Caste and Land Productivity in Rural Nepal

Jeetendra P. Aryal and Stein T. Holden
Department of Economics and Resource Management
Norwegian University of Life Sciences (UMB),
P.O. Box 5003, N-1432 Ås, Norway

Abstract

This paper assessed the caste-related land productivity differential and its explanations in rural Nepal combining non-parametric and parametric methods using household plot panel data. The non-parametric methods showed that low-caste have higher land productivity as compared to high-caste households. The productivity differential was reduced when controlling for land quality but still remained significant. It was further reduced when controlling for household endowments. When analyzing rented in plots and owner-operated plots separately, the productivity differential was larger on rented-in plots than on owner-operated plots and the productivity differential became insignificant after controlling for both plot and household characteristics on owner-operated plots.

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

1. Introduction

Nepal is a young democratic republic and a secular nation. Its governance was however highly influenced by caste system before 2007 as it was a Hindu Kingdom. The caste system which prevails in Hindu religion divides people into vertical hierarchies with *Brahmin*[1]*s* on the top, *Chhetries*[2] in the second, *Baishyas*[3] in the third and *Sudras*[4] *(Dalits)* at the lowest rank. As a person attains caste position by birth, there is no way to move upward by any other means such as acquiring higher education or earning higher level of income. Even though the recent constitution of Nepal protects everyone from discrimination on the basis of caste, this provision

[1] *Brahmins* refer to highest caste group in Hindus. They are priests and are allowed to perform religious activities
[2] *Chhetries* refer to Second highest caste group in Hindus. They are warrior and rule the nation.
[3] *Baishyas* refer to third highest caste group in Hindus. Their main occupation is business or trade
[4] *Sudras* refer to the lowest caste group (*Dalits*) in Hindus. Their main occupations include cleaning, tailoring, farm labor etc. Other high castes groups do not eat any cooked food touched by them. They are considered as untouchables under the traditional and conservative Hindu caste system.

has not yet well implemented and the reality, especially in the rural areas, is far from what the constitutional provision states.

In spite of the fact that poverty cuts across all castes, *Dalits* belong mostly to the poorest of the poor in the society. Incidence of poverty is about 46 per cent for *Dalits* whereas it is only 18 per cent in case of high caste people (WB 2006). *Dalits* have been historically excluded from several aspects of the life, let alone the political participation and decision making opportunities'. The caste system in many ways institutionalized the process of exclusion(DFID and WB 2006). Several researches have considered that caste inequality as one of the major reasons behind the success of Maoist led armed struggle "The People's War" in Nepal (Murshed and Gates 2005).

In addition to caste differences, social diversity is also high in Nepal due to the existence of several ethnic groups belonging to the Tibeto-Burman and Indo-Aryan linguistic families (Pradhan and Shrestha 2005). According to national survey (2001), *Dalits* constitutes nearly 13 per cent of the total population in Nepal; of which 55 per cent reside in the *Hills*[5] region. The percentage of food deficit in this region is nearly 37 per cent(Gill 2003). Though some discrimination can be observed between other caste groups too, *Dalits* faces the most severe social discrimination (Bennett 2005). This can be observed if one closely looks at the rural society in Nepal.

In Nepal, high caste households control most of the fertile land and other economic resources (Pradhan and Shrestha 2005). This is mainly due to the fact that historically land ownership was closely and systematically associated with the caste hierarchy in Nepal (Dahal 1995). In Hindu society, differences in the average land holdings between high and low caste are not accidental but fundamental to the caste structure (Hazari and Kumar 2003). In Indian villages, caste might make a difference in leasing behavior (Bliss and Stern 1982) and high cast households are found to be more active participant in the land lease market as both suppliers and demanders of land(Skoufias 1995). Moreover, *Dalits* have been systematically deprived of several social and economic opportunities due to the practice of untouchability. The detail discourse related to caste system is however beyond the scope of this paper. Therefore, we divide all castes into two major

[5]Ecologically Nepal can be divided into three regions- *Mountain*, *Hills* and *Terai*. *Mountain* region covers area above 4870 meter above sea level. *Hill* region ranges from 610 meters to 4870 meter above sea level and this region covers about 10 per cent of arable land in Nepal. *Terai* region covers the flat land in the southern Nepal.

groups – high castes and low castes. In this division, high caste (H) comprises all castes except the *Dalits*, while the low caste (L) includes all those falling under *Dalits*. For the analytical purpose of this paper, we assume that the division is appropriate because the gap between high and low caste groups with regard to access and ownership of resources is very wide.

A recent study (Khatri-chhetri and Maharjan 2006) carried out in Nepal found that the resource distribution is highly favorable to high caste and thus both depth and severity of food insecurity is higher among low caste people as compared to high castes. Low caste people have much lower life expectancy, literacy rates, and years of schooling; and per capita income than the high caste. For instance, the percentage of population having higher education among *Dalits* is less than 1 per cent, while it is much higher in case of high caste groups (Gurung 2005). Still, in rural areas ploughing is considered as inferior job and is only performed by low caste. High caste household rarely perform this. Caste differences highly influence the participation in the labor market. High caste households do not work as a labor in low caste's households whereas majority of low caste households work as agricultural/household labor in the high castes' households. Similarly, the participation in other occupational jobs such as shoemaking, iron-works and tailoring are also considered as works to be carried out by low castes only. This may have contributed to labor market imperfections in rural areas.

In this backdrop, the implication of caste differences on land productivity may be critical in a country like Nepal, where caste differences, especially between high and low caste plays important role in distribution of and access to resources. This study therefore focuses on whether caste affects land productivity in rural Nepal.

Most of the past studies on land productivity focused on the application of physical inputs and farm characteristics. Recent studies (Holden, Shiferaw and Pender 2001; Kassie and Holden 2007) undertaken in rural areas of developing countries have focused on imperfections in factor markets while studying land productivity. Studies (Holden and Bezabih 2009; Udry 1996) on gender and land productivity have shown how the weaker position of women with regards to land rights and land related decisions affect land productivity. However, none of the studies so far have focused on the implications of caste differences on land productivity given that low caste has weaker position in society.

One of the major contributions of this paper is that this is the first empirical study assessing the impact of caste differential on land productivity. Secondly, this study tries to apply both parametric and nonparametric tools while carrying out econometric analysis.

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

2. Theoretical Framework

Consider that all households in the study area can be separated into two major caste groups as high caste (H) and low caste (L) i.e. $C = \{H, L\}$. For simplicity, consider only access to land and land rental market by these caste groups. The land ($\bar{A}$) distribution function can be expressed as:

$$\bar{A} = \bar{A}(C) \text{ and } \frac{\partial \bar{A}}{\partial C} > 0$$

Assume that high caste households have skilled labor (l^s), while low caste households possess only unskilled labor (l^u) and therefore, $\bar{l} = \{l^s, l^u\}$ and $\bar{l}_c = \{l^s(C), l^u(C)\}$

$$l^s = l^s(C) \quad ; \quad \frac{\partial l^s}{\partial C} < 0 \; ; \; \frac{\partial l^u}{\partial C} > 0$$

For simplicity, assume that both skilled and unskilled labors are equally productive in farming. Though casual labor market is active, there are labor market imperfections and thus hired labor is not a perfect substitute for the family labor. There are supervision costs for hired labor, which is given by: $-(\omega^a + \tau^a) l_h^u$ .There is search cost in the off-farm labor market. Search cost may not be constant rate per hour worked off-farm. Rather it is an initial cost. But there may be some traveling involved in off-farm work and such costs can be formulated as: $+(\omega^o - \tau^o) l_o^s$

The access to off-farm labor market can be stated as: $l_o \leq \bar{l}_o(C)$; $\frac{\partial \bar{l}^S}{\partial C} < 0$ where l_o is off-farm labor involvement and $\bar{l}_o$ is off-farm labor access, which is mainly defined by caste.

