of yields (Mas-Colell, et al., 1995). The FSD criterion fails to give a decision if the graphs of the CDFs intersect each other. Under such a situation, we call for second order stochastic dominance (SSD). The SSD criterion compares the area under the CDFs. The decision rule appears similar as in the case of FSD. The distribution with larger area under the CDF is dominated by the distribution with smaller area under the CDF. Hence, under SSD criterion, the distribution *c(y)* dominates *C(y)* if $\int_{-\infty}^{y}\left(C(y)-c(y)\right)dy \geq 0,\ \forall_y \in \Re$, with strict inequality for some $y \in \Re$.

4.2 Propensity Score and Matching Methods

Most of the sample households have multiple plots and the quality of land may vary over plots. In order to control for plot quality differences, this study used the propensity score (PS) matching method and examined whether the data under study satisfied the balancing requirement and also invoked the common support requirement (Becker and Ichino, 2002; Holden and Bezabih, 2009). Matching methods are used to estimate the average treatment effect based on PS.

The PS matching provides a method to correct the estimation of treatment effects by controlling for the existence of confounding factors (Becker and Ichino, 2002). The basic idea behind it is to reduce the bias that may occur while comparing the outcomes of treated and control groups. Matching subjects on an *n*-dimensional vector of characteristics is usually not viable as *n* becomes larger. To overcome this problem of dimensionality, the matching method therefore summarizes pre-treatment characteristics of each subject into a single index variable, the PS (Becker and Ichino, 2002). The PS is defined as the conditional probability of receiving a treatment given the pre-treatment characteristics (Rosenbaum and Rubin, 1983):

$$p(X) = \Pr\{D = 1 \mid \mathbf{X}\} = E\{D \mid \mathbf{X}\}$$

Where, $D = \{0,1\}$ is the indicator variable representing exposure to treatment and $\mathbf{X}$ is the multidimensional vector of pre-treatment characteristics. Given this, the average effect of treatment on the treated (*ATT*) is given by:

$$ATT = E\left\{E\left\{Y_{1i} \mid D_i = 1, p\left(X_i\right)\right\} - E\left\{Y_{0i} \mid D_i = 0, p\left(X_i\right)\right\} \mid D_i = 1\right\}$$

The basic logic is that for a given PS, the exposure to treatment is random and in general the treated and control groups should have identical observable characteristics. As PS can be estimated by using any standard probability model, we used the binary logit model in this paper.

The estimate of PS should satisfy the balancing property and common support requirements to ensure that treated and untreated observations are comparable.

The following variables were used to construct the propensity score: three slope dummies (foot-hill, mid-hill, and steep-hill), four soil type dummies, two dummies for soil depth (swallow and medium), dummy for irrigation status of plot, and distance to plot from homestead. We estimated propensity score for three different cases: for rented in plots versus the owner-operated plots of low-caste households, for owner operated plots of high-caste versus low-caste, and for owner-operated plots of high-caste versus rented in plots of low-caste. The results of the propensity score are presented in Appendix 2. It can be seen that the balancing property was satisfied in all three estimations. However, while estimating propensity score for owner-operated plots of high-caste versus low-caste, we dropped irrigation dummy as an explanatory variable because the balancing property was not satisfied when we included it. For the same reason, we could not include irrigation dummy and distance to plot from homestead while estimating propensity score for rented in plots of low-caste households versus the owner-operated plots of high-caste households. The common support requirements were also invoked in all of these estimations.

4.3 Parametric Method

In order to test the robustness of the result obtained from non-parametric methods, we apply parametric methods for empirical analysis. As there are multiple plots per households, we were able to carry out panel data models. We applied random effects (RE) models because the variable caste is plot invariant and thus fixed effects (FE) models cannot be estimated that could otherwise have been used for controlling the intra-group correlation that may arise due to

unobserved cluster effects (Udry, 2000; Wooldridge, 2002). While estimating the RE model, only those sample plots were considered for analyses that satisfy common support obtained after estimating PS matching models. This provides a way to compare if the plot quality differences explain the land productivity differential. Hence, the models become:

$$Y_{ip} = \alpha + \beta_1 X_i + \beta_2 X_{ip}^{sq} + \beta_3 X_{ip}^{h} + \zeta S + \mu_i + \varepsilon_{ip} \quad \text{where } S = \begin{cases} 1 & \text{common support is satisfied} \\ 0 & \text{otherwise} \end{cases}$$

$$Y_{ip} = \alpha + \beta_1 X_i + \beta_2 X_{ip}^{sq} + \beta_3 X_{ip}^{h} + \gamma D + \zeta S + \mu_i + \varepsilon_{ip} \quad \text{where } D = \begin{cases} 1 & \text{low caste} \\ 0 & \text{otherwise} \end{cases}$$

Where Y_{ip} is the value of output obtained from plot *p* per unit of land for household *i*, X_i refers to farm size, X_{ip}^{sq} is a vector of observed plot characteristics, X_{ip}^{h} is vector of plot invariant farm household characteristics, μ_i is unobserved plot invariant household attributes and unobserved plot variant attributes, and ε_{ip} the error term. For the estimation, we assumed that μ_i is uncorrelated with X_{ip}^{h}.

4.4 Variable Specification

Productivity is measured as the total value of output of crops per unit of land. Land is measured in hectare. Output value is calculated by multiplying crop produce by average local producer prices. Same average prices for both seller and buyers of the agricultural outputs are used because all outputs in the study area are traded in the local market. Therefore, this study assumes low transaction costs in these output markets.

Following the theoretical framework of this study, we used a number of explanatory variables that can affect land productivity. Given that there are labor market imperfections, family labor endowment in the household is assumed to have effect on it. Therefore, we included the amount of adult male and female labor per unit of land in the analysis. As there are division of labor in farming such as transplanting of rice is done usually by female labor, ploughing is done usually

by the male member of low-caste households, threshing of grains by using oxen is also done by male members and so forth, we therefore included them separately. Another variable 'consumer-land ratio' (calculated as the ratio of standard consumer unit divided by ownership land holding) proxies the food needs per unit land of the household and is taken as a proxy for subsistence constraint.

5. Results and Discussion

Stata version 10.1 was used to estimate all the empirical models in this paper. As we have already tested the hypotheses (H1 and H2) related to the initial assumptions of our theoretical models in section 3, we focus on the remaining hypotheses here.

5.1 Labor market imperfections and land productivity differences

Our fourth hypothesis (H4) stated that land productivity is higher on owner-operated land of low-caste households than on owner-operated land of high-caste households. The results of both non-parametric methods (Figure 1 and Table 5) and parametric methods (Table 6) support our hypothesis.

Figure 1 shows the results of the stochastic dominance analysis. In Figure 1, the CDF of yield for low-caste households lies to the right of the CDF of yield for high-caste households. This implies that the land productivity on owner-operated land of low-caste households is stochastically dominating that of high-caste households. The same is found with the propensity score matching method (see Table 5). From Table 5, we see that low-caste households produced an output equivalent to Rs. 81834 per hectare on their own land while high-caste households produced an output equivalent to Rs. 63783 per hectare on owner-operated land. Hypothesis 4 cannot be rejected, indicating that there are significant transaction costs in the labor market and preventing productivity equalization.

The same findings are obtained from the parametric methods presented in Table 6. The land productivity differential between high-caste and low-caste households on owner-operated land was reduced from about 30 percent to about 15 percent after controlling for land quality. After controlling for both plot and household endowment and market access characteristics, the difference in mean productivity reduced to 9.3 percent. This shows that we need to include additional controls in order to know the reasons why the mean productivity difference between high-caste and low-caste remained significant even after controlling for the market access and endowment characteristics. One of the possible reasons is that our variables did not fully capture labor market access or land use intensity due to unobserved heterogeneity and endogeneity.

The variable consumer-own land ratio was found to have significant positive association with land productivity implying that households with more family members to feed per unit own land used the land more intensively. Labor-rich households had higher land productivity and this is likely to be because they applied more labor due to their lower opportunity cost (of labor). Most of the high-caste households were engaged in off-farm activities, especially jobs outside the village. This enhanced their family labor scarcity per farm size as compared to low-caste households and this is likely to have affected their land productivity negatively.

Besides the availability of labor, the attitude towards farming may influence land productivity. High-caste people consider farming to be inferior work and do not want to work as farm labor if they get any other jobs. Still, working as a ploughman is considered as an impure job and high-caste people rarely perform it. This sort of segmentation of work by caste might have reduced the average land productivity of high-caste households. In addition, low-caste households migrate less because of discrimination against them in regular employment. As a result, they may concentrate their labor in farming, leading to higher land productivity.

5.2 Land rental market imperfections and land productivity differences

Our third hypothesis (H3) stated that sharecropping is associated with Marshallian inefficiency. For this, we compared land productivity between the owner-operated and rented in land of low-caste households. Table 7 presents the results when applying propensity score matching. Table 7 shows that there is no significant difference in land productivity between the owner-operated and rented in land of low-caste households. Similar result is found with household random effects models (see Table 8). These findings indicate that hypothesis 3 can be rejected. This indicates that transaction costs in the labor market dominate over the disincentive effect of sharecropping and this is driving up the land productivity of low-caste tenants. From Table 8, we can see that low-caste tenants in Rivan and Lwang-Ghalel villages have significantly higher land productivity as compared to those in Lahachok village (used as baseline village). It may be due to the fact that Lahachok village is relatively near to the market centre and offering better opportunities to engage in off-farm work even for low-caste households and increasing the opportunity cost of labor. Household labor endowment, both male and female, is found to be significantly positively associated with land productivity, indicating more abundant labor and a lower opportunity cost of labor.

5.3 Land rental and labor markets imperfections, and land productivity differences

Our fifth hypothesis (H5) stated that land productivity is higher on rented in land of low-caste (tenant) households than on owner-operated land of high-caste households. Results of both non-parametric and parametric methods support this.

Figure 2 shows the results of stochastic dominance analysis for the land productivity difference between owner-operated land of high-caste households and rented in land of low-caste households. In Figure 2, the CDF of output value per hectare for rented in plots of low-caste households stochastically dominates the owner-operated plots of high-caste households. A

similar result is found with matching methods (see Table 9). Table 9 shows that low-caste households produce an output equivalent to Rs. 77139 per hectare on their rented in land against Rs. 63783 per hectare on owner-operated land of high-caste households. This productivity difference is significant at 1 percent level. This difference implies that transaction costs in the labor market dominate over the Marshallian inefficiency effects of sharecropping and we cannot reject hypothesis 5. This makes sense since hypothesis 3 had to be rejected (no significant Marshallian inefficiency on the rented in land of low-caste households).

The results from random effects regression model are presented in Table 10. The land productivity differential is significant when we compare the owner-operated land of high-caste households with the rented in land of low-caste households. Even after controlling for both land and household endowment and labor market access characteristics, the land productivity difference is about 24 percent. Households participating in off-farm employment are found to have significantly lower productivity as compared to those who do not participate in off-farm employment. The results show that households with more family labor per unit of land have higher land productivity. High productivity in rented-in land may be due to the fact that many of the low-caste tenants are very land-poor and thus, rely more on what they produce on rented in land for their subsistence. Poor tenant households may use the land more intensively to cope with the situation of extreme poverty (Pagiola and Holden, 2001). In a study of land lease market in Ethiopia, Pender and Fafchamps (2006) argue that if transaction costs (related to monitoring and enforcement of tenant's use of inputs on the plot) is positive for landlord or if the monitoring cost is a decreasing function of the share of output received by tenant, tenant's yield on the rented land can be higher than landlord's yield on their land. There are therefore still omitted

variables (unobserved heterogeneity) that may explain the significance of the tenancy/caste variable.

6. Conclusion

This paper assessed and looked for possible explanations for the land productivity differential between high-caste and low-caste farm households. Land and labor market imperfections are among the major explanations for this difference. Close to 60 percent of high-caste households hired in agricultural labor while about 20 percent rented out land. About 83 percent of low-caste households sold their labor in the agricultural labor market while about 50 percent rented in land. This indicates that adjustment of land and labor endowments were more common through the labor market than through the land rental market. However, the land rental market has improved the access to land for low-caste households as they were able to almost double their operational holding of land by participating in the land rental market. The key results of the analyses are: i) low-caste households have significantly higher land productivity on their owner-operated (28 percent higher) and sharecropped in (21 percent higher) land as compared to on owner-operated land of high-caste households, and ii) in the case of low-caste households, land productivity on their owned land and on sharecropped in land are not significantly different, implying no significant Marshallian inefficiency.

From the theoretical analysis, we come with three basic reasons behind the difference in land productivity between high-caste and low-caste households. Firstly, the agricultural production in the study area requires substantial amounts of human labor for operations such as tilling land, managing land, applying manure and fertilizer, carrying inputs to plots, water management and harvesting. The technology is also such that labor-intensification is feasible. Hence, labor and land market imperfections cause low-caste households with relatively more family labor per unit

of land to apply more labor to cultivate land intensively and achieve higher land productivity. Households with less endowment of family labor can hire in labor but it is difficult to monitor hired labor in spatially-dispersed agricultural environments, except perhaps for simple tasks such as ploughing. Hiring of labor is thus associated with search, monitoring and enforcement costs (Hayami and Otsuka, 1993) and this may explain the lower labor-intensity and land productivity of high-caste households despite their high rate of participation in the agricultural labor market. High transaction cost in the labor market is thus a possible explanation for land productivity difference between high-caste and low-caste households. The land rental market is not fully compensating for the labor market imperfections although Marshallian disincentive effects due to the dominance of sharecropping were not found to have a strong negative effect on land productivity on rented (sharecropped) land.

The other side of the coin of this productivity difference is the differences in opportunity cost of labor. Low-caste households have lower opportunity cost of labor due to discrimination in non-agricultural labor markets, especially in regular off-farm employment. Thus, they concentrate their labor in farming and in the seasonal agricultural labor market where they have an 'advantage' because high-caste households consider some of this work to be below their dignity. The low land endowment of low-caste households contributes to their labor supply in the agricultural labor market and low wage rates there. Furthermore, the persistence of the land productivity differential even after the participation in the land rental market indicates significant transaction costs in the land rental market (Holden, et al., 2009). This is investigated in another paper by the authors (Aryal and Holden, 2010).

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Notes

1. The caste system that prevails in the Hindu religion, divides people into vertical hierarchies placing *Brahmins* on the top, *Chhetries* second, *Baishyas* third and *Sudras (Dalits)* at the lowest rank. Dalits are considered as untouchables under the traditional and conservative Hindu caste system. Therefore, other high-caste groups do not eat any cooked food touched by them. As a person attains caste position by birth, there is no way to move upward through any other means such as acquiring higher education or earning a higher level of income. However, the detailed discourse related to caste system is beyond the scope of this paper. This paper divides all castes/ethnic households in to two major categories: high-caste household and low-caste household. In this division, high-caste comprises all castes/ethnic groups except the *Dalits*, while the low-caste includes all those falling under *Dalits*. For the analytical purpose of this paper, it is assumed that the division is appropriate, because the gap between high-caste and low-caste households with regard to access and ownership of resources is very wide.

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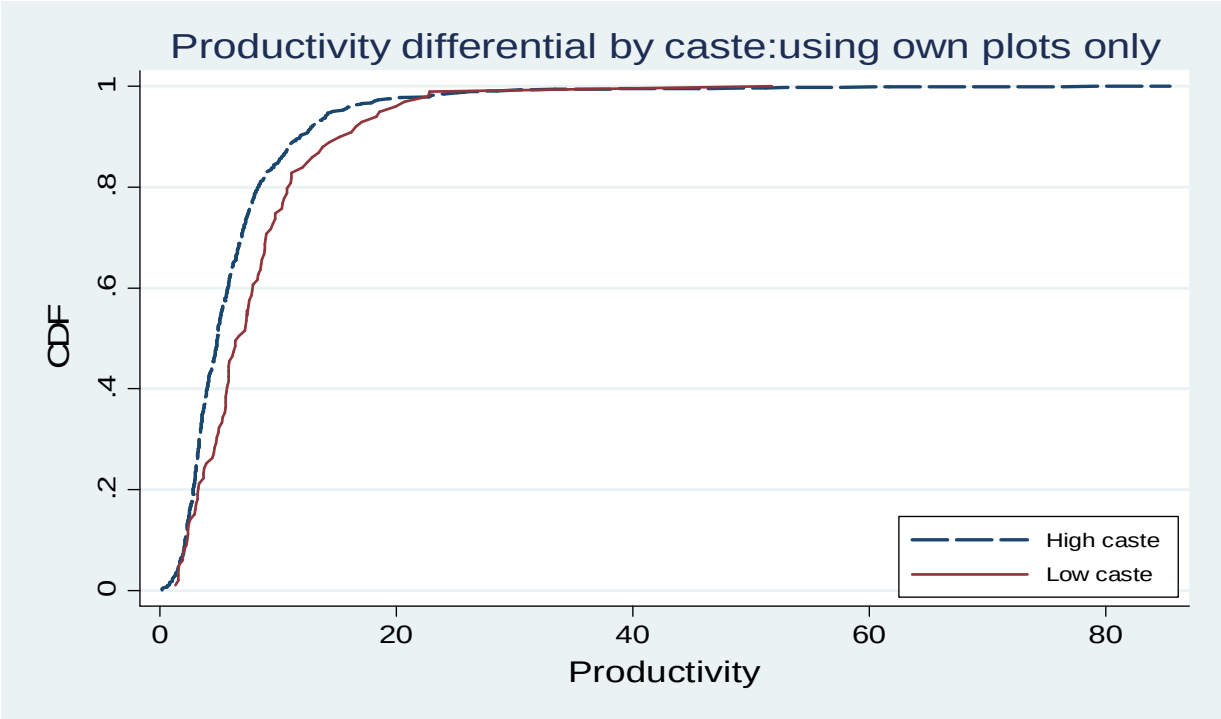

Figure 1: First order stochastic dominance analysis for owner operated plots of high-caste and low-caste households

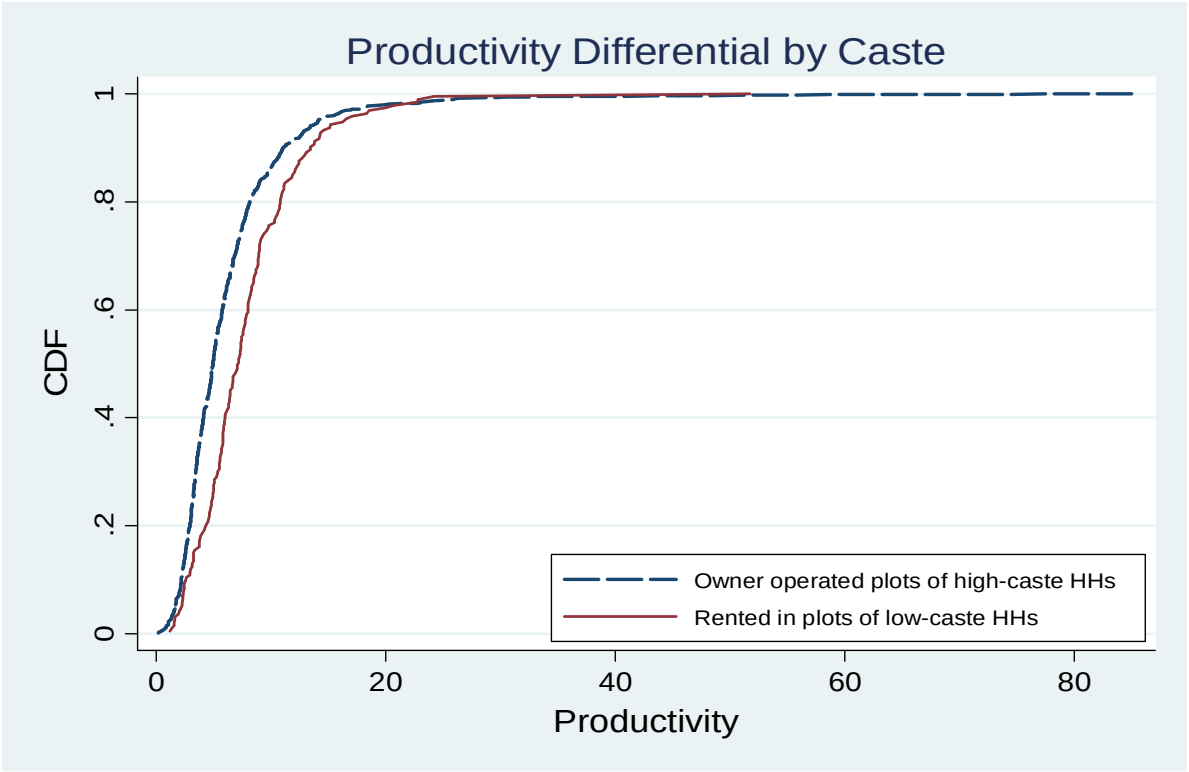

Figure 2: First order stochastic dominance analysis for owner operated plots of high-caste households and rented in plots of low caste households

Table 5
Land productivity on owner-operated plots using propensity score matching

Variable	Kernel Matching	Nearest Neighbor
Land Productivity		
Owner-operated plots of low-caste households	81834.46	81834.47
Owner-operated plots of high-caste households	63783.15	63783.15
Difference	18051.31	18051.31
Standard error[1]	6601.92	7075.63
t-statistic	2.73***	2.55***
Number of observations		
Owner-operated plots of low-caste households	99	99
Owner-operated plots of high-caste households	639	639

Significance levels: *: 10% level, **: 5% level, ***:1% level
1. In case of Kernel matching the bootstrapped standard error based on 500 replications is reported

Table 6
Land productivity difference between low-caste and high-caste households on their owner-operated plots

	Linear relation		With plot characteristics		With plot and Household characteristics	
Log of total value product/ha	Coef.	S. E.	Coef.	S. E.	Coef.	S. E.
Caste dummy (1=Low-caste)	0.300***	0.081	0.153***	0.041	0.093***	0.025
Plot size (in ha)			-0.018	0.038	0.077	0.058
Village (Rivan)			0.043	0.082	0.107	0.079
Village (Lwang-Ghalel)			0.066	0.057	0.058	0.055
Distance to plot (in minutes)			-0.069***	0.026	-0.054**	0.025
Slope (foot-hill)			0.069	0.088	0.044	0.089
Slope (mid-hill)			-0.105*	0.062	-0.102*	0.061
Slope (steep-hill)			-0.174***	0.061	-0.162***	0.058
Soil type 2			-0.096	0.069	-0.078	0.067
Soil type 3			-0.072	0.085	-0.005	0.088
Soil type 4			-0.019	0.106	-0.018	0.097
Soil type 5			-0.025	0.064	0.003	0.063
Soil depth (swallow)			-0.640***	0.060	-0.636***	0.059
Soil depth (medium)			0.129*	0.077	0.110	0.073
Oxen holding/ha					0.006	0.024
Value of asset/ha					0.089**	0.041
Off-farm dummy(1=Has access)					0.019	0.059
Consumer-own land ratio					0.259***	0.039
Number of adult female/ha					0.028	0.051
Number of adult male/ha					0.125***	0.042
Male head dummy (1)					-0.020	0.070
Constant	10.812***	0.034	11.582***	0.116	10.201***	0.444
Number of observations	738		738		738	

Significance levels: *: 10% level, **: 5% level, ***:1% level and all continuous variables are in logarithms

Table 7
Assessment of Marshallian inefficiency in low-caste tenant households only

Variable	Kernel Matching	Nearest Neighbor
Land Productivity		
Rented in plots	67456.6	67456.6
Owner-operated plots	69920.8	69920.8
Difference	-2464.2	-2464.2
Standard error[1]	9277.1	10462.2
t-statistic	-0.27	-0.24
Number of observations		
Owner-operated plots	20	20
Rented in plots	32	32

Significance levels: *: 10% level, **: 5% level, ***:1% level
Notes:
1. For Kernel matching, we reported the bootstrapped standard error with 500 replications.
2. Number of observations reduced as we included only owner-tenant low-caste households.

Table 8
Land productivity difference between own land and rented in land of low-caste tenants (Assessment of Marshallian Inefficiency)

	Linear relation		With plot characteristics		With plot and household characteristics	
Log of total value product/ha	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Tenure dummy (1=rented in)	-0.026	0.117	-0.115	0.127	-0.047	0.160
Plot size (in ha)			0.010	0.109	0.333	0.203
Village (Rivan)			0.421**	0.186	0.458***	0.178
Village (Lwang-Ghalel)			0.388**	0.183	0.443***	0.144
Distance to plot (in minutes)			0.056	0.058	0.062	0.060
Slope (foot-hill)			0.121	0.167	0.071	0.170
Slope (mid-hill)			-0.131	0.142	-0.072	0.174
Slope (steep-hill)			-0.173	0.128	-0.131	0.126
Soil type 2			-0.380**	0.170	-0.278	0.191
Soil type 3			-0.541***	0.146	-0.528***	0.145
Soil type 4			0.000	0.000	0.000	0.000
Soil type 5			-0.208	0.128	-0.120	0.141
Irrigation dummy (1=yes)			0.403	0.289	0.259	0.321
Soil depth (swallow)			0.046	0.110	0.062	0.100
Soil depth (medium)			0.017	0.124	0.037	0.144
Oxen holding/ha					-0.135	0.237
Value of asset/ha					0.125	0.082
Consumer-own land ratio					-0.006	0.023
Number of adult female/ha					0.208**	0.094
Number of adult male/ha					0.169***	0.051
Male head dummy (1)					0.205	0.208
Constant	11.116***	0.111	10.800***	0.355	9.562***	0.936
Number of observations	52		52		52	

Significance levels: *: 10% level, **: 5% level, ***:1% level and all continuous variables are in logarithms

Table 9
Land productivity differences in owner operated plots of high-caste and rented in plots of low-caste households

Variable	Kernel matching	Nearest neighbor matching
Land Productivity		
Low-caste (Rented in plots)	77139.9	77193.8
High-caste (Owner operated plots)	63783.2	63813.2
Difference	13410.7	13410.6
Standard error	4966.3	4439.4
t-statistic	2.71***	3.02***
Number of observations		
Low-caste (Rented in plots)	94	94
High-caste (Owner operated plots)	646	646

Significance levels: *: 10% level, **: 5% level, ***:1% level
Note: In the case of Kernel matching the bootstrapped standard error with 500 replications is reported.

Table 10
Land productivity difference between owner-operated plots of high-caste households and rented in plots of low-caste households

	Linear relation		With plot characteristics		With plot and Household characteristics	
Log of total value product/ha	Coef.	S. E.	Coef.	S. E.	Coef.	S. E.
Plot type/Caste dummy (1=Rented in/Low-caste)	0.358***	0.065	0.132**	0.066	0.237***	0.097
Plot size (in ha)			-0.002	0.037	0.077	0.059
Village (Rivan)			0.093	0.079	0.131*	0.076
Village (Lwang-Ghalel)			0.117**	0.058	0.125**	0.059
Slope (foot-hill)			0.134	0.090	0.129	0.089
Slope (mid-hill)			-0.110*	0.057	-0.114**	0.056
Slope (steep-hill)			-0.174***	0.056	-0.174***	0.055
Soil type 2			0.041	0.067	0.048	0.066
Soil type 3			-0.214***	0.079	-0.178**	0.081
Soil type 4			0.100	0.116	0.110	0.115
Soil type 5			-0.030	0.062	-0.020	0.062
Soil depth (swallow)			-0.599***	0.055	-0.593***	0.055
Soil depth (medium)			0.102	0.064	0.092	0.062
Oxen holding/ha					0.003	0.024
Value of asset/ha					0.051	0.042
Off-farm dummy(1=Has access)					-0.132***	0.047
Consumer-own land ratio					0.123***	0.024
Number of adult female/ha					0.129***	0.052
Number of adult male/ha					0.138***	0.042
Male head dummy (1)					-0.011	0.085
Constant	10.811***	0.034	11.274***	0.077	10.481***	0.433
N	740		740		740	

Significance levels: *: 10% level, **: 5% level, ***:1% level and all continuous variables are in logarithms

Notes:

1. The plot type/caste dummy has two alternatives: rented in plots of low-caste households (1) and owner operated plots of high-caste households (0).
2. Number of observations is reduced from 764 to 740 because we considered only those observations for which common support is satisfied while performing propensity score matching.

Appendix 1

1a: For high-caste households (C)

A. Change in agricultural family labor due to change in agricultural wage

$$\frac{\partial l_a^f}{\partial \omega_a}=\frac{1}{|H|}\left[\frac{\partial^2 U}{\partial L_o \partial \omega_a}\frac{\partial^2 U}{\partial l_a^{h2}}\frac{\partial^2 U}{\partial L_o \partial l_a^f}+\frac{\partial^2 U}{\partial L_o^2}\left(-\frac{\partial^2 U}{\partial l_a^f \partial \omega_a}\frac{\partial^2 U}{\partial l_a^{h2}}+\frac{\partial^2 U}{\partial l_a^h \partial \omega_a}\frac{\partial^2 U}{\partial l_a^f \partial l_a^h}\right)\right]$$

$$=\frac{1}{|H|}\left\{\begin{array}{l}-(\omega_o-\tau_o)l_a^h\left(\overline{A}\right)^3 p_q\frac{\partial U}{\partial Y}\frac{\partial^2 U}{\partial Y^2}\frac{\partial^2 q}{\partial l_a^{h2}}\frac{\partial^2 U}{\partial L_e^2}+l_a^h\left(p_q\right)^2\left(\overline{A}\right)^3\frac{\partial U}{\partial Y}\frac{\partial q}{\partial l_a^f}\frac{\partial^2 U}{\partial Y^2}\frac{\partial^2 q}{\partial l_a^{h2}}\frac{\partial^2 U}{\partial L_e^2} \\ -(\omega_o-\tau_o)^2 p_q\left(\overline{A}\right)^2\left(\frac{\partial U}{\partial Y}\right)^2\frac{\partial^2 q}{\partial l_a^f \partial l_a^h}\frac{\partial^2 U}{\partial Y^2}-p_q\left(\overline{A}\right)^2\left(\frac{\partial U}{\partial Y}\right)^2\frac{\partial^2 q}{\partial l_a^f \partial l_a^h}\frac{\partial^2 U}{\partial L_e^2}\end{array}\right\}>0$$

Here, the first term is positive, but the second, third and fourth terms are negative. So, the sum of the terms inside the curly brackets becomes negative. As a result $\frac{\partial l_a^f}{\partial \omega_a}>0$, given that $|H|<0$.

B. Change in agricultural family labor due to change in transaction costs in hiring agricultural labor market

$$\frac{\partial l_a^f}{\partial \tau_a}=\frac{1}{|H|}\left[\frac{\partial^2 U}{\partial L_o \partial \tau_a}\frac{\partial^2 U}{\partial l_a^{h2}}\frac{\partial^2 U}{\partial L_o \partial l_a^f}+\frac{\partial^2 U}{\partial L_o^2}\left(-\frac{\partial^2 U}{\partial l_a^f \partial \tau_a}\frac{\partial^2 U}{\partial l_a^{h2}}+\frac{\partial^2 U}{\partial l_a^h \partial \tau_a}\frac{\partial^2 U}{\partial l_a^f \partial l_a^h}\right)\right]$$

$$=\frac{1}{|H|}\left\{\begin{array}{l}-(\omega_o-\tau_o)l_a^h\left(\overline{A}\right)^3 p_q\frac{\partial U}{\partial Y}\frac{\partial^2 U}{\partial Y^2}\frac{\partial^2 q}{\partial l_a^{h2}}\frac{\partial^2 U}{\partial L_e^2}+l_a^h\left(p_q\right)^2\left(\overline{A}\right)^3\frac{\partial U}{\partial Y}\frac{\partial q}{\partial l_a^f}\frac{\partial^2 U}{\partial Y^2}\frac{\partial^2 q}{\partial l_a^{h2}}\frac{\partial^2 U}{\partial L_e^2} \\ -(\omega_o-\tau_o)^2 p_q\left(\overline{A}\right)^2\left(\frac{\partial U}{\partial Y}\right)^2\frac{\partial^2 q}{\partial l_a^f \partial l_a^h}\frac{\partial^2 U}{\partial Y^2}-p_q\left(\overline{A}\right)^2\left(\frac{\partial U}{\partial Y}\right)^2\frac{\partial^2 q}{\partial l_a^f \partial l_a^h}\frac{\partial^2 U}{\partial L_e^2}\end{array}\right\}>0$$

Here, the first term is positive, but the second, third and fourth terms are negative. So, the sum of the terms inside the curly brackets becomes negative. As result, $\frac{\partial l_a^f}{\partial \tau_a}>0$ given that $|H|<0$.