The total time endowments of a household for skilled labor (T^s) and unskilled labor (T^u) can be defined as: $T^s = l_o^s + l_a^s + l_e^s$ and $T^u = l_o^u + l_a^u + l_e^u$ where l_o^s, l_a^s and l_e^s refer to skilled labor allocated to off-farm, farm and leisure respectively.

Under this, a farm household maximizes utility function: $U = U(Y, l_e^s, l_e^u)$ subject to *Y*, the net income from both agricultural production and off-farm work. Utility function is assumed to be concave and thus $U_Y > 0, U_{l_e} > 0, U_{YY} < 0$ and $U_{l_e l_e} < 0$.

In agricultural production, the household uses two inputs, land (*A*) and labor (l_a). The amount of 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}). The production function is: $q = q(l, A)$; $q_l > 0$, $q_A > 0$, $q_{ll} < 0$ and $q_{AA} < 0$. Assuming constant returns to scale, we can express production function in terms of farm productivity, $q = q(l)A$ where $q(l)$ refers to farm productivity.

Based on these concepts, we develop following models:

1. Model with imperfect labor market and missing land market.
2. Model with land rental market (sharecropping) and missing agricultural labor market.
3. Model with imperfect labor market and land rental market (sharecropping).

Each model has two cases: for high caste households (*H*) and for low caste households (*L*)

Model 1: Model with imperfect labor market and no land market

Case 1: For high caste households (H)

The utility function is: $U = U(Y, l_e)$

The income constraint is: $Y = p_q\, q(l_a^f + l_a^h)\bar{A} + l_o^S(\omega^o - \tau^o) - l_a^h(\omega^a + \tau^a)\,\bar{A}$

Assuming skilled and unskilled labor equally productive in farming and corner solution:

$$T = T^s + T^u = \bar{A} l_a^f + \bar{l}_o^s + l_e;\ l_a = l_a^f + l_a^h;\ l_a \geq 0;\ l_o \geq 0,\ l_o^s \leq \overline{l_o^s}$$

By substitution, we can express utility function as:

$$\underset{\{l_a^f, l_a^h\}}{Max}\ U = U\left[p_q q(l_a^f + l_a^h)\bar{A} + \bar{l}_o^S(\omega^o - \tau^o) - l_a^h(\omega^a + \tau^a)\bar{A}; T - \bar{l}_o^S - l_a^f \bar{A} \right]$$

Solving for first order conditions, we obtain: $\omega^*(H) = \dfrac{\partial U / \partial l_e}{\partial U / \partial Y} = \omega^a + \tau^a$

Case 2: For low caste households (L)

Assume that land-poor low caste households can hire out agricultural labor to high caste households. Therefore, they maximize: $U = U(Y, l_e)$ subject to

$$Y = p_q q(l_a^f)\bar{A} + l_o^f(\omega^a - \tau^a) \quad \text{and} \quad T = l_a^f \bar{A} - l_o^f + l_e$$

By substitution, the utility function becomes:

$$\underset{\{l_a^f, l_o^f\}}{Max}\ U = U\left[p_q q(l_a^f)\bar{A} + l_o^f(\omega^a - \tau^a); T - l_a^f \bar{A} - l_o^f \right]$$

Solving for the first order conditions, we get: $\omega^*(L) = \dfrac{\partial U / \partial l_e}{\partial U / \partial Y} = \omega^a - \tau^a$

From case 1 and case 2, $\omega^*(L) < \omega^*(H)$ if $\tau^a > 0$.

Comparing the high caste and the low caste households with respect to marginal return to labor, we got that shadow price of labor 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 same. Households, neither hiring out nor hiring in labor (inside price band) should have land productivity somewhere between those hiring in and hiring out labor because $\omega^a - \tau^a < \omega^* < \omega^a + \tau^a$.

In order to find out how the application of family labor in farming varies with the change in exogenous variables, we carried out comparative statics for both cases. For this we applied the concept of Bordered Hessian determinant and Crammer's rule (Silberberg and Suen 2001). The results of the comparative statics are summarized in the table 1 below.

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

Comparative statics	Low caste	High caste
Change in agricultural family labor due to change in farm wage	$dl_a^f / d\omega^a < 0$	$dl_a^f / d\omega^a > 0$
Change in agricultural family labor due to change in transaction cost of agricultural labor market	$dl_a^f / d\tau^a > 0$	$dl_a^f / d\tau^a > 0$
Change in agricultural family labor due to change total time endowment of the HH	$dl_a^f / dT = 0$	$dl_a^f / dT > 0$
Change in agricultural family labor due to change in price of output	$dl_a^f / dp_q > 0$	$dl_a^f / dp_q > 0$
Change in agricultural labor supply due to change in farm wage	$dl_o^f / d\omega^a < 0$	NA
Change in agricultural family labor due to change in off-farm wage	NA	$dl_a^f / d\omega^o < 0$
Change in agricultural family labor due to change in transaction cost in off-farm labor market	NA	$dl_a^f / d\tau^o > 0$

Note: See appendix 1 for detail derivation of comparative statics; NA refers to not applicable

Model 2: Sharecropping with Marshallian inefficiency and missing agricultural labor market

For this model we assume: 1) Uniform land quality 2) High caste people have larger farms, better access to off-farm skilled employment, and lack farm labor but can sharecrop out their land. 3) Low caste people have small farm size, no access to off-farm employment but can rent in land through sharecropping arrangement with high-caste households and 4)There are constant returns to scale in agricultural production such that: $q(A,l_a)=q(l_a).A$

Case 1: For High caste households (H)

The household maximizes the utility function: $\underset{\{l_a,\, A^{ro}\}}{Max} \quad U=U(Y,l_e)$ subject to

$$Y=p_q\, q(l_a)(\overline{A}-A^{ro})+(1-\alpha)p_q\, q^{ro}\, A^{ro}+\overline{l}_o^s(\omega^o-\tau^o) \text{ and}$$

$$T=l_a(\overline{A}-A^{ro})+\overline{l}_o^s+l_e$$

Assuming expected constant return: $E(q^t)=q^t=q^{ro}$ Substituting these into objective function,

$$\underset{\{l_a,\, A^{ro}\}}{Max} \quad U=U\left[p_q\, q(l_a)(\overline{A}-A^{ro})+(1-\alpha)p_q\, q^{ro}\, A^{ro}+\overline{l}_o^s(\omega^o-\tau^o);T-\overline{l}_o^s-l_a(\overline{A}-A^{ro})\right]$$

Now solving for the first order conditions, we get

$$\omega^*=\frac{\partial U/\partial l_e}{\partial U/\partial Y}=p_q\frac{\partial q}{\partial l_a}$$

Comparative statics with respect to $\omega^o,\tau^o,$ and T are summarized in table 2 below.