C. Change in agricultural labor supply due to change in total time endowment of the household.

$$\frac{dl_a^f}{dT^C}=\frac{1}{|H|}\left[\frac{\partial^2 U}{\partial L_o \partial T^C}\frac{\partial^2 U}{\partial l_a^{h2}}\frac{\partial^2 U}{\partial l_a^f \partial L_o}-\frac{\partial^2 U}{\partial L_o^2}\frac{\partial^2 U}{\partial l_a^f \partial T^C}\frac{\partial^2 U}{\partial l_a^{h2}}\right]$$

$$=\frac{1}{|H|}\left\{\left((\omega_o-\tau_o)p_q\left(\overline{A}\right)^2\frac{\partial U}{\partial Y}\frac{\partial^2 q}{\partial l_a^{h2}}\frac{\partial^2 U}{\partial L_e^2}\frac{\partial^2 U}{\partial Y^2}\right)\left((\omega_o-\tau_o)-p_q\frac{\partial q}{\partial l_a^f}\right)\right\}>0$$

Here, the first part is negative while the second part becomes positive if net wage in the off-farm employment is higher than the marginal value product of labor in agriculture (As assumed). The product inside the curly brackets becomes negative. Therefore, $\frac{dl_a^f}{dT^C} > 0$ given that $|H| < 0$.

D. Change in agricultural labor supply due to change in off-farm wage

$$\frac{dl_a^f}{d\omega_o} = \frac{1}{|H|}\left[\frac{\partial^2 U}{\partial L_o \partial \omega_o}\frac{\partial^2 U}{\partial l_a^{h2}}\frac{\partial^2 U}{\partial l_a^f \partial L_o} - \frac{\partial^2 U}{\partial L_o^2}\frac{\partial^2 U}{\partial l_a^f \partial \omega_o}\frac{\partial^2 U}{\partial l_a^{h2}}\right]$$

$$= \frac{1}{|H|}\left\{\begin{array}{l}(\omega_o - \tau_o)\, p_q \left(\overline{A}\right)^2 L_o \frac{\partial U}{\partial Y}\frac{\partial^2 U}{\partial Y^2}\frac{\partial^2 q}{\partial l_a^{h2}}\frac{\partial^2 U}{\partial L_e^2} + (\omega_o - \tau_o)\left(p_q \overline{A}\right)^2 \frac{\partial q}{\partial l_a^f}\frac{\partial^2 q}{\partial l_a^{h2}}\frac{\partial^2 U}{\partial Y^2}\left(\frac{\partial U}{\partial Y}\right)^2 \\ + p_q \left(\overline{A}\right)^2 \frac{\partial^2 q}{\partial l_a^{h2}}\frac{\partial^2 U}{\partial L_e^2}\left(\frac{\partial U}{\partial Y}\right)^2 - \left(p_q \overline{A}\right)^2 L_o \frac{\partial U}{\partial Y}\frac{\partial q}{\partial l_a^f}\frac{\partial^2 q}{\partial l_a^{h2}}\frac{\partial^2 U}{\partial Y^2}\frac{\partial^2 U}{\partial L_e^2}\end{array}\right\} < 0$$

Here the first part is negative while the remaining three terms are positive. So, the sum inside the curly brackets becomes positive. As a result, $\frac{dl_a^f}{d\omega_o} < 0$ given that $|H| < 0$.

E. Change in agricultural labor supply due to change in transaction costs in off-farm employment

$$\frac{dl_a^f}{d\tau_o} = \frac{1}{|H|}\left[\frac{\partial^2 U}{\partial L_o \partial \tau_o}\frac{\partial^2 U}{\partial l_a^{h2}}\frac{\partial^2 U}{\partial l_a^f \partial L_o} - \frac{\partial^2 U}{\partial L_o^2}\frac{\partial^2 U}{\partial l_a^f \partial \tau_o}\frac{\partial^2 U}{\partial l_a^{h2}}\right]$$

$$= \frac{1}{|H|}\left\{\begin{array}{l}-(\omega_o - \tau_o)\, p_q \left(\overline{A}\right)^2 L_o \frac{\partial U}{\partial Y}\frac{\partial^2 U}{\partial Y^2}\frac{\partial^2 q}{\partial l_a^{h2}}\frac{\partial^2 U}{\partial L_e^2} - (\omega_o - \tau_o)\left(p_q \overline{A}\right)^2 \frac{\partial q}{\partial l_a^f}\frac{\partial^2 q}{\partial l_a^{h2}}\frac{\partial^2 U}{\partial Y^2}\left(\frac{\partial U}{\partial Y}\right)^2 \\ - p_q \left(\overline{A}\right)^2 \frac{\partial^2 q}{\partial l_a^{h2}}\frac{\partial^2 U}{\partial L_e^2}\left(\frac{\partial U}{\partial Y}\right)^2 + \left(p_q \overline{A}\right)^2 L_o \frac{\partial U}{\partial Y}\frac{\partial q}{\partial l_a^f}\frac{\partial^2 q}{\partial l_a^{h2}}\frac{\partial^2 U}{\partial Y^2}\frac{\partial^2 U}{\partial L_e^2}\end{array}\right\} > 0$$

Here the first part is positive while the remaining three terms are negative. Therefore, the sum inside the curly brackets becomes negative. As a result, $\frac{dl_a^f}{d\tau_o} > 0$ given that $|H| < 0$.

1b: For low-caste households (c)

A. Change in agricultural labor supply (family labor) to own farm due to change in agricultural wage

$$\frac{dl_a^f}{d\omega_a}=\frac{1}{|H|}\left[-\frac{\partial^2 U}{\partial l_a^f \partial \omega_a}\frac{\partial^2 U}{\partial L_g^2}-\left(-\frac{\partial^2 U}{\partial L_g \partial \omega_a}\frac{\partial^2 U}{\partial l_a^f \partial L_g}\right)\right]=\frac{1}{|H|}\left\{p_q\frac{\partial q}{\partial l_a^f}\overline{A}(\omega_a-\upsilon_a)\frac{\partial U}{\partial Y}\frac{\partial^2 U}{\partial Y^2}+\frac{\partial U}{\partial Y}\frac{\partial^2 U}{\partial L_e^2}\overline{A}\right\}<0$$

B. Change in agricultural labor supply to own family farms due to change in transactions costs in the agricultural labor market in the village

$$\frac{dl_a^f}{d\upsilon_a}=\frac{1}{|H|}\left[-\frac{\partial^2 U}{\partial l_a^f \partial \upsilon_a}\frac{\partial^2 U}{\partial L_g^2}-\left(-\frac{\partial^2 U}{\partial L_g \partial \upsilon_a}\frac{\partial^2 U}{\partial l_a^f \partial L_g}\right)\right]=\frac{1}{|H|}\left\{\overline{A}\frac{\partial U}{\partial Y}\left((\omega_a-\upsilon_a)^2\frac{\partial^2 U}{\partial Y^2}+\frac{\partial^2 U}{\partial L_e^2}\right)\right\}>0$$

C. Change in agricultural labor supply (own farm) due to change in time endowment of the household

$$\frac{dl_a^f}{dT^c}=\frac{1}{|H|}\left[-\frac{\partial^2 U}{\partial l_a^f \partial T^c}\frac{\partial^2 U}{\partial L_g^2}-\left(-\frac{\partial^2 U}{\partial L_g \partial T^c}\frac{\partial^2 U}{\partial l_a^f \partial L_g}\right)\right]$$

$$=\frac{1}{|H|}\left\{\overline{A}(\omega_a-\upsilon_a)^2\frac{\partial^2 U}{\partial Y^2}\frac{\partial^2 U}{\partial L_e^2}+\overline{A}\left(\frac{\partial^2 U}{\partial L_e^2}\right)^2-\overline{A}(\omega_a-\upsilon_a)^2\frac{\partial^2 U}{\partial Y^2}\frac{\partial^2 U}{\partial L_e^2}-\overline{A}\left(\frac{\partial^2 U}{\partial L_e^2}\right)^2\right\}=0$$

D. Change in agricultural labor supply (outside) due to change in wage in the agricultural sector in village

$$\frac{dL_g}{d\omega_a}=\frac{1}{|H|}\left[-\frac{\partial^2 U}{\partial L_g \partial \omega_a}\frac{\partial^2 U}{\partial l_a^{f\,2}}-\left(-\frac{\partial^2 U}{\partial l_a^f \partial \omega_a}\frac{\partial^2 U}{\partial L_g \partial l_a^f}\right)\right]$$

$$=\frac{1}{|H|}\left\{\begin{array}{l}-\overline{A}p_q(\omega_a-\upsilon_a)L_g\dfrac{\partial U}{\partial Y}\dfrac{\partial^2 U}{\partial Y^2}\dfrac{\partial^2 q}{\partial l_a^{f\,2}}-(\omega_a-\upsilon_a)^2\left(\overline{A}\right)^2\dfrac{\partial U}{\partial Y}\dfrac{\partial^2 U}{\partial Y^2}\\ -\overline{A}p_q\left(\dfrac{\partial U}{\partial Y}\right)^2\dfrac{\partial^2 q}{\partial l_a^{f\,2}}-\left(\overline{A}\right)^2\dfrac{\partial U}{\partial Y}\dfrac{\partial^2 U}{\partial L_e^2}\end{array}\right\}>0$$

E. Change in agricultural labor supply (outside) due to change in the transactions costs in agricultural labor market in the village

$$\frac{dL_g}{d\upsilon_a}=\frac{1}{|H|}\left[-\frac{\partial^2 U}{\partial L_g\partial\upsilon_a}\frac{\partial^2 U}{\partial l_a^{f2}}-\left(-\frac{\partial^2 U}{\partial l_a^f\partial\upsilon_a}\frac{\partial^2 U}{\partial L_g\partial l_a^f}\right)\right]$$

$$=\frac{1}{|H|}\left\{\begin{array}{l}\overline{A}p_q(\omega_a-\upsilon_a)L_g\dfrac{\partial U}{\partial Y}\dfrac{\partial^2 U}{\partial Y^2}\dfrac{\partial^2 q}{\partial l_a^{f2}}+(\omega_a-\upsilon_a)^2\left(\overline{A}\right)^2\dfrac{\partial U}{\partial Y}\dfrac{\partial^2 U}{\partial Y^2}\\ +\overline{A}p_q\left(\dfrac{\partial U}{\partial Y}\right)^2\dfrac{\partial^2 q}{\partial l_a^{f2}}+\left(\overline{A}\right)^2\dfrac{\partial U}{\partial Y}\dfrac{\partial^2 U}{\partial L_e^2}\end{array}\right\}<0$$

F. Change in agricultural labor supply (outside) due to change in total time endowment in the household

$$\frac{dL_g}{dT^c}=\frac{1}{|H|}\left[-\frac{\partial^2 U}{\partial L_g\partial T^c}\frac{\partial^2 U}{\partial l_a^{f2}}-\left(-\frac{\partial^2 U}{\partial l_a^f\partial T^c}\frac{\partial^2 U}{\partial L_g\partial l_a^f}\right)\right]=\frac{1}{|H|}\left(\overline{A}p_q\frac{\partial U}{\partial Y}\frac{\partial^2 q}{\partial l_a^{f2}}\frac{\partial^2 U}{\partial L_e^2}\right)>0$$

Table A.1
Summary of comparative statics for model with imperfect labor market and no land market

Comparative statics	Low-caste	High-caste
Change in agricultural labor supply (in own farm) due to change in farm wage	$dl_a^f/d\omega_a<0$	$dl_a^f/d\omega_a>0$
Change in agricultural labor supply (in own farm) due to change in transaction cost of agricultural labor market	$dl_a^f/d\upsilon_a>0$	$dl_a^f/d\tau_a>0$
Change in agricultural labor supply (in own farm) due to change in total time endowment of the HH	$dl_a^f/dT^c>0$	$dl_a^f/dT^C>0$
Change in agricultural labor supply (to other HHs in the village) due to change in farm wage	$dL_g/d\omega_a>0$	NA
Change in agricultural labor supply (to other HHs in the village) due to change in transaction cost in the agricultural labor market	$dL_g/d\upsilon_a<0$	NA
Change in agricultural labor supply due to change in off-farm wage	NA	$dl_a^f/d\omega_o<0$
Change in agricultural labor supply due to change in transaction cost in the off-farm labor market	NA	$dl_a^f/d\tau_o>0$

Note: See Appendix 1 for detailed results; NA= Not applicable

Appendix 2

Table A.2
Estimations of propensity scores

	Owner-operated vs. rented in plots of low-caste Tenants (Case I)		Owner-operated plots of low-caste vs. owner-operated plots of high-caste (Case II)		Rented in plots of low-caste vs. owner-operated plots of high-caste (Case III)	
Dependent variables	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Slope (foot-hill)	-0.106	0.553	0.016	0.249	-0.137	0.258
Slope (mid-hill)	0.008	0.495	-0.102	0.196	-0.045	0.184
Slope (steep-hill)	-0.497	0.399	0.473***	0.163	0.049	0.173
Soil type 2	-0.274	0.387	0.796***	0.145	0.152	0.184
Soil type 3	1.645***	0.554	-0.154	0.355	1.348***	0.192
Soil type 4			-0.443	0.402	-0.759	0.498
Soil type 5	-0.100	0.549	-0.030	0.203	0.113	0.201
Soil depth (swallow)	-0.747*	0.386	-1.032***	0.154	-1.110***	0.153
Soil depth (medium)	-0.336	0.472	-0.075	0.226	-0.084	0.211
Distance to plot (minutes)	0.002	0.002	0.001	0.001		
Irrigated plot dummy (1)	-0.318	0.942				
Constant	0.825*	0.472	-0.881***	0.169	-0.703***	0.160
Number of observations	52		769		764	
Other Outputs						
Number of observations before invoking Common Support	52		769		764	
Number of Treated (1)	32		99		94	
Number of control (0)	20		670		670	
Balancing property	Satisfied		Satisfied		Satisfied	
Total number of observation after invoking Common Support	52		738		740	
Number of Treated (1)	32		99		94	
Number of control (0)	20		639		646	

Significance levels: *: 10% level, **: 5% level, ***:1% level
Note:
1. Dependent variable is different for each case. For case I, it is *tenuretype* (where 0 refers to owner-operated plot and 1 refers to rented in plot of low-caste households). For case II, it is *ownertype* (where 0 refers to owner-operated plots of high-caste households and 1 refers to owner-operated plots of low-caste households) and for case III, it is *ownhcrentlc* (where 0 refers to owner-operated plot of high-caste households and 1 refers to rented in plots of low-caste households).
2. In case II, irrigation dummy is not included because balancing property is not satisfied when it is included. For the same reason, distance to plot and irrigation dummy are not included in case III.

Caste, Marshallian Inefficiency and the Farm Size-Productivity Relationship

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Abstract
This paper assesses the association between Marshallian inefficiency, allocative inefficiency, and an inverse farm size productivity relationship (IR), and determines how these phenomena are affected by caste discrimination in Nepal. Marshallian disincentive effects were found for high-caste tenants only. After controlling for the Marshallian disincentive effect, the IR remained and was strongly associated with caste discrimination. Low-caste households had smaller farm sizes than high-caste households and significantly higher land productivity even after controlling for farm size. Caste discrimination and high transaction costs in labor and land rental markets, rather than Marshallian inefficiency, appeared to be the most important explanations for the IR.

Key words: farm size, land productivity; Marshallian inefficiency; caste; Nepal

1. Introduction

Many studies have empirically tested the relationship between farm size and land productivity (Sen, 1962; Bardhan, 1973; Deolalikar, 1981; Carter, 1984; Feder, 1985; Barrett, 1996; Townsend, et al., 1998; Lamb, 2003; Fan and Chan-Kang, 2005; Kimhi, 2006; Assuncao and Braido, 2007) and many of these studies have found an inverse relationship (Carter, 1984; Benjamin, 1995; Barrett, 1996; Heltberg, 1998). The main explanations for the inverse

relationship, after controlling for land quality differences between large and small farms, is related to imperfections in labor and land markets causing labor use intensity to be higher on small farms. Another empirical literature has focused more specifically on land rental markets and the dominance of sharecropping and whether it leads to inefficient land use (Shaban, 1987; Otsuka, 2007). Otsuka (2007) reviewed the empirical literature on sharetenancy, allocative efficiency of land rental markets, the inverse farm size-productivity relationship, and land-related investments. He noted that most studies have focused independently on only one of these issues although they are closely related and he identified this as an important gap in the research literature. A joint study of these would lead to a deeper understanding. This paper attempts to address this gap by jointly assessing the existence of Marshallian inefficiency, allocative inefficiency and an inverse farm size productivity relationship and how these phenomena are affected by caste discrimination in Nepal. Caste[8] discrimination has affected the land distribution and may also affect market access (Ito, 2009) and thus the productivity differences of tenants and landlords on owner-operated and rented-in land under sharecropping arrangements.

This study poses the question; does discrimination of low-caste households make them less productive in agriculture and is this further enhanced by Marshallian inefficiency since they may depend on short-term sharecropping contracts which may undermine their incentives to enhance land productivity? Additionally, does such discrimination also eliminate the inverse relationship? Or can it be the other way around, that discrimination of low-caste households leads to a concentration of their labor on small farms and therefore a strengthening of the inverse

[8] The caste system exists in Hindu religion. Caste refers to hierarchical ranking of a person based on hereditary membership. It fixes the social status of individuals at birth and prevents movements from one category to another. The major caste groups are: *Brahmins* (the highest caste); *Chhetries* (the second highest caste); Baishyas (the third highest caste); and *Sudras* (often called *Dalits* or *Scheduled castes*- the lowest caste). Dalits face severe discrimination due to the practice of untouchability, which prevents them to participate in many religious functions and even, entering into the houses of other caste groups. This study classified all households into two broad groups: Low-caste (*Dalits* households only) and High-caste (All other categories except *Dalits*).

relationship? This may be the outcome if they face very high transaction costs in the land and labor markets. The allocative efficiency of the land rental market may therefore affect the inverse relationship and the existence or non-existence of Marshallian inefficiency. The authors are not aware of any earlier studies that have investigated these interrelated issues.

The combination of these ideas also necessitates that this paper make the distinction between owned farm size and operational farm size, as in the first case, land productivity on rented land affects average land productivity on the typically larger farms that rent out land, while in the latter case, it affects the land productivity on the typically smaller farms, often operated by low-caste households that rent in land. Inequality in the distribution of agricultural land is substantial in Nepal as the Gini-coefficient for land is found to be 0.54 (CBS, 1997). High-caste households possess most of the fertile land and other economic resources (Pradhan and Shrestha, 2005).

In traditional Hindu societies, differences in land holding are systematically associated with the caste hierarchy (Banerjee and Knight, 1985; Dahal, 1995; Hazari and Kumar, 2003). In Indian villages, high-caste households are found to be active participants in the land lease market (Skoufias, 1995). In Nepal, low-caste households own less land and thus rent in more, while high-caste households own more land and rent in less (Wily, et al., 2008). As land ownership is one of the main factors influencing the participation in the land rental market, caste becomes one of the important variables to consider. Despite this, no studies on the farm size productivity relationship in South Asia that we are aware of have looked at the role of caste.

In analyzing the efficiency of land rental market and Marshallian inefficiency of share tenancy transactions, we also need to account tenancy regulations (Otsuka, 2007). Landlords' tenure security is threatened by the past land-to-the-tiller policy in Nepal which was first implemented in 1964. According to this policy, a formal tenant could claim ownership rights on 25 percent of

total rented land (Yadav, 1999) and this policy was amended in 1996, which provided the tenants the rights to claim 50 percent of the rented land if they cultivate the land for three consecutive years (Wily, et al., 2008). Therefore, landlords prefer informal short-term contracts in order to avoid the risk of land loss. The risk of loss of land may reduce the incentives to rent out and invest in productivity enhancing inputs by landlords. Landlords may furthermore fear the loss of land due to the possibility of lowering the ceiling[9] of ownership holding of land.

The tenure insecurity has been further increased due to the Maoist war, as the Maoists strongly lobby for the land-to-the-tiller policy, and also many landowners suffered from their atrocities and intimidation. Unlike other political parties in Nepal, Maoists are against any compensation to landlords for their loss of land due to redistribution. Furthermore, Maoists captured land from many landholders in the areas where they had stronghold during the period of war. This has increased the tenure insecurity of landlords, and thus, they are more concerned about securing their ownership of land rather than using the land productively. Under such a situation, the inverse farm size productivity relationship can be enhanced because landlords are not willing to invest in productivity enhancing methods. Furthermore, it may cause many high-caste households to rent out land to other high-caste households in spite of the low-caste tenants possibly being more productive. Although this study does not directly estimate the tenure insecurity effect due to such circumstances, it recognizes these factors as some of the possible reasons for the inefficiency of the land rental market.

Marshallian inefficiency were found to be significant for high-caste tenants only while there were strong signs of allocative inefficiency in the tenancy market, particularly affecting land

[9] The Land Act 1964 set a provision that a household can own an area of 16.93 ha in Terai, 4.07 ha in the Hills and Mountains and 2.54 ha in Kathmandu valley. This Act was amended in 2001 and set new ceilings on the size of ownership land holdings. According to this new provision, a household can own 6.7 ha in Terai, 3.5 ha in the Hills and Mountains, and 1.3 ha in Kathmandu valley.

access of land-poor tenants. Low-caste households had smaller farm sizes than high-caste households, but also significant higher land productivity even when farm size is controlled for. The inverse relationship was significant for all households, but caste discrimination and allocative inefficiency, rather than Marshallian inefficiency appear to be more important explanations for the inverse relationship.

The rest of the paper is structured as follows. The second part contains a brief literature review. A theoretical model is presented in part three. Descriptions of the study area and data are provided in part four, followed by the empirical estimation methods in part five. The sixth part presents the major results and discussion, while the last part concludes the study.

2. Literature review

Under market imperfections, the distribution of assets is not neutral on efficiency (Sadoulet and de Janvry, 1995; Holden, et al., 2001) and therefore, inequality in distribution of land and other assets between low-caste and high-caste households may affect the farm size productivity relationship. Market imperfections here may include missing markets, rationing, seasonality, thin markets, and interlinked markets (Sadoulet and de Janvry, 1995; Holden and Binswanger, 1998). On this backdrop, if low-caste households are land-poor households, they can be more productive than the land-rich high-caste households, and this may contribute to the presence of an inverse farm size productivity relationship. Small and big farmers confront different factor prices due to imperfections in factor markets (Ellis, 1993). Small farmers confront a low opportunity cost of labor, while large farmers confront a higher one. In addition, the land tenancy market may not perform effectively due to the presence of transaction costs (Bliss and Stern, 1982; Skoufias, 1995) and thus, cannot fully equalize the land labor ratios among farm households. Though the land tenancy market contributes to reduce inefficiency losses that occur

due to the imperfections in other markets, it does not guarantee efficiency unless they perform plausibly well (Binswanger and Rosenzweig, 1986). Allocative inefficiency of the land rental market may therefore, contribute to explain the inverse relationship between farm size and farm productivity (Carter, 1984; Otsuka, 2007; Holden, et al., 2009; Yamano, et al., 2009) because in the absence of capital intensive farming systems, labor-rich small farmers may cultivate their limited land more intensively than land-rich farmers (Otsuka, et al., 1992).

Moreover, high-caste households dislike working for others (Bliss and Stern, 1982) and the division of labor depends greatly on caste identity (Dixon, 1982). High-caste households consider manual labor as undignified and supposed to be done by the low-caste (Dixon, 1982). For instance, ploughing land using oxen is considered an inferior job and thus, high-caste households hire low-caste men for this (Adhikari, 1992) because ploughing by women is not allowed for cultural reasons. This may partly explain why a household cannot easily adjust for factor services for land cultivation by hiring these services (Bliss and Stern, 1982). A study in Nepal (Hatlebakk, 2002) states that caste is one of the important factors explaining low wages of farm workers and in many cases, a landless high-caste is better paid than a landless Dalit. This sort of discrimination is also observed in the informal credit market as Dalits are found to have paid higher interest rates in the informal credit market than the other castes (Hatlebakk, 2009). He further stated that low-caste households rarely get other work than agricultural labor. As agricultural labor is seasonal, they rely on other sources of income and food such as fishing, hunting, and other forms of food-gathering.

Though this paper did not directly test for such discrimination, several recent studies (Kijima, 2006; Madheswaran and Attewell, 2007; Thorat and Attewell, 2007; Ito, 2009) in India have shown the existence of discrimination against low-caste persons regarding access to regular

employment. This applies reasonably well in the case of rural Nepal, as the social and cultural settings are similar. Under such circumstances, low-caste households are mostly engaged in the agricultural sector either as small farmers, farm laborers or as tenants to high-caste households. This may have implications for the existence of an inverse farm size productivity relationship.

3. Theoretical framework

This theoretical framework draws on Carter and Yao (2002) who studied participation in the land rental market when participation is associated with transaction costs. The focus here is different because this paper first deal with farm household's participation in the labor market when there are transaction costs and analyzes farming intensity and labor market participation along the land ownership continuum. Second, it introduces land rental market participation through sharecropping while also including transaction costs. This framework facilitates understanding how a farm household chooses between labor market and land rental market strategies depending on their endowment portfolios and the return expectations and transaction costs they face in the markets.

Consider a household with endowments of labor, $\overline{L}$ and land, $\overline{A}$. The household can hire in or hire out labor depending on its labor requirement in farming. However, there are transactions costs for hiring in as well as for hiring out labor. Hiring labor involves search and negotiation costs as well as costs related to monitoring hired laborers. For simplicity, assuming linear transaction costs, cost of hiring in farm labor can be expressed as: $(\omega+\tau^{li})L^{i}$ where ω, τ^{li} and L^{i} represent wage, transactions cost for hiring in labor, and units of labor hired in, respectively. By analogy, earnings from hiring out labor can be expressed as: $(\omega-\tau^{lo})L^{o}$ where τ^{lo} and L^{o} represent transaction costs associated with hiring out labor and units of labor hired out,

respectively. Assume that the household uses two inputs, land and labor, for agricultural production. Given this, the household's decision problem can be expressed as the following:

$$1)\ \underset{\{L^i,L^o\}}{Max}\ \pi = pq\left(\overline{L}+L^i-L^o,\overline{A}\right)-(\omega+\tau^{li})L^i+(\omega-\tau^{lo})L^o;\ \ L^i\geq 0; L^o\geq 0$$

We assume that for those who hire in labor: $L^i > 0 \rightarrow L^o = 0$ and for those who hire out labor: $L^o > 0 \rightarrow L^i = 0$. Autarchy households therefore represent a double corner solution: $L^i = L^o = 0$. For simplicity, we assume constant returns to scale, which is a plausible assumption in smallholder tropical agriculture (Binswanger and Rosenzweig 1986). Let prices be normalized to output price (p=1). Equation (1) can be put in labor intensity form as follows:

$$1a)\ \underset{\{l^i,l^o\}}{Max}\ \pi = q\left(\bar{l}+l^i-l^o\right)\overline{A}-(\omega+\tau^{li})l^i\overline{A}+(\omega-\tau^{lo})l^o\overline{A}; \text{where, } \bar{l}=\frac{\overline{L}}{\overline{A}};\ l^i=\frac{L^i}{\overline{A}} \text{ and } l^o=\frac{L^o}{\overline{A}}$$

The first order Kuhn-Tucker conditions are:

$$1.1)\ \frac{\partial q}{\partial l}-(\omega+\tau^{li})\leq 0;\ \ l^i\frac{\partial \pi}{\partial l^i}=0;\ l^i\geq 0\Rightarrow \frac{\partial q}{\partial l}\leq(\omega+\tau^{li})$$

$$1.2)\ -\frac{\partial q}{\partial l}+(\omega-\tau^{lo})\leq 0;\ \ l^o\frac{\partial \pi}{\partial l^o}=0;\ l^o\geq 0\Rightarrow \frac{\partial q}{\partial l}\geq(\omega-\tau^{lo})$$

For autarchic equilibrium, the double corner solution conditions must hold:

$$1.3)\ (\omega-\tau^{lo})\leq\frac{\partial q}{\partial l}\leq(\omega+\tau^{li})$$

This implies that the marginal return to labor is lower on farms that rent out land than on farms that rent in land, while marginal returns should fall somewhere between these for autarchic households.

Autarchy households (Double corner solution)

Denoting optimal farm labor intensity for households in this regime as l^*, we can show that:

$$1.4)\ \frac{\partial l^*}{\partial \overline{A}}<0 \text{ and } \frac{\partial l^*}{\partial \overline{L}}>0$$

As they do not participate in the land and labor markets, they cultivate the land they own using the family labor available to them and therefore, an increase in land endowment leads to a fall in the labor intensity and in land productivity. By analogy, an increase in family labor endowment increases labor intensity in farming. With the increase in the family labor endowment, the shadow wage of labor will decline and thus, the household increases the use of family labor on a fixed amount of land.

Let endowment ratio $\varepsilon = \frac{\overline{A}}{\overline{L}}$. Optimal autarchy labor intensity monotonically decreases with the increase in per capita land endowment, $\frac{\partial l^*}{\partial \varepsilon} < 0$ and the shadow wage, ω^*, increases in per capita land endowment, $\frac{\partial \omega^*}{\partial \varepsilon} > 0$. For the households that fall in the autarchy regime, the average land productivity declines with an increase in per capita land endowment

1.5) $\frac{\partial\left[q\left(\bar{l}\right)\right]}{\partial \varepsilon} < 0$ (as $\bar{l} = \frac{\overline{L}}{\overline{A}} \Rightarrow \bar{l} = \varepsilon^{-1}$)

Households participating in the labor market

If a household participates in the labor market, then it can adjust the labor intensity based on its requirements in farming. Equation (1.1) provides the condition for those households that hire in farm labor. A household hires in farm labor up to the point where the marginal contribution of labor intensity to productivity equals the wage of labor marked up by the transaction costs of hiring in labor.

Equation (1.2) provides the condition for those households that hire out labor. A household hires out farm labor up to the point where the marginal contribution of labor intensity to productivity equals the net earnings from labor (i.e. wage earned after the deduction of transaction costs associated with hiring labor out).

When a household can participate in the labor market, the following conditions hold:

1.6) $\frac{\partial l^*}{\partial \overline{A}} = \frac{\partial l^*}{\partial \overline{L}} = 0$ and $\frac{\partial l^*}{\partial \varepsilon} = \frac{\partial \omega^*}{\partial \varepsilon} = 0$

In contrast with autarchic households, agricultural input intensity will then be locally separable (independent of individual households' land or labor endowment) for households that participate in the labor market. In similar fashion, we can carry out the analysis for those who hire out labor; the conclusions are the same as shown in equation (1.6). However, this condition requires that there are no adjustment costs in the labor market. With significant adjustment costs the responses will turn in direction of the responses in equation (1.4).

Factor allocation with land rental market (sharecropping) only

Assume that a land rental market (sharecropping) exists. Let us ignore production risk for the sake of simplicity. Assume that there are transaction costs (τ^{ro}, τ^{ri}) related to renting out or in land due to search, negotiation, monitoring, and so forth. For simplicity, we assume linear transactions costs and if units of land rented in is positive $(A^{ri} > 0)$, then units of land rented out is zero $(A^{ro} = 0)$. By analogy, if $A^{ro} > 0 \rightarrow A^{ri} = 0$. For autarchy households in the land rental market, $A^{ro} = A^{ri} = 0$. We analyze participation on each of the two sides of the market separately.

Households that may rent in land (potential tenants)

The profit maximization problem of the farm household that may rent in land can be expressed in labor intensity form as:

$$2) \underset{\{l^{ri}, A^{ri}\}}{Max} \ \pi = q(l)\overline{A} + \alpha q^{ri}(l^{ri})A^{ri} - \tau^{ri}A^{ri}; \text{ where } l = \frac{\overline{L} - L^{ri}}{\overline{A}} \text{ and } l^{ri} = \frac{L^{ri}}{A^{ri}}$$

where α is the share of output that goes to the tenant, L^{ri} refers to the labor used in rented in land, and q^{ri} is production on the rented in land. All other notations are as described earlier.

The first order (Kuhn-Tucker) conditions are:

$$2.1)\ -\frac{\partial q}{\partial l}+\alpha\frac{\partial q^{ri}}{\partial l^{ri}}\le 0;\frac{\partial \pi}{\partial l^{ri}}l^{ri}=0;l^{ri}\ge 0$$

$$2.2)-\alpha l^{ri}\frac{\partial q^{ri}}{\partial l^{ri}}+\alpha q^{ri}(l^{ri})-\tau^{ri}\le 0;\frac{\partial \pi}{\partial A^{ri}}A^{ri}=0;A^{ri}\ge 0$$

From equations (2.1) and (2.2) we get the condition for land renting in:

$$2.3)\ \frac{\partial q}{\partial l}\ge\alpha\frac{\partial q^{ri}}{\partial l^{ri}}\ge\frac{\alpha q^{ri}(l^{ri})-\tau^{ri}}{l^{ri}}$$

This expression implies that land will be rented in only if the net return to labor on rented in land is at least as large as the marginal return to land on owner-operated land. The fact that a tenant gets only a share of the output implies that labor intensity may be lower on rented in land due to this Marshallian disincentive effect and the net return may also be reduced due to the transaction costs related to accessing rented land. These factors together may therefore discourage land rental market participation.

Comparative statics for tenants show that the labor intensity on rented-in land declines in ownership land holding. This implies an inverse farm size-productivity relationship for tenant households.

$$\frac{dl^{ri}}{d\overline{A}}=\frac{1}{|H|}\left(-\frac{A^{ri}l}{\overline{A}}\frac{\partial^2 q}{\partial l^2}\right)\left(\frac{\alpha l^{ri}}{A^{ri}}\frac{\partial^2 q^{ri}}{\partial l^{ri2}}\right)<0$$

The area of land rented in decreases with the ownership land holding.

$$\frac{dA^{ri}}{d\overline{A}}=\frac{1}{|H|}\left(\frac{A^{ri}l}{\overline{A}}\frac{\partial^2 q}{\partial l^2}\right)\left(-\frac{\partial q}{\partial l}+\alpha\frac{\partial q^{ri}}{\partial l^{ri}}-\alpha l^{ri}\frac{\partial^2 q^{ri}}{\partial l^{ri2}}\right)<0 \text{ if } \frac{\partial q}{\partial l}<\alpha\left(\frac{\partial q^{ri}}{\partial l^{ri}}-l^{ri}\frac{\partial^2 q^{ri}}{\partial l^{ri2}}\right)$$

This holds when

$$\frac{\partial q}{\partial l}=\alpha\frac{\partial q^{ri}}{\partial l^{ri}}$$

Similarly, the area rented in declines with an increase in the transaction cost in the land rental market.

$$\frac{dA^{ri}}{d\tau^{ri}} = \frac{1}{|H|}\left(\frac{\left(A^{ri}\right)^2}{\overline{A}} \frac{\partial^2 q}{\partial l^2} + \alpha A^{ri} \frac{\partial^2 q^{ri}}{\partial l^{ri2}} \right) < 0$$

Households that may rent out land (potential landlords)

The profit maximization problem of the farm household that may rent out land can be expressed as:

$$3)\ \underset{\{A^{ro}\}}{Max}\ \pi = \left\{ q\left(\bar{l}\right)\left(\overline{A} - A^{ro}\right) + \left[\beta q^{ro}(l^t) A^{ro} - \tau^{ro} A^{ro} \right] \right\} \text{ where } \bar{l} = \frac{\overline{L}}{\overline{A} - A^{ro}}$$

where, β is the landlord's share of output on rented out land, l^t is the labor intensity on the rented out land and it is for simplicity assumed to be an exogenous variable for the landlord.

The first order (Kuhn-Tucker) condition becomes:

$$3.1)\ \beta q^{ro}(l^t) - \tau^{ro} \le q(\bar{l}) - \bar{l}\frac{\partial q}{\partial \bar{l}};\ A^{ro}\frac{\partial \pi}{\partial A^{ro}} = 0;\ A^{ro} \ge 0$$

This implies that the return to rented out land after subtraction of the transaction costs must at least be as large as the net return on owner-operated land after subtracting the own labor cost valued at its marginal return on owner-operated land.

From equations (2.3) and (3.1) we have:

$$3.2)\ \frac{q(\bar{l}) - \beta q^{ro}(l^t) + \tau^{ro}}{\bar{l}} \le \frac{\partial q}{\partial \bar{l}} \le \frac{\alpha q^{ri}(l^{ri}) - \tau^{ri}}{l^{ri}}$$

Equation (3.2) shows the condition for those households that neither rent in nor rent out land, where the marginal return to labor on own land is higher than that on rented out land and lower than that for those that choose to rented in land. This implies that land productivity will be lower for autarchic households than for tenants but higher than that of landlords.

We can further extend out theoretical analysis by considering alternative market participation choices for farm households with varying resource endowments.

Households that can rent out land and/or hire in labor (land-rich and labor-poor)
This situation resembles that of many high-caste landlords (relatively land-rich and labor-poor) in the study area.

$$4)\ \underset{\{l,A^{ro}\}}{Max}\ \pi = q(l)\left(\overline{A}-A^{ro}\right)+\left[\beta q^{ro}(l^t)A^{ro}-\tau^{ro}A^{ro}\right]-(\omega+\tau^{li})L^i-\omega^*\overline{L};\ 0\le A^{ro}\le\overline{A}$$

$$\text{where } l=\frac{\overline{L}+L^i}{\overline{A}-A^{ro}}\ \Rightarrow L^i=l\left(\overline{A}-A^{ro}\right)-\overline{L} \text{ and } \left(\omega-\tau^{lo}\right)\le\omega^*\le\left(\omega+\tau^{li}\right)$$

In equation 4, ω^* is the shadow wage of household labor. All other notations are as described earlier.

The first order Kuhn-Tucker conditions are:

$$4.1)\ \frac{\partial q}{\partial l}-(\omega+\tau^{li})\le 0;\ L^i\frac{\partial \pi}{\partial l}=0;\ L^i\ge 0$$

$$4.2)\ l\frac{\partial q}{\partial l}-q(l)+\beta q^{ro}(l^t)-\tau^{ro}\le 0;\ \ A^{ro}\frac{\partial \pi}{\partial A^{ro}}=0;\ A^{ro}\ge 0$$

From equations (4.1) and (4.2), we get

$$4.3)\quad (\omega+\tau^{li})\ge\frac{\partial q}{\partial l}\le\frac{q(l)-(\beta q^{ro}(l^t)-\tau^{ro})}{l}$$

The first part implies that the household will not participate in the labor market when the cost of hiring labor is higher than the marginal return to labor on the farm. The second part implies that the household will not rent out land if the marginal cost of labor under owner-cultivation is lower than the net return to labor under owner-cultivation after subtracting the net return on rented out land (including transaction cost). For the households that participate in both markets, we can

show that labor intensity is not dependent on ownership land holding, whereas labor intensity declines with the increase in transaction costs of hiring labor[10].

$$\frac{dl}{d\overline{A}} = \frac{1}{|H|}\left\{ l\frac{\partial^2 q}{\partial l^2}\left(\frac{l^2}{\left(\overline{A} - A^{ro}\right)}\frac{\partial^2 q}{\partial l^2} \right) + \left(\frac{-l^2}{\left(\overline{A} - A^{ro}\right)}\frac{\partial^2 q}{\partial l^2} \right) l\frac{\partial^2 q}{\partial l^2} \right\} = 0$$

$$\frac{dl}{d\tau^{li}} = \frac{1}{|H|}\left(\frac{\partial^2 q}{\partial l^2} \right) < 0$$

Households that can rent in land and/or hire out labor

This situation resembles with low-caste tenants in the study area and can be specified as:

$$5)\quad \underset{\{l^o, l^{ri}, A^{ri}\}}{Max}\ \pi = q(l)\overline{A} + \left[\alpha q^{ri}(l^{ri})A^{ri} - \tau^{ri}A^{ri} \right] + (\omega - \tau^{lo})l^c\overline{A}$$

where $l = \frac{\overline{L} - L^o - L^{ri}}{\overline{A}}$, $l^{ri} = \frac{L^{ri}}{A^{ri}}$, and $l^c = \frac{L^o + \overline{L}}{\overline{A}}$, if $L^o = 0 \rightarrow \tau^{lo} = 0$

The first order Kuhn-Tucker conditions are:

$$5.1)\ -\frac{\partial q}{\partial l} + (\omega - \tau^{lo}) \le 0;\ l^o\frac{\partial \pi}{\partial l^i} = 0;\ l^o \ge 0$$

$$5.2)\ \alpha q^{ri}(l^{ri}) - \alpha l^{ri}\frac{\partial q^{ri}}{\partial l^{ri}} - \tau^{ri} \le 0;\ A^{ri}\frac{\partial \pi}{\partial A^{ri}} = 0; A^{ri} \ge 0$$

$$5.3)\ -\frac{\partial q}{\partial l} + \alpha\frac{\partial q^{ri}}{\partial l^{ri}} \le 0;\ l^{ri}\frac{\partial \pi}{\partial A^{ri}} = 0; l^{ri} \ge 0$$

The corner solution conditions from 5.1, 5.2 and 5.3 can be summarized as:

$$5.4)\ \ \omega - \tau^{lo} \le \frac{\partial q}{\partial l} \ge \alpha\frac{\partial q^{ri}}{\partial l^{ri}} \ge \frac{\alpha q^{ri}(l^{ri}) - \tau^{ri}}{l^{ri}}$$

[10] Given our assumption that labor use intensity in case of rented out land is exogenous, labor intensity on rented out land should not be affected by farm size of the landlord household. However, relaxing this assumption such that monitoring and enforcement activities of the landlord can increase land productivity on rented out land could also imply that landlords' characteristics can affect land productivity. We refer to other studies such as Pender and Fafchamps (2006) for such an analysis.

With unconstrained participation in both the labor and the land rental markets the expressions in 5.4 will become equalities. The household does not participate in any of the markets if the marginal product of labor is higher than the return to labor in the labor market and in the land rental market, taking into account the transaction costs in these two markets. With participation in one of the markets, net return to labor in that market will be the same as on own land but will be lower in the market where the household is not participating as long as it is not rationed out from that market.

A summary of the first order conditions from alternative market participation regimes of the farm households is presented in Table 1.

Table 1 Summary of first order conditions

Labor Market	Land rental market		
	Rent out $(A < \overline{A})$	Non-participant $(A = \overline{A})$	Rent in $(A > \overline{A})$
Hire out $(L < \overline{L})$	$\frac{\partial q}{\partial l} = \omega - \tau^{lo}$ $\frac{\partial q}{\partial l} = \frac{q(l) - \beta q^{ro}(l^t) + \tau^{ro}}{l}$	$\frac{\partial q}{\partial l} = \left(\omega - \tau^{lo}\right)$ $\left\{\begin{array}{l} \frac{q(l) - \beta q^{ro}(l^t) + \tau^{ro}}{l} \le \frac{\partial q}{\partial l} \\ \le \frac{\alpha q^{ri}(l^{ri}) - \tau^{ri}}{l^{ri}} \end{array}\right\}$	$\frac{\partial q}{\partial l} = \left(\omega - \tau^{lo}\right)$ $\frac{\partial q}{\partial l} = \frac{\alpha q^{ri}(l^{ri}) - \tau^{ri}}{l^{ri}}$
Non-participant $(L = \overline{L})$	$\left(\omega + \tau^{li}\right) \le \frac{\partial q}{\partial l} \le \left(\omega - \tau^{lo}\right)$ $\frac{\partial q}{\partial l} = \frac{q(l) - \beta q^{ro}(l^t) + \tau^{ro}}{l}$	$\left(\omega + \tau^{li}\right) \le \frac{\partial q}{\partial l} \le \left(\omega - \tau^{lo}\right)$ $\left\{\begin{array}{l} \frac{q(l) - (\beta q^{ro}(l^t) - \tau^{ro})}{l} \le \frac{\partial q}{\partial l} \\ \le \frac{\alpha q^{ri}(l^{ri}) - \tau^{ri}}{l^{ri}} \end{array}\right\}$	$\left(\omega + \tau^{li}\right) \le \frac{\partial q}{\partial l} \le \left(\omega - \tau^{lo}\right)$ $\frac{\partial q}{\partial l} = \frac{\alpha q^{ri}(l^{ri}) - \tau^{ri}}{l^{ri}}$

Hire in $(L > \bar{L})$	$\frac{\partial q}{\partial l} = (\omega + \tau^{li})$ $\frac{\partial q}{\partial l} = \frac{q(l) - (\beta q^{ro}(l^t) - \tau^{ro})}{l}$	$\frac{\partial q}{\partial l} = \left(\omega + \tau^{li}\right)$ $\left\{ \begin{array}{l} \frac{q(l) - \beta q^{ro}(l^t) + \tau^{ro}}{l} \leq \frac{\partial q}{\partial l} \\ \leq \frac{\alpha q^{ri}(l^{ri}) - \tau^{ri}}{l^{ri}} \end{array} \right\}$	$\frac{\partial q}{\partial l} = \left(\omega + \tau^{li}\right)$ $\frac{\partial q}{\partial l} = \frac{\alpha q^{ri}(l^{ri}) - \tau^{ri}}{l^{ri}}$

The larger the transaction costs in these markets the more likely we are to find non-participation in these markets. High transaction costs hinder efficient adjustment between land and non-land factors of production in agriculture, which in turn leads to the inverse relationship. In our context, if low-caste households have smaller farms than high-caste households and typically have more labor endowment per unit of land, and are discriminated in the labor market such that their opportunity cost of labor outside agriculture is lower than that of high-caste households, this should strengthen the inverse farm size- land productivity relationship.

Based on this theoretical analysis, we propose the following testable hypotheses for this study:

1. Marshallian disincentive effects cause lower land productivity on rented (sharecropped) land than on owner-operated land of tenants (Shaban 1987).
2. Low-caste households have small farm sizes, poor access to off-farm employment (face high transaction costs in the labor market), and poor access to additional land in the land rental market (due to high transaction costs in the land rental market) causes a low opportunity cost of labor, high labor intensity and land productivity on their own farms as well as on their rented in land.
3. Marshallian disincentive effects (MD) in sharetenancy contracts is responsible for the inverse relationship between land productivity and ownership land holdings.

4. The inverse relationship between land productivity and farm size is caused by high transaction costs in agricultural labor and land rental markets.

4. Study area and data

Data for this study were collected from 500 households in the Mardi watershed area of western Nepal in 2003. This paper uses information from 489 households; information from the remaining 11 sample households was discarded due to poor data quality. The data were collected both at household and at farm plot level. The household level data covered a wide range of household characteristics such as household composition, consumption expenditure, income from different sources, sales and purchases, credit, resource endowments, asset ownership and household preferences. The plot level data included biophysical characteristics of the plots, plot trade information, input use, crop choice and production. This gave a sample size of 489 households and 1131 plots.

Hills and mountains higher than 1200m are the major topographical features of this region (Thapa and Weber, 1995) as the altitude of this area ranges from 900m to 5000m above the sea level (Awasthi, 2004) and cultivation is found even upto 2300m above sea level. The settlements of the Mardi watershed are 15-45 km far from the district headquarter, Pokhara. This area lies in the highest rainfall region of Nepal with an average annual amount of rainfall of 4500 mm.

Agriculture is the major economic activity in this area. The households practice traditional cropping systems for agricultural production. They cultivate a variety of crops, the most common in the valley are paddy and wheat while maize and millet are common in the terraced land. Farmers practice a crop rotation system, growing one to three crops in a plot in a rotation per

year. Livestock is a major component in the production system because oxen are used to plough the land and manure is one of the major farm inputs.

Land is the main asset for households in the study area. Table 2 presents the land distribution and land rental market participation status of the sample households by caste. Of the total sample households, 8.8 percent are landless. Percentage of landless among high-caste households is only 2.9 while it is almost 30 for low-caste households. None of the low-caste households own more than one hectare of land. Of the total sample households, 59 percent do not participate in the land rental market. Nearly 50 percent of the low-caste households and about 17 percent of the high-caste households were tenants. Land rental market participation contributed to reducing the inequality in land distribution as the gini coefficient for the ownership holding of land was 0.49 versus 0.42 for operational land holding.

Table 3 presents information on household characteristics by caste. High-caste households were found to be significantly more literate, have larger farm size, have higher incomes, and higher asset values. On the other hand low-caste households were found to have significantly higher leased in area, higher livestock holding per ha, oxen per ha, male and female labor per ha, and consumer units her ha. Low-caste households were also more likely to have a male head present (65% against only 20% for high-caste households). This may reflect the larger involvement in off-farm employment by high-caste households as well as the political situation with Maoist control in the study area.

5. Empirical Methods

5.1 Estimation methods for Marshallian inefficiency

In order to test whether there is Marshallian inefficiency, both non-parametric and parametric methods were used. Propensity score matching methods (Dehejia and Wahba, 2002) and local polynomial regression were the main non-parametric methods applied for the analysis. The parametric analysis involved using a household fixed effects model for tenant households who operated both own and rented in plots. This resembles the study of Shaban (1987) but was combined with controls for plot selection bias due to unobservable plot characteristics and separate as well as combined analyses for high-caste and low-caste households. Shaban was concerned that the Marshallian disincentive effect could be masked by unobservable household characteristics and use of household fixed effects would resolve this problem. To test and control for plot selection bias that may arise due to unobservable plot characteristics, the Inverse Mills Ratio (IMR) from probit models run on the rental status of the plots were included in the fixed effects models. In this case, we relied on nonlinearities. For all models with IMR and other predicted variables, bootstrapped standard errors were generated using 500 replications resampling households.

The inverse relationship between farm size and land productivity was tested for after controlling for the influences of the Marshallian disincentives for owner-tenants. For this, there was a need to unpack the household fixed effect/ shadow price term, which is hidden away as a nuisance parameter in the Shaban-like estimation. In order to unpack this shadow price term, we simply recovered the household fixed effects (which are indicators of the impact of shadow prices on yields) as follows (we are thankful to an anonymous reviewer for this useful suggestion)

$$\eta_{it} = \varepsilon_{it}(fe) - \varepsilon_{it}(ols)$$

Where $\varepsilon_{it}(fe)$ and $\varepsilon_{it}(ols)$ refers to the error terms obtained from the fixed effects and OLS models, and the difference between them is denoted by η_{it}.

The fixed effect error components, η_{it}, is plotted against the owned farm size in order to check whether they are consistent with an inverse relationship, while also including Lowess (locally weighted scatter plot smoothing) and local polynomial estimators in the graph (Figure 2).. Furthermore, a random effect model was estimated for the fixed effect error component with own farm size and caste as right hand side variables. This helps us to identify whether the impacts of the Marshallian disincentives might be hidden by the fact that those who rent in land under sharecropping contract are precisely the households with low opportunity cost of labor, and to separate the Marshallian disincentive and other shadow price effects due to transaction costs and discrimination as explanations for the inverse farm size-productivity relationship. Furthermore, labor market participation dummies and their interactions with the farm size variable were included to assess whether labor market participation was efficiently eliminating the IR.

5.2 Assessment of transaction costs in the land rental market

In order to test for the allocative efficiency of the land rental market, the basic reduced form models of Bliss and Stern (1982) and Skoufias (1995) were followed:

$$NLI = \beta_0 + \beta_1 L + \beta_2 O + \beta_3 \overline{A} + \varepsilon$$

where *NLI* refers to net land leased in, *L* is labor endowment with the household, *O* is oxen holding and $\overline{A}$ is ownership land holding. If the coefficient on land, $\beta_3 = -1$, this is evidence of a well functioning land rental market. Any significant higher (closer to zero) value of this coefficient implies presence of significant transaction costs and therefore, only partial adjustment

through the land rental market which then cannot fully compensate for imperfections in other factor markets.

In order to test this empirically, censored Tobit and double hurdle models were estimated on each side of the land rental market to test whether there are significant differences in access and transaction costs on the two sides of the market. The variable *NLI* takes zero, negative and positive values. Therefore, while estimating the leasing in model, only zero and positive values were considered because the value of *NLI* is positive for tenants and zero for autarky households. For the leasing out model, only zero and negative values of *NLI* were included. This implies that the tenant model was left censored whereas the landlord model was right censored.

The censored Tobit model assumes that the same mechanism determines both the zeros and the positives and the amount of the variable in question given that the variable is positive (Wooldridge, 2002). This may be too restrictive and to overcome this problem double hurdle models which allow the decision to participate and the amount of participation to be influenced by different variables, were estimated. Of the variants of the double hurdle model, the Cragg model (Cragg, 1971; Wooldridge, 2002) was chosen. As the double hurdle model nests the censored Tobit model, we could test which one is more appropriate of these two models by using a likelihood ratio test (Cameron and Trivedi, 2009). Based on such tests, the censored Tobit models were rejected.

5.3 Additional methods for assessment of the farm size productivity relationship

We carried out the analysis for all households both at household and at farm plot levels. In the household level analysis ordinary least squares regression was used. In order to see the possible impacts of caste on productivity, the following model with and without caste dummy were used:

$$Y_i = \alpha + \beta_1 X_i^a + \beta_2 X_i^h + \beta_3 X_i^p + \gamma D_i + \varepsilon_i$$

Where Y_i is total value product per unit of land for household *i*; X_i^a is a vector of farm characteristics variables such as farm size and average distance to farm plots; X_i^h is a vector of household characteristics such as age of the household head and value of assets; X_i^p is a vector of average farm plot characteristics; D_i is the caste dummy (1 refers to low-caste); β and γ are parameters to be estimated; and ε_i is the error term. Models with and without the household and plot characteristics were run with and without the caste dummy to assess the sensitivity of the inverse relationship to the alternative specifications. In the analysis, possible heterogeneity was corrected for by using the Huber-White-sandwich estimator. Correction for possible selection bias related to participation in the land rental market was tested and controlled for by inclusion of the Inverse Mills Ratio (IMR) from a probit model for land market participation as a tenant. Bootstrapped standard errors were derived in the case where predicted input use and IMR were included. In the household level analysis, we also incorporated a variable that measures the rented in fraction of land operated. This is done to control for the Marshallian disincentive effect, while estimating the IR.

Farm plot level analysis was carried out using household random effects models separately and jointly for low-caste and high-caste households. The general random effects model can be expressed as:

$$Y_{ip} = \alpha + \beta_1 X_i + \beta_2 X_{ip}^{sq} + \beta_3 X_i^h + \mu_i + \varepsilon_{ip}$$

where Y_{ip} is the value of output obtained from plot *p* per unit of land for household *i*, X_i refers to farm size, X_{ip}^{sq} is a vector of observed plot characteristics, X_i^h is a vector of plot invariant farm household characteristics, μ_i is unobserved plot invariant household attributes, and ε_{ip} the error

term. In order to control for Marshallian disincentive effects, we included a tenure dummy in the analysis. To test and correct for selection bias due to unobservable household and plot characteristics, the inverse Mills ratios (IMRs) from household and plot level probit models for participation in the rental market and tenancy status of plots were included. Due to few plot characteristics variables that can be excluded in the stage regression, we relied on the nonlinearities.

Assuming that μ_i is uncorrelated with X_i^h, random effects models were estimated. As the variables of interest (caste, farm size and operational land holding) were plot invariant, household fixed effects models could not be used.

6. Results and discussion

6.1 Assessment of Marshallian disincentive effects and the inverse relationship

Table 4 presents the results of kernel and nearest neighbor matching methods for all owner-tenant households, and for low-caste and high-caste owner-tenant households separately. Rented in plots were used as the treatment group and owner operated plots as the control group in the analysis. The balancing properties were satisfied and the common support requirements were invoked. Table 4 shows that the productivity difference between owner-operated plots and rented in plots is about 8270 NRs/ha for all owner-tenant households, which is significant at 5 percent level. The separate analysis for high-caste and low-caste owner-tenant households showed that there is no significant Marshallian disincentive effect in the case of low-caste households while it is highly significant in the case of high-caste households. The results of local polynomial regressions also supported this (see Figure 1) because the distance between the thick line (representing own plots of high-caste households) and the dashed line (representing the rented in

plots of high-caste households) can be clearly observed. This supports Hypothesis 1 which states that Marshallian disincentive effects cause lower land productivity on rented land than on owner-operated land of tenants.

Table 5 contains the results of fixed effects models with and without controlling for selection bias at plot level. Land productivity on rented in plots was found to be significantly (at a 5 percent level) lower as compared to owner operated plots in the joint analysis for all households as well as for high-caste households when analyzed separately. There was no significant Marshallian disincentive effect for low-caste households. The fixed effects model results, controlling for unobservable household characteristics, were consistent with the matching method results. No significant selection bias was found but in the case of high-caste households the level of significance reduced to 10 percent after controlling for selection bias and it increased the coefficient on the tenure dummy from -0.233 to -0.209. It can therefore be concluded that there is evidence of Marshallian inefficiency in the data but such inefficiency is not prevalent for low-caste owner-tenant households. Therefore Marshallian inefficiency is not the only factor contributing significantly to the inverse relationship between farm size and land productivity that can be observed in Figure 1.

In all models in Table 5 we controlled for observable plot characteristics such as distance to plot, slope, plot size, soil type, soil depth and irrigation status of the plot. A joint test for plot characteristics variables showed that they had a highly significant impact on land productivity. One of our main objectives is to test for the existence of the IR after controlling for the influence of the Marshallian disincentives. We used household fixed effects to achieve a robust assessment of the existence of Marshallian disincentive effects. A first assessment of the possible IR can be achieved through a closer inspection of the fixed effects (we are thankful to an anonymous

reviewer for this suggestion). The fixed effects capture the unobservable shadow price differences across households and that are associated with market imperfections and caste discrimination for households that participated as tenants in the land rental market. In particular we investigate whether labor market participation contributes to reduce the inverse farm size – productivity relationship. We applied the method described in section 5.1 to assess this. The results are shown in Figure 2 and Table 6.

The results of the non-parametric regressions (Lowess and Local linear regressions) that are presented in Figure 2 are consistent with the IR. This implies that Marshallian disincentive effects are not the only reason for it.

The results in the first model (OLS1) in Table 6 also show that the inverse relationship persists after controlling for the Marshallian disincentive effect. The second model (OLS2) demonstrates that a large share of the inverse relationship can be attributed to caste discrimination as the caste dummy variable is positive and highly significant while the coefficient on farm size is reduced from -0.535 to -0.341 and becoming insignificant. It is possible that households participating in the labor market are able to eliminate or reduce the negative effect of farm size. This is tested in the remaining models in Table 6 by including labor market participation dummy variables for sellers and buyers of labor and by interacting these with the farm size variable. The results show, however, that these variables do not reduce the inverse relationship significantly while the caste dummy variable remains highly significant also after the labor market variables are included. Low-caste owner-tenants have significantly higher land productivity than high-caste owner-tenant households. This signals that low-caste households have lower opportunity cost of labor and thus, their participation in the land and labor markets does not eliminate the caste discrimination effects. This is evidence of persisting strong caste discrimination in the labor and

land markets even though 80 percent of low-caste tenant households participated in labor market (this is agricultural labor market in village which is highly seasonal and many of them worked as ploughman using oxen, a kind of attached labor). This analysis lends support to Hypothesis 2 stating that low-caste households have higher land productivity as they invest more labor on their own as well as on the rented in land as they have lower opportunity cost of labor due to their small farm sizes, poor access to land and labor markets.

6.2 Allocative efficiency in the land rental market

The results of the double hurdle (Cragg) models that analyze the land rental market participation by the sample households are presented in Table 7. A smooth adjustment in the rental market implies that the coefficient on owned land should be close to -1 in the tenant model and close to +1 in the landlord model. The coefficient on own land in the truncated tenant model is -0.126 (close to zero) and far from -1. This indicates clearly that tenants are facing large transaction costs in the land rental market. On the landlord side, the coefficient in the truncated model is 0.765 and also significantly below +1 but adjustment appears relatively better for landlords than tenants.

Furthermore, Table 7 shows that endowments of male labor and oxen enhanced tenants' access to land in the land rental market. Low-caste households were more likely to be tenants in the market but were able to rent in significantly less land than high-caste households. To further assess the relationship between caste and farm size on land market access, interaction variables of the caste dummy and farm size were included in the probit and truncated models on both sides of the market. On the tenant side the interaction variable was insignificant in the probit model but it had a significant positive effect in the truncated model. This seems to indicate that low-caste households that own more land are also more able to get additional land. We only have

tentative suggestions to explain this. One could be that landlords fear more to rent out land to landless or near landless households for tenure insecurity reasons as such households are more likely to claim the land. Another could be that near landless households may be poorer farmers and cannot demonstrate that they have sufficient skills to farm larger areas. The caste and farm size interaction variable was not significant on the landlord side of the market. On the landlord side shortage of oxen stimulated land renting out and more male labor reduced the amount of land rented out and low-caste households that rented out land were renting out significantly more land. These findings indicate that land renting is a response to imperfections in markets for oxen and labor and that caste has an additional effect where particularly land-poor low-caste tenant households appear to face problems accessing additional land. This could contribute to strengthen the inverse farm size productivity relationship.

6.3 The farm size - productivity relationship and factor market participation

While section 6.1 assessed the farm size-productivity relationship for owner-tenant households this section looks at the relationship for the whole sample of tenant, landlord and non-participant households. The results of the analysis at farm level are presented in Table 8. In all models a strong and highly significant inverse relationship between farm size and productivity was found. Controlling for observable household characteristics (with or without the caste dummy), farm characteristics and participation in the tenancy and labor markets appeared to enhance rather than reduce the inverse relationship. The results demonstrated the importance of male labor and oxen for land productivity, highlighting the importance of factor market imperfections. We introduced the variable ‘proportion of rented in land in operated land’, as a control for the Marshallian disincentive effects in the farm level analysis. This variable was significant at 5 percent level and with a positive sign in the models with only farm and village characteristics. This could indicate

that tenant households are more productive producers and the Marshallian disincentive effects are not strong enough to counteract this. It can be also be seen from model five in Table 8 that tenant households are found to have significantly higher land productivity as compared to non-participant households in the land rental market, indicating that land rental market participation reduces the IR. However, when we introduced household characteristics and market participation variables, the sign of the 'proportion of rented land' variable shifted. The fact that the IR remained strong and significant indicates that the Marshallian disincentive effect does not explain the inverse relationship, in line with the findings in section 6.1. The inclusion of interaction variables between farm size and labor and land market participation variables did not reduce the IR. Based on these analyses, we cannot reject hypothesis four which stated that the IR is caused by high transaction costs in agricultural labor and land rental markets.

The analysis of the farm size and productivity relationship with plot level data allows us to control better for land quality as a potential explanation for the IR. The results of the plot level analysis are presented in Table 9 separately for low-caste and high-caste households. To assess the robustness of the inverse relationship, household random effects models with and without observable household characteristics, observable plot characteristics, and with and without correcting for sample selection for households and plots in the land rental market were included. For low-caste households, no significant IR was found while the IR was highly significant for high-caste households. The lack of significance for low-caste households may partly be explained by the smaller sample size and smaller variation in farm sizes. The findings imply that caste discrimination of Dalits alone cannot explain the IR as a significant IR is detected when doing a separate analysis of high-caste households. This implies that Hypothesis 2 cannot be rejected but also that it does not explain the whole story.

For further robustness assessment and testing of Hypothesis 4, the analysis of the IR was carried out at plot level controlling for market participation (see Appendix 1). In this analysis, when we control for plot rental status, plot quality and village effects, the low-caste dummy became insignificant but still had a positive sign. By introducing rental status of the plot such as rented in and rented out dummies, we control for Marshallian disincentive effects in the analysis although this is a less robust test than that applied on owner-tenant households in section 6.1. The rented in dummy was highly significant and negative in all model specifications indicating that owner-operated plots are more productive as compared to rented in plots. It became less negative after controlling for plot quality indicating that rented plots may be of poorer quality but was still highly significant. The IR also remained highly significant after controlling for plot quality, tenancy status of operators, labor market participation status, and interaction of tenancy and labor market participation with farm size. Therefore, the IR may be explained by general factor market imperfections in labor, land and traction power markets, according to hypothesis 4, which cannot be rejected. The results show that even households that participate in these markets face transaction costs in adjusting their level of participation in these markets. The IR is further enhanced by caste discrimination and to some extent by Marshallian inefficiency in sharetenancy contracts for high-caste tenants.