Table 2 Summary of comparative statics for high caste households (Analytical solutions)

Change in agricultural family labor due to change in off-farm wage	$dl_a^f/d\omega^o<0$
Change in agricultural family labor due to change in transaction cost in off-farm market	$dl_a^f/d\tau^o>0$
Change in agricultural family labor due to change total time endowment of the HH	$dl_a^f/dT=0$
Change in agricultural family labor due to change in price of output	$dl_a^f/dp_q=?$

Note: See appendix 2 for detail derivation of comparative statics

Case2: For low caste households (L)

The low caste household maximizes the utility function: $U=U(Y,l_e)$ subject to

$$Y=p_q\, q(l_a^a)\overline{A}+\alpha\, p_q\, q(l_a^{ri})\, A^{ri} \quad \text{(assume that } A^{ri} \text{ could be constrained)}$$

$$T=l_a^a\,\overline{A}+l_a^{ri}\, A^{ri}+l_e$$

By substitution, the utility function of the household becomes

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

Solving for the first order conditions yield

$$\frac{\partial q}{\partial l_a^a} = \alpha \frac{\partial q}{\partial l_a^{ri}} \quad \Rightarrow \alpha\, p_q\, q(l_a^{ri}) = \omega^*\, l_a^{ri}$$

We can carry out comparative statics for this model with respect to $\alpha, p_q, \overline{A}, T$ and A^{ri}. For simplicity, we assume A^{ri} as constrained while carrying out comparative statics. In many cases, it is realistic because tenants are often rationed in the sharecropping market. It also has some implication to threat of eviction. The results of this model imply:

1. Low caste (tenant) households have higher land productivity on their own land than on rented-in land.
2. High caste (landlord) households have the same net return on owner-operated land as on their rented out land:
$$p_q q(l_a) - \frac{\partial U/\partial l_e}{\partial U/\partial Y} l_a = (1-\alpha)\, p_q q^t \quad \Rightarrow p_q q(l_a) - \omega^*(H) l_a = (1-\alpha)\, p_q q^t$$
3. Since for low caste (tenant) households: $\alpha\, p_q\, q(l_a^{ri}) = \frac{\partial U/\partial l_e}{\partial U/\partial Y} l_a^{ri} = \omega^*(L)\, l_a^{ri}$

In this case, though bordered Hessian determinant is positive (that means unique solution exists), the comparative statics are quite complex to deal algebraically. For this reason, we go for empirical estimation based on the generalization we got from these theoretical models.

Model 3: Imperfect labor market and share cropping

Case 1: For high caste households (H)

$$\underset{\{l_a^f, l_a^h, A^{ro}\}}{Max} \; U = U(Y, l_e^u, l_e^s) \quad \text{subject to}$$

$$Y = p_q\, q(l_a^f + l_a^h)(\overline{A} - A^{ro}) + (1-\alpha)\, p_q q^{ro} A^{ro} + \overline{l}_o^s(\omega^o - \tau^o) - l_a^h(\omega^a + \tau^a)(\overline{A} - A^{ro})$$

$$T = l_a^f(\overline{A} - A^{ro}) + \overline{l}_o^s + l_e$$

By substitution, the utility function can be written as:

$$U = U\left[\, p_q\, q(l_a^f + l_a^h)(\overline{A} - A^{ro}) + (1-\alpha)\, p_q q^{ro} A^{ro} + \overline{l}_o^s(\omega^o - \tau^o) - l_a^h(\omega^a + \tau^a)(\overline{A} - A^{ro}); T - l_a^f(\overline{A} - A^{ro}) - \overline{l}_o^s \,\right]$$

Solving for the first order conditions gives: $\omega^*(H) = \frac{\partial U/\partial l_e}{\partial U/\partial Y} = \omega^a + \tau^a$

Case2: For low caste households (L)

$$\underset{\{l_a^f,\, l_a^{ri}, l_o^f\}}{Max}\; U = U(Y, l_e^u) \quad \text{subject to}$$

$$Y = p_q\, q(l_a^f)\,\overline{A} + \alpha\, p_q\, q(l_a^{ri}) A^{ri} + l_o^f(\omega^a - \tau^a) \text{ and } T = l_a^f\,\overline{A} + l_a^{ri} A^{ri} + l_o^f + l_e$$

Hence, by substitution, the utility function becomes:

$$U = U\left[\, p_q\, q(l_a^f)\,\overline{A} + \alpha\, p_q\, q(l_a^{ri}) A^{ri} + l_o^f(\omega^a - \tau^a);\, T - l_a^f\,\overline{A} - l_a^{ri} A^{ri} - l_o^f \,\right]$$

Solving for the first order conditions, we get: $\omega^*(L) = \dfrac{\partial U/\partial l_e}{\partial U/\partial Y} = p_q \dfrac{\partial q}{\partial l_a^a} = \omega^a - \tau^a$

Note that we also obtain: $\omega^* = \dfrac{\partial U/\partial l_e}{\partial U/\partial Y} = \alpha\, p_q \dfrac{\partial q}{\partial l_a^{ri}}$

This is similar to the above result in case of own land. If it is own land $\alpha = 1$, then it makes no difference in general result. From this model, we observe that the shadow wage of labor for low caste household is less than the shadow wage of labor for high caste households.

$$\therefore \omega^*(H) > \omega^*(L) \quad \text{when } \tau^a > 0$$

Based on above theoretical analysis, we propose following testable hypotheses for this study.

H1: If low caste households are less productive on rented in land, they may still be more productive on their own land (Marshallian inefficiency).On the contrary, if they are pure tenants, they may be more productive in rented in land because they cultivate the land intensively in order to meet their subsistence requirement.

H2: If high caste households rent in good quality land and they have better input access, they may be more productive.

H3: If low caste households have limited access to credit and farm input markets, they may be less productive but it will depend on ability to substitute labor for other inputs.

H4: If low caste households have limited access in the land rental as well as labor market, they may invest more of their time on their own land and have high land productivity.

H5: Households with larger share of off-farm income in their total household income have lower land productivity because they have relatively less labor endowment and are less dependent on farming in order to satisfy their basic consumption needs. However, if viewed from the credit market imperfections perspective, it may go other way round because more remittance income will improve the liquidity situation of the household.

3. Study Area and Data

Data for this study were collected from 500 households in the Mardi watershed area of the western Nepal in 2003. Of the 500 households, this paper uses information from 489 households because the information from the remaining 11 sample households was discarded due to inconsistency. The data were collected both at household level and at the 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, and household preferences. The plot level data included the biophysical characteristics of the plot, plot trade information, input applied in the plot, crop and production at plot level. Therefore, at household level analysis the sample size is 489 households where as at the plot level analysis the sample size is 1131 plots operated by 489 households.

The altitude of this area ranges from 900m to 5000m above the sea level (Awasthi 2004).The settlements of the Mardi watershed are 15-45 km far from the district headquarter, Pokhara. Mardi watershed area has ridges of various aspects, hill slopes of varying degrees and the valley floors (Awasthi 2004; Thapa 1990). Hills and mountains higher than 1200m 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 starts in early June and lasts till mid-September.

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 crop in the valley is paddy while maize and millet are common in the terraced land. Farmers practice crop rotation system, growing one to three crops in a plot in a rotation 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.

Land is the main asset for the household in the study area. There are mainly two types of land: the farm land in the valley floor (locally called *Khet*) and the terraced land (locally called *Bari*). As this paper focused on the possible productivity differences between high caste and low caste households, table 3 presents the distribution of land ownership by caste.

Table 3 Ownership distribution of land by caste

Size of ownership land holding (in hectare)	High Caste HHs		Low Caste HHs		All Sample HHs	
	number	per cent	number	per cent	number	percent
Landless	11	2.88	32	29.91	43	8.79
up to 0.2	59	15.45	33	30.84	92	18.81
Greater than 0.2 & up to 0.5	172	45.03	34	31.78	206	42.13
Greater than 0.5 & up to 1	96	25.13	8	7.48	104	21.27
Greater than 1	44	11.52	0	0	44	9
Total	382	100	107	100	489	100

Of the total sampled households, 8.8 per cent are landless. Percentage of landless among high caste households is only 2.8 while it is almost 30 for low caste households. The interesting point to note is that none of the low caste households own more than one hectare of land. In the study area, the average size of land holding is small as it is the case in Asia (Otsuka 2007). Share tenancy is the common mode of land transfers from relatively land abundant households to households with little land. Land sales/purchase market is very thin. Despite imperfections, land rental market is the main way of acquiring land for the landless households. Table 4 presents the land rental market participation of the sample households by caste.