One of the remaining puzzles is why many high-caste households prefer to sharecrop out their land to other high-caste households that are less efficient than neighboring low-caste households. We suggest that there are likely two reasons for this. First, it may be due to tenure insecurity caused by the past land-to-the-tiller policy (Yadav, 1999; Wily, et al., 2008). Secondly, this tenure insecurity may also have been stimulated by the politically unstable situation at the time of our survey. The Maoist war was at its peak, and Maoists controlled the study area. Particularly

high-caste households may therefore have felt threatened by this. The risk of loss of land may have been perceived to be lower if they rented their land to other high-caste households rather than to low-caste households and particularly to landless or near landless low-caste households. This could imply that they preferred to rent out the land to close relatives that they trusted but that were poorer farmers. However, our data do not allow us to test these hypotheses, and so they are left for future research.

7. Conclusion

This paper assessed how Marshallian disincentive effects, caste discrimination in land access and labor market participation, and transaction costs in the land rental market affect the farm size productivity relationship. Caste differences in the Hindu dominated Nepali society is a sign of historical social exclusion (DFID and World Bank, 2006). This study revealed that there were significant transaction costs limiting adjustment on both sides of the land rental market but particularly on the tenant side of the market where landless or near landless low-caste households were less able to access land. This hindered efficient allocation of land resources as a response to imperfections in other factor markets for male labor and oxen traction.

Low-caste owner-tenant households had higher land productivity as compared to high-caste owner-tenant households even after controlling for farm size and other household and farm characteristics and adjustment for labor and land rental market participation. A strong and significant inverse relationship between farm size and land productivity was found for high-caste households. Low-caste households are land-poor; they apply more labor per unit of land, and thus, they achieve higher land productivity also on rented in land due to their poorer access to off-farm employment and the transaction costs faced in the land rental market. Policies that can reduce the transaction costs in land and labor markets may reduce the level of caste

discrimination and lead to more efficient resource allocation. In order to improve the efficiency of land rental market, there is a need to remove the land-to-the-tiller policy, especially the provision that a tenant can claim the ownership right on a certain percentage of rented land. This will reduce tenure insecurity among landlords, and thus, increase tenants' access to land through the land rental market. This will also reduce conflicts between landlords and tenants. However, there is a need to redistribute land from less efficient to more efficient farmers, and this can be done peacefully by imposing a progressive land tax which would induce land sales by large land owners. Furthermore, the government should establish a land bank where a poor farmer can receive loan for purchasing land at a subsidized rate. Moreover, without improving the security situation and bringing Maoists under rule of law, many of these improvements cannot be realized.

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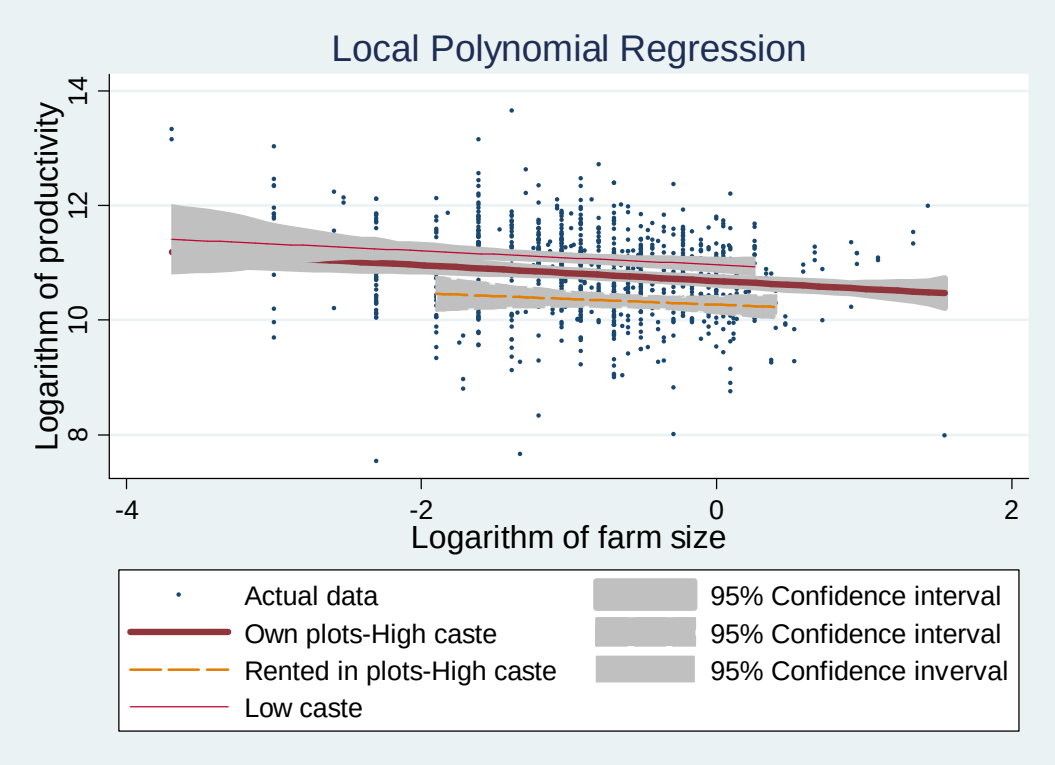

Figure 1: Analysis of the farm size productivity relationship using local polynomial regression

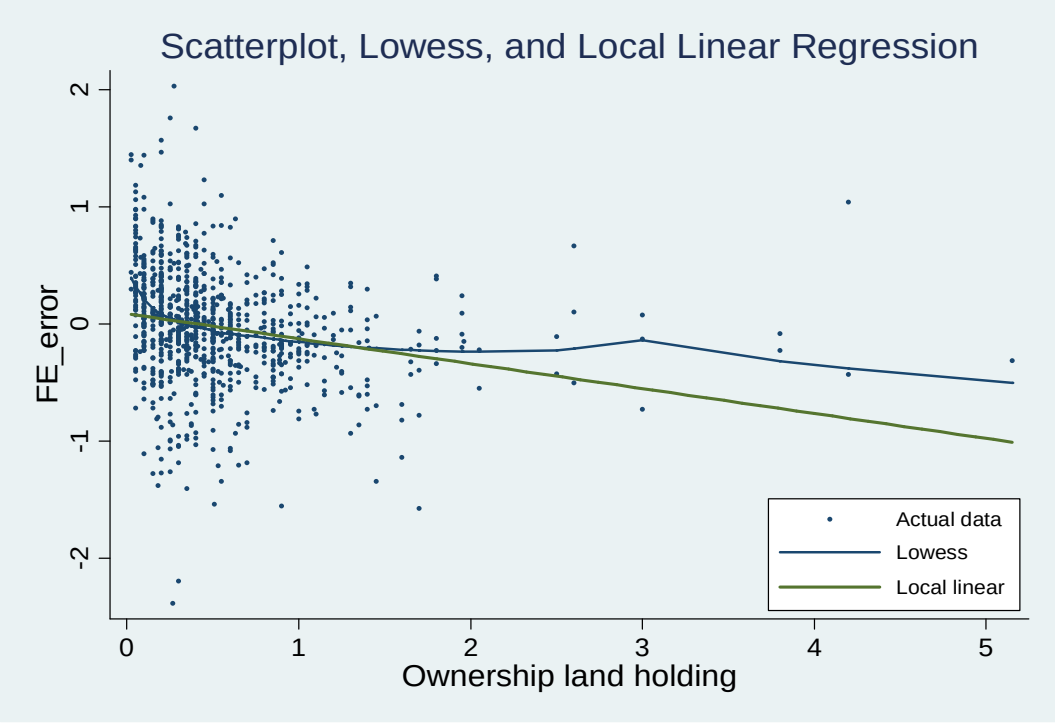

Figure 2: Analysis of FE error using scatterplot, Lowess and local linear regressions

TABLE 2
LAND DISTRIBUTION AND LAND RENTAL MARKET PARTICIPATION BY CASTE

	High-caste HHs		Low-caste HHs		All sample HHs	
	number	percent	number	percent	number	percent
Ownership holding (in hectares)						
Landless	11	2.9	32	29.9	43	8.8
Up to 0.2	21	5.5	33	30.8	92	11
Greater than 0.2 & up to 0.5	172	45	34	31.8	206	42.1
Greater than 0.5 & up to 1	107	28	8	7.5	104	23.5
Greater than 1	71	18.6	0	0	44	14.5
Operational holding (in hectares)						
Up to 0.2	65	17	21	19.6	86	17.6
Greater than 0.2 & up to 0.5	183	47.9	68	63.6	251	51.3
Greater than 0.5 & up to 1	94	24.6	14	13.1	108	22.1
Greater than 1	40	10.5	4	3.7	44	9
Land rental market participation						
Nonparticipant	242	63.4	48	44.9	290	59.3
Landlord	76	19.9	6	5.6	82	16.8
Tenant	64	16.7	53	49.5	117	23.9
Labor market participation						
Non-participant	111	29.1	15	14	126	25.7
Net buyer	228	59.7	3	2.8	231	47.3
Net seller	43	11.2	89	83.2	132	27.1
Total	382	100	107	100	489	100

TABLE 3
MAJOR HOUSEHOLD CHARACTERISTICS VARIABLES BY CASTE

Household Characteristics variables	High-caste HHs	Low-caste HHs	All sample HHs	test
Male head dummy (%)	20	65	30	82.72***
Literate head (%)	35	19	31	10.40***
Age of household head (in year)	49.12	49.01	49.10	0.09
Ownership holding (in hectare)	0.64	0.17	0.53	8.83***
Operational holding (in hectare)	0.63	0.35	0.56	5.86***
Net land leased-in (in hectare)	-0.01	0.17	0.03	4.96***
No. of adult male	2.25	2.32	2.26	0.50
No. of adult female	1.99	1.85	1.96	1.24
Standard labor unit	3.81	3.98	3.85	0.85
Standard consumer unit	4.93	5.20	4.99	1.09
No. of oxen holding	0.76	0.92	0.79	1.45
Farm income (in Rs.)	32034.9	15312.3	28375.83	5.57***
Remittance income (in Rs.)	20126.9	3448.6	17365.03	4.41***
Total income (in Rs.)	72360.3	30928.85	63294.4	8.02***
Value of asset (in Rs.)	38581.22	15173.4	33459.3	8.29***
Livestock holding per unit area	12.52	20.72	13.92	3.26***
Value of asset per unit area	150753.5	72758.33	135721.2	3.54***
Oxen holding per unit area	2.45	6.41	3.13	5.03***
Number of adult male per unit area	8.02	20.51	10.15	6.85***
Number of adult female per unit area	6.91	17.54	8.72	6.55***
Standard labor unit per unit area	13.92	35.86	17.66	7.16***
Standard consumer unit per unit area	18.07	47.68	23.12	7.24***
Number of observations	382	107	489	

Note: test shows the difference between high-caste and low-caste households. We used t-test for continuous variables and chi-square test for categorical variables. Significance levels: *: 10% level, **: 5% level, ***:1% level

TABLE 4
ASSESSMENT OF MARSHALLIAN INEFFICIENCY (KERNEL AND NEAREST NEIGHBOR MATCHING MODELS)

	All households		Low-caste households		High-caste households	
Variable	Kernel Matching	Nearest Neighbor	Kernel Matching	Nearest Neighbor	Kernel Matching	Nearest Neighbor
Land Productivity						
Rented in plots	56936.9	56936.9	67456.6	67456.6	53700.6	53700.6
Owner-operated plots	65207.1	65207.1	69920.8	69920.8	62823.2	62823.2
Difference	-8270.2	-8270.2	-2464.2	-2464.2	-9122.6	-9122.6
Bootstrapped std. error	4164.2	4219.1	9277.1	10462.2	3455.5	3655.5
t-statistic	-1.98**	-1.96**	-0.27	-0.24	-2.64***	-2.50***
Number of observations						
Owner-operated plots	56	56	20	20	36	36
Rented in plots	136	136	32	32	104	104

Note: Significance levels: *: 10% level, **: 5% level, ***:1% level

TABLE 5
ASSESSMENT OF MARSHALLIAN INEFFICIENCY (HOUSEHOLD FIXED EFFECTS MODELS)

	All HHs		Low-caste HHs		High-caste HHs	
Total value product/ha	w/o IMR	IMR	w/o IMR	IMR	w/o IMR	IMR
Tenure dummy (rent in=1)	-0.180**	-0.182**	-0.045	-0.036	-0.233**	-0.209*
	(0.08)	(0.08)	(0.20)	(0.21)	(0.11)	(0.11)
IMR (plot)		-0.018		-0.592		0.132
		(0.16)		(0.51)		(0.16)
Joint test for plot quality variables[1]	15.65***	7.40***	22.65***	16.58***	78.35***	334.60***
Constant	11.43***	11.44***	11.43***	11.30***	11.41***	11.30***
	(0.26)	(0.31)	(0.60)	(0.95)	(0.26)	(0.30)
Number of observations	217	217	52	52	165	165

Notes: Significance levels: *: 10% level, **: 5% level, ***: 1% level and all continuous variables are in logarithms. IMR refers to inverse mills ratio and we reported bootstrapped standard errors for models with IMR. We re-sampled households (bootstrapped with replications 500) in order to get corrected standard errors.
1. F-test results are used in fixed effects models (without IMR) while chi-square are used in the bootstrapped models (with IMR).
2. The number of households reduced in this analysis due to the exclusion of pure tenant households. Out of 117 tenant households, this analysis includes only 71 tenant households.

TABLE 6
ANALYSIS OF THE RELATIONSHIP BETWEEN FIXED EFFECTS ERROR COMPONENT, FARM SIZE, CASTE DUMMY AND LABOR MARKET PARTICIPATION

Fixed effect error component	OLS1	OLS2	OLS3	OLS4	OLS5	OLS6
Farm size	-0.535**	-0.341	-0.549**	-0.320	-0.585**	-0.276
	(0.22)	(0.22)	(0.22)	(0.23)	(0.24)	(0.24)
Low caste dummy(1)		0.319***		0.345***		0.348***
		(0.06)		(0.09)		(0.09)
Labor market participation (1=seller)			-0.046	0.047	-0.045	0.072
			(0.10)	(0.10)	(0.13)	(0.13)
Labor market participation (1=buyer)			-0.119	0.046	-0.177	0.065
			(0.09)	(0.10)	(0.13)	(0.15)
Labor buyer dummy*farm size					-0.009	-0.095
					(0.58)	(0.57)
Labor seller dummy*farm size					0.236	-0.070
					(0.40)	(0.40)
Constant	0.132**	0.005	0.185**	-0.033	0.194**	-0.046
	(0.06)	(0.07)	(0.08)	(0.11)	(0.09)	(0.12)
Number of observations	217	217	217	217	217	217
Number of groups	70	70	70	70	70	70
Chi2 statistic	5.92**	34.97***	9.10**	35.03***	10.35**	36.12***

Notes: Significance levels: *: 10% level, **: 5% level, ***: 1% level. Standard errors corrected for clustering at household level.

TABLE 7
ASSESSMENT OF THE ALLOCATIVE EFFICIENCY OF THE LAND RENTAL MARKET

	Land rented in (Yes=1)				Land rented out (Yes=1)	
	Probit Models		Truncated models		Probit model	Truncated model
Owned land (ha)	-1.752***	-1.918***	-0.126**	-0.207***	1.213***	0.765***
	(0.23)	(0.28)	(0.05)	(0.06)	(0.16)	(0.09)
Male head dummy (1)	0.219	0.240	0.105*	0.123**	-0.234	-0.112
	(0.22)	(0.22)	(0.06)	(0.05)	(0.23)	(0.08)
Literate head dummy (1)	0.089	0.089	-0.085	-0.073	-0.077	-0.122*
	(0.21)	(0.21)	(0.05)	(0.05)	(0.18)	(0.07)
Number of adult males	0.215	0.238	0.191***	0.201***	0.139	-0.055
	(0.20)	(0.20)	(0.06)	(0.05)	(0.18)	(0.07)
Oxen holding	0.581***	0.580***	0.082***	0.084***	-0.663***	-0.137***
	(0.09)	(0.09)	(0.03)	(0.03)	(0.13)	(0.04)
Low-caste dummy (1)	0.724***	0.467	-0.154**	-0.247***	-0.397	0.369**
	(0.26)	(0.34)	(0.06)	(0.07)	(0.33)	(0.16)
Village dummy (1=Lahachok)	-0.375*	-0.352	0.064	0.077	-0.874***	0.256***
	(0.22)	(0.22)	(0.05)	(0.05)	(0.21)	(0.08)
Village dummy (1=Rivan)	-0.071	-0.038	-0.042	-0.015	-0.495**	0.308***
	(0.28)	(0.28)	(0.07)	(0.06)	(0.25)	(0.10)
Share of irrigated land	0.458**	0.539**	0.059	0.076*	-0.219***	0.006
	(0.20)	(0.21)	(0.04)	(0.04)	(0.06)	(0.02)
Caste *farm size		1.421		0.717***		
		(1.24)		(0.27)		
Constant	-2.167***	-2.222***	0.009	-0.080	-0.273	0.425
	(0.59)	(0.60)	(0.16)	(0.16)	(0.58)	(0.26)
Sigma constant			0.207***	0.199***		0.223***
			(0.02)	(0.02)		(0.02)
Number of observations	407	407	117	117	372	82
Chi2 statistic	245.7***	247.1***	73.1***	84.5***	102.5***	98.8***
Log likelihood of double hurdles	-81.35				-111.7	

Significance levels: *: 10% level, **: 5% level, ***:1% level and all continuous variables are in logarithms. Censored Tobit models for each side of the land rental market were estimated and tested against double hurdle models and the likelihood ratio tests favored the double hurdle models. The results of the censored Tobit model can be obtained from the authors upon request. We did not report (but included in estimation) the coefficients for variables like number of adult females and average distance to plot as these are not significant in all models.

TABLE 8
FARM LEVEL ANALYSIS OF THE FARM SIZE PRODUCTIVITY RELATIONSHIP

	With plot and village characteristics		Added household characteristics		Land and labor market participation	
	Without caste	With caste	Without caste	With caste	Without caste	With caste
Farm size	-0.540***	-0.524***	-0.631***	-0.626***	-0.595***	-0.712***
	(0.037)	(0.041)	(0.039)	(0.044)	(0.046)	(0.060)
Proportion of rented in land in operated land	0.124**	0.115**	-0.046	-0.048	-0.124*	-0.063
	(0.051)	(0.051)	(0.036)	(0.036)	(0.074)	(0.053)
Average distance to farm (minutes walk)	-0.051	-0.050	-0.059	-0.058	-0.062	-0.051
	(0.046)	(0.046)	(0.044)	(0.044)	(0.045)	(0.044)
Village dummy(1=Rivan)	-0.154*	-0.145*	-0.071	-0.069	-0.076	-0.061
	(0.087)	(0.088)	(0.086)	(0.086)	(0.091)	(0.091)
Village dummy(1=Lwang-Ghalel)	-0.262***	-0.262***	-0.195***	-0.198***	-0.185**	-0.182**
	(0.072)	(0.072)	(0.071)	(0.071)	(0.073)	(0.073)
Low caste dummy (=1)		0.122		0.037		0.060
		(0.081)		(0.081)		(0.081)
Literate head dummy(=1)			-0.068	-0.063	-0.094	-0.058
			(0.067)	(0.068)	(0.068)	(0.068)
Male head dummy(=1)			0.126*	0.117*	0.155**	0.110
			(0.069)	(0.071)	(0.073)	(0.074)
Number of adult females			0.037	0.036	0.020	0.024
			(0.034)	(0.034)	(0.034)	(0.037)
Number of adult males			0.205***	0.206***	0.179***	0.199***
			(0.050)	(0.051)	(0.051)	(0.050)
Age of head			-0.130	-0.131	-0.099	-0.109
			(0.124)	(0.124)	(0.112)	(0.127)
Number of oxen			0.163***	0.165***	0.106***	0.150***
			(0.032)	(0.033)	(0.033)	(0.033)
Value of assets			-0.016	-0.012	-0.030	-0.044
			(0.032)	(0.034)	(0.039)	(0.034)

Tenant dummy(=1)					0.381***	
					(0.120)	
Landlord dummy (=1)					-0.107	
					(0.104)	
Labor market participation dummy(1=buyer)					0.061	
					(0.083)	
Labor market participation dummy(1=seller)					-0.166**	
					(0.084)	
Tenant dummy*farm size						0.183
						(0.163)
Landlord dummy*farm size						0.041
						(0.115)
Labor buyer dummy*farm size						0.246***
						(0.085)
Labor seller dummy*farm size						-0.076
						(0.178)
Constant	10.951***	10.943***	11.550***	11.507***	11.577***	11.573***
	(0.188)	(0.188)	(0.571)	(0.582)	(0.539)	(0.596)
R-square	0.374	0.377	0.466	0.466	0.485	0.479
Number of observations	446	446	446	446	446	446

Significance levels: *: 10% level, **: 5% level, ***:1% level and all continuous variables are in logarithms.

TABLE 9
PLOT LEVEL ANALYSIS OF THE FARM SIZE PRODUCTIVITY RELATIONSHIP SEPARATELY FOR LOW-CASTE AND HIGH-CASTE HOUSEHOLDS

	Low-caste				High-caste			
Total value product/ha	Linear relation	With household variables	With household and plot variables	With household, plot and IMR variables	Linear relation	With household variables	With household and plot variables	With household, plot and IMR variables
Farm size (Owned land)	-0.110	-0.107	-0.034	-0.194	-0.169***	-0.196***	-0.215***	-0.362***
	(0.07)	(0.09)	(0.07)	(0.17)	(0.04)	(0.05)	(0.04)	(0.06)
Tenure dummy(1=rented in)			-0.043	-0.161			-0.288***	-0.297***
			(0.13)	(0.14)			(0.09)	(0.09)
Tenant household				-0.045				-0.127**
				(0.16)				(0.06)
Landlord household				-0.281				-0.244***
				(0.24)				(0.08)
Joint chi-squire test for household variables		4.79	7.64	49.9***		17.7**	30.12***	98.22***
Joint chi-squire test for plot quality variables			103.2***	462.8***			428.95***	556.7***
Joint chi-squire test for village dummies			2.66	4.61**			1.47	4.70**
IMR (tenant)				0.901				0.533**
				(0.88)				(0.16)
IMR (landlord)				0.798				0.547
				(0.85)				(0.37)
IMR (plot)				-0.271				-0.246
				(0.52)				(0.16)
Constant	10.87***	11.09***	11.17***	12.30***	10.61***	11.56***	11.37***	11.08***
	(0.12)	(1.39)	(1.27)	(2.65)	(0.04)	(0.57)	(0.48)	(0.51)
Number of observations	138	138	138	138	774	774	774	774
Model test	2.42	8.49	124.5***	220.7***	27.9***	49.8***	575.2***	1433.4***

Significance levels: *: 10% level, **: 5% level, ***: 1% level and all continuous variables are in logarithms. IMR refers to inverse mills ratio and we reported bootstrapped standard errors in case of models with IMR. (bootstrapping by re-sampling households (with 500 replications) to get corrected standard errors).

Appendix

TABLE A1
TEST FOR INVERSE LAND PRODUCTIVITY RELATIONSHIP IN OWNED FARM SIZE, PLOT LEVEL ANALYSIS OF ALL HOUSEHOLDS

	Linear relation		With plot rental	with plot quality and village dummies		Market participation		
	w/o caste	caste	status	w/o caste	caste	Land	Labor	Both
Farm size	-0.205***	-0.196***	-0.234***	-0.216***	-0.200***	-0.231***	-0.243***	-0.250***
	(0.03)	(0.04)	(0.04)	(0.03)	(0.04)	(0.04)	(0.06)	(0.04)
Low-caste dummy (=1)		0.327***	0.286**		0.031	0.008	0.074	0.067
		(0.11)	(0.12)		(0.12)	(0.11)	(0.10)	(0.11)
Low-caste dummy*farm size		0.090	0.040		-0.041	-0.051	-0.048	-0.063
		(0.08)	(0.07)		(0.08)	(0.07)	(0.08)	(0.07)
Rented in dummy(=1)			-0.571***	-0.342***	-0.342***	-0.355***	-0.357***	-0.363***
			(0.06)	(0.06)	(0.07)	(0.08)	(0.08)	(0.07)
Rented out dummy(=1)			-0.141**	-0.076	-0.067	-0.033	-0.057	-0.023
			(0.06)	(0.06)	(0.06)	(0.05)	(0.07)	(0.07)
Joint chi-square test for plot quality variables				454.5***	445.6***	459.1***	523.6***	552.5***
Tenant household dummy (=1)						-0.072		-0.038
						(0.08)		(0.08)
Landlord household dummy(=1)						-0.375***		-0.391***
						(0.10)		(0.10)
Tenant household dummy*farm size						0.171		0.182
						(0.14)		(0.14)
Landlord household dummy*farm size						0.201		0.206*
						(0.13)		(0.12)
Number of adult male						0.056**	0.054*	0.058**
						(0.03)	(0.03)	(0.03)
Number of adult female						0.012	0.012	0.012
						(0.03)	(0.04)	(0.03)
Labor market participation dummy(1=buyer)							0.092	0.017
							(0.08)	(0.06)

Labor market participation dummy(1=seller)							-0.070	-0.176**
							(0.09)	(0.08)
Labor buyer dummy*farm size							0.037	0.028
							(0.10)	(0.08)
Labor seller dummy*farm size							0.140	0.096
							(0.13)	(0.15)
Constant	10.612***	10.597***	10.633***	11.249***	11.231***	11.342***	11.213***	11.309***
	(0.04)	(0.04)	(0.04)	(0.10)	(0.10)	(0.13)	(0.12)	(0.15)
Number of observations	1053	1053	1053	1053	1053	1053	1053	1053

Significance levels: *: 10% level, **: 5% level, ***: 1% level and all continuous variables are in logarithms. Note: Village dummies were found to be insignificant and thus dropped.

Caste Differentiation and Livestock Rental Market Participation in Rural Nepal

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Abstract
This paper examines factors related to the existence of a livestock rental market in western Nepal as rental markets for livestock are rare. It assesses whether and how the livestock rental market is associated with caste differentiation. Furthermore, it assesses whether there exists any association between livestock rental and land rental markets. A combination of double hurdle models for livestock rental market participation and a bivariate ordered probit model for the association between the livestock and land rental markets were applied in the analysis. Migration was found to be strongly related to livestock renting out by high-caste households who have better access to off-farm employment. Low-caste households were typically poor in land as well as livestock holding and faced more restrictions in the labor market. Low-caste male-headed households and households with more male labor endowment were more likely to rent in livestock. Livestock-poor households were more likely to rent in livestock and rented in more. Land-rich and livestock-rich households rented out more animals. The bivariate ordered probit model showed a significant positive association between participation on the same side of the livestock and land rental markets.

Key words: livestock rental market; land rental market; caste; Nepal

1. Introduction

Livestock is an important asset for farm households in rural areas of developing countries as a provider of multiple services and commodities like traction power, manure, productive asset stock, insurance, cash, meat, milk and wool. In addition, it can be a major source of income. Livestock contributes nearly 20 percent of total household income in the rural hills of Nepal (NRB, 1988).

Livestock is typically a more liquid asset than land because livestock sales markets are not exposed to the same legal restrictions; in addition, livestock are mobile in contrast to the immobile land resources. This on the other hand has caused land to be favored for collateral purposes while livestock - due to its mobility and fragility - are considered unsuitable for such purposes (Binswanger and Rosenzweig, 1986). Related to this is also the empirical phenomenon that land rental markets tend to be more developed and function better than sales markets for land while the opposite is the case for livestock. Binswanger and Rosenzweig (1986) explain the poor development of rental markets for livestock and their services like ploughing services by the considerable moral hazard problem and fragility of animals. Another reason for this poor development could be the short season for such demand in rainfed agriculture while one could expect more of such rental services in irrigated agriculture (Holden, et al., 2009). This may also explain why there have been many empirical studies of land rental markets but hardly any studies of livestock rental markets.

Contrary to the statements above we found livestock rental transactions to be quite common in our study area in Nepal and so was the case with land rental transactions. We therefore question why households participate in livestock rental markets and how this relates to the asset distribution and the functioning of other input and output markets. In particular we relate

livestock renting to the discriminatory caste[11] system that is of primary importance for the asset distribution as well as factor market access (Banerjee and Knight, 1985; Ito, 2009) in Nepal. We are not aware of any earlier studies on this.

Using farm household data collected by the first author in 2003 in the western hills of Nepal, we examine household participation in the livestock and land rental markets. Given the fact that land and livestock are complementary inputs in farming, households with land also need livestock for manure and traction power. Our first hypothesis is that livestock renting occurs as a complementary contract to a land rental contract. When a land-poor (often low-caste) household obtains a temporary land rental contract, it may fail to buy the complementary livestock resources due to its poverty and therefore prefer a livestock rental contract to gain the benefits from land and livestock synergies (traction power, manure, and fodder production). Therefore, the livestock rental market can serve as a way to overcome the capital constraint of the poor households. The lumpiness of livestock investments may also contribute to this benefit of a livestock rental market.

Our second hypothesis is that better labor market access of high-caste households increases the probability that they rent out both land and livestock. Rich high-caste households that have surplus livestock (and land) resources but lack labor to manage these resources due to migration of particularly adult male members, rent out their land and livestock. Due to restricted labor market access, low-caste households migrate less as compared to high-caste households. The off-farm opportunities of high-caste households indirectly improve the access to land and livestock

[11] The caste system is a part of the Hindu religion. Caste refers to hierarchically ranked categories based on hereditary membership. It fixes the social status of individuals at birth and prevents movements from one category to another. The major caste groups are: *Brahmins* (the highest caste); *Chhetries* (the second highest caste); *Baishyas* (the third highest caste); and *Sudras* (often called *Dalits* or *Scheduled castes*- the lowest caste). Dalits face severe discrimination due to the practice of untouchability, which prevents them from participating in many religious functions and even, from entering into the houses of other caste groups. This study classified all households into two broad groups: Low-caste (*Dalits* households only) and High-caste (all other categories).

resources for low-caste tenant households. The two hypotheses imply that we should expect a positive correlation between participation in these two rental markets, making it relevant to analyze jointly the decisions to participate in these two markets. Such an analysis is another novel contribution of this paper.

We apply bivariate ordered probit models for the joint decisions to participate on both sides of these markets. We find a strong positive correlation between participation on the same side in the two markets. Households that rented out livestock were also more likely to rent out land and households more likely to rent in livestock were more likely to rent in land. Households renting out both livestock and land were, in almost all cases, high-caste households while households that rented in livestock and land were in most cases low-caste households.

The rest of the paper is organized as follows. Section two provides a brief introduction to the study area and data. Section three presents the theoretical framework of the study whereas section four highlights on the methods used for the empirical analysis of data. Major results and discussions are summarized in section five while the last section presents the conclusion.

2. Study area and data

Data for this study was collected by the first author in the Mardi watershed in the western hills of Nepal in 2003. A total of 500 households were randomly sampled from three Village Development Committees[12] (VDCs) namely, Lahachok, Rivan and Lwang-Ghalel. This paper utilizes data from 489 households as 11 households were dropped from the analysis due to some inconsistencies. The settlements in the study area are 15-45 km from the main city centre, Pokhara. Due to the poor road networks, the area is not accessible by road during the rainy season, but a rough road links the central plain area, called Khoramukh, which is accessible

[12] A Village Development Committee (VDC) is the administrative unit at village level in Nepal. Each VDC consists of 9 wards: a ward is a smallest unit within a VDC.

during dry season. As many settlements are on the hills, people have to walk 2 to 6 hours even to reach the village market centre at Khoramukh, a place where they usually sell their agricultural products. Human labor is the common mode of transporting agricultural products to the market. Hills and mountains higher than 1200 m are the major topographical feature of this region (Thapa and Weber, 1995).

Agriculture is the main economic activity in the study area. Integration of crop and livestock is a main characteristic of the agriculture as livestock is essential not only for traction power but also for sustainable crop production through the use of manure. This is one of the possible reasons why the land and livestock rental market decisions are inter-related. Almost all of the households in the study area own livestock (Annapurna Conservation Area Project (ACAP), 1999). Buffaloes, cows and oxen are the major large livestock, while goats and sheep are the main small ruminants. In addition, unlike other types of livestock, oxen and cows are not sold for the purpose of meat consumption in Hindu society and therefore, markets for cows and oxen are limited outside the rural areas where agriculture is not the major activity. Resource poor farmers in the hills - who cannot invest in cattle and buffalo - usually prefer sheep and goat husbandry. Labor-rich tenants may rent in livestock from landlords because they require both manure and traction power for agricultural production. In the case of high-caste landlord and low-caste tenant, there may also be an interlinked contract where the tenant works as a ploughman and agricultural laborer on the land of the landlord (Adhikari, 1992).

Table 1 presents the information on the major household characteristics by caste. Differences between high-caste and low caste households are found to be highly significant in the case of ownership land holding, operational land holding, farm income, remittance income and the value of assets. Likewise, at least one member has migrated for 43 percent of the high caste households

whereas this is the case for only 18 percent of the low-caste households. Furthermore, 41 percent of the high-caste households have a member with regular job against only 9 percent of the low-caste households.

Households participated both in land and livestock rental markets. Nearly 13 percent of the total sample households rented in livestock while about 11 percent rented out. Cows, oxen and buffaloes are the major livestock used for rental transactions. Out of the total households that rented out livestock, 76 percent reported that they have rented out oxen to low-caste households and this is also associated with labor contracts for ploughing. Some high-caste households also have shared ownership holding of oxen because they need a pair of oxen to plough the land. Non-participation in the livestock rental market is higher than that of the land rental market, which possibly implies that there are larger transaction costs in the livestock rental market as compared to the land rental market (Binswanger and Rosenzweig, 1986). Ranking of all sample households on the basis of net land leased-in and net livestock leased-in separately also depicts this (see Figure 1).

Table 2 summarizes livestock and land rental market participation of the sample households by caste. From Table 2 it can be seen that about 28 percent of the households that rented in land have also rented in livestock. Likewise, 36.6 percent of the households that rent out livestock have also rented out land. None of the sample households that have rented out land were found to rent in livestock and similarly, very few households that have rented in land were found to rent out livestock. Another interesting feature is that households that rent out both land and livestock are mostly high-caste households whereas households that rent in both land and livestock are mostly low-caste households, favoring our first hypothesis. Out of 30 households that rent out both land and livestock, 28 are high-caste households.

Table 3 presents the major characteristics of the farm households participating in the land and livestock rental markets. The percentage of female-headed households is significantly higher among the households renting out livestock (land), whereas households renting in livestock (land) are mostly male-headed. Out of total households renting in livestock, only 19.4 percent have at least one adult member migrated, while it is much higher, 82 percent, in the case of households renting out livestock. Similar difference can be seen between the households that are renting in and renting out land. Of the total households that rented in livestock, 66 percent were low-caste households, while in the case of households renting out livestock the percentage of low-caste households was only seven. Chi-square tests showed that differences with regard to male headship, caste, and migration are highly significant between the households that rent in and rent out livestock (land).

From Table 3, it can be seen that there were also significant differences in own land holding, operational land holding, and family labor endowment between the households that rent in and rent out livestock (land). From the same table, we can see that average ownership land holding of the households that rent out livestock was 0.73 ha while it is only 0.23 ha in the case of households that rent in livestock. Similarly, the differences in ownership livestock holding were also significant: households renting out livestock owned 3.28 TLU (Tropical Livestock Units) against 1.45 TLU in the case of households that rented in. However, the size of operated livestock holding did not differ significantly between the households that participated on the two sides of the land rental market while this differs significantly between the households that participated on the two sides of the livestock rental market. Owned livestock per unit of owned land differed significantly between the households that rented in land and the households that

rented out land while there was no such significant difference between households that rented in and rented out livestock in the livestock rental market.

Table 3 shows that the family labor endowment (measured as standard labor units) was significantly higher among the households that rented in land and the case for the households that rented in livestock was similar. In addition, the labor endowments per unit own land holding was also significantly higher for households that rented in land (livestock) versus households that rented out land (livestock). This implies that land and livestock has moved to those with larger family labor endowment on the farm. Of the total households that rented in both livestock and land 63.4 percent have rented in from the same household.

The Gini coefficient for ownership land holding is 0.49 while it is 0.42 for the operational land holding, implying that the land rental market has reduced inequality in the distribution of land. The Gini coefficient for ownership of livestock holding is 0.40, while it is 0.38 for operational livestock holding. The rental markets for land and livestock therefore appear to contribute to a more egalitarian distribution of these resources across households.

3 Theoretical framework

A farm household has initial endowments of land $\overline{A}$ and livestock $\overline{N}$. Assume that both of these are associated with caste of the household, *C*. A_j and N_j are land and livestock resources transacted in the land and livestock rental markets. Consider that the labor endowment of the household L depends on the migration *M*, which in turn depends on the caste as high-caste households have more migrated members - partly because they have better access to regular off-farm employment due to better family networks and higher level of education. The production function, *q* is then given by

1) $q = q\left(N, A; L\left(M\left(C\right)\right)\right)$; where q_N, q_A, q_L, q_{NA}, q_{NL}, $q_{AL} > 0$; $q_{NN}, q_{AA}, q_{LL} < 0$

$N = \overline{N} + N_j$ and $A = \overline{A} + A_j$

where N and A refer to operational holding of livestock and land resources respectively. Assume a linear non-negative transaction cost in both rental markets for land and livestock, τ_N, τ_A, and rental prices, P_N, P_A, excluding the transaction cost. The transaction cost is primarily the monitoring cost for the owners of livestock and land, causing a reduction in the return to the owner. For simplicity, we assume that tenants do not face transaction costs but adding such a cost would not change the key results.

A general parsimonious model[13] allowing renting in and out of livestock and land can be presented as follows where households are assumed to maximize their net income (as a simple measure of household welfare) subject to their resource constraints and market opportunities:

2) $y = P_q q\left(\overline{N}\left(C\right) + N_i - N_o, \overline{A}\left(C\right) + A_i - A_o; L\left(M\left(C\right)\right)\right) + \left(P_N - \tau_N\right)N_o + \left(P_A - \tau_A\right)A_o - P_N N_i - P_A A_i$

In equation (2), N_o, N_i, A_o and A_i refer to the units of livestock rented out, units of livestock rented in, area of land rented out and area of land rented in, respectively. In the model, N_o, N_i, A_o and A_i are endogenous variables and assumed to be non-negative. Also, if $N_i > 0$, then $N_o = 0$ and vice versa, and similarly for land. Both caste and migration are categorical variables such that $C = 1$ for low-caste and $C = 0$ for high-caste households, and $M = 1$ for households with migrated household members and $M = 0$ otherwise. We also assume that

$\left[\overline{N}(C=1) - \overline{N}(C=0)\right] < 0$; $\left[\overline{A}(C=1) - \overline{A}(C=0)\right] < 0$ and

[13] The model may be expanded to capture credit constraints faced by the households and also the possible incentive effects of renting livestock by those households that have sharecropping contracts with their tenants. In addition, another possibility is to develop a two-period model with tenure insecurity by including costs of possible land or livestock loss due to renting out. However, lack of panel data limits us from testing those issues empirically and is left for future work.

$\left[L(M=1)-L(M=0)\right]<0 \Rightarrow \left[L(M \mid C=1)-L(M \mid C=0)\right]>0$. This is based on the assumption that caste discrimination causes low-caste households to have lower endowments of land and livestock and poorer access to the labor market. Therefore, they have a larger concentration of labor on their farm. In addition, according to Nepalese culture, male members are primarily responsible for providing the economic support to their family and therefore, migration is predominantly for male labor. This ultimately results in a reduction in male labor endowment of the household.

Table 4 summarizes the first order conditions that are derived for different feasible outcomes, ignoring the possibility of renting out all land and livestock. From Table 4, it can be seen that the shadow prices for land and livestock for the non-participant households lie between the prices for the renting out households and renting in households i.e.

$P_A-\tau_A<P_A^*<P_A$ and $P_N-\tau_N<P_N^*<P_N$.

In order to arrive at testable hypotheses from this theoretical framework, we carried out comparative statics. The key comparative statics results are summarized in Table 5. Furthermore, comparative statics with respect to transaction costs in land and livestock rental markets (that are not presented in Table 5) show that increasing transaction costs are found to have negative impacts on amounts of land and livestock rented out.

Based on these analyses, the following hypotheses are derived:

H1. Livestock renting occurs as a complementary contract to a land rental contract.

H1.1 Amounts of livestock rented in (out) decrease (increase) with ownership holding of livestock and land.

H1.2 Low-caste households are relatively poorer than high-caste households in land and livestock and thus, more likely to rent in both land and livestock (+rent in more) from

high-caste households. Alternatively, they are less likely to rent out livestock (+rent out less).

H1.3 There is a positive correlation between the likelihood of land and livestock renting in (out).

H2. High-caste households with better labor market access are more likely to rent out both land and livestock.

H2.1 Labor-poor households are more likely to rent out their livestock (+rent out more) and less likely to rent in (+rent in less) than labor-rich households.

H2.2 Migration is positively correlated with renting out livestock (+rent out more), while it is negatively correlated with renting in livestock (+rent in less).

4. Methods

Double hurdle models were chosen (for reasons explained below) to identify the factors that influence the probability and level of livestock rental market participation by farm households. Furthermore, a bivariate ordered probit model was applied to test whether there was any association between livestock and land rental market participation. The details of these econometric models are described below.

4.1 Participation in the livestock rental market

First, we tested censored Tobit models vs. the double hurdle (Cragg) models for our data. The censored Tobit model assumes that the same mechanism determines both the zeros and the positives and the amount of the variable in question given that the variable is positive (Wooldridge, 2002; Cameron and Trivedi, 2009). Therefore, in the case of the censored Tobit model, a variable which increases (decreases) the probability of participation in the livestock rental market also increases (decreases) the amount of livestock rented in or out. The double

hurdle model allows more flexibility assuming that the decision to participate and the amount of participation may be influenced by different variables. In the Cragg model, the first part corresponds to households' choice of whether to participate or not in the livestock rental market (a probit model) and the second part corresponds to the extent of participation in the market given that it has decided to participate (a truncated regression model).

For this comparison, we applied the likelihood ratio test as the Cragg model nests the censored Tobit model (Fin and Schmidt, 1984; Greene, 2003). The test led us to reject the censored Tobit model in favor of the Cragg model on both sides of the market. We then tested the Cragg model versus the Wooldridge model by using a Voung[14] test for model selection as these two models are non-nested to each other (Voung, 1989). This test favored the Cragg model against the Wooldridge model in the demand side of the livestock rental market whereas it did not discriminate between these two models in the supply side of the market. Therefore, only the results of the Cragg model are presented. The log-likelihood for the Cragg model is:

$$\ln L = \sum_{0} \ln\left[1-\Phi\left(\mathbf{z}\boldsymbol{\gamma}\right)\right] + \sum_{+}\left\{\ln\Phi\left(\mathbf{z}\boldsymbol{\gamma}\right) + \ln\phi\left[\frac{1}{\sigma}\left(\frac{y-\mathbf{x}\boldsymbol{\beta}}{\sigma}\right)\right] - \ln\Phi\left(\frac{\mathbf{x}\boldsymbol{\beta}}{\sigma}\right)\right\}$$

[14] Voung test is given by $V = n^{-\frac{1}{2}} LR_n\left(\hat{\theta}_n, \hat{\gamma}_n\right)\Big/\hat{\omega}_n \xrightarrow{D} N(0,1)$ where n refers to number of observations, $LR_n\left(\hat{\theta}_n, \hat{\gamma}_n\right) \equiv L_n^f\left(\hat{\theta}_n\right) - L_n^g\left(\hat{\gamma}_n\right)$, is the likelihood ratio statistic for the model F_θ against the model G_γ and $\hat{\omega}_n^2 \equiv \frac{1}{n}\sum_{t=1}^{n}\left[\log\frac{f\left(Y_t \mid Z_t;\hat{\theta}_n\right)}{g\left(Y_t \mid Z_t;\hat{\gamma}_n\right)}\right]^2 - \left[\frac{1}{n}\sum_{t=1}^{n}\log\frac{f\left(Y_t \mid Z_t;\hat{\theta}_n\right)}{g\left(Y_t \mid Z_t;\hat{\gamma}_n\right)}\right]^2$. For model selection, we choose a critical value c from the standard normal distribution for a specified significance level such as 2.58 (for 1 percent) and 1.96 (for 5 percent). If $V > c$, we reject null hypothesis that the models are equivalent in favor of F_θ being better than G_γ. If $V < (-c)$, we reject the null hypothesis in favor of G_γ being better than F_θ. If $|V| \leq c$, then we cannot discriminate between the two competing models given the data (For details see Voung, 1989).

4.2 Association between the land and livestock rental markets

In order to find out if there exists any relation between land and livestock rental markets participation, a bivariate ordered probit model was applied. Ordinal dependent variables - net livestock leased-in (*nlsli*) and net land leased-in (*nli*) - have three alternative outcomes. In each rental market, a household can either rent-out or remain autarkic or rent-in. Bivariate ordered probit models can be derived from the latent variable model (Sajaia, 2008). Assume that two latent variables y_1^* and y_2^* are given by:

$$y_{1i}^* = \mathbf{x}_{1i}'\boldsymbol{\beta}_1 + \varepsilon_{1i}$$
$$y_{2i}^* = \mathbf{x}_{2i}'\boldsymbol{\beta}_2 + \gamma y_{1i}^* + \varepsilon_{2i}$$

where $\boldsymbol{\beta}_1$ and $\boldsymbol{\beta}_2$ are vectors of unknown parameters, γ is an unknown scalar, ε_1 and ε_2 are the error terms. The explanatory variables in the model satisfy the conditions of exogeneity such that $E\left(\mathbf{x}_{1i}\varepsilon_{1i}\right) = 0$ and $E(\mathbf{x}_{2i}\varepsilon_{2i}) = 0$.

We observe two categorical variables y_1 and y_2 such that:

$$y_{1i} = \begin{cases} 1 & \text{if} \quad y_{1i}^* \le c_{11} \\ 2 & \text{if} \quad c_{11} < y_{1i}^* \le c_{12} \\ \vdots & \qquad \vdots \\ J & \text{if} \quad c_{1J-1} < y_{1i}^* \end{cases} \qquad y_{1i} = \begin{cases} 1 & \text{if} \quad y_{2i}^* \le c_{21} \\ 2 & \text{if} \quad c_{21} < y_{2i}^* \le c_{22} \\ \vdots & \qquad \vdots \\ K & \text{if} \quad c_{1K-1} < y_{2i}^* \end{cases}$$

The unknown cutoffs satisfy the condition that $c_{11} < c_{12} < \cdots < c_{1J-1}$ and $c_{21} < c_{22} < \cdots < c_{2K-1}$.

Under the assumption that observations are independent, the log likelihood for the entire sample in the case of bivariate ordered probit is given by:

$$\ln \ell = \sum_{i=1}^{N}\sum_{j=1}^{J}\sum_{k=1}^{K} I\left(y_{1i} = j,\ y_{2i} = k\right) \ln \Pr(y_{1i} = j,\ y_{2i} = k)$$

Given that ε_{1i} and ε_{2i} are distributed normally, the system of equations are estimated by full-information maximum likelihood (Sajaia, 2008).

In estimating the econometric models stated above, we included migration as if it were an exogenous variable. However, most of the economic models treat migration as an endogenous variable. Therefore, we looked for the possibility to overcome this problem of endogeneity associated with it by instrumenting for migration. However, we were not able to find any good instrument for it due to data limitations. We considered using caste as an instrument but caste also has other direct or indirect effects that made it unsuitable as an instrument and could not be left out in the second stage of the regressions. The caste variable was also of primary interest in our analysis through its effects on labor market participation and asset distribution and therefore also participation in other factor markets like the livestock and land rental markets.

5. Results and discussions

5.1 Participation in the livestock rental market

The results of the double hurdle models for both sides of the livestock rental market are presented in Table 6. The table shows that there were substantial differences between which variables were significant in the probit versus the truncated models on each side of the market. Hypothesis 1 claims that the livestock renting occurs as a complementary contract to a land rental contract. In order to test this hypothesis empirically, we put forth three sub-hypotheses. Results in Table 6 show that Hypothesis 1.1 that the amount of livestock rented in (out) decreases (increases) with ownership holding of livestock, cannot be rejected. From Table 6, it can be seen that having more livestock was found to be significantly negatively associated with the likelihood of renting in livestock and the amount of livestock rented in, given that the household decided to rent in. Furthermore, it also shows that owned livestock holding positively

affected the amount of livestock rented out. However, unlike the case of renting in livestock, owned livestock holding was not significantly correlated with the likelihood to rent out livestock. Likewise, owned land holding was positively associated with the probability of renting out livestock (at a one percent level of significance) but was not significantly correlated with the amount rented out. This indicates that land poverty also affects livestock rental market participation by the farm households. This also indicates that land and livestock markets jointly serve to balance factor ratios across farm households.

Table 6 indicates that low-caste households were found to have significantly higher (lower) probability of renting in (out) livestock as compared to high-caste households. Thus, Hypothesis H1.2 cannot be rejected. However, in the case of amount of livestock rented in the low-caste dummy is significant only at a 10 percent level and in the case of likelihood to rent out livestock, the caste dummy was not found to have a significant association (but we noticed that it was highly significant before the introduction of the migration dummy). As low-caste households are often discriminated against in the regular outside job market (Ito, 2009), they are more dependent on the agricultural sector - either as farmers or as laborers. In addition, high-caste households consider ploughing land by using oxen as an inferior job and thus, this job has been traditionally carried out by low-caste household members. Such caste-related labor restrictions might have favored low-caste households in renting livestock and land. It might be the reason why caste membership remains highly significant in empirical analyses even after controlling for possible factors that represent inequalities in resource endowments between these two groups such as land, livestock, and family labor endowments. Caste differentiation also matters in the access to the labor market (especially off-farm labor market) and credit market. Even the inclusion of the migration dummy in the empirical analysis does not fully control for labor market access. Under

such a condition, the caste dummy might reflect a separate effect beyond the resource endowment effects and the off-farm employment access. In such a case, caste dummy may capture other internal differences like ploughing being a job only carried out by low-caste males and other omitted variables correlated with caste.

Data from the study area also revealed that 73.6 percent of the low-caste households have worked as permanently attached labor ploughing land using oxen or tending livestock. This can therefore be one of the possible reasons why low-caste households have higher probability to rent in livestock. As low-caste households are relatively poorer in land and livestock, poverty and liquidity constraints of poor potential tenant households create incentives to rent in livestock which is a lumpy asset where renting can facilitate smoother adjustment.

The empirical results in Table 6 also support our second hypothesis which claims that high-caste households with better labor market access are more likely to rent out both land and livestock. In order to test this hypothesis empirically, we have made two sub-hypotheses and both of these hypotheses cannot be rejected by our analysis. Hypothesis H2.1 claims labor-poor households are more likely to rent out their livestock (+rent out more) and less likely to rent in (+rent in less) than labor-rich households and cannot be rejected. The higher the male labor endowment in the household, the higher (lower) is the likelihood to rent in (out) livestock. Male-headed households were found to have a significantly higher probability of renting in and a significantly lower probability of renting out livestock as compared to female-headed households. But in both cases, the sex of the household head was not significantly related to the amount of livestock rented in or out. Households with more adult males were found to have a higher probability of renting in and lower probability of renting out livestock. In addition, the amount of livestock rented out was also significantly lower (at a 5 percent level) with more adult males in the household. Male-

headed households have advantages in decisions making and management of livestock, given the patriarchal structure of the Nepalese rural society.

The empirical results in Table 6 cannot be used to reject Hypothesis H2.2 that migration is positively correlated with renting out livestock (+rent out more), while it is negatively correlated with renting in (+rent in less). Given that many male members of high-caste households have migrated, they need to manage their resources and thus rent out both land and livestock mostly to their low-caste tenants expecting that they can get them back when they come back. This may be the reason why the low-caste dummy turned out to be insignificant in the case of likelihood to renting out livestock (See Table 6) after we introduced the migration dummy. In general, the results indicate that the livestock rental market participation is driven by resource endowments and market access that are closely associated with caste differentiation.

5.2 Association between livestock and land rental market participation

Integration of crop and livestock is one of the main characteristics of agriculture in the study area and, therefore, there are possibilities that households' decisions to participate in the livestock and land rental markets can be inter-related. In order to test this, we estimated a bivariate ordered probit model. For the sake of comparison, we also estimated univariate ordered probit models for livestock and land rental markets separately. Table 7 provides the results of these models.

The results show that all of the variables that significantly affected the livestock (land) rental market participation in the univariate ordered probit models were also found to be significant in the bivariate ordered probit model. However, the size of coefficients and the levels of significance were found to have changed slightly. Both models show that low-caste households had a higher probability of renting in livestock and land compared to high-caste households. This may be due to the fact that low-caste households with limited or no land resources overcome

their land and cash constraints by going into land and livestock rental or share contracts with limited or no initial payment requirements. Furthermore, land-livestock synergies create incentives to increase the livestock-land ratio on small farms. The results show that a higher land endowment was associated with a lower probability of renting in both livestock and land. This implies that land-rich high-caste households are less likely to rent in livestock. Male-headed households and households with more male labor endowment were more likely to rent-in livestock as well as land. In addition, households with migrated adult members were less likely to have rented in livestock and land. This implies that caste differentiation, male labor force, lack of migration, land poverty and male headship jointly drive the renting of livestock and land. The variable *Athrho*[15] in Table 7 tests whether there is a significant correlation between the errors in the two ordered probit models. The results show a significant positive correlation and therefore, hypothesis H1.3 cannot be rejected. This implies that there was a significant positive association between livestock and land rental market participation such that those households that were more likely to rent in land were also more likely to rent in livestock and households that were more likely to rent out land also were more likely to rent out livestock and hence the rental arrangements were integrated. These results are also supported by the descriptive statistics, which we presented in Table 2. In a way it implies that tenants who have rented in land may also rent in livestock from the same landlord and this may also help to control the related moral hazard in such contracts (however we do not have data on those variables to empirically test it in this paper). The local presence of part of the family in high-caste households can also help in the monitoring and enforcement of land and livestock contracts. Besides that, there might be some

[15] It is estimated as: $Athrho = \frac{1}{2}\ln\left(\frac{1+\rho}{1-\rho}\right)$ where, $\rho = corr(u_1, u_2)$; $u_1 \sim N(0, \sigma)$ and $u_2 \sim N(0, 1)$.

complementary effects of renting livestock which contributes to overall farm productivity given that land is rented under sharecropping arrangement (Aryal and Holden, 2010).

6. Conclusions

While rental markets are the only form of market for labor (due to the prohibition of slavery) and a very common form of market for land, they are very uncommon for livestock due to the fragility and mobility of livestock. The mystery attempted solved in this paper is therefore to examine the rationale for the existence of a livestock rental market in our study area in western Nepal. While analyzing this, we also considered the caste differentiation that prevails in the study area.

One of the major findings of our study is that low-caste households are more likely to rent in and less likely to rent out livestock as compared to high-caste households. Typically both land and livestock were rented out by high-caste households. This was associated with the fact that high-caste households have relatively larger endowment of land and livestock and also better access to off-farm employment. Another major finding is that there is a positive association between land rental and livestock rental market participation decisions of both high-caste and low-caste households.

The rental markets for livestock and land improve resource access for resource-poor low-caste households that are also discriminated in labor markets and may also be rationed out of credit markets. The livestock rental market therefore serves as a substitute for the credit market, allowing low-caste households to benefit from crop-livestock interactions on their rented-in land. Overall, differences in resource endowments and in the access to factor markets between high-caste and low-caste households are observed to be important reasons for the emergence of livestock rental markets. Therefore, while designing policies for promoting agricultural

productivity in rural areas, the complementarities between factors of production, mainly livestock and land should not be ignored.

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Table 1 Major household characteristics variable by caste

Household Characteristics variables	High-caste	Low-caste	All sample	Test
Male head dummy (%)	20	65	30	82.72***
Literate head (%)	35	19	31	10.40***
Age of household head (in year)	49.12	49.01	49.1	0.09
Ownership holding (in hectare)	0.64	0.17	0.53	8.83***
Operational holding (in hectare)	0.63	0.35	0.56	5.86***
Owned livestock (in TLU)	3.52	1.47	3.09	272.76***
Operated livestock (in TLU)	3.37	2.43	3.17	294.59***
Standard labor unit	3.81	3.98	3.85	0.85
Standard consumer unit	4.93	5.2	4.99	1.09
Farm income (in Rs.)	32034.9	15312.3	28375.8	5.57***
Remittance income (in Rs.)	20126.9	3448.6	16477.5	4.41***
Total income (in Rs.)	72360.3	30928.2	63294.4	8.02***
Value of asset (in Rs.)	38581.2	15173.4	33459.3	8.29***
Agricultural wage labor (unskilled) (%)	12.3	69.8	24.94	7.16***
Non-agricultural wage employment (unskilled) (%)	34.2	25.6	32.31	3.78***
Regular salary jobs (at least one member) (%)	41.3	9.2	26.58	5.71***
At least one member earning pension (%)	26.7	5.6	22.09	3.96***
At least one adult member migrated (%)	43.1	18.3	30.7	7.48***

Note: Test shows the difference between high-caste and low-caste households; t-test is used for continuous variables and chi-square test for categorical variables.
Note: Regular salary jobs include the jobs both in and outside the country.
Note: Livestock is measured as Tropical Livestock Unit (TLU)

Table 2 Livestock and land rental market participation of the sample households by caste

	Livestock												
	Rent in				Owner operated				Rent out				
	High-caste		Low-caste		High-caste		Low-caste		High-caste		Low-caste		
Land	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	Total
Rent in	9	7.7	24	20.5	50	42.7	31	26.5	3	2.6	0	0	117
Owner operated	12	4.1	17	5.9	207	71.4	31	10.7	21	7.2	2	0.7	290
Rent out	0	0	0	0	48	58.5	4	4.9	28	34.2	2	2.4	82
Total	21	33.9	41	66.1	305	82.2	66	17.8	52	92.8	4	7.2	489

Note: Of the total sample households, 107 households are low-caste households.

Table 3 Characteristics of households participating in land and livestock rental markets

	Land			Livestock		
Variables	Rent in	Rent out	test	Rent in	Rent out	test
Male Head (%)	52.14	19.51	21.63***	70.96	14.81	38.63***
Literate (%)	26.49	35.36	1.80	22.58	33.96	1.84
Low-caste (%)	49.53	5.61	31.03***	66.12	7.17	47.46***
At least 1 adult member migrated (%)	25.64	73.17	43.96***	19.35	82.14	54.97***
Age of household head (years)	48.82	51.01	1.42	48.23	51.02	1.42
Owned land (ha)	0.24	0.61	6.29***	0.24	0.73	5.47***
Family labor endowment	5.05	3.54	5.63***	4.78	3.50	2.16**
Family labor endowment/Owned land	35.18	9.65	5.87***	27.00	7.55	4.71***
Operated land (ha)	0.51	0.39	2.44**	0.42	0.61	2.09**
Family labor endowment /Operated land	13.44	18.34	2.37**	15.09	11.43	1.61
Family labor endowment /own livestock	4.99	1.64	2.68***	4.15	1.19	5.87***
Family labor endowment /operated livestock	3.87	2.09	1.41	1.25	5.03	3.49***
Own livestock (in TLU)	2.37	3.82	4.52***	1.45	3.28	8.74***
Own livestock/Owned land	15.59	9.69	2.56**	6.60	8.33	1.34
Own livestock/Operated land	6.51	19.07	5.42***	11.09	5.34	3.49***
Operated livestock (in TLU)	3.05	3.37	0.96	3.46	1.61	8.17***
Operated livestock/owned land	21.48	8.81	4.28***	22.91	2.64	6.15***
Operated livestock/Operated land	8.96	16.77	3.29***	13.88	5.16	4.74***
Number of observations	117	82		62	56	

Note: Test for significance of difference between those renting in and renting out land and livestock (t-test for continuous variables and chi-square test for categorical variables). Family labor endowment is measured as Standard labor units (SLU). Livestock is measured in Tropical Livestock Unit (TLU).
Significance levels: *: 10% level, **: 5% level, ***:1% level

Table 4 First order conditions for different feasible outcomes

		Land rental market		
		Rent out	Non-participant	Rent in
Livestock rental market	Rent out	$P_q \frac{\partial q}{\partial A} = P_A - \tau_A$ $P_q \frac{\partial q}{\partial N} = P_N - \tau_N$	$P_q \frac{\partial q}{\partial A} = P_A^*$ $P_q \frac{\partial q}{\partial N} = P_N - \tau_N$	$P_q \frac{\partial q}{\partial A} = P_A$ $P_q \frac{\partial q}{\partial N} = P_N - \tau_N$
	Non-participant	$P_q \frac{\partial q}{\partial A} = P_A - \tau_A$ $P_q \frac{\partial q}{\partial N} = P_N^*$	$P_q \frac{\partial q}{\partial A} = P_A^*$ $P_q \frac{\partial q}{\partial N} = P_N^*$	$P_q \frac{\partial q}{\partial A} = P_A$ $P_q \frac{\partial q}{\partial N} = P_N^*$
	Rent in	$P_q \frac{\partial q}{\partial A} = P_A - \tau_A$ $P_q \frac{\partial q}{\partial N} = P_N$	$P_q \frac{\partial q}{\partial A} = P_A^*$ $P_q \frac{\partial q}{\partial N} = P_N - \tau_N$	$P_q \frac{\partial q}{\partial A} = P_A$ $P_q \frac{\partial q}{\partial N} = P_N$

Table 5 Comparative statics for households renting in or renting out both land and livestock[16]

Households renting in both land and livestock	Households renting out both land and livestock
$\frac{\partial N_i}{\partial \overline{N}} = \frac{P_q q_{AA}}{P_q^2\left(q_{NN}q_{AA} - q_{AN}^2\right)} < 0$	$\frac{\partial N_o}{\partial \overline{N}} = \frac{-P_q q_{AA}}{P_q^2\left(q_{NN}q_{AA} - q_{AN}^2\right)} > 0$
$\frac{\partial N_i}{\partial \overline{A}} = \frac{-P_q q_{NA}}{P_q^2\left(q_{NN}q_{AA} - q_{AN}^2\right)} < 0$	$\frac{\partial N_o}{\partial \overline{A}} = \frac{-P_q q_{AA}}{P_q^2\left(q_{NN}q_{AA} - q_{AN}^2\right)} > 0$
$\frac{\partial N_i}{\partial \overline{L}} = \left(\frac{-q_{NA}}{q_{NN}}\right)\frac{\partial A_i}{\partial \overline{L}} = \left(\frac{-q_{AA}}{q_{AN}}\right)\frac{\partial A_i}{\partial \overline{L}}$	$\frac{\partial N_o}{\partial \overline{L}} = \left(\frac{-q_{NA}}{q_{NN}}\right)\frac{\partial A_o}{\partial \overline{L}} = \left(\frac{-q_{AA}}{q_{AN}}\right)\frac{\partial A_o}{\partial \overline{L}}$
$\frac{\partial A_i}{\partial \overline{N}} = \frac{-P_q q_{AN}}{P_q^2\left(q_{NN}q_{AA} - q_{AN}^2\right)} < 0$	$\frac{\partial A_o}{\partial \overline{N}} = \frac{P_q q_{AN}}{P_q^2\left(q_{NN}q_{AA} - q_{AN}^2\right)} > 0$
$\frac{\partial A_i}{\partial \overline{A}} = \frac{P_q q_{NN}}{P_q^2\left(q_{NN}q_{AA} - q_{AN}^2\right)} < 0$	$\frac{\partial A_o}{\partial \overline{A}} = \frac{P_q q_{AN}}{P_q^2\left(q_{NN}q_{AA} - q_{AN}^2\right)} > 0$
$\frac{\partial A_i}{\partial \overline{L}} = \left(\frac{-q_{NN}}{q_{NA}}\right)\frac{\partial N_i}{\partial \overline{L}} = \left(\frac{-q_{AN}}{q_{AA}}\right)\frac{\partial N_i}{\partial \overline{L}}$	$\frac{\partial A_o}{\partial \overline{L}} = \left(\frac{-q_{NN}}{q_{NA}}\right)\frac{\partial N_o}{\partial \overline{L}} = \left(\frac{-q_{AN}}{q_{AA}}\right)\frac{\partial N_o}{\partial \overline{L}}$
Households that are renting in livestock but do not participate in the land rental market	Households that are renting out livestock but do not participate in the land rental market
$\frac{\partial N_i}{\partial \overline{N}} = \frac{1}{P_q q_{NN}} < 0$	$\frac{\partial N_o}{\partial \overline{N}} = \frac{-1}{P_q q_{NN}} > 0$

[16] In our sample, none of the households renting in livestock have rented out land. Similarly, only 3 households that rented out livestock though they have rented in land. Those cases are therefore, not dealt here.