Table 4 Land market participation by caste

HH position	High Caste HHs		Low caste HHs		All sample HHs	
	number	per cent	number	per cent	number	percent
Nonparticipant	242	63.35	48	44.86	290	59.3
landlord	76	19.9	6	5.61	82	16.77
tenant	64	16.75	53	49.53	117	23.93
Total	382	100	107	100	489	100

Almost 59 per cent of the total sampled households do not participate in the land rental market. Nearly 50 per cent of the low caste households are tenants while it is about 17 per cent in case of high caste households. Land rental market participation has contributed to reducing the inequality in operational holding of land among sampled households. The value of gini coefficient for the ownership holding of land is 0.49 where as it is 0.42 for the operational holding of the land. Table 5 provides the distribution of operational land holding by caste. All sample households perform farming activities despite the differences in size of land holding.

Table 5 Operational distribution of land by caste

Size of Land holding(in hectare)	High Caste HHs		Low caste HHs		All sample HHs	
	number	per cent	number	per cent	number	percent
Up to 0.2	65	17.02	21	19.63	86	17.59
Greater than 0.2 & up to 0.5	183	47.91	68	63.55	251	51.33
Greater than 0.5 & up to 1	94	24.61	14	13.08	108	22.09
Greater than 1	40	10.47	4	3.74	44	9
Total	382	100	107	100	489	100

Table 6 present the information on the household characteristics by caste. Differences between high caste and low caste households are found to be highly significant in case of literate head, sex of the household head, ownership holding of land, operational land holding, farm income, remittance income and value of asset. However, if we consider the demographic composition of the household such as age of the household head, number of adult male in the household, number of adult female in the household, standard labor unit and standard consumer unit, there are no significant differences between them. The differences in some of these variables however need to be analyzed in relation to the land size.

Table 6 Major household characteristics variable by caste

Household Characteristics variables	High Caste	Low caste	All sample	t-test
Male head dummy (%)	20	65	30	-9.96***
Literate head (%)	35	19	31	3.25***
Age of household head (in year)	49.12	49.01	49.1	0.09
Ownership holding (in hectare)	0.54	0.17	0.46	7.28***
Operational holding (in hectare)	0.53	0.35	0.49	3.77***
Net land leased-in (in hectare)	-0.01	0.17	0.03	-4.96***
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
No. of oxen with household	0.76	0.92	0.79	-1.45
Farm income (in Rs.)	32034.98	15312.33	28375.83	5.57***
Remittance income (in Rs.)	20126.96	7504.67	17365.03	3.30***
Total income (in Rs.)	72360.29	40467.85	65381.78	6.08***
Value of asset (in Rs.)	38581.22	15360.29	34217.52	8.22***

Note: t-test shows the difference between high caste and low caste households

Table 7 presents the distribution of the major variables in relation to land size. It shows that differences between high caste and low caste are significant in all the variables included.

Table 7 Distribution of some variables per unit area by caste

Variables	High Caste	Low caste	All sample	t-test
Livestock holding per unit area	12.52	20.72	13.92	-3.26***
Value of asset per unit area	150753.50	72758.33	135721.20	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	-6.56***
Standard labor unit per unit area	13.92	35.87	17.66	-7.16***
Standard consumer unit per unit area	18.07	47.68	23.12	-7.24***

Note: t-test shows the difference between high caste and low caste households

High caste households possess fewer units of family labor per unit area, livestock holding per unit area and oxen holding per unit area as compared to the low caste household. This is also consistent with our theoretical framework that the low caste households possess more family labor per unit area and thus, they have lower shadow wage for family labor. The main reason behind it is that low caste households on the average possess smaller land area. The value of asset per unit area is higher in case of high caste household than in low castes.

4. Empirical Methods

Several econometric methods were applied in order to test whether caste affect the land productivity significantly. We applied both parametric and non-parametric techniques. Stochastic dominance analysis (SDA) and the 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 (Bekele 2005; Kassie and Holden 2007; Mas-Colell, Whinston and Green 1995). There are two criteria for comparing the stochastic dominance- first order stochastic dominance (FSD) criterion and second order stochastic dominance (SSD) criterion.

Given that $L(y)$ and $H(y)$ are cumulative distribution functions for low caste and high caste farm households respectively. FSD criterion assumes that households maximize expected utility and therefore, they prefer more to less. Hence, under FSD criterion, the distribution *L(y)* dominates *H(y)* if $H(y)-L(y)\geq 0,\ \forall_y \in \Re$, with strict inequality for some $y \in \Re$. It means the distribution with lower density function dominates the distribution with higher density function. In our case, then *L(y)* dominates *H(y)* if the CDF of yield for high caste *H(y)* is greater than the CDF of yields for low caste *L(y)* for all level of yields (Mas-Colell, Whinston and Green 1995). The FSD criterion fails to give decision if the graphs of 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 seems similar as in case of FSD. The distribution with larger area under CDF is dominated by the distribution with smaller area under the CDF. Hence, under SSD criterion, the distribution *L(y)* dominates *H(y)* if $\int_{-\infty}^{y}\left(H(y)-L(y)\right)dy \geq 0,\ \forall_y \in \Re$, 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, we used propensity score matching method and examined whether the data under study satisfy common support requirement(Becker and Ichino 2002; Holden and Bezabih 2009). Matching methods are used to estimate the average treatment effect based on propensity scores.

Propensity score matching provides a method to correct the estimation of treatment effects by controlling 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, matching method therefore summarizes pre-treatment characteristics of each subject into a single index variable, the propensity score (Becker and Ichino 2002). The propensity score is defined as the conditional probability of receiving a treatment given the pre-treatment characteristics(Rosenbaum and Rubin 1983):

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

Where, $D = \{0,1\}$ is the indicator variable representing exposure to treatment and **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 propensity score, the exposure to treatment is random and in general the treated and control groups should have identical observations. As propensity score can be estimated by using any standard probability model, we used binary logit model in this paper. The estimate of propensity score should satisfy the balancing property. The test of balancing property is restricted to the observations that satisfy common support.

Given that *p(X)* is a continuous variable, the probability of having two units with exactly the same value of the propensity score is zero and thus one has to accept some distances between treated and control units. It implies that for estimating average effect of treatment on the treated (*ATT*), the estimation of propensity score alone is not sufficient. Hence, we used kernel matching and nearest neighbor matching methods in this paper. For details about these matching methods and their estimation in Stata, we refer to Becker and Ichino (2002).

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 we have 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 which may arise due to unobserved cluster effects (Udry 2000; Wooldridge 2002).

While estimating RE model, only those sample plots were considered for analyses which satisfy common support obtained after estimating propensity score matching models. This provides us 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}.

5. Results and Discussion

Stata version 10.1 was used to estimate all the empirical models in this paper.

5.1 Stochastic Dominance Analysis

Stochastic dominance analysis (SDA) was estimated for plots under different cultivation arrangement. Firstly, we estimated the yield difference between all sample plots (both owner operated and rented in plots) operated by high caste and low caste households (see figure-1). In figure-1, the cumulative distribution function (CDF) of yields for low caste households is always to the right of CDF of yield for high caste households. Since the distribution with lower density function dominates the distribution with higher density function, this implies that the land productivity in case of low caste households is higher than in case of high caste households. Secondly, we estimated if there was yield difference on the owner operated plots by caste (see figure-2). The figure-2 also confirms the same conclusion that land productivity is higher in case of low caste households. Stochastic dominance analyses were also carried out for the rented-in plots by caste (see figure -3) and this also confirms that land productivity is higher in case of low caste households. All of these CDF graphs showed that the land productivity is higher in case of low caste households.

5.2 Propensity Score and Matching Methods

We compared the land productivity of high caste and low caste households on all sample plots, owner-operated plots and on rented in plots separately. The summary of key results of Kernel matching methods and Nearest Neighbor matching are presented in Table 8. The results of the matching methods showed that land productivity is significantly higher for low caste households as compared to high caste ones.