Table 6 Analysis of livestock rental market participation

	Renting in (Yes=1)		Renting out (Yes=1)	
	Probit	Truncreg	Probit	Truncreg
Caste dummy: low(1)	0.520**	0.628*	-0.682	-1.477**
	(0.236)	(0.354)	(0.427)	(0.654)
Value of Asset (In Rs.)	-0.003	-0.012	-0.087**	-0.003
	(0.046)	(0.059)	(0.039)	(0.055)
Owned livestock (in TLU)	-0.258***	-0.406***	-0.034	0.285***
	(0.072)	(0.145)	(0.048)	(0.107)
Owned land holding (ha)	-0.117	0.269	0.747***	-0.054
	(0.291)	(0.483)	(0.194)	(0.215)
Age of household head (years)	-0.007	0.016	0.015*	0.004
	(0.008)	(0.011)	(0.009)	(0.012)
Sex head dummy: male(1)	0.885***	0.258	-0.587**	0.077
	(0.207)	(0.266)	(0.262)	(0.342)
Number of adult males	0.250***	0.146	-0.436***	-0.228**
	(0.080)	(0.106)	(0.101)	(0.107)
Number of adult females	-0.203*	-0.141	0.142	-0.061
	(0.104)	(0.137)	(0.100)	(0.139)
Migration dummy: yes (1)	-0.550**	-0.734**	1.807***	1.062**
	(0.216)	(0.297)	(0.258)	(0.412)
Constant	-0.755	1.174*	-2.274***	0.162
	(0.461)	(0.693)	(0.531)	(0.782)
Sigma constant		0.848***		0.830***
		(0.076)		(0.078)
Wald chi2	109.943	55.849	113.251	25.826
Number of observations	433	62	427	56

Test	**Renting in**	**Renting out**
LR Test (Tobit vs. Cragg model)	LR chi2(10)= 24.98 Prob>chi2=0.0054	LR chi2(10)= 23.63 Prob>chi2=0.0059
Voung Test (Wooldridge vs. Cragg model)	V=-22.95; c= 2.58 V< (-c) →Cragg is better	V=-1.586; c=2.58 |V|<c → cannot discriminate between two models

Significance levels: *: 10% level, **: 5% level, ***:1% level

Note: we also estimated these models without including caste variable, but that does not affect the key results of the model. Likewise, we tried to include interaction terms such as caste*land endowment, caste*male labor endowment, caste*livestock endowment, caste*sex of household head, and caste*migration. Including interaction terms, we were able to estimate renting in model, whereas we had the problem of convergence in case of renting out model. Even after dropping some of the interaction terms, the renting out model suffered highly from multicollinearity problem. Therefore, we dropped those models.

Table 7 Analysis of association between land and livestock rental markets participation

	Ordered probit		Bivariate ordered probit	
Market participation[1]	livestock	land	livestock	land
Caste dummy: low(1)	0.777***	0.365**	0.778***	0.362**
	(0.212)	(0.177)	(0.212)	(0.177)
Value of Asset (In Rs.)	0.039	0.003	0.040	0.003
	(0.025)	(0.026)	(0.024)	(0.026)
Owned livestock (in TLU)	-0.068***	-0.066**	-0.070***	-0.067**
	(0.023)	(0.026)	(0.023)	(0.026)
Ownership holding (ha)	-0.510***	-0.517***	-0.518***	-0.516***
	(0.136)	(0.146)	(0.132)	(0.146)
Age of household head (years)	-0.014**	-0.013***	-0.014**	-0.013***
	(0.006)	(0.005)	(0.006)	(0.005)
Sex head dummy: male(1)	0.777***	0.475***	0.770***	0.479***
	(0.168)	(0.139)	(0.167)	(0.139)
Number of adult males	0.281***	0.336***	0.287***	0.336***
	(0.055)	(0.053)	(0.056)	(0.053)
Number of adult females	-0.125*	-0.002	-0.123**	-0.002
	(0.064)	(0.062)	(0.063)	(0.062)
Migration dummy: yes(1)	-1.135***	-0.772***	-1.127***	-0.773***
	(0.157)	(0.123)	(0.155)	(0.123)
Constant (cut1)	-2.376***	-1.646***		
	(0.345)	(0.299)		
Constant (cut2)	0.987***	0.460		
	(0.357)	(0.286)		
Constant (Athrho)				0.344***
				(0.077)
Wald chi2	165.235	141.637		169.893
Number of observations	489	489		489

Significance levels: *: 10% level, **: 5% level, ***:1% level

1. There are three categories: rent out (-1); non-participation (0), and rent in (1)

2. It is estimated as: $Athrho = \frac{1}{2}\ln\left(\frac{1+\rho}{1-\rho}\right)$ where, $\rho = corr(u_1, u_2);\ u_1 \sim N(0, \sigma)$ and $u_2 \sim N(0, 1)$.

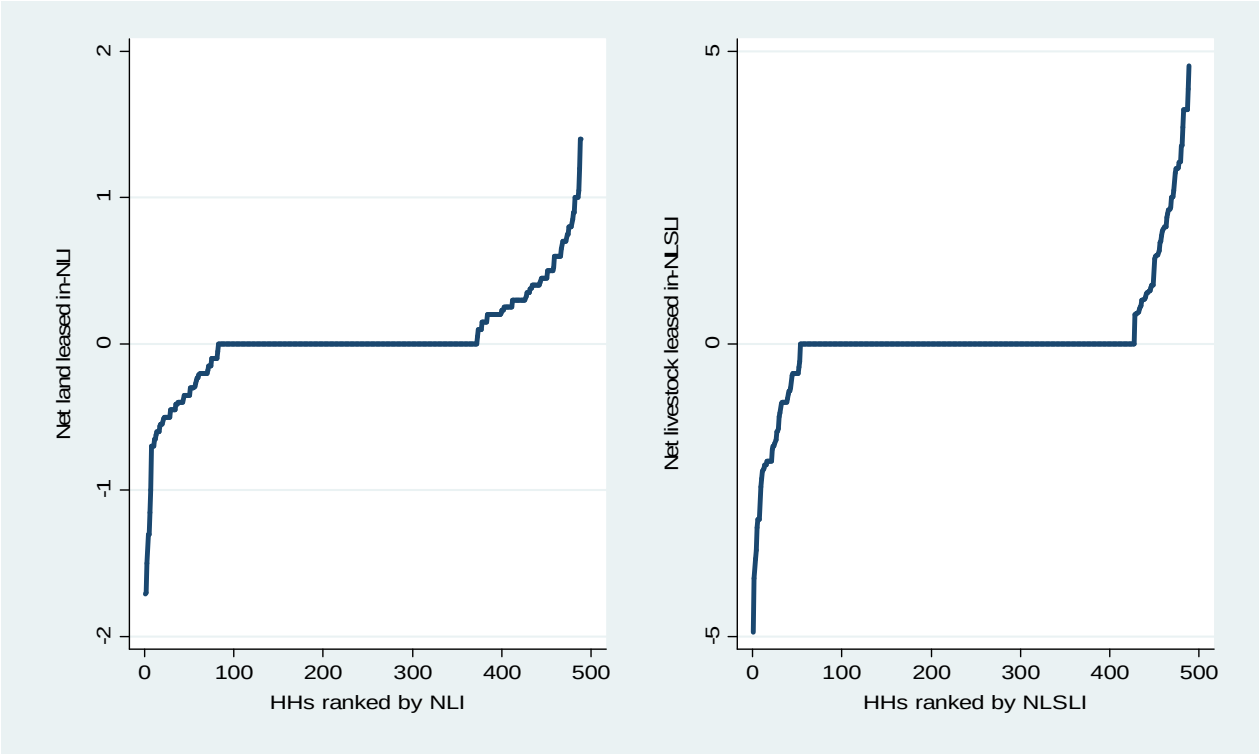

Figure1 Households ranked by Net land leased in and Net livestock leased in

Caste, Investment and Intensity of Production

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Abstract
This paper assesses whether investment and intensity of production differ between high-caste and low-caste households in rural Nepal. We examine the probabilities and levels of fertilizer use, manure use, and terrace maintenance, and the intensity of production. The results show the amount of fertilizer used is significantly lower among low-caste households while they are more likely to apply manure. Conservation investment does not differ significantly between low-caste and high-caste households. Households with access to off-farm employment are found to have significantly negative impact on likelihood to invest on land conservation. Male labor endowment is associated positively with level of fertilizer used, manure applied and conservation investment. Low-caste households have significantly higher cropping intensity than high-caste households.

Key words: investment, fertilizer, manure, terrace maintenance, caste, Nepal

1. Introduction

Studies of factors determining investment and intensity of production by farm households are generally related to two broader issues – poverty and tenure insecurity. Some studies (Li, et al., 1998; Gavian and Ehui, 1999; Deininger and Jin, 2006) find that land tenure security is an important factor in determining the investment and intensity of production. These studies

therefore conclude that tenure insecurity lessens the incentive to invest in productivity-enhancing inputs and claims that farmers divert resources from less secured to more secured land (Gavian and Fafchamps, 1996). Other studies (Holden, et al., 1998; Pagiola and Holden, 2001; Holden and Yohannes, 2002; Holden and Shiferaw, 2002) argue that poverty and inequality in the distribution of income and resources are major determinants explaining levels of investment and intensity of production. Some studies (Prakash, 1997; Holden, et al., 1998) find a close association between higher discount rates and lower willingness to pay for conservation and assert that poverty reduces long term investment. As poverty is a multidimensional concept, the comparison of results from empirical studies that deal with the relationship between poverty and investment should be done with care.

In south Asian context, poverty is also associated with the socio-institutional factors such as caste status of the household. Though some of the studies (Pender and Kerr, 1998; Paudel and Thapa, 2004; Tiwari, et al., 2008) have included caste status of the household as a right hand side variable in their analysis of factors influencing the adoption of land management or soil and water conservation, none of these studies have given proper attention on why the differences between low-caste and high-caste matter. For example, those studies did not explain the differential access to land and other resources and the possible impacts of these differences on the conservation investment. Pender and Kerr (1998) is one of the few studies that included caste as a variable that can affect soil and water conservation investment in rural India. Their study found conflicting effects of caste on soil and water conservation investment across the villages. In two villages (Aurepalle and Shirapur) low-caste households were found to have significantly higher investments on soil and water conservation as compared to high-caste households, whereas in one village (Kanzara) they found the opposite. According to them, this difference in

conservation investment is due to variation in the village economies, occupations of the low-caste households and the timing of conservation investment. They used Tobit regressions for the analysis, which suffers from the assumption of similar effects on the participation decision and the magnitude of the investment.

A recent study in a middle mountain watershed of central Nepal (Tiwari, et al., 2008) showed that the adoption of improved soil conservation technology was higher in the case of low-caste households. Abundance of family labor force, dependency on small farms and diminishing trend of employment in traditional professions of low-caste households are some of the major reasons for their higher adoption of improved soil conservation technology. In the case of high-caste households one of the main reasons behind the low rate of improved soil conservation technology is their better access to Khet land (low land) that reduces their need to invest in their Bari land (upland) which is less productive. Other reasons are higher involvement of their children in the schools outside the village and increasing family labor shortages. However, they have not provided any information that can show the differences in land holding and other variables among the caste groups. Though this study discusses on several factors that may influence farmer's adoption of improved soil conservation technology, it has not controlled for the factors such as family labor endowment per unit land.

Another study in Nepal by Paudel and Thapa (2004) found that high-caste households have higher rate of adoption of land management technologies. However, this study separated caste into three major groups: upper-caste (Brahmin and Chhetris), middle caste (Gurung and Tamang) and lower caste (former untouchables). Though this study briefly mentions that high-caste households have better access to resources, it does not provide any information to compare their relative position.

None, to the best of our knowledge, has given caste a central focus and thus, the effect that caste has on land conservation through its impact on land access and labor market participation. Moreover, as inheritance is the major form of land access in Nepal, Dalits remain land-poor due to past inequality. Therefore, there still lacks a study which focuses on this issue more carefully. This paper relates caste[17] with poverty as low-caste households on average are poorer than high-caste households both in terms of income and major assets like land holding in Nepal (see Table 1 for assessment of this in our sample from Western Nepal). Incidence of income poverty is about 46 per cent for Dalits (low-caste households) whereas it is only 18 per cent in high-caste households (World Bank, 2006). Low-caste households are more land-poor (Wily, et al., 2008). As low-caste households in Nepal suffer from social exclusion, including discrimination in labor markets (DFID and World Bank, 2006), linking caste with poverty helps to broaden the concept of poverty beyond income and asset poverty (Bennett, 2005). In Nepal, caste is found to be a more powerful predictor of social exclusion than gender (DFID and World Bank, 2006). This study therefore makes an attempt to explore how the investment and intensity of production decisions differ between high-caste and low-caste households in rural Nepal by analyzing the differences on short term investments - in terms of fertilizer use and manure use - and more long term investments - in terms of terrace maintenance expenses and intensity of cropping. Effects of tenure security on long term investment, efficiency of share tenancy, allocative efficiency of land tenancy transactions, and the inverse correlation between farm size and productivity are closely

[17] The caste system is a part of Hindu religion. Caste refers to the hierarchical ranking of a person based on hereditary membership. It fixes the social status of individuals at birth and prevents movements from one category to another. The major caste groups are: *Brahmins* (the highest caste); *Chhetries* (the second highest caste); *Baishyas* (the third highest caste); and *Sudras* (often called *Dalits* or *Scheduled castes* - the lowest caste). Dalits face severe discrimination due to the practice of untouchability, which prevents them from participating in many religious functions, and even from entering into the houses of other caste groups. This study classified all households into two broad groups: low-caste (*Dalits* households only) and high-caste (all other categories except *Dalits*).

related issues (Otsuka, 2007). If insecurity of land ownership is the major reason behind the inefficiency of share tenancy, it will also affect the investment decisions of farm households (Otsuka, 2007). A proper understanding of these issues therefore requires an integrated approach. Aryal and Holden (2010) used an integrated approach to jointly analyze the farm size - productivity relationship, inefficiency of share tenancy and allocative inefficiency of tenancy transactions using data from rural Nepal. Their findings showed that inefficiencies exist in land tenancy transactions due to the presence of transaction costs on both sides of land tenancy market. Furthermore, they found that Marshallian inefficiency and the inverse farm size productivity relationship are stronger for high-caste households, while low-caste households are found to have higher land productivity in general, probably due to their lower opportunity cost of labor. These findings raised the question: How are these differences between low-caste and high-caste households related to differences in investments and intensity of production? Furthermore, as low-caste households are poorer in land and other endowments than high-caste households, and this might capture some or most of the effects of caste on investment and intensity of production. However, caste may also have other direct or indirect effects. One is the discrimination in labor markets which reduces the opportunity cost of time and may lead to more investment of household labor in conservation by low-caste households. Another important aspect is the higher tenure insecurity felt by landlords, especially the high-caste households due to past land-to-the-tiller policy that had a provision to give ownership rights to the tenant on half of the rented land. Furthermore, the Maoist insurgency which strongly supports the land-to-the-tiller policy aggravated tenure insecurity of landlords. This might have influenced the investment decisions of the high-caste households. However, we have not included this issue in our empirical estimation due to lack of data on this issue. Actually, we did not collect that

information related to the Maoist war and its impacts in order to minimize risk during data collection. Therefore, the impact of tenure insecurity on investment is left for future study. However, the tenure insecurity due to these reasons is acknowledged when interpreting the results.

The main objective of the paper is therefore to assess the impact of caste discrimination in resource and market access on investment and intensity of production. Resource poverty is one of the consequences of caste discrimination. Low-caste households are therefore land-poor and this can have direct effects on their willingness and ability to invest in their land. However, caste discrimination in the labor market and in the education system may also affect the opportunity cost of labor as well as ability to invest in human capital. Higher land scarcity combined with lower opportunity cost of time due to labor market discrimination may cause low-caste households to concentrate more of their investments on their limited land resources unless they are too poor to invest. As we linked the caste issue with poverty, the major research question is whether or not low-caste households invest more than high-caste households. We applied censored Tobit and double hurdle models in estimating fertilizer, manure and conservation expenses. To estimate cropping intensity, an ordered probit model was applied. Empirical results confirmed that there are significant differences between low-caste and high-caste households regarding likelihood to invest in fertilizer and manure and also in intensity of production. In case of conservation investment, both likelihood and its intensity of use are significantly positively associated with male headship and male labor endowment.

The remainder of the paper is structured as follows: Section Two offers a brief review of relevant literature, while the theoretical framework is provided in Section Three. Information about study area and the data are presented in Section Four, which is followed by Section Five, containing

empirical methods applied for the analysis. Section Six presents the results and a discussion, and is followed by the paper's conclusion.

2. Review of Relevant Literature

The relationship between poverty and environmental degradation is a key focus in the sustainable development debate (WCED, 1987; Lele, 1991). As environmental degradation is a broad term, it encompasses several types of environmental degradation including land degradation. Despite growing research on the linkages between poverty and land management/land degradation, there is still no consensus on how poverty affects land management/land degradation. Empirical evidences on this issue are often mixed (Nkonya, et al., 2008).

Many (WCED, 1987; Durning, 1989; Mink, 1993; Pinstrup-Andersen and Pandya-Lorch, 1994) conceptualize the linkage between poverty and land degradation (environmental degradation in general) as a - downward spiral - assuming that poverty leads to environmental degradation and which in turn aggravates poverty. Therefore, the poor are both agents and victims of environmental degradation. A common hypothesis among these studies is that the poor have short-term perspectives and are unable to invest in resource conservation and improvement, which results in land degradation (Reardon and Vosti, 1995; Ravnborg, 2003). The downward spiral hypothesis is also associated with population pressure and economic marginalization (Scherr, 2000) assuming that poverty contributes to rapid population growth, which is asserted to cause poor land management. A central premise of the poverty trap thesis is the mutual and spiraling relationship between poverty and environmental degradation (Prakash, 1997). The poor, mainly because of their inherent short time horizons and risk, overexploit natural resources, leading to further impoverishment.

Empirical evidences from several studies (Pender, 1996; Holden, et al., 1998; Yesuf, 2004) show that the poor discount the future heavily and at higher rates than those who are wealthier, and thus these findings are consistent with the downward spiral hypothesis. In addition, some studies undertaken in Ethiopia (Shiferaw and Holden, 1998; Holden and Shiferaw, 2002) show that higher discount rates and lower willingness to pay for conservation are closely associated. However, high discount rates are not the only factor through which poverty might affect the land improving investment and degradation (Nkonya, et al., 2008).

Poverty may also affect land investment decisions by influencing households' attitudes toward risk (Ekbom and Bojo, 1999). The possible impact of differences in risk aversion on land investments rests on whether land investments are risk increasing or risk decreasing. Studies show mixed results on whether poor people are more risk averse or not; some studies (Binswanger, 1980; Cardenas and Carpenter, 2005) found no relationship between households' degree of partial risk aversion and wealth. In northern Ethiopia, poorer households were found to be more risk averse and that was associated with less investment in soil and water conservation (Hagos and Holden, 2006). Risk averting behavior caused by constraints facing farm households might lead to risk-induced path dependence and poverty traps (Yesuf and Bluffstone, 2009). In developing countries, due to absence or lack of well developed credit and insurance markets, agricultural production and investment decisions are affected by risks such as drought, flooding, and human illness. In a recent study in Ethiopia, Yesuf and Bluffstone (2009) found that one-third to two-thirds of households are extremely risk averse. Their findings also exhibited that the risk averting behavior significantly differs by wealth level implying that households with more assets accept more risk in exchange for higher expected gains.

Many argue that a direct link between poverty and environmental degradation is too simplistic and such a generalization ignores the complex set of other variables and multiple dimensions of poverty such as asset poverty (Duraiappah, 1998; Nkonya, et al., 2008). Theoretically, under perfect markets there is no causal link between poverty and land (resource in general) degradation (Singh, et al., 1986; Janvry, et al., 1991; Sadoulet and de Janvry, 1995). But, assumptions of perfect markets are unrealistic, especially for rural areas of developing countries where the majority of the poor resides. Under labor and land market imperfections, households with more family labor endowment are more likely to use labor-intensive farming practices such as farming on steep slopes, frequent tilling (less fallowing) and applying more manure. The impact of intensification of labor on land degradation is unclear in such circumstances. Duraiappah (1998) stresses on how institutional and market failures affect the behavior of agents from various income groups, forcing them to carry out unsustainable activities. Under market imperfections, the nature of poverty plays an important role in determining the impact of poverty on land degradation (Nkonya, et al., 2008).

Reardon and Vosti (1995) focused on the different types of poverty rather than a single concept of poverty. They introduced the concept of investment poverty, which refers to the inability of a household to make minimum investments in resource improvements. Therefore, a household that is not poor according to the traditional definition of welfare poverty can be poor in terms of investment poverty. The threshold of investment poverty, however, is context-specific as it is dependent on local input prices and the nature of conservation investment required. Investment poverty prevents households from making profitable investment in resource conservation (Reardon and Vosti, 1995). Poverty can thus be defined in terms of different assets and the income flows from those assets. A household that is poor in terms of land holding can be rich in

terms of human resources; therefore, these differences might affect the household's behavior regarding investment in conservation.

The rural poor in developing countries often lack access to liquid savings or to credit (Barrett, et al., 2002a). In the absence of such insurance, poor households' may have to compromise their future income prospects while responding to transitory income shocks. These strategies might lead to stochastic poverty traps and chronic destitution (Barrett, 2002). In a situation of declining productivity of labor in agriculture, small farmers often reallocate labor to activities that contribute to environmental degradation such as deforestation, poaching, and soil nutrient mining (Barrett and Arcese, 1998; Barrett, 1999). Small farmers in developing countries usually lack the cash required to purchase inputs during the planting season; this sharply increases the marginal cost of capital, which might prevent small farmers from purchasing high-return inputs like chemical fertilizer or investing in land improvements such as soil and water conservation measures (Barrett, et al., 2002b). Financial market (formal or informal) failures are essential conditions for the possibility of becoming trapped in poverty (Carter and Barrett, 2006).
Poverty may affect land management through its influence on opportunity cost of labor. Under labor market imperfections - or due to lack of human capital or because of high transaction costs of entry to high paying regular off-farm employment - poor households with small land holdings may have lower opportunity cost of labor than richer ones (Nkonya, et al., 2006). Under such circumstances, land-poor households are more likely to carry out labor-intensive land management practices (Pender and Kerr, 1998) and are found to invest more per unit of land (Clay, et al., 1998; Pender and Kerr, 1998; Hagos and Holden, 2006).
Land endowments may affect the decision and level of intensification investment and input use. Under credit market imperfections, larger land endowments can affect the use of purchased

inputs like chemical fertilizer via its impact on access to credit and therefore; therefore land-rich households are more likely to apply chemical fertilizer (Nkonya, et al., 2008). Empirical evidence however is mixed. Studies in Ethiopia showed that the relation between land poverty and fertilizer use is context dependent. A study in a high rainfall area of Ethiopia showed that households with large land endowments are more likely to use chemical fertilizer (Benin, 2006), while another study in a low rainfall area of Ethiopia reported the opposite (Pender and Gebremedhin, 2006). In addition, larger farms are found to have lower fertilizer use intensity (Croppenstedt, et al., 2003).

There are competing views on the evolution of agriculture and the extent to which land-scarcity and increased intensity of land use are complemented by investments that sustain the productivity of the resource base (Pender, et al., 1999; Templeton and Scherr, 1999). Boserup (1965) argued that increased subsistence demand encourages the development of new technologies that are more land-saving and labor-intensive; therefore resulting in more intensive land use systems. In this case, scarcity of resources leads to a sustainable intensification of agriculture (Boserup, 1965). The theories of induced technical and institutional innovations also support this argument, expecting that the evolutionary process of agricultural innovations will offset degradation of the resource base (Hayami and Ruttan, 1985). To the contrary, neo-Malthusians advanced a view that population growth is a major factor contributing to poverty and environmental degradation (Hardin, 1993; Cleaver and Schreiber, 1994). This view supports the poverty trap argument. Empirical evidence is mixed; some support Boserup (Tiffen, et al., 1994), while others support the Malthusian view (Cleaver and Schreiber, 1994; Grepperud, 1997) and still others indicate mixed arguments (Pingali, et al., 1987; Turner, et al., 1993; Templeton and Scherr, 1999).

Poverty may also be associated with gender of the household head and the gender composition of the households' labor endowment (Nkonya, et al., 2006). Studies have shown that gender composition of the households' labor endowment also influences land management. In a study of India, Pender and Kerr (1998) found that households with more male labor endowment have higher investment in soil and water conservation whereas conservation is less for households with more female laborers. Some studies (Kazianga and Masters, 2002; Jagger and Pender, 2006) found a positive association between male labor endowment of the household and use of labor intensive practices such as labor-intensive soil conservation measures.

Many poor farmers manage complex crop and livestock portfolios; hence they are ecological farmers. Therefore, changing focus to loss of biodiversity and chemical pollution might change the role currently played by poverty in environmental degradation (Reardon and Vosti, 1995). Though several studies assume poverty leads to land degradation, these studies are not able to explain the existence of poor communities living sustainably within their environments for long periods of time (Ellis-Jones, 1999).

In the South Asian context poverty may be associated with the caste status of the household. However, there are few studies that have included caste status of the household as a variable that has possible impacts on land conservation investment by farm households in rural areas. Pender and Kerr (1998), in their study in rural Indian villages, found conflicting effects of caste on soil and water conservation investment across the villages. In two villages (Aurepalle and Shirapur), low-caste households were found to have significantly higher investments on soil and water conservation as compared to high-caste households, whereas in one village (Kanzara) the effect was opposite. Differences in the village economies, occupations of the low-caste households and

time of the conservation investment were considered as the major reasons explaining the differences in conservation investment. In Kanzara, low-caste households were found to have invested less on soil and water conservation because they have a tradition of migrating during the dry season, a period when conservation investments are usually made. Unlike in Kanzara, there was no such tradition in Shirapur and Aurepalle. In Shirapur low-caste households were discriminated against by the government employment scheme operating in the village and thus they invested more on soil and water conservation as opportunity cost of their labor was low. In Aurepalle, nearly 50 percent of the total households were low-caste households that were mainly shepherds or toddy (palm wine) tappers. These low-caste toddy tappers had more free time for conservation investment.

Paudel and Thapa (2004) in a study of mountain watersheds of Nepal found that high-caste households have a higher rate of adoption of land management technologies. However, this study separated caste into three major groups: upper-caste (Brahmin and Chhetries), middle-caste (Gurung and Tamang), and lower-caste (former untouchables). According to them, upper-caste households are more dependent on agriculture as compared to others and thus, they have higher rate of adoption of land management technologies. Middle-caste households give less priority to farming as they earn substantial amount of income from remittance from abroad. Lower-caste households have small land holding and rely more on wage labor income from their traditional occupations such as metalwork and leatherwork rather than from farming. However, the study did not provide information on the differences in resource ownership and access to resources and markets between the caste groups.

A recent study in a middle mountain watershed of central Nepal (Tiwari, et al., 2008) showed that the adoption of improved soil conservation is higher in the case of low-caste households.

The study classified all sample households into three caste groups: higher caste (Brahmin and Chhetries), middle caste (Newar and Danuwar), and lower caste (occupational caste/Dalits). Their study focused on the adoption of improved soil conservation technology in the Bari land (up land / terraced land). Abundance of family labor force, dependency on small farms and diminishing trend of employment in traditional professions of low-caste households are some of the major reasons for their higher adoption of improved soil conservation technology. In the case of high-caste households one of the main reasons behind the low rate of adoption of improved soil conservation technology on Bari land was their higher endowment of fertile Khet (lowland), reducing their dependency on upland for food production. Other reasons for lower adoption of conservation technologies by higher-caste households were higher participation of their children in schools outside the village and family labor shortages. However, the study did not provide information on differences in land holdings and differences in access to markets and resources among caste groups.

3. Theoretical Framework

This theoretical framework basically draws from the models developed by Holden, Pagiola and Angelsen (1999), and Pagiola and Holden (2001). Consider a basic two-period farm household model. Assume that households face pervasive imperfections in land, labor and credit markets; however, there are markets for output. The household maximizes the following utility function:

1) $Max\ U = u(c_0 - \gamma, L_{e0} - \eta) + \rho u(c_1 - \gamma, L_{e1} - \eta)$

Where c, L_e, γ, η and ρ refer to consumption, leisure, subsistence consumption requirement, minimum leisure requirement and the discount factor[18] respectively. Subscripts 0 and 1 refer to

[18] In this case ρ is the discount factor and is given by $1/(1+\delta)$, where δ is the discount rate.

period one and period 2 in all cases. The utility function is assumed to be strictly concave and thus, $u'(c) > 0; u''(c) < 0; u'(L_e) > 0; u''(L_e) < 0.$

The household possesses a given amount of time, *T* which it allocates for agricultural production, L_{a0} land-related investment L_i and leisure, L_{e0} in the first period and in the second period it allocates time for agricultural production, L_{a1} and leisure, L_{e1}. As we assume that caste discrimination causes low-caste households to have lower endowment of land, the following relation holds true:

2) $A|_{C=1} - A|_{C=0} < 0$

In expression (2), caste (*C*) is a categorical variable such that 1 refers to low-caste household and 0 to high-caste households.

Time allocations in periods one and two can be expressed as:

3) $T_0 = A(C)L_{a0} + A(C)L_i + L_{e0}$
$T_1 = A(C)L_{a1} + L_{e1}$

The household produces agricultural commodities using the land (*A*) and its labor endowments. Assume that investment in intensification enhances productivity in the next period. Assuming constant returns to scale, the production functions for period one and period two can be expressed as:

4) $q_0 = q_0(A(C), L_{a0}) = A(C)q[L_{a0}];\ q_{L_{a0}} > 0, q_{L_{a0}L_{a0}} < 0$

5) $q_1 = \theta[L_i]q_1(A(C), L_{a1}) = A(C)\theta[L_i]q_1[L_{a1}];\ q_{L_{a1}} > 0, q_{L_{a1}L_{a1}} < 0$

Where $\theta[L_i]$ refers to the productivity enhancement due to investment in intensification in period one by the farm household. For simplicity, let us assume that consumption in period t is directly

dependent on the value of production in period t. Therefore, the consumption in periods one and two are given by:

6) $c_0 = pA(C)q_0\left[L_{a0}\right]$

7) $c_1 = pA(C)\theta\left[L_i\right]q_1\left[L_{a1}\right]$

Substituting equations (2), (6) and (7) into equation (1), we obtain:

8) $Max\left\{\begin{array}{l} U = u\left(pA(C)q_0\left[L_{a0}\right]-\gamma,\ T_0 - A(C)L_{a0} - A(C)L_i - \eta\right)+ \\ \qquad \rho u\left(pA(C)\theta\left[L_i\right]q_1\left[L_{a1}\right]-\gamma,\ T_1 - A(C)L_{a1} - \eta\right) \end{array}\right\}$

In this case, there are three endogenous variables in the model: L_{a0}, L_{a1} and L_i. Assuming interior solutions, the first order conditions are (note that we used A rather than $A(C)$ to simplify the notation below):

9) $\dfrac{\partial U}{\partial L_{a0}} = \dfrac{du}{dc_0}\,pA\dfrac{dq_0}{dL_{a0}} - A\dfrac{du}{dL_{e0}} = 0$

10) $\dfrac{\partial U}{\partial L_{a1}} = \rho\dfrac{du}{dc_1}\,pA\theta\left[L_i\right]\dfrac{dq_1}{dL_{a1}} - \rho A\dfrac{du}{dL_{e1}} = 0$

11) $\dfrac{\partial U}{\partial L_i} = -A\dfrac{du}{dL_{e0}} + \rho\dfrac{du}{dc_1}\,pAq_1\left[L_{a1}\right]\dfrac{d\theta}{dL_i} = 0$

From these, we can derive the following comparative statics (For details see Appendix-1):

12) $\dfrac{dL_i}{dA} = \left|H\right|^{-1}\left\{\dfrac{\partial^2 U}{\partial L_{a1}^2}\dfrac{\partial^2 U}{\partial L_i \partial L_{a0}}\dfrac{\partial^2 U}{\partial L_{a0}\partial A} + \dfrac{\partial^2 U}{\partial L_{a0}^2}\dfrac{\partial^2 U}{\partial L_i \partial L_{a1}}\dfrac{\partial^2 U}{\partial L_{a1}\partial A} - \dfrac{\partial^2 U}{\partial L_{a0}^2}\dfrac{\partial^2 U}{\partial L_{a1}^2}\dfrac{\partial^2 U}{\partial L_i \partial A}\right\} \ >< 0$

13) $\dfrac{dL_i}{d\gamma} = \left|H\right|^{-1}\left\{\dfrac{\partial^2 U}{\partial L_{a1}^2}\dfrac{\partial^2 U}{\partial L_i \partial L_{a0}}\dfrac{\partial^2 U}{\partial L_{a0}\partial \gamma} + \dfrac{\partial^2 U}{\partial L_{a0}^2}\dfrac{\partial^2 U}{\partial L_i \partial L_{a1}}\dfrac{\partial^2 U}{\partial L_{a1}\partial \gamma} - \dfrac{\partial^2 U}{\partial L_{a0}^2}\dfrac{\partial^2 U}{\partial L_{a1}^2}\dfrac{\partial^2 U}{\partial L_i \partial \gamma}\right\} \ < 0$

14) $\dfrac{dL_i}{d\rho} = \left|H\right|^{-1}\left[\dfrac{\partial^2 U}{\partial L_{a0}^2}\left(p^2A^2\dfrac{d\theta}{dL_i}\dfrac{du}{dc_1}\left\{\rho^2\theta\left(\dfrac{dq_1}{dL_{a1}}\right)^2\dfrac{du}{dc_1} - \rho\theta q_1\dfrac{du}{dc_1}\dfrac{d^2q_1}{dL_{a1}^2} - \dfrac{A}{P}q_1\dfrac{d^2u}{dL_{e1}^2}\right\}\right)\right] > 0$

In the above equations, $|H|$ is the Hessian determinant. The sign of the analytical solution for equation (12) is ambiguous. It is therefore not possible to say analytically whether land-poor households invest less or more in intensification than land-rich households. We resort to empirical analysis to assess this in our case study area. Equation (13) implies that increasing subsistence consumption requirements decrease the ability to invest in intensification. Within a cross section of households with varying dependency ratios, households with high dependency ratios may be less able to invest in intensification than households with lower dependency ratios. A high dependency ratio is an indication of poverty and this may cause a higher discount rate, further strengthening the effect on investment (Holden, et al., 1999). Equation (14) implies that poverty, which may cause a high discount rate, leads to less investment in intensification, as higher priority is given to increasing current consumption.

There is a possibility to extend this theoretical framework by including access to off-farm employment opportunities, L_o (For details see Holden, Pagiola and Angelsen, 1999). This helps us to understand how the participation in off-farm employment may affect land conservation investment. In general, increased participation in off-farm employment reduces investment in land intensification ($\frac{\partial L_i}{\partial L_o} < 0$). However, access to off-farm labor market may also have an indirect effect on intensification through the discount rate. If the wage rate in the off-farm labor market is higher than the return to labor in farming, access to off-farm employment may help to reduce the discount rate as it will reduce the poverty of the household participating in off-farm employment. This indirect effect of access to off-farm employment on intensification may dampen the direct effect $\left(\frac{\partial L_i}{\partial \rho} \frac{\partial \rho}{\partial L_o} > 0 \right)$. Similarly the effect of an increase in the opportunity cost

of time through access to off-farm employment raises the (shadow) wage rate, ω, and the effect on investment of labor can be expressed as: $\frac{\partial L_i}{\partial \omega} = \left\{ \left. \frac{\partial L_i}{\partial \omega} \right|_{\rho=\text{constant}} + \frac{\partial L_i}{\partial \rho} \frac{\partial \rho}{\partial \omega} \right\} \leq \geq 0$. In this expression, the first term is negative while the second is positive. While the first term is likely to dominate and cause a negative overall effect, we cannot rule out that second term under certain conditions also can be significant.

Based on this theoretical analysis, we put forth the following hypotheses:

H1: Low-caste households are land-poor and less able to invest than high-caste households, vs.

H2: Low-caste households depend more on agricultural production on limited land and therefore invest more per unit of land to increase their land productivity and have a higher intensity in their production.

H3. Access to off-farm income is associated with lower investment in conservation

H4. Low-caste households have lower opportunity cost of labor due to discrimination in the labor market and therefore invest more and intensify more their agricultural production Vs.

H5. Lack of off-farm employment in combination with land poverty causes low-caste households to be less able to invest in intensification and purchase farm inputs.

4. Study Area and Data

Data for this study was collected from 500 households in the Mardi watershed area of western Nepal in 2003. This paper uses information from 489 households; information from the remaining 11 sample households was discarded due to inconsistency. The data was collected both at household and at farm plot levels. The household level data covered a wide range of household characteristics such as household composition, consumption expenditure, income from different sources, sales and purchases, credit, and household preferences. The plot level

data included the biophysical characteristics of the plots, plot trade information, inputs applied, crop choice and production at plot level. The sample households operated 1131 plots.

Hills and mountains higher than 1200 meters are the major topographical features of the study region (Thapa and Weber, 1995).The settlements of the Mardi watershed are 15-45 kilometers from the district headquarter in Pokhara. This area lies in the highest rainfall region of Nepal with an average annual amount of rainfall 4500 millimeters.

Agriculture is the major economic activity in this area. Farmers produce a variety of crops using traditional cropping systems for agricultural production. The most common crops in the valley are paddy and wheat while maize and millet are common in the terraced land. Farmers practice crop rotation, growing one to three crops in a plot in rotation per year. Livestock is a major component in the production system as it provides traction power and manure.

Of the total sample households, 382 belong to the “high-caste” (non-Dalit) households as defined in this study, though those households may not match the high-caste definition of many other studies. However, it is reasonable in the study area, where the high-caste group comprises Brahmins, Chhetries, Gurung and Newar and all of these caste/ethnic groups have higher income level as compared to low-caste (Dalits) households (see Table 1).

Table 1 presents the major characteristics of the households in the study area. The average size of land holding is small as is typical in Asia (Otsuka, 2007). High-caste households own 0.64 ha of land while it is only 0.17 ha in the low-caste households. The difference in average levels of income is more than double between high-caste and low-caste households. If we compare the average income of the households in the study area with the poverty line income of Nepalese Rupees 8901 (after adjusting for the price index at 2003) per capita per annum as defined by the

Nepal Living Standard Survey (NLSS) 1996, the average household income of low-caste households falls below the poverty line income.

Table 2 shows the percentage of farm plots that received major intensification investment. We considered four main indicators of intensification investment: fertilizer, manure, terrace maintenance expenses, and number of crops grown in the plot annually. Of the total sample plots, 57 per cent plots have received fertilizer, while 72 per cent have received manure application. In comparing the owner cultivated plots of high-caste and low-caste households, nearly 80 per cent plots operated by low-caste households received manure, compared with 71 percent in caste of high-caste households. Cropping intensity is also higher among low-caste households as low-caste households have grown three crops per year in 37 percent of the plots they owned whereas high-caste households have grown three crops per year only in 20 percent of the plots they owned. This difference is higher in cases of rented plots.

Table 3 below presents the level of intensification investment by caste of the household and tenure status of the plot. Out of four major indicators of intensification, we summarize the mean level of three inputs only as the remaining one is the categorical variable. It is interesting to note that level of investment is significantly lower in rented plots than in owned plots operated by high-caste households. However, this difference is only significant for the level of fertilizer use in cases of low-caste households.

Comparing the own plots of low-caste and high-caste households, low-caste households are found to have applied significantly higher unit of manure and terrace management expenditure

per unit of land. This difference is wider when comparing rented plots operated by low-caste and high-caste households.

5. Empirical Estimation Methods

We were able to carry out panel data models because we have information on multiple plots per household. Random effects (RE) models were applied because the variable caste is plot invariant and thus fixed effects (FE) models cannot be estimated, which could otherwise have been used for controlling the intra-group correlation that may arise due to unobserved cluster effects (Udry, 2000; Wooldridge, 2002). Manure, chemical fertilizer, terrace maintenance expenditures and cropping intensity are the major variables analyzed.

In case of manure, chemical fertilizer and terrace management expenditure, plot level censoring is possible as all plots may or may not receive these investments. Therefore, we applied a random effect censored Tobit model and the variants of Tobit models (double hurdle models). Of the variants of double hurdle models, we applied the Wooldridge model (Wooldridge, 2002) as a Cragg model cannot be applied in panel data structure. For the comparison between the censored Tobit model and the Wooldridge model, we used the Voung[19] test for model selection. In the

[19] Voung test is given by $V = n^{-\frac{1}{2}} LR_n\left(\hat{\theta}_n, \hat{\gamma}_n\right) \Big/ \hat{\omega}_n \xrightarrow{D} N(0,1)$ where n refers to number of observations, $LR_n\left(\hat{\theta}_n, \hat{\gamma}_n\right) \equiv L_n^f\left(\hat{\theta}_n\right) - L_n^g\left(\hat{\gamma}_n\right)$, is the likelihood ratio statistic for the model F_θ against the model G_γ and $\hat{\omega}_n^2 \equiv \frac{1}{n}\sum_{t=1}^{n}\left[\log\frac{f\left(Y_t \mid Z_t;\hat{\theta}_n\right)}{g\left(Y_t \mid Z_t;\hat{\gamma}_n\right)}\right]^2 - \left[\frac{1}{n}\sum_{t=1}^{n}\log\frac{f\left(Y_t \mid Z_t;\hat{\theta}_n\right)}{g\left(Y_t \mid Z_t;\hat{\gamma}_n\right)}\right]^2$. For model selection, we choose a critical value c from the standard normal distribution for a specified significance level such as 2.58 (for 1 per cent) and 1.96 (for 5 per cent). If $V > c$, we reject null hypothesis that the models are equivalent in favor of F_θ being better than G_γ. If $V < (-c)$, we reject the null hypothesis in favor of G_γ being better than F_θ. If $|V| \leq c$, then we cannot discriminate between the two competing models given the data (For details see Voung, 1989).

case of the Wooldridge model, the first stage refers to the probit model and the second stage to log normal regression. In the case of chemical fertilizer, manure and terrace maintenance expenditure, one major issue is whether an explanatory variable has the same impact on decision to use an input (probability of investment) and the level of its use (amount of investment). The censored Tobit model assumes that a variable that increases the probability of adoption also increases the level of use and vice versa (Cameron and Trivedi, 2005; Cameron and Trivedi, 2009). This is a more restrictive assumption; therefore, we applied Wooldridge model, which relaxes this assumption and allows that a variable can have different effects on the probability to use and extent of use.

In the case of cropping intensity, we applied ordered probit models and variants of count models such as random effect Poisson and random effect negative binomial regression. All of these econometric analyses were carried out at the farm plot level as a farm household can have more than one plot. This provides us the opportunity to control for several land quality attributes. Since we do not have direct measure of discount rate, we specified this as a function of household characteristics variables (Holden, et al., 1998).

To test and control for selection biases that may arise due to unobservable plot characteristics, the Inverse Mills Ratio (IMR) from probit models run on the rental status of the plots were included in the random effects models. While doing this, we have also excluded some variables in the second stage that were used in the first stage in order to satisfy the exclusion restriction. This is done because relying only on the nonlinearities for identification has recently become less acceptable. For all models with IMR and other predicted variables, bootstrapped standard errors were generated using 500 replications and re-sampling households to obtain corrected standard errors.

6. Result and Discussions

The results of the double hurdle models estimated for analyzing the determinants of the probabilities and level of investment in intensification are presented in Table 4. Only the results from double hurdle model (Wooldridge version) are presented as the censored Tobit model was rejected in favor of the double hurdle model. The rejections of the censored Tobit model implies that variables affecting the likelihood of adoption do not necessarily affect the level of use in a similar way. In order to test for the robustness of our results, we have also estimated the models presented in Table 4 with different specifications[20].

In the case of fertilizer, hypothesis one, that low-caste households are land-poor and less able to invest than high-caste households, cannot be rejected as the level of use of fertilizer was significantly lower for low-caste households as compared to high-caste households. Farm size is found to have a significant positive effect on the intensity of fertilizer use; this implies that land-poor low-caste households have lower intensity of fertilizer use. This is plausible under the credit market imperfections in the study area. Male labor endowment of the household was positively (significant at 5 percent level) correlated with intensity of use for those utilizing fertilizer while households hiring labor were more likely to apply fertilizer on a plot. Households with larger livestock endowments were less likely to use fertilizer and used less fertilizer. This may be because animal manure served as a good substitute. We controlled for the land quality variables including soil type (four soil type dummies), soil depth (three soil depth dummies), slope (four slope dummies) and irrigation status of the plot. Joint chi-square tests showed that these

[20] We estimated two alternative models to the double hurdle model results presented in Table 4: 1) with tenure status of the plot controlling for plot selection biases (using inverse mills ratio) and 2) using control function approach (i.e. using tenure status of the plot and error obtained from the difference between actual value of tenure and predicted tenure value that we got from the probit model). However, the signs and levels of significance of the variables of interest (such as caste, farm size, and labor endowment) did not change in either of these specifications. Therefore, we do not present those alternative model results here but they confirm that the key results were quite robust. Those results are available from the authors upon request.

variables had significant effects on both probability and extent of fertilizer use. The results also imply that we cannot reject hypothesis H5.

Hypothesis H1 is partly rejected in cases of manure use as the results showed that low-caste household were more likely to use manure, but caste was found to have no significant effect on the level of manure application. Household labor endowments were found to be highly significant in the intensity of manure use, while both male and female labor endowments did not influence the decision to apply manure significantly. Unlike the case of fertilizer, male-headed households were found to use more manure per unit of area. Just opposite to the case of fertilizer, households with more livestock not only had a higher likelihood of applying manure, but also applied more manure per unit of land. Labor market participation and access to off-farm income had no significant association with manure use.

In the case of conservation investment, hypothesis H1 has to be rejected, as caste and farm size turned out to be insignificant. Hypothesis H3 cannot be rejected as the off-farm income dummy significantly negatively associated (significant at 1 percent level) with the probability of conservation investment on plots. Buyers of labor were also less likely to invest in conservation. Buyers of labor are likely to face labor constraints and have higher opportunity cost of labor. It was typically high-caste households that bought labor. This finding is therefore supporting hypothesis H4. Such households are likely to have higher opportunity cost of labor and this may be in line with Households with male heads invested more in conservation and households with more male labor were both more likely to invest in and invested more in conservation. Strikingly, households with higher endowments of female labor were less likely to invest in conservation while households with more livestock were more likely to invest in conservation. Such investments were less likely to take place on more distant plots.

In all of these models, we controlled for the land quality variables as mentioned above. Joint chi-square tests showed that these variables were significant at 1 percent level in cases of fertilizer and conservation investment and at 5 percent level in the case of manure. Table 5 presents the result of the analysis of cropping intensity using ordered probit models. Models without and with the off-farm income dummy and agricultural labor market participation dummies were included to assess the sensitivity to alternative specifications and to test hypotheses H3-H5. The low-caste dummy variable was highly significant and positive (1 percent level) in all model specifications while the farm size and off-farm income and labor market dummy variables were insignificant. Based on this we have to reject hypothesis H1 in favor of hypotheses H2 and H4. Furthermore, we estimated the ordered probit model, including interaction between farm size and caste dummy. The interaction variable, however, neither turned out to be significant. The findings are in line with Aryal and Holden (2010) who found that land productivity was significantly higher for low-caste households. This is realistic, as expansion of agricultural land is difficult for the poor low-caste households. More land can be acquired either through land purchase or through participation in the land rental market. However, under severe credit market imperfections, the poor have almost no access to the land purchase market. Likewise, Aryal and Holden (2010) showed that the land rental market is also highly imperfect and the transaction costs are higher for tenants than for landlords. Therefore, the only way that the low-caste households can produce more is through intensification.

7. Conclusions

This paper examined whether investment and intensity of production differ between high-caste and low-caste households in rural Nepal. We considered fertilizer, manure, conservation expenditures, and intensity of production as four major variables that represent investment in

intensification. The econometric estimation showed mixed results. Low-caste households were less likely to apply fertilizer and similar is the case for intensity of its use. However, low-caste households were more likely to apply manure as compared to high-caste households and have higher cropping intensity. In the case of conservation investment, the caste variable was insignificant.

Another interesting result was that fertilizer use intensity increased with farm size. This shows that land-rich households invest in labor-saving inputs like fertilizer while relatively low-caste households with low opportunity cost of labor invest in labor-intensive inputs like manure and intensify their production by growing more crops per year.

An important policy implication provided by this study is that the conventional downward spiral hypothesis need not be seen as inevitable. Designing policies and incentive structures for enhancing conservation investments need to focus on resource differences between households as well as market access and discrimination that may take many forms and have multiple impacts and begging for a broader definition of poverty, rather than on income poverty alone.

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Appendix-1

The total derivatives of the interior solutions to the first order conditions may be expressed as follows:

$$\begin{bmatrix} \frac{\partial^2 U}{\partial L_{a0}^2} & \frac{\partial^2 U}{\partial L_{a0}\partial L_{a1}} & \frac{\partial^2 U}{\partial L_{a0}\partial L_i} \\ \frac{\partial^2 U}{\partial L_{a1}\partial L_{a0}} & \frac{\partial^2 U}{\partial L_{a1}^2} & \frac{\partial^2 U}{\partial L_{a1}\partial L_i} \\ \frac{\partial^2 U}{\partial L_i\partial L_{a0}} & \frac{\partial^2 U}{\partial L_i\partial L_{a1}} & \frac{\partial^2 U}{\partial L_i^2} \end{bmatrix} \begin{bmatrix} dL_{a0} \\ dL_{a1} \\ dL_i \end{bmatrix} = \begin{bmatrix} -\frac{\partial^2 U}{\partial L_{a0}\partial A} & -\frac{\partial^2 U}{\partial L_{a0}\partial \gamma} & -\frac{\partial^2 U}{\partial L_{a0}\partial \rho} \\ -\frac{\partial^2 U}{\partial L_{a1}\partial A} & -\frac{\partial^2 U}{\partial L_{a1}\partial \gamma} & -\frac{\partial^2 U}{\partial L_{a1}\partial \rho} \\ -\frac{\partial^2 U}{\partial L_i\partial A} & -\frac{\partial^2 U}{\partial L_i\partial \gamma} & -\frac{\partial^2 U}{\partial L_i\partial \rho} \end{bmatrix} \begin{bmatrix} dA \\ d\gamma \\ d\rho \end{bmatrix} \qquad (1)$$

Where the element of the matrices are:

i) $\frac{\partial^2 U}{\partial L_{a0}^2} = \left(pA\frac{dq_0}{dL_{a0}} \right)^2 \frac{d^2u}{dc_0^2} + pA\frac{du}{dc_0}\frac{d^2q_0}{dL_{a0}^2} + A^2\frac{d^2u}{dL_{e0}^2} \quad < 0$

ii) $\frac{\partial^2 U}{\partial L_{a1}\partial L_{a0}} = \frac{\partial^2 U}{\partial L_{a0}\partial L_{a1}} = 0$

iii) $\frac{\partial^2 U}{\partial L_i\partial L_{a0}} = \frac{\partial^2 U}{\partial L_i\partial L_{a0}} = A^2\frac{d^2u}{dL_{e0}^2} \; < 0$

iv) $\frac{\partial^2 U}{\partial L_{a1}^2} = \rho\, pA\theta\left[L_i\right]\frac{du}{dc_1}\frac{d^2q_1}{dL_{a1}^2} + \rho\left(pA\theta\left[L_i\right]\frac{dq_1}{dL_{a1}} \right)^2 \frac{d^2u}{dc_1^2} + A^2\frac{d^2u}{dL_{e1}^2} \; < 0$

v) $\frac{\partial^2 U}{\partial L_{a1}\partial L_i} = \frac{\partial^2 U}{\partial L_i\partial L_{a1}} = \rho\, pA\frac{d\theta}{dL_i}\frac{dq_1}{dL_{a1}}\left(\frac{du}{dc_1} + pA\theta\left[L_i\right]q_1\left[L_{a1}\right]\frac{d^2u}{dc_1^2} \right) < 0$

vi) $\frac{\partial^2 U}{\partial L_i^2} = \rho\, pAq_1\left[L_{a1}\right]\frac{du}{dc_1}\frac{d^2\theta}{dL_i^2} + \rho\left(pAq_1\left[L_{a1}\right]\frac{d\theta}{dL_i} \right)^2 \frac{d^2u}{dc_1^2} + A^2\frac{d^2u}{dL_{e0}^2} \; < 0$

vii) $-\frac{\partial^2 U}{\partial L_{a0}\partial A} = \left\{ -pL_{a0}\frac{du}{dc_0}\frac{d^2q_0}{dL_{a0}^2} + \frac{dq_0}{dL_{a0}}\left\{ -Ap^2L_{a0}\frac{d^2u}{dc_0^2}\frac{dq_0}{dL_{a0}} + Ap^2q_0\left[L_{a0}\right]\frac{d^2u}{dc_0^2} + \frac{du}{dc_0}p \right\} - \frac{du}{dL_{e0}} \right\} >< 0$

viii) $-\frac{\partial^2 U}{\partial L_{a1}\partial A} = \left\{ \begin{array}{l} \rho\, pA\theta\left[L_i\right]\frac{dq_1}{dL_{a1}}\frac{d^2u}{dc_1^2}\left\{ p\theta\left[L_i\right]q_1\left[L_{a1}\right] - pL_iq_1\left[L_{a1}\right]\frac{d\theta}{dL_i} - pL_{a1}\theta\left[L_i\right]q_1\frac{dq_1}{dL_{a1}} \right\} \\ -\rho\, pL_i\frac{du}{dc_1}\frac{dq_1}{dL_{a1}}\frac{d\theta}{dL_i} - \rho\, pL_{a1}\theta\left[L_i\right]\frac{du}{dc_1}\frac{d^2q_1}{dL_{a1}^2} - \rho\frac{du}{dL_{e1}} + \rho\, p\theta\left[L_i\right]\frac{du}{dc_1}\frac{dq_1}{dL_{a1}} \end{array} \right\} <> 0$

ix) $-\frac{\partial^2 U}{\partial L_i\partial A} = \left\{ \begin{array}{l} -\frac{du}{dL_{e0}} + \rho\, pq_1\left[L_{a1}\right]\frac{du}{dc_1}\frac{d\theta}{dL_i} - \rho\, pL_{a1}\frac{du}{dc_1}\frac{d\theta}{dL_i}\frac{dq_1}{dL_{a1}} - \rho\, pL_iq_1\left[L_{a1}\right]\frac{du}{dc_1}\frac{d^2\theta}{dL_i^2} + \\ \rho\, pAq_1\left[L_{a1}\right]\frac{d\theta}{dL_i}\frac{d^2u}{dc_1^2}\left\{ p\theta\left[L_i\right]q_1\left[L_{a1}\right] - pq_1\left[L_{a1}\right]L_i\frac{d\theta}{dL_i} - p\theta\left[L_i\right]L_{a1}\frac{dq_1}{dL_{a1}} \right\} \end{array} \right\} <> 0$

$$x)\ -\frac{\partial^2 U}{\partial L_{a0}\partial\gamma}=\left\{-pA\frac{dq_0}{dL_{a0}}\frac{d^2u}{dc_0^2}\right\}\ <0$$

$$xi)\ -\frac{\partial^2 U}{\partial L_{a1}\partial\gamma}=\left\{-\rho\, pA\theta\left[L_i\right]\frac{dq_1}{dL_{a1}}\frac{d^2u}{dc_1^2}\right\}\ <0$$

$$xii)\ -\frac{\partial^2 U}{\partial L_i\partial\gamma}=\left\{-\rho\, pAq_1\left[L_{a1}\right]\frac{d\theta}{dL_i}\frac{d^2u}{dc_1^2}\right\}\ <0$$

$$xiii)\ -\frac{\partial^2 U}{\partial L_{a0}\partial\rho}=0$$

$$xiv)\ -\frac{\partial^2 U}{\partial L_{a1}\partial\rho}=\left\{pA\theta\left[L_i\right]\frac{dq_1}{dL_{a1}}\frac{du}{dc_1}\right\}\ <0$$

$$xv)\ -\frac{\partial^2 U}{\partial L_i\partial\rho}=\left\{pAq_1\left[L_{a1}\right]\frac{d\theta}{dL_i}\frac{du}{dc_1}\right\}\ <0$$

Thus the required Hessian determinant is:

$$\left|H\right|=\left\{\left(pA\frac{dq_0}{dL_{a0}}\right)^2\frac{d^2u}{dc_0^2}+pA\frac{du}{dc_0}\frac{d^2q_0}{dL_{a0}^2}+A^2\frac{d^2u}{dL_{e0}^2}\right\}$$
$$\left\{\begin{array}{l}\rho^2p^2A^2\theta q_1\left(\frac{du}{dc_1}\right)^2\frac{d^2q_1}{dL_{a1}^2}\frac{d^2\theta}{dL_i^2}+\rho^2pA\theta\frac{du}{dc_1}\frac{d^2q_1}{dL_{a1}^2}\left(pAq_1\frac{d\theta}{dL_i}\right)^2\frac{d^2u}{dc_1^2}+\\ \rho^2pAq_1\left(pA\theta\frac{dq_1}{dL_{a1}}\right)^2\frac{d^2u}{dc_1^2}\frac{du}{dc_1}\frac{d^2\theta}{dL_i^2}+\rho pq_1A^3\frac{d^2u}{dL_{e1}^2}\frac{du}{dc_1}\frac{d^2\theta}{dL_i^2}+A^2\rho\left(pAq_1\frac{d\theta}{dL_i}\right)^2\\ \frac{d^2u}{dL_{e1}^2}\frac{d^2u}{dc_1^2}-\underline{\left(\rho\, pA\frac{d\theta}{dL_i}\frac{dq_1}{dL_{a1}}\frac{du}{dc_1}\right)^2}-2\rho^2p^3A^3\theta q_1\left(\frac{d\theta}{dL_i}\frac{dq_1}{dL_{a1}}\right)^2\frac{du}{dc_1}\frac{d^2u}{dc_1^2}\end{array}\right\}$$

Given that both production and utility functions are strictly concave, the first part is sure to be negative. Likewise all the terms inside the large bracket except the underlined expression are positive and thus it is sure to be positive. Therefore, the Hessian matrix is sure to be negative in this case. This is what we need for the maximization. We may summarize the expected signs of the various elements of the total derivatives of the FOCs as follows:

$$\begin{bmatrix}(-) & (0) & (-)\\ (0) & (-) & (-)\\ (-) & (-) & (-)\end{bmatrix}\begin{bmatrix}dL_{a0}\\ dL_{a1}\\ dL_i\end{bmatrix}=\begin{bmatrix}(+-) & (-) & (0)\\ (+-) & (-) & (-)\\ (+-) & (-) & (-)\end{bmatrix}\begin{bmatrix}dA\\ d\gamma\\ d\rho\end{bmatrix} \tag{2}$$

Therefore the required comparative statics are:

$$\frac{dL_i}{dA}=|H|^{-1}\left\{\frac{\partial^2U}{\partial L_{a1}^2}\frac{\partial^2U}{\partial L_i\partial L_{a0}}\frac{\partial^2U}{\partial L_{a0}\partial A}+\frac{\partial^2U}{\partial L_{a0}^2}\frac{\partial^2U}{\partial L_i\partial L_{a1}}\frac{\partial^2U}{\partial L_{a1}\partial A}-\frac{\partial^2U}{\partial L_{a0}^2}\frac{\partial^2U}{\partial L_{a1}^2}\frac{\partial^2U}{\partial L_i\partial A}\right\}\ ><0 \tag{3}$$

$$\frac{dL_i}{d\gamma}=|H|^{-1}\left\{\frac{\partial^2U}{\partial L_{a1}^2}\frac{\partial^2U}{\partial L_i\partial L_{a0}}\frac{\partial^2U}{\partial L_{a0}\partial \gamma}+\frac{\partial^2U}{\partial L_{a0}^2}\frac{\partial^2U}{\partial L_i\partial L_{a1}}\frac{\partial^2U}{\partial L_{a1}\partial \gamma}-\frac{\partial^2U}{\partial L_{a0}^2}\frac{\partial^2U}{\partial L_{a1}^2}\frac{\partial^2U}{\partial L_i\partial \gamma}\right\}\ <0 \tag{4}$$

$$\begin{aligned}\frac{dL_i}{d\rho}&=|H|^{-1}\left\{\frac{\partial^2U}{\partial L_{a1}^2}\frac{\partial^2U}{\partial L_i\partial L_{a0}}\frac{\partial^2U}{\partial L_{a0}\partial \rho}+\frac{\partial^2U}{\partial L_{a0}^2}\frac{\partial^2U}{\partial L_i\partial L_{a1}}\frac{\partial^2U}{\partial L_{a1}\partial \rho}-\frac{\partial^2U}{\partial L_{a0}^2}\frac{\partial^2U}{\partial L_{a1}^2}\frac{\partial^2U}{\partial L_i\partial \rho}\right\}\\ &=|H|^{-1}\left\{\frac{\partial^2U}{\partial L_{a0}^2}\left(\frac{\partial^2U}{\partial L_i\partial L_{a1}}\frac{\partial^2U}{\partial L_{a1}\partial \rho}-\frac{\partial^2U}{\partial L_{a1}^2}\frac{\partial^2U}{\partial L_i\partial \rho}\right)\right\}=|H|^{-1}\left\{\frac{\partial^2U}{\partial L_{a0}^2}(\psi-\zeta)\right\}\ >0\end{aligned} \tag{5}$$

Note that**,**

$$\psi=\rho p^2A^2\theta[L_i]\frac{d\theta}{dL_i}\left(\frac{dq_1}{dL_{a1}}\frac{du}{dc_1}\right)^2+\rho p^3A^3q_1[L_{a1}]\left(\theta[L_i]\frac{dq_1}{dL_{a1}}\right)^2\frac{d^2u}{dc_1^2}\frac{d\theta}{dL_i}\frac{du}{dc_1}$$

$$\zeta=\begin{bmatrix}\rho p^2A^2\theta[L_i]q_1[L_{a1}]\frac{d\theta}{dL_i}\left(\frac{du}{dc_1}\right)^2\frac{d^2q_1}{dL_{a1}^2}+\rho p^3A^3q_1[L_{a1}]\left(\theta[L_i]\frac{dq_1}{dL_{a1}}\right)^2\frac{d^2u}{dc_1^2}\frac{d\theta}{dL_i}\frac{du}{dc_1}\\ +pA^3q_1[L_{a1}]\frac{d\theta}{dL_i}\frac{du}{dc_1}\frac{d^2u}{dL_{e1}^2}\end{bmatrix}$$

Therefore,

$$\psi-\zeta=\begin{Bmatrix}\rho p^2A^2\theta[L_i]\frac{d\theta}{dL_i}\left(\frac{dq_1}{dL_{a1}}\frac{du}{dc_1}\right)^2-\rho p^2A^2\theta[L_i]q_1[L_{a1}]\frac{d\theta}{dL_i}\left(\frac{du}{dc_1}\right)^2\frac{d^2q_1}{dL_{a1}^2}\\ -pA^3q_1[L_{a1}]\frac{d\theta}{dL_i}\frac{du}{dc_1}\frac{d^2u}{dL_{e1}^2}\end{Bmatrix}>0$$

$$\frac{dL_i}{d\rho}=|H|^{-1}\left[\frac{\partial^2U}{\partial L_{a0}^2}\left(p^2A^2\frac{d\theta}{dL_i}\frac{du}{dc_1}\left\{\rho^2\theta\left(\frac{dq_1}{dL_{a1}}\right)^2\frac{du}{dc_1}-\rho\theta q_1\frac{du}{dc_1}\frac{d^2q_1}{dL_{a1}^2}-\frac{A}{P}q_1\frac{d^2u}{dL_{e1}^2}\right\}\right)\right]>0$$

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Table 1 Major household characteristics variable by caste

Household Characteristics variables	High-caste	Low-caste	All sample	test
Male head dummy (%)	20	65	30	82.72***
Literate head (%)	35	19	31	10.40***
Age of household head (in year)	49.12	49.01	49.1	0.09
Ownership holding (in hectare)	0.64	0.17	0.53	8.83***
Operational holding (in hectare)	0.63	0.35	0.56	5.86***
No. of adult male in household	2.25	2.32	2.26	0.5
No. of adult female in household	1.99	1.85	1.96	1.24
Standard labor unit	3.81	3.98	3.85	0.85
Standard consumer unit	4.93	5.2	4.99	1.09
Farm income (in Rs.)	32034.9	15312.3	28375.83	5.57***
Off-farm income (in Rs.)	20544.4	6154.6	17461.1	4.11***
Total income (in Rs.)	72360.3	30928.2	63294.4	8.02***
Value of asset (in Rs.)	38581.2	15173.4	33459.3	8.29***

Note: test shows the difference between high-caste and low-caste households. Chi-square test is used for categorical variables and t-test for continuous variables.