Table 8 Caste and land productivity using propensity score matching

Variable	All plots		Owner-Operated plots		Rented in plots	
	Kernel Matching	Nearest Neighbor	Kernel Matching	Nearest Neighbor	Kernel Matching	Nearest Neighbor
Land Productivity						
Low caste	79574.27	79574.27	81834.46	81834.47	77193.85	77193.85
High caste	62390.04	62390.04	63783.15	63783.15	55040.56	55040.56
Difference	17184.23	17184.23	18051.31	18051.31	22153.29	22153.29
Bootstrapped std. Error	4007.25	4377.46	6601.92	6808.61	4358.46	4356.02
t-statistic	4.29***	3..93***	2.73***	2.65***	5.08***	5.08***
Number of observations						
Low caste	193	193	99	99	94	94
High caste	797	797	670	670	127	127

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

For all matching methods, we checked for whether the balancing property was satisfied under each case. The balancing property was satisfied in each case. It implies that inequality in plot quality might not be the culprit in the observed productivity difference between low caste and high caste households. In addition, we also carried out radius matching and stratification method (not reported here) and found that low caste households have higher land productivity.

5.3 Parametric Estimation Methods

We estimated the random effects regression models for all sample plots (see Table 9), for only rented in plots (see Table 10) and for owner operated plot (see Table 11)using observations which satisfy the common support requirement in propensity score matching models estimated before. Therefore, few observations are dropped because they do not satisfy the condition that common support equals to 1. All models are estimated with robust standard errors. Since a household can have more than one plot, we adjusted for clustering at household level in all models and number of household is then considered as different clusters (groups).

For all sample plots

Random effect models using all sample plots (Table 9) showed that caste is highly significant variable in explaining land productivity in the study area. However, when we introduced land quality variables, the size and significance level of caste dummy reduced. Likewise, introduction of household characteristics variables further reduced the size of the caste dummy.

We start with a simple model (Model1) estimating the relation between land productivity and caste, and introduced other variables sequentially in order to control for observed plot variant attributes and plot invariant farm household characteristics. Introduction of farm size (Model2) does not alter the relation between land productivity and caste. In this case, the variable farm size turned out to be insignificant.

We estimated Model 3 including the plot characteristics variables but without caste dummy and introduced the caste dummy in Model4 keeping same plot characteristics variables as in Model3. This did not affect the direction of relationship between land productivity and those variables which were significant in both of these models. However, the magnitudes of some significant variables were reduced with the introduction of caste dummy. In both cases, distance to plot has significant negative impacts on land productivity and is as per our a priori expectation because the farther the plots from the homestead the more difficult to manage it properly. In a hilly setting, farmers need more labor to carry inputs to the plot such as carrying farm yard manure and managing water tracts during high rainfall season. This implies that there are significant transaction costs.

Likewise, plots with steep slope are found to have significantly lower land productivity as compared to the reference group, the plots in flat area. Moreover, the plots with steep slope have higher soil erosion and thus soil depth is usually low leading to lower productivity. Similarly, soil type dummy for gray soil was significant throughout all models. The base category is the black soil, which the local farmers consider as the best soil and thus, we expected to have significant negative coefficient for all other soil type dummies. But none of the other soil type dummies were significant.

We estimated Model 5 including both plot characteristics and household characteristics variables but without caste dummy; and then estimated Model 6 with all the variables as in Model 5 including caste dummy. In both models, most of the variables which were significant in Model 3 and Model 4 were found to be significant except in case of soil 5 which turns out to be significant only at 10 per cent level of significance. Oxen holding are found to have significant positive effect on farm productivity. This is as per our expectation because there is no alternative way for tilling land without oxen power. The area on the one hand, has no good road access and on the other, even if there is road access, most of the farm plots are in hills with small narrow terraces limiting the use of tractors.

The endowment of household labor is found to have positive impact on land productivity. The variables, total number of adult male per unit land and total number of adult female per unit land are found to be significant at 1 per cent level of significance. This is as per our theoretical model because households with relatively more endowment of labor will allocate more labor in farming under the assumption of labor and land rental market imperfections. Primary logic of the theoretical model rests on this fact: as low cast households are labor rich and land poor relative to high caste households, they can have achieve higher land productivity. Empirical results support this logic pretty well.

In both models, increases in share of off-farm income in total income were found to have reduced the farm productivity significantly. In this case, we had no fixed a priori expectation and thus, it was left as an empirical question. The negative effect is possibly due to the fact that higher off-farm income implies taking more household labor out of farming and in a rural setting, where labor market imperfection is a rule rather than exception it can have negative impacts on farm productivity. The variable food requirement, which measures the food needs of the household (computed as the ratio of standard consumer unit divided by operational holding) is taken as a proxy for subsistence constraint. This variable has significant positive effect on land productivity and it shows that households facing harder subsistence constraint have more land productivity. This implies the poor may use the land intensively in order to cope with the situation of intense poverty (Pagiola and Holden 2001).

One of the most striking results of these models is that rented in land is found to have higher land productivity. This is found to be contrary to the other results obtained by other studies in South Asia. It is possible if the tenant households are land poor and labor rich households facing stricter subsistence constraint. Furthermore, it may be due to the fact that low caste households rent-in more land as nearly 50 per cent of low caste households are tenant households. Despite the fact that this result needs more scrutiny, one could not generalize that research in Asia support Marshallian inefficiency of share tenancy (Otsuka, Chuma and Hayami 1992).

For rented in plots only

Table 10 presents the results of random effects model estimated using only rented in plots. We estimated the similar models as in the previous analyses using same variables except tenure dummy, which is not feasible to include in this case. Under all specification of the model presented in Table 10, low caste households were found to have significantly higher land productivity in case of rented in plots. Even after controlling for land quality and household characteristics, caste dummy remains highly significant. It may be due to Marshallian inefficiency that ensues for high caste households, while low caste are driven more by subsistence constraint. Irrigation, number of crops grown per year, soil type and soil depth variables have similar effects as in previous model. Despite having same variables, some significant changes were found in the results. We therefore highlight more on only those results.

One of the interesting results is that in Model 2, plot size was found to be highly positively significant indicating some sign of economies of scale in case of larger plot. However, when we introduced other plot characteristics variables, this effect vanished completely. Distance to plot used to be highly significant previously, but now it is no more significant (though still has negative sign). It may be due to the fact that renting in plot is more influenced by other factors like labor endowment of the household, oxen holding and food requirement of the household rather than distance to plot from homestead.

Male headed household are found to have significantly higher land productivity on rented in plots, which was not significant when we estimated model using all sample plots (Table 9). It may be because those households who rent in land are mostly male headed households in the study area. Food requirement of the household, the number of adult female and male per unit land have significant positive impact on land productivity, which is in accordance with our theoretical expectation. The significant impact of household labor on land productivity indicates the labor market imperfections.

Interesting issue here is that share of off-farm income has significant positive effect at 10 per cent level of significance in Model 5 (it is not significant in Model 6, but still has positive sign), which is just opposite of what we found in previous analysis with all plots. It may be due to the fact that the households who rented in plots are poor households and have lower off-farm income. For households with limited liquidity at hand, increase in off-farm income may initially help to overcome financial constraint they face in purchasing variable inputs like chemical fertilizer. Predicted manure application at plot level is found highly significant in this model.

For owner operated plots only

Table 11 presents the results of this estimation. The interesting result is that land productivity differential between high caste and low caste households which were highly significant in both previous cases, became insignificant when we controlled for both land quality and household characteristics. In simple linear models (Model 1 and 2), the low cast dummy is highly significant. But, the level of significance dropped down to 10 per cent level once we introduced plot characteristics variables and when we introduced both plot and household characteristics variables together, the low caste dummy became insignificant. The implication of this result is that low caste households mostly own poor quality plots and therefore, when we introduce plot quality variables in the models only with owner operated plots, they seem to have less significant effect on land productivity. Furthermore, the difference in productivity is due to the relative endowment of labor, and thus caste dummy became insignificant as we introduced household characteristics variables in the model.

Dummies for crop rotation and irrigation have usual positive and significant impact on land productivity. The result also confirms that the farther the plot from homestead the lower the land productivity. Plots with low soil depth are found to have lower productivity. Therefore, most of the soil characteristics variables are found to have similar effects as in previous models.

The share of off-farm income in total income is found to have once again negative impact; however, it is not significant in Model 5. Food requirement or subsistence constraint is again significant here. Both variables indicating labor endowment of the household (the number of adult male and female per unit land) are positive sign and significant at 1 per cent level.

Household labor per unit area is significant in all models implying that labor market is imperfect. Hence, the labor rich households may apply more labor and obtain high land productivity. In the study area, most of the high caste people are engaged in other off-farm activities especially for jobs outside. Therefore, the family labor per farm size is less for high caste household as compared to low caste households in the study area (see table 5), which in turn may affect the land productivity negatively. High productivity in rented-in land may be due to the fact that poor low caste households rent-in more land as nearly 50 per cent of low caste households are tenant households (table 2). Poor low caste households may intensively use the land in order to cope with the situation of extreme poverty (Pagiola and Holden 2001).

Not only the availability of labor, but also the attitude towards farming matter for land productivity. High caste people consider farming as inferior work and they do not want to work as farm labor if they get any job outside. Still, working as a ploughman is considered as impure job and high caste people rarely perform it. This sort of segmentation or classification of work by caste might have reduced the average land productivity of high caste household despite their high level of asset holding.

6. Conclusion

This paper looked for the possible explanations for the land productivity differential between high caste and low caste farm households. We applied both parametric and nonparametric methods to test whether land productivity differs by caste position. Nonparametric methods applied showed that land productivity is higher among low caste households. We estimated random effects models separately for the owner operated plots, rented in plots and for all plots (including both owner operated and rented in plots together). In case of owner operated plots, the land productivity differential between low caste and high caste is found to be insignificant after controlling for land quality and household characteristics. However, this difference remains highly significant in case of rented in plots. In case of all plots, the land productivity difference between high caste and low caste remains significant, but the size of coefficient and significance level decreased when controlled for land quality and household characteristics.

As land productivity was measured as the total value product per unit area, number of cropping was one of the significant variables. Low caste households, who have more unit of family labor in relation to farm size, can apply their family labor for intensifying cultivation. This can be one of the logics for their higher land productivity. This was the basic hypothesis we have drawn from our theoretical model also. As hired labor requires both search and monitoring cost and it is difficult to monitor hired labor in spatially dispersed agricultural environments (Hayami and Otsuka 1993) and hence, family labor based low caste farmers are more productive.

Overall, in a rural setting where physical infrastructures are not well developed, the agricultural production system is primitive and thus do not apply inputs like tractors and advanced methods for crop production. The farmers in study area still use the primitive methods which require more human labor for each activity associated with farming such as tilling land, managing plots, applying manure and fertilizer, carrying inputs to plots, water management and harvesting. Therefore, all activities related to agriculture is labor demanding. In such a situation, low caste households with relatively more unit of labor per unit land can achieve higher land productivity. This reasoning resembles with the inverse farm size and productivity relationship as researches in south Asia demonstrated that small farmers are more productive because they face lower cost of labor than large farms (Bhalla 1979; Bhalla and Roy 1988a; Bhalla and Roy 1988b; Ellis 1993). This is however, an issue which is dealt in next paper.

Persistence of productivity differential even after the land rental market participation is an indication of significant transaction costs in the land rental market (Holden, Otsuka and Place 2009). Improvement of land rental market is thus an appropriate policy for poverty reduction and efficiency. Furthermore, land rental market help reduce productivity differential by increasing the access of the poor households to land. One way of improving land rental market is to design the policy in such a way that landlords do not hesitate to rent out land with a formal contract due to fear of losing full or partial ownership of land. In Nepal, the land-to-the-tiller policy existed as Land Reform Act was implemented in 1962. If the land holding size with a household is under the ceiling fixed by the government, that households should not face any insecurity while leasing out land. It is because migration of household members for outside jobs changes the land-labor ratio among farm households, which in turn requires the land rental market in order to equalize this. Administrative land relocation is not possible with the change in these factors and if done, it is costly and time consuming(Deininger, Jin and Nagarajan 2007) and thus, improving laws related to land rental market are essential for poverty reduction and efficiency enhancement.

Data for this study was collected during the period of Maoist war in Nepal. During that period, all sectors including agriculture was suffered from Maoist activities in the village because they have captured land of many high caste people who supported political parties other than Maoism. Still now, Maoists have not returned all of the captured land to many of the land owners. Due to the fear of Maoist war many male members of the high caste households have left the village because Maoists were brutal against those who do not support their political ideology. This may be the reason why low caste households are found to be more productive than that of high caste. However, the data in hand is not enough to dig out that issue and is rather an arena for future research.

Overall, caste position still plays a vital role in rural areas of Nepal and thus, such a study can help in making policies that affect the land productivity. On policy issue, the model suggests that reducing caste based inequality may improve the overall productivity in agriculture. We, both at central and local level, need to make policies to ensure social inclusion(DFID and WB 2006; WB 2006) and bringing low caste in the mainstream of development by improving their access to economic resources.

References

Awasthi, Keshav D. 2004. "Land Use Change Effects on Soil Degradation, Carbon and Nutrient Stocks and Greenhouse Gas Emission in Mountain Watersheds." in *Department of Plant and Environmental Sciences*. Aas: Agricultural University of Norway.

Becker, Sascha O., and Andrea Ichino. (2002). "Estimation of Average Treatment Effects Based on Propensity Scores." *The Stata Journal* **2**(**4**): 358-377.

Bekele, Wagayehu. (2005). "Stochastic Dominance Analysis of Soil and Water Conservation in Subsistence Crop Production in the Eastern Ethiopian Highlands: The Case of the Hunde-Lafto Area." *Environmental and Resource Economics* **32**: 533-550.

Bennett, Lynn. 2005. "Gender, Caste and Ethnic Exclusion in Nepal: Following the Policy Process from Analysis to Action." in *Arusha Conference "New Frontiers of Social Policy"*. Arusha.

Bhalla, S. S. 1979. "Farm Size Productivity and Technical Change in Indian Agriculture" In *Agrarian Structure and Productivity in Developing Countries*, Eds. R. A. Berry and W. C. Kline. Baltimore, MD: John Hopkins Press.

Bhalla, S. S., and P. Roy. (1988a). "Mis-specification in Farm Productivity Analysis: The Role of Land Quality." *Oxford Economic Paper* **40**: 55-73.

—. (1988b). "Misspecification in Farm Productivity Analysis: The Role of Land Quality." *Oxford Economic Papers* **40**: 55-73.

Bliss, C. J., and N.H. Stern. (1982). *Palanpur: The Economy of an Indian Village*. Delhi and New York: Oxford University Press.

Dahal, Dilli R. 1995. "Ethnic Couldron, Demography and Minority Politics: The Case of Nepal" In *States, Leadership and Politics of Nepal*, Ed. Dhruba Kumar. Kathmandu: Centre for Nepal and Asian Studies (CNAS).

Deininger, Klaus, Songqing Jin, and Hari K. Nagarajan. 2007. "Efficiency and Equity Impacts of Rural Land Rental Restrictions: Evidence from India." The World Bank, Development Research Group, Sustainable Rural and Urban Development Team, Policy Research Working Paper 4324.

DFID, and WB. 2006. "Unequal Citizens: Gender, Caste and Ethnic Exclusion in Nepal." Kathmandu: Department for International Development (DFID) and The World Bank (WB).

Ellis, F. (1993). *Peasant Economics: Farm Households and Agrarian Development*: Cambridge University Press.