Table 2: Number of plots and percentage of plots with intensification investments by caste and tenure status

	High-caste		Low-caste		All sample HHs		
	Own plot	RI-plots	Own plot	RI-plots	Own plot	RI-plots	Total plots
Fertilizer	385(57.5)	83(65.4)	47(47.5)	48(51.1)	432(56.2)	131(59.3)	563(56.9)
Manure	477(71.2)	85(66.9)	79(79.8)	75(79.7)	556(72.3)	160(72.4)	717(72.4)
TME	379(56.6)	61(48.1)	53(53.5)	51(54.3)	432(56.2)	112(50.7)	545(55.1)
Cropping intensity							
One crop/year	232(34.6)	56(44.1)	23(23.2)	18(19.2)	255(33.2)	74(33.5)	329(33.2)
Two crops/year	306(45.7)	53(41.7)	39(39.4)	45(47.9)	345(44.9)	98(44.3)	443(44.7)
Three crops/year	132(19.7)	18(14.17)	37(37.4)	31(32.9)	169(21.9)	49(22.17)	218(22.0)
Total	670(100)	127(100)	99(100)	94(100)	769(100)	221(100)	990(100)

Note: Percentages are provided in parentheses. RI- refers to rented-in plots and TME refers to terrace maintenance expenses.

Table 3 Level of intensification investment by caste and tenure status (for uncensored sample)

	High-Caste Households			Low-Caste Households			Difference (HC-LC)	
	Own plots	RI-plots	t-test	Own plots	RI-plots	t-test	t-test (Own)	t-test (RI)
Fertilizer (in Rs.)/ha	3937.4 (3704.0)	2952.7 (2544.1)	2.92***	3357.7 (2587.9)	2418.5 (1826.2)	2.04**	1.37	1.39
Manure (in kg)/ ha	2037.75 (2433.3)	1263.7 (1281.5)	4.35***	2792.5 (3047.2)	2339.4 (2351.4)	1.03	2.07**	3.52***
TME (in Rs.) /ha	5789.2 (4604.1)	4266.3 (3031.7)	3.35***	8280.6 (7162.1)	6603.2 (4358.1)	1.44	2.46**	3.23***

Note: 1. Standard deviations are provided in parentheses. RI- refers to rented-in plots and TME refers to terrace maintenance expenses. HC and LC refer to high-caste and low-caste respectively.

Significance levels: *: 10% level, **: 5% level, ***: 1% level

Table 4 Determinants of the probabilities and level of fertilizer, manure and conservation investment

	DH(Fertilizer)		DH(Manure)		DH(Conservation)	
	RE_Probit	RE_Reg	RE_Probit	RE_Reg	RE_Probit	RE_Reg
Low-caste dummy(1)	-0.253	-0.212**	0.519**	0.028	-0.032	-0.049
	(0.17)	(0.09)	(0.23)	(0.13)	(0.16)	(0.08)
Plot size	0.033	-0.455***	0.100	-0.707***	0.368***	-0.701***
	(0.07)	(0.03)	(0.08)	(0.05)	(0.07)	(0.03)
Farm size	0.069	0.155**	0.111	-0.064	0.086	-0.043
	(0.12)	(0.07)	(0.17)	(0.09)	(0.12)	(0.06)
Male head dummy (1)	-0.108	0.020	0.093	0.561***	0.177	0.565***
	(0.11)	(0.06)	(0.15)	(0.09)	(0.11)	(0.05)
Male labor per ha	-0.041	0.104**	0.061	0.205***	0.214**	0.105**
	(0.09)	(0.05)	(0.12)	(0.07)	(0.09)	(0.04)
Female labor per ha	0.152	-0.047	0.045	0.212***	-0.195**	-0.027
	(0.10)	(0.05)	(0.13)	(0.08)	(0.10)	(0.05)
Distance to plot	0.107**	0.027	-0.411***	-0.246***	-0.140***	-0.033
	(0.05)	(0.03)	(0.06)	(0.03)	(0.05)	(0.02)
Livestock owned	-0.135***	-0.052***	0.249***	0.089***	0.094***	0.027
	(0.03)	(0.02)	(0.04)	(0.03)	(0.03)	(0.02)
Off-farm access dummy(1)	0.051	-0.085	0.004	0.062	-0.275***	0.069
	(0.11)	(0.06)	(0.14)	(0.08)	(0.10)	(0.05)
Labor market dummy (buyer)	0.304***	0.064	-0.024	0.047	-0.219**	-0.022
	(0.11)	(0.06)	(0.15)	(0.09)	(0.11)	(0.05)
Labor market dummy(seller)	0.089	-0.093	-0.037	-0.028	-0.010	0.008
	(0.13)	(0.07)	(0.18)	(0.11)	(0.13)	(0.07)
JCT (Land quality variables)	152.1***	24.8***	19.1**	15.9**	98.5***	34.5***
Constant	0.828	7.296***	2.367**	4.874***	-0.422	7.036***
	(0.78)	(0.42)	(1.04)	(0.60)	(0.75)	(0.39)
Constant (lnsig2u)	-9.432		-0.853**		-11.572	
	(17.93)		(0.35)		(19.71)	
Constant (sigma_u)		0.179***		0.459***		0.253***
		(0.05)		(0.04)		(0.03)
Constant(sigma_e)		0.496***		0.664***		0.388***
		(0.02)		(0.03)		(0.02)
Number of observations	990	563	990	716	990	544
Number of groups	489	369	489	424	489	377
Chi2 statistic	205.1***	227.8***	88.9***	614.7***	144.5***	693.7***

Notes: Significance levels: *: 10% level, **: 5% level, ***:1% level. DH refers to double hurdle model. JCT refers to joint chi-square test of all land quality variables including slope dummies, soil type, soil depth, and irrigation status of the plot.

Table 5 Determinants of cropping intensity

Cropping intensity	oprobit3	oprobit4	oprobit5
Low caste Dummy	0.482***	0.462***	0.495***
	(0.14)	(0.14)	(0.15)
Plot size	0.128**	0.130**	0.130**
	(0.06)	(0.06)	(0.06)
Farm size	0.054	0.049	0.040
	(0.11)	(0.11)	(0.11)
Male head	0.183*	0.189*	0.187*
	(0.10)	(0.10)	(0.10)
Male labor per ha	0.094	0.093	0.093
	(0.07)	(0.07)	(0.07)
Female labor per ha	-0.061	-0.067	-0.073
	(0.09)	(0.09)	(0.09)
Age of HH head	-0.073	-0.074	-0.068
	(0.17)	(0.17)	(0.17)
Distance to plot	-0.028	-0.028	-0.026
	(0.04)	(0.04)	(0.04)
Livestock owned	-0.012	-0.012	-0.010
	(0.03)	(0.03)	(0.03)
Slope(foot-hill)	1.032***	1.034***	1.035***
	(0.15)	(0.15)	(0.15)
Slope(mid-hill)	0.618***	0.623***	0.624***
	(0.11)	(0.11)	(0.12)
Slope(steep-hill)	0.304***	0.312***	0.312***
	(0.11)	(0.11)	(0.11)
Irrigated plot Dummy	0.302***	0.306***	0.309***
	(0.08)	(0.08)	(0.08)
Off-farm dummy		0.076	0.069
		(0.09)	(0.09)
Labor market (buyer dummy)			0.083
			(0.09)
Labor market (seller dummy)			0.018
			(0.13)
Constant(cut1)	-0.512	-0.464	-0.381
	(0.65)	(0.65)	(0.66)
Constant (cut2)	0.816	0.865	0.949
	(0.65)	(0.65)	(0.66)
Number of observations	990	990	990
Chi2 statistic	145.9***	145.1***	145.6***

Significance levels: *: 10% level, **: 5% level, ***:1% level. We included distance to plot, three soil type dummies (keeping soil type 1 as reference group) and two soil depth dummies (keeping soil depth(deep) as the reference group), but none of them became significant and thus, we did not report them in the table. We estimated the model with the interaction between farm size and caste dummy but the interaction variable did not turn out to be significant. Moreover, inclusion of the interaction variable did not affect the basic results of the model.

Appendix

Questionnaire for Household Survey 2003

Market Imperfections and the Sustainability of Land Use in Nepal

Kaski District, Mardi Watershed, Pokhara Valley, Nepal

The information collected will be used for research purposes. It will be treated as confidential and will not be used by tax authorities or other assistances.

Name of VDC	
Village	
Ward Number	
Household Number (HHN)	
Name of Household Head	
Distance from Local Market Centre	
Distance from District Market Centre	
Distance from Nearest Road Head	

Enumerator's Name	
Date of First Interview	
Date of Second Interview	

Data Checked By	**When**	**Status**		**Comments**
		OK	**Return**	

Data Punched	**When**	**Who**	**Comments**
Pages			
Pages			
Pages			
Pages			
Pages			
Pages			

1. Farm Household Survey: Household Characteristics

HHN_____ Number of household members_____ _____Caste group_____

Members living in the household during the last year (2002)

S. N.	Name	Relation to head	Sex	Age (in years)	Education	Skill	Occupation					Months of presence
							Type	Time	Time	Time	Time	
1												
2												
.												
.												
10												
11												

Relation to head: 1=wife, 2=child, 3=grand child, 4=brother, 5=sister, 6= hired labor, 7=daughter in law, 8=other (specify); **Sex:** 0=male, 1=female
Skill: 0=unskilled, 1=skilled; **Education:** # of years, I=illiterate, L=literate; **Occupation:** 0=student, 1=agriculture, 2=private service, 3= public service, 4=business, 5=tourism, 6=industry, 7=without any occupation, 8=other (specify)

Did any member of the family live outside home during the last year for more than a month? Yes_____ No____

If yes,

S. N.	Name	Relation to head	Sex	Age (in years)	Marital Status	Education	Destination	Period	Purpose	Remittance (in Rs.) last year	Remittances used for

Have any member of the family who migrated few years back come back? Yes_____ No_____
If yes, state reason _____
What are the negative effects when a person migrates/moves from the family? _____
How do workload in household change when the person moved out? _____
Who gets higher load? _____ Who gets smaller workload? _____
If children get higher workload, does this affect-

- School attendance? Yes _____ No _____
- Time spent on homework? Yes_____ No _____
- Drop out of school completely? Yes_____ No_____

Did the consumption of food per person change when the person moved out? Improved_____ Constant_____ Declines _____

2. Farm Household Survey: Land Degradation and Conservation Practices

HHN _____

How is the soil fertility status on your farm in general?

Decreasing _____ Increasing _____ Constant _____ Don't know _____

Give reasons if decreasing _____

Give reasons if increasing _____

Is there any soil degradation problem in your farm? Yes____ No____

If yes, rank indicators as follows:

Plot No.	Degradation indicators				Degree of degradation	Conservation labor (man days)		
	First	Second	Third	Fourth		New structures	Maintenance	Removal

Degradation indicators: 1=rill erosion, 2=gully formation/expansion, 3=shallow stony plot, 4=siltation on down slope, 5=lack of vegetation, 6=tree root exposure, 7=seed washed away, 8=land slide, 9=hail storm, 10=riser failure, 11= other (specify); **Degree of Degradation:** 0=not a problem, 1=less severe, 2=severe, 3=very severe

Did you carry out soil conservation activities? Yes _____ No_____

If yes, show conservation technology used and expenditure:

Type of activity	Area conserved (In Ropani)	Total labor days needed		Other form of expenses (in Rs.)	Land conserved used for (crop)
Land slide treatment in farm land (retaining wall, check dam, dry stone..)					
Broadcasting of seed on land slide area					
Planting bamboo/Napir grass					
Bench terracing/ maintaining					
Other (specify)					

If no, give reasons_____

Do you use chemical fertilizer on your farm land? Yes_____ No_____

If no, give reasons_____

Have you ever had training on soil conservation uses and practices? Yes_____ No_____

If yes, when_____ By whom_____

If no, why?

Don't have time_____ No opportunity_____ Other specify_____

Landholding

Type	Size (in Ropani)		Source of change					
	This year	Last year	Purchase	Sharecropping	Rent out	Rent in	Sale	Inheritance
Upland Bari								
Upland Khet								
Low land								
Forest land								
Grazing land								

3. Farm Household Survey: Household Consumption Expenditures

HHN_____

A: Food Items

Commodity	Quantity		If bought			Source of money	Frequency of Purchase	How much each time?	Seasonality	Total expenditure per year
	Own production	Bought	Where	Price	Per (unit)					
Rice										
Paddy										
Wheat										
Maize										
Millet										
Potato										
Beans										
Soya bean										
Cauliflower										
Cabbage										
Onion										
Tomato										
Meat										
Fish										
Egg										
Other (Specify)										

Where bought: 1=from neighbor, 2=local market, 3=distant market, 4=trader visiting village; **Source of money:** 1=own, 2=borrowed (credit)

Note: we included milk, ghee, milk products, curd, salt, spices (masala), tea, fruits and sugar in the table. However, we dropped it here to save the space.

B. Non-food Items

Commodity	Frequency of purchase	When	Where bought	Quantity	Source of money	Total cost per year
Medicine						
Clothing						
Foot wear						
Education						
Stationary						
Cigarettes/tobacco						
Fuel						
Fests/festivals						
Soap						
Cosmetics						
Other (specify)						

4. Farm Household Survey: Crop and Livestock Selling Activities

Did you sell any crop, livestock, or their products last year? Yes _____ No _____

If yes, fill the following table:

Crop /Livestock products	Local market					Distant market				
	Quantity	Price/unit	Month sold	Where	Income	Quantity	Price/unit	Month sold	Where	Income
Paddy										
Rice										
Maize										
Wheat										
Millet										
Potato										
Pulses										
Ginger										
Spices										
Soya beans										
Fruits										
Mustard										
Vegetables										
Buffalo										
Cow										
Calves										
Sheep										
Goat										
Chicken										
Milk										
Meat										
Ghee										
Curd										
Milk Products										
Dung/manure										
Skin										
Eggs										
Honey										
Straw (Nal, Paral, etc.)										
Other (specify)										

5. Farm Household Survey: Livestock Related Information

Do you keep livestock? Yes _____ No_____

If yes, answer the following:

Livestock type	Number		Total	Current value (in Rs.)	End 2001	End 2002	2002 died	Born	Slaughtered
	Male	Female							
Buffalo									
Cattle									
Calves									
Oxen									
Sheep									
Goat									
Chicken									
Other (specify)									

Livestock Purchase Activities

	Quantity purchased			
Type/Product	Price/unit	Per	Where bought	Source of money
Buffalo				
Cow				
Oxen				
Calves				
Sheep				
Goat				
Chicken				
Milk				
Meat				
Ghee				
Curd				
Milk products				
Dung/manure				
Skin				
Eggs				
Honey				
Other (specify)				

Where bought: 1=from neighbor, 2=local market, 3=distant market, 4=trader visiting village;
Source of money: 1=own, 2=borrowed (credit)

How is the livestock status for the last 8-10 years? Increase_____ Decrease _____ Same_____

If there is change over the last 8-10 years in the number of livestock that your households owns, what are the reasons for the change?

Livestock disease_____ Unprofitable production _____

Fodder shortage _____ More profitable production_____

Reduced grazing land _____ More land need for production _____

Labor shortage in the household _____ Labor availability in the household _____

Other (specify) _____

What do you see as the most important constraints in livestock production?

_____

_____

6. Farm Household Survey: Credit

Have you obtained credit for investments or other purposes? Yes_____ No_____

If yes, give details for the last 5 years:

Source	Who took?	Year obtained	Purpose	Amount	Repayment conditions				Collateral requirement	What was the credit actually used for?
					Frequency	Duration	Interest	Completed		

Source: 1=government bank, 2=village money lender, 3=relatives, 4=mother groups, 5= SFDP, 6=other (specify); **Who took?:** 1=wife, 2=child, 3=grand child, 4=brother, 5=sister, 6=daughter in law, 7=other (Specify); **Duration:** length of loan period; **Frequency:** number of times repayment has to be made during the loan period; **Completed:** 1=yes, 0=No

If you want, are you able to obtain credit for?

Source	Purpose				Max amount	Interest rate	Duration	Collateral requirement
	Investment	Consumption	Family events	Migration				
Government bank								
Village money lender								
Relatives								
Mother group								
SFDP								

7. Farm Household Survey: Other Sources of Income

Source	Input quantity	Input cost	Who earned	Where	Price/wage	Unit	Duration	Where	Total income
Hiring out oxen									
Hire out labor									
Employment									
Labor assistance received									
Rent out land									
Pension									
Total remittance income									
Senior citizen allowances									
Widow allowances									
Disability allowances									
Government transfers									
Gifts									
Interest from loan									
Other (specify)									

Sources of income with input costs

Source	Input quantity	Input cost	Who earned?	Where sold?	Price	Total income	Where?
Sales of handicraft							
Sale of beverages							
Other services (specify)							
Other business (specify)							

What durable commodities and implements does the household have?

Household assets	Number	Current value (in Rs.)
Property elsewhere (specify)		
Vehicle (specify)		
Radio/cassette player		
Wrist watch		
Bio-gas plant		
Jwellery		
Furniture		
Utensils		
Other (specify)		

Over the last 8-10 years, have the living conditions of the household:
Improved_____ Been stable _____ Worsened
If changed, what are the reasons for the change? _____

8. Farm Household Survey: Expenditure on Farm Inputs (2002)

Item	Quantity	Own production	Purchased	Price	Unit	Total expenditure	Where bought	Source of money
Seed paddy								
Seed wheat								
Seed maize								
Seed millet								
Seed soya bean								
Seed lentil								
Fertilizer, UREA								
Fertilizer, DAP								
Herbicide								
Pesticide								
Tools/equipment								
Manure								
Own oxen								
Hired oxen								
Animal feed								
Animal salt								
Animal medicine								
Animal bought								
Hired labor (male)								
Hired labor (female)								
Other (specify)								

Where bought: 1=neighbor, 2= local market, 3=distant market, 4=trader visiting village; **Source of money:** 1=own money, 2= borrowed (credit)

9. Farm Household Survey: Time Preferences and Risk

HHN_____

If you receive Rs. 500 today, how would you distribute this amount over the following expenditure items?

Expenditure Item	Amount spent	Percentage share
Buy fertilizer		
Buy other inputs		
Buy farm equipment		
Buy livestock		
Hire in labor		
Invest in small business		
Buy food		
Pay family events		
Buy house equipment		
Soil conservation		
Finance education		
Save money		
Pay back credit		
Buy firewood or other energy		
Other (specify)		

Time preferences: if you have the choice between receiving Rs. 100 one year into the future (with certainty) and another amount today, how large would that amount today have to be for you to prefer than amount today or prefer to wait for the Rs. 100 in a year?

Amount today	Prefer next day	Amount in one year
10		100
15		100
.		100
.		100
95		100
100		100

If you received Rs. 50 today, what would you use the money for?

	Tick	Budget	Husband	Budget	Wife
Consumption, what?					
Investment, what					
Savings, for what?					
Pay back credit					
Other (specify)					

Do you expect next year's income will be: Higher___Same____Lower____ than the 2002 year income?
If higher/lower, how much higher/lower:
0-25%_____25-50%_____ 50-75%_____more than 75%_____

If you use Rs. 100 today in business, to how much do you think it would grow in one year from now? Rs_____
Which type of activity? _____
How many mandays of work do you expect to invest to achieve this? _____ mandays

How well does the farmer understand these hypothetical questions?

	Wife	Husband
Very well		
Good		
Poor		

10. Farm Household Survey: Risk

HHN_____

Risk exposure: indicate the factors that lead to major changes in your farm households wealth or income

	Level of risk (mark one)			Major consequences of risk (mark only one)			
Risk factor	Low	Medium	High	Production	Input use	Labor use	Consumption
Price of paddy							
Price of fertilizer							
Price of other inputs							
Off-farm wages							
Taxes or fees							
Type of weather/rainfall							
Floods							
Soil erosion							
Animal disease							
Other (specify)							

Response to prices: How would you react to (a) Rs. 20 decline in paddy price (per Muri)? (b) Rs. 20 rise in fertilizer prices (per kg)?

	Response to a Rs. 20 decline in paddy price			Response to a Rs. 20 rise in fertilizer price		
Type of adjustment	Less	Equal	More	Less	Equal	More
Cultivated rice area						
Cultivated annual crop area						
Cultivated vegetable area						
Fallow/wasteland area						
Fertilizer use						
Manure use						
Labor use						
Irrigation						
Green manure planting						
Off and non-farm wage labor						
Other (specify)						

11. Farm Household Survey: Market Characteristics

HHN_____

11.1 Land and Land rental Market

Did you sell land during the last 8-10 years? Yes_____ No_____

If yes, why? _____Frequency_____

If no, why? _____

Did you buy land during the last 8-10 years? Yes_____ No_____

If yes, why? _____Frequency_____

If no, why?_____

Is there any difference in selling and buying prices of the same land? Yes____ No_____

If yes, why? _____

Have you rented in or out the land over the last 3 years? Yes _____ No_____

If yes, fill the following?

Number of plots	2000	2001	2002
Rented in			
Rented out			

Are you interested in renting out some more of your land? Yes _____ No_____

If yes, why?_____

If no, why don't you do that?_____

How much more land would you rent out?_____

Are you interested in renting in some more land? Yes_____ No_____
If yes, why?_____
If no, why don't you do it?_____
How much more land would you like to rent in?_____
What is the current price or standard contract conditions in land rental market?
_____

What are the major problems of land rental market?
_____

11.2 Livestock sale and rental market
Did you sell livestock during the last 8-10 years? Yes_____ No_____
If yes, fill the following:

Type of livestock	When	Price per unit	Total income	Where
Oxen				
Cow				
Buffalo				
..				
Other (specify)				

Is there any difference between livestock selling and buying prices? Yes_____ No_____
If yes, why?_____
If no, why?_____
Have you rented in or out livestock over the last 3 years? Yes_____ No_____
If yes, fill the following:

Type of livestock	When	With whom	Total income	Where
Oxen				
Cow				
Buffalo				
..				
Other (specify)				

Are you interested in renting in your livestock more than your did? Yes_____ No_____
If yes, why?_____
If no, why?_____
Did you also rent in land with the same household with whom you rented in livestock? Yes_____ No_____
If yes, why?_____

Are you interested in renting out your livestock more than your did? Yes_____ No_____
If yes, why?_____
If no, why?_____

11.3 Credit market
What are the main sources of credit in your village?
Banks_____ Village money lender_____
Formal credit institutions_____ Friends_____
SFDP_____ Relatives_____

Is there rationing in the credit market?_____
Is there segmentation in the credit market?_____
Do you take credit in kind? Yes_____ No_____
If yes what is the most common?_____

If you do not take credit, state the reasons for this:

Reasons	(Can be more than one)
Have enough cash from other sources of income	
Afraid of risk of repayment problems	
Interest rate is too high	
Can't provide collateral	
No credit available	
No credit available for the purpose I need	
Other (specify)	

Are you satisfied with the credits you obtained? Yes_____ No_____
If no, fill the following table:

Source	Reasons for dissatisfaction			
	Not enough amount	Collateral requirement is too high	Interest rate is too high	Other (specify)

11.4 Output market

Where do you sell the surplus farm output?
Local market_____Distant market_____To villagers_____Traders visiting village_____
Is there price difference when you sell or buy the output? Yes_____ No_____
If yes, how much and why? _____

Give the following information, if you have bought or sold the farm output?

Output	Selling price	Buying price	Reason for the difference
Paddy			
Maize			
Millet			
Wheat			
Potato			
Beans			
Lentil			
Other (specify)			

11.5 Labor market

What are the main activities in agriculture that the household uses labor?
_____
_____
_____
Is the labor available in the household enough for farm labor? Yes_____ No_____
If not, how do you manage it?_____
If not, state the unit of hired labor used in year 2002 for farming? _____mandays
Is there any difference between the wages of hiring out and hiring in labor? Yes_____No_____
If yes, why?_____
If yes; state hiring in wage_____ and hiring out wage_____
Is there any search cost of labor such as time to find labor? _____
If yes, state the extra time spent on searching labor?_____
Are there transaction costs in labor market such as going to the job? _____
Do you need to spend time to monitor hired labor if used? Yes_____ No_____
If yes, how do you do it?_____
Is it difficult to get farm labor? Yes_____ No_____
If yes, why?_____

Is there any difference between the wages of male and female labor? Yes_____ No_____
If yes, what are the reasons for this?
If yes, please state the wage rates (in Rs.): Male_____ Female_____
Do you think that both male and female labor have equal access to farm labor? Yes_____ No_____
If no, why?_____
Do you think that both male and female labor have equal access to off-farm labor? Yes _____No_____
If no, why? _____

12. Farm Household Survey: Plot Level Information

HHN_____

A: Plot ownership, and type of contract

Plot No.	Owned plot (2002)	Distance from home (in minutes)	Rented in (out) plots			Reasons for renting in (out)			Share of plot unsuitable for cropping			Use of degraded plots/areas	Type of contract		
			2000	2001	2002	2000	2001	2002	2000	2001	2002		Share tenancy	Fixed rent	Duration
1															
2															
3															
4															
5															
6															

Reasons for renting out: 1=lack of labor, 2= lack of oxen, 3=unable to rent oxen, 4=lack of cash, 5=credit obligation, 5=other (specify);
Reasons for renting in: 1=sufficient household labor, 2= more unit of oxen, 3=able to rent oxen, 4=lack of enough land, 5=lack other jobs, 5=other (specify);
Share tenancy: state the share of output between landlord and tenant; **Fixed rent:** state the amount; **Duration:** the period for which contract is done.

B: Land quality variables and conservation

Plot No.	Soil type	Soil depth	Slope	Land quality	Susceptibility to erosion	Degree of soil degradation	Type of conservation	No. of tree planted for	Changes in last three years			Reasons for change	Quality of constructions
									Construction structure	Land quality	Yields		
1													
2													
3													
4													
5													

Soil type: 1=red, 2= black, 3= gray, 4=other (specify); **Soil depth:** 1=shallow (<30cm), 2=medium (30-60 cm), 3=deep (>60cm);
Slope: 1=flat, 2=foothill, 3=midhill, 4=steephill; **Land quality:** 1=poor, 2=medium, 3=good; **Susceptibility to erosion:** 1=high, 2=medium, 3=low, 4=none;
Degree of soil degradation: 1=highly degraded, 2=degraded, 3=moderately degraded, 4=no degraded
Changes in conservation structures: 1=improved, 0=no change, -1=removed or reduced quality;
Changes in land quality: 1=improved quality, 0=no change, -1= worsened land quality;
Changes in yields: 1=increased yields, 0=no yield change, -1=reduced yields;
Quality of conservation structures: 0=poor, 1=medium, 2= good

C: Plot level inputs and output information

Plot size and inputs	Unit	Plot 1			Plot 2			Plot 3		
		Crop 1	Crop 2	Crop 3	Crop 1	Crop 2	Crop 3	Crop1	Crop 2	Crop 3
Plot size	Ropani									
Crops grown (2002)										
Area planted	Ropani									
Crop output	Kg									
Seed (own)	Kg									
Seed (purchased)	Kg									
Manure (own)	Kg									
Manure (purchased)	Kg									
Fertilizer	Kg									
No. of ploughing										
No. of Weeding										
Labor (own-male)	Hour									
Labor (own-female)	Hour									
Labor (hired-male)	Hour									
Labor (hired-female)	Hour									
Labor (exchange-male)	Hour									
Labor (exchange-female)	Hour									
Oxen used –own	Hour									
Oxen used-hired	Hour									
Oxen used-exchange	Hour									
Pesticides	Kg									
Insecticides	Kg									

Crop: 1=paddy, 2=maize, 3=wheat, 4=millet, 5=barley, 6=potato, 7=beans, 8=other (specify)

Note 1: that labor is used for activities like nursery, fertilizing, land preparation, apply manure, transplanting, weeding, pest management, irrigation, harvesting, transporting, marketing, water management, threshing, manuring.
Note 2: we need another copy of this page if the household has more than 3 plots.

D: Detail information about crop production in each plot (crop rotation)
HHN_____ Plot No. _____ Plot size (in Ropani)_____
Plot ownership status: Owned_____ Rented in_____
If rented in, give details:
Name of the owner_____ VDC_____ Ward No._____ Name of the village_____
How is the fertility status of the plot? Increasing _____Decreasing_____Constant_____Don't know_____
Land type: Irrigated Khet_____ Unirrigated Khet_____ Bari_____ Other_____

Month	Input Activity	Quantity		Yield of the crop (write it at the end of the crop rotation month)
		Own	Purchased	
Baisakh				
Chaitra				

Note: use this page separately for each plot. This table should be longer than this.

Final Remarks

By Enumerator

General impressions of the interview

	Good	Reasonable	Fair	Poor	Remarks
Willingness to reply					
Accurate answers					
Time used					

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Jeetendra Prakash Aryal was born at Purana Jhanga Jholi in Sindhuli, Nepal in 1968 and later on, resided in Kirtipur, Kathmandu. He holds a Master degree in Economics from Tribhuvan University, Nepal in 1994 and M.Sc. degree in Development and Resource Economics from Agricultural University of Norway, Norway in 2002.

The dissertation investigates the issues related to land tenancy transactions, land productivity and land related investment with a due focus on caste discrimination in the Nepalese rural society. This study also explores the potential interlinkages between land and livestock rental markets in rural Nepal. This dissertation comprises of an introduction and four independent papers. All the papers were based on the data collected in 2003 from the Western region of Nepal. Paper I assesses the caste-related land productivity differential in rural Nepal and its possible explanations. The analysis showed that low-caste households have higher land productivity as compared to high-caste households both on owner operated plots and rented in plots. The major reason behind this can be the concentration of their labor in small farms as they have lower access to regular off-farm income due to caste discrimination, low education/skills, lack of family networks and stronger subsistence constraints. Paper II examines jointly the existence of Marshallian inefficiency in sharecropping, allocative inefficiency of land tenancy transactions and an inverse farm size-productivity relationship and how these phenomena are associated with caste discrimination in Nepal. The analysis revealed that inefficiency of land tenancy transactions and caste discrimination are the major causes of inverse relationship. Paper III examined the factors that drive livestock rental market participation of the farm households in rural Nepal. Results show that differences in resource endowments and in the access to factor markets between low-caste and high-caste households as the important reasons for the emergence of the livestock rental market. Paper IV assesses if the investment and intensity of production differ between high-caste and low-caste households. This paper relates caste issue with poverty as low-caste households are poor both in terms of income and land asset. The paper analyzes the differences in short-term investments in terms of fertilizer use and manure use as well as more long-term investments in terms of terrace maintenance expenditure and intensity of cropping. Results show that there are differences in the likelihood to use manure and amount of fertilizer used between high-caste and low-caste households. Access to off-farm employment is found to have significant negative effect on land conservation investment.

Professor Stein T. Holden was Jeetendra's advisor.

Jeetendra was a lecturer at the Central Department of Economics, Tribhuvan University when he joined his studies in this Department.

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