Gill, Gerard J. 2003. "Seasonal Labour Migration in Rural Nepal: A Preliminary Overview." London: Overseas Development Institute, Working Paper 218.

Gurung, Harka. 2005. "Social Exclusion and Maoist Insurgency." in *National Dialogue Conference on ILO Convention 169 on Indigenous and Tribal Peoples*. Kathmandu.

Hayami, Y., and K. Otsuka. (1993). *The Economics of Contract Choice: An Agrarian Perspective*. Oxford: Oxford University Press.

Hazari, B. R., and A. Kumar. (2003). "Caste, Land and Livestock Holdings in India: An Analysis." *International Forestry Review* **5**(**4**): 364-369.

Holden, Stein T., and Mintewab Bezabih. 2009. "Gender and Land Productivity on Rented Land in Ethiopia" In *The emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency*, Eds. Stein T. Holden, Keijiro Otsuka, and Frank M. Place: Resources for the Future.

Holden, Stein T., Keijiro Otsuka, and Frank M. Place. 2009. "Understaning Land Markets" In *The emergence of Land Markets in Africa: Impacts on Poverty, Equity, and Efficiency*, Eds. Stein T. Holden, Keijiro Otsuka, and Frank M. Place: Resources for the Future.

Holden, Stein T., Bekele Shiferaw, and John Pender. (2001). "Market Imperfections and Land Productivity in the Ethiopian Highlands." *Journal of Agricultural Economics* **52**(**3**): 62-79.

Kassie, Menale, and Stein T. Holden. (2007). "Sharecropping Effficiency in Ethiopia: Threats of Eviction and Kinship." *Agricultural Economics* **37**(**2-3**): 179-188.

Khatri-chhetri, Arun, and K. L. Maharjan. (2006). "Food Insecurity and Coping Strategies in Rural Areas of Nepal: A Case Study of Dailekh District in Mid Western Development Region." *Journal of International Development and Cooperation* **12**(**2**): 22-45.

Mas-Colell, A., M. D. Whinston, and J. R. Green. (1995). *Microeconomic Theory*. New York: Oxford University Press.

Murshed, S. Mansoob, and Scott Gates. (2005). "Spatial-Horizontal Inequality and the Maoist Insurgency in Nepal." *Review of Development Economics* **9**: 121-134.

Otsuka, Keijiro. 2007. "Efficiency and Equity Effects of Land Markets" In *Handbook of Agricultural Economics*, Eds. Robert Evenson and Prabhu Pingali: Elsevier B. V. .

Otsuka, Keijiro, H. Chuma, and Y. Hayami. (1992). "Land and Labor Contracts in Agrarian Economies: Theories and Facts." *Journal of Economic Literature* **30**(**4**): 1965-2018.

Pagiola, S., and Stein T. Holden. 2001. "Farm Household Intensification Decisions and the Environment." In *Trade offs or Synergies? Agricultural Intensification, Economic Development and The Environment*, Eds. D. R. Lee and C. B. Barret. Wallingford, UK: CAB International.

Pradhan, R., and Ava Shrestha. 2005. "Ethnic and Caste Diversity: Implications for Development." in *NRM working paper (4)*: Asian Development Bank.

Rosenbaum, P. R., and D. B. Rubin. (1983). "The Central Role of the Propensity Score in Observational Studies for Causal Effects." *Biometrika* **70**(**1**): 41-55.

Silberberg, Eugene, and Wing Suen. (2001). *The Structure of Economics: A Mathematical Analysis*. Singapore: McGraw-Hill.

Skoufias, Emmanuel. (1995). "Household Resources, Transaction Costs, and Adjustment through Land Tenancy." *Land Economics* **71**(**1**): 42-56.

Thapa, G. B., and K. E. Weber. (1995). "Natural Resource Degradation in a Small Watershed in Nepal." *Natural Resource Forum* **19**(**4**): 290-298.

Thapa, Govinda Bahadur. 1990. "Integrated Watershed Management in the Upper Pokhara Valley." in *Asian Institute of Technology*. Bangkok.

Udry, C. (1996). "Gender, Agricultural Production and the Theory of the Household." *Journal of Political Economy* **104**(**6**): 1010-1046.

Udry, Christopher. 2000. "Gender, Agricultural Production, and the Theory of the Household" In *Readings in Development Economics: Empirical Microeconomics*, Eds. Pranab Bardhan and Christopher Udry. Cambridge, Massachuttes, London, England: The MIT Press.
WB. 2006. "Nepal-Resilience Amidst Conflict: An Assessemnt of Poverty in Nepal, 1995-96 and 2003-04." The World Bank.
Wooldridge, Jeffrey M. (2002). *Econometric Analysis of Cross Sectional and Panel Data*. London: MIT Press, Cambridge, Massachuttes, London, England.

Appendix-1

1. For High caste households

A. *Change in agricultural family labor (l_a^f) due to change in off-farm wage (ω^o)*

$$\frac{dl_a^f}{d\omega^o}=\frac{\frac{\partial^2 U}{\partial l_a^f \partial \omega^o}\frac{\partial^2 U}{\partial l_a^{h2}}-\left(-\frac{\partial^2 U}{\partial l_a^h \partial \omega^o}\right)\frac{\partial^2 U}{\partial l_a^f \partial l_a^h}}{|H|}=-\frac{\bar{l}_o^s\left(p_q\,\overline{A}\right)^2\frac{\partial q}{\partial l_a}\frac{\partial U}{\partial Y}\frac{\partial^2 U}{\partial Y^2}\frac{\partial^2 q}{\partial l_a^2}}{|H|}<0$$

B. *Change in agricultural family labor (l_a^f) due to change in transaction cost in off-farm labor market (τ^o)*

$$\frac{dl_a^f}{d\tau^o}=\frac{\frac{\partial^2 U}{\partial l_a^f \partial \tau^o}\frac{\partial^2 U}{\partial l_a^{h2}}-\left(-\frac{\partial^2 U}{\partial l_a^h \partial \tau^o}\right)\frac{\partial^2 U}{\partial l_a^f \partial l_a^h}}{|H|}=\frac{\bar{l}_o^s\left(p_q\,\overline{A}\right)^2\frac{\partial q}{\partial l_a}\frac{\partial U}{\partial Y}\frac{\partial^2 U}{\partial Y^2}\frac{\partial^2 q}{\partial l_a^2}}{|H|}>0$$

C. *Change in agricultural family labor (l_a^f) due to change farm wage (ω^a)*

$$\frac{dl_a^f}{d\omega^a}=\frac{\frac{\partial^2 U}{\partial l_a^f \partial \omega^a}\frac{\partial^2 U}{\partial l_a^{h2}}-\left(-\frac{\partial^2 U}{\partial l_a^h \partial \omega^a}\right)\frac{\partial^2 U}{\partial l_a^f \partial l_a^h}}{|H|}=\frac{p_q\left(\overline{A}\right)^2\frac{\partial U}{\partial Y}\frac{\partial^2 q}{\partial l_a^2}\left[l_a^h p_q \overline{A}\frac{\partial q}{\partial l_a}\frac{\partial^2 U}{\partial Y^2}-\frac{\partial U}{\partial Y}\right]}{|H|}>0$$

D. *Change in agricultural family labor (l_a^f) due to change in transaction cost of agricultural labor market (τ^a)*

$$\frac{dl_a^f}{d\tau^a}=\frac{\frac{\partial^2 U}{\partial l_a^f \partial \tau^a}\frac{\partial^2 U}{\partial l_a^{h2}}-\left(-\frac{\partial^2 U}{\partial l_a^h \partial \tau^a}\right)\frac{\partial^2 U}{\partial l_a^f \partial l_a^h}}{|H|}=\frac{p_q\left(\overline{A}\right)^2\frac{\partial U}{\partial Y}\frac{\partial^2 q}{\partial l_a^2}\left[l_a^h p_q \overline{A}\frac{\partial q}{\partial l_a}\frac{\partial^2 U}{\partial Y^2}-\frac{\partial U}{\partial Y}\right]}{|H|}>0$$

E. *Change in agricultural family labor (l_a^f) due to change total time endowment of the household (T)*

$$\frac{dl_a^f}{dT}=\frac{\frac{\partial^2 U}{\partial l_a^f \partial T}\frac{\partial^2 U}{\partial l_a^{h2}}-\left(-\frac{\partial^2 U}{\partial l_a^h \partial T}\right)\frac{\partial^2 U}{\partial l_a^f \partial l_a^h}}{|H|}=\frac{p_q\left(\overline{A}\right)^2\frac{\partial U}{\partial Y}\frac{\partial^2 q}{\partial l_e^2}\frac{\partial^2 q}{\partial l_a^2}}{|H|}>0$$

F. *Change in agricultural family labor (l_a^f) due to change in price of output (p_q)*

$$\frac{dl_a^f}{dp_q}=\frac{-\frac{\partial^2 U}{\partial l_a^f \partial p_q}\frac{\partial^2 U}{\partial l_a^{h2}}-\left(-\frac{\partial^2 U}{\partial l_a^h \partial p_q}\right)\frac{\partial^2 U}{\partial l_a^f \partial l_a^h}}{|H|}=\frac{p_q^2\left(\overline{A}\right)^3 q(.)\frac{\partial q}{\partial l_a}\frac{\partial U}{\partial Y}\frac{\partial^2 U}{\partial Y^2}\frac{\partial^2 q}{\partial l_a^2}}{|H|}>0$$

2. For low caste households

A. *Change in agricultural family labor (l_a^f) due to change in price of output (p_q)*

$$\frac{dl_a^f}{dp_q}=\frac{-\frac{\partial^2 U}{\partial l_a^f \partial p_q}\frac{\partial^2 U}{\partial l_o^{f2}}-\left(-\frac{\partial^2 U}{\partial l_o^f \partial p_q}\right)\frac{\partial^2 U}{\partial l_o^f \partial l_a^f}}{|H|}=\frac{-\overline{A}\frac{\partial q}{\partial l_a^f}\frac{\partial U}{\partial Y}\left[\left(\omega^a-\tau^a\right)^2\frac{\partial^2 U}{\partial Y^2}+\frac{\partial^2 q}{\partial l_e^2}\right]}{|H|}>0$$

B. *Change in agricultural family labor (l_a^f) due to change in farm wage (ω^a)*

$$\frac{dl_a^f}{d\omega^a}=\frac{-\frac{\partial^2 U}{\partial l_a^f \partial \omega^a}\frac{\partial^2 U}{\partial l_o^{f2}}-\left(-\frac{\partial^2 U}{\partial l_o^f \partial \omega^a}\right)\frac{\partial^2 U}{\partial l_a^f \partial l_o^f}}{|H|}=\frac{(\omega^a-\tau^a)^2\overline{A}\frac{\partial U}{\partial Y}\frac{\partial^2 U}{\partial Y^2}+\overline{A}\frac{\partial U}{\partial Y}\frac{\partial^2 U}{\partial l_e^2}}{|H|}<0$$

C. *Change in agricultural family labor (l_a^f) due to change in transaction cost of agricultural labor market (τ^a)*

$$\frac{dl_a^f}{d\tau^a}=\frac{-\frac{\partial^2 U}{\partial l_a^f \partial \tau^a}\frac{\partial^2 U}{\partial l_o^{f2}}-\left(-\frac{\partial^2 U}{\partial l_o^f \partial \tau^a}\right)\frac{\partial^2 U}{\partial l_a^f \partial l_o^f}}{|H|}=\frac{-\overline{A}\frac{\partial U}{\partial Y}\left[(\omega^a-\tau^a)^2\frac{\partial^2 U}{\partial Y^2}+\frac{\partial^2 U}{\partial l_e^2}\right]}{|H|}>0$$

D. *Change in agricultural family labor (l_a^f) due to change in total time endowment of the household (T)*

$$\frac{dl_a^f}{dT}=\frac{-\frac{\partial^2 U}{\partial l_a^f \partial T}\frac{\partial^2 U}{\partial l_o^{f2}}-\left(-\frac{\partial^2 U}{\partial l_o^f \partial T}\right)\frac{\partial^2 U}{\partial l_a^f \partial l_o^f}}{|H|}=0$$

E. *Change in agricultural labor supply (l_o^f) due to change in farm wage (ω^a)*

$$\frac{dl_o^f}{d\omega^a}=\frac{-\frac{\partial^2 U}{\partial l_o^f \partial \omega^a}\frac{\partial^2 U}{\partial l_a^{f2}}-\left(-\frac{\partial^2 U}{\partial l_a^f \partial \omega^a}\right)\frac{\partial^2 U}{\partial l_a^f \partial l_o^f}}{|H|}$$

$$=\frac{-(\omega^a-\tau^a)p_q\bar{A}l_o^f\frac{\partial U}{\partial Y}\frac{\partial^2 q}{\partial l_a^{f2}}\frac{\partial^2 U}{\partial Y^2}-\bar{A}^2(\omega^a-\tau^a)^2\frac{\partial U}{\partial Y}\frac{\partial^2 U}{\partial Y^2}-p_q\bar{A}\left(\frac{\partial U}{\partial Y}\right)^2\frac{\partial^2 q}{\partial l_a^{f2}}-\bar{A}^2\frac{\partial U}{\partial Y}\frac{\partial^2 U}{\partial l_e^2}}{|H|}>0$$

Appendix-2

1. High caste households

A. *Change in agricultural family labor ($l_a^f=l_a$) due to change in off-farm wage (ω^o)*

$$\frac{dl_a^f}{d\omega^o}=\frac{\frac{\partial^2 U}{\partial l_a^f \partial \omega^o}\frac{\partial^2 U}{\partial A^{ro2}}-\left(-\frac{\partial^2 U}{\partial A^{ro}\partial \omega^o}\right)\frac{\partial^2 U}{\partial l_a^f \partial A^{ro}}}{|H|}$$

$$=\frac{\left[(\bar{A}-A^{ro})\bar{l}_o^s\right]\frac{\partial^2 U}{\partial Y^2}\left\{Z^2 p_q\frac{\partial q}{\partial l_a}\left(\frac{\partial^2 U}{\partial Y^2}\right)-p_q\frac{\partial q}{\partial l_a}l_a^2\frac{\partial^2 U}{\partial l_e^{\,2}}-zl_a\frac{\partial^2 U}{\partial l_e^{\,2}}-Z^2 p_q\frac{\partial q}{\partial l_a}\left(\frac{\partial^2 U}{\partial Y^2}\right)\right\}}{|H|}<0$$

B. *Change in agricultural family labor ($l_a^f=l_a$) due to change in transaction cost in off-farm sector (τ^o)*

$$\frac{dl_a^f}{d\tau^o}=\frac{\frac{\partial^2 U}{\partial l_a^f \partial \tau^o}\frac{\partial^2 U}{\partial A^{ro2}}-\left(-\frac{\partial^2 U}{\partial A^{ro}\partial \tau^o}\right)\frac{\partial^2 U}{\partial l_a^f \partial A^{ro}}}{|H|}=0$$

C. *Change in agricultural family labor ($l_a^f=l_a$) due to change in time endowment of the household (T)*

$$\frac{dl_a^f}{dT}=\frac{\frac{\partial^2 U}{\partial l_a^f \partial T}\frac{\partial^2 U}{\partial A^{ro2}}-\left(-\frac{\partial^2 U}{\partial A^{ro}\partial T}\right)\frac{\partial^2 U}{\partial l_a^f \partial A^{ro}}}{|H|}=0$$

Figure 1: CDF for impact of cast on yield: First order stochastic dominance analysis (All plots).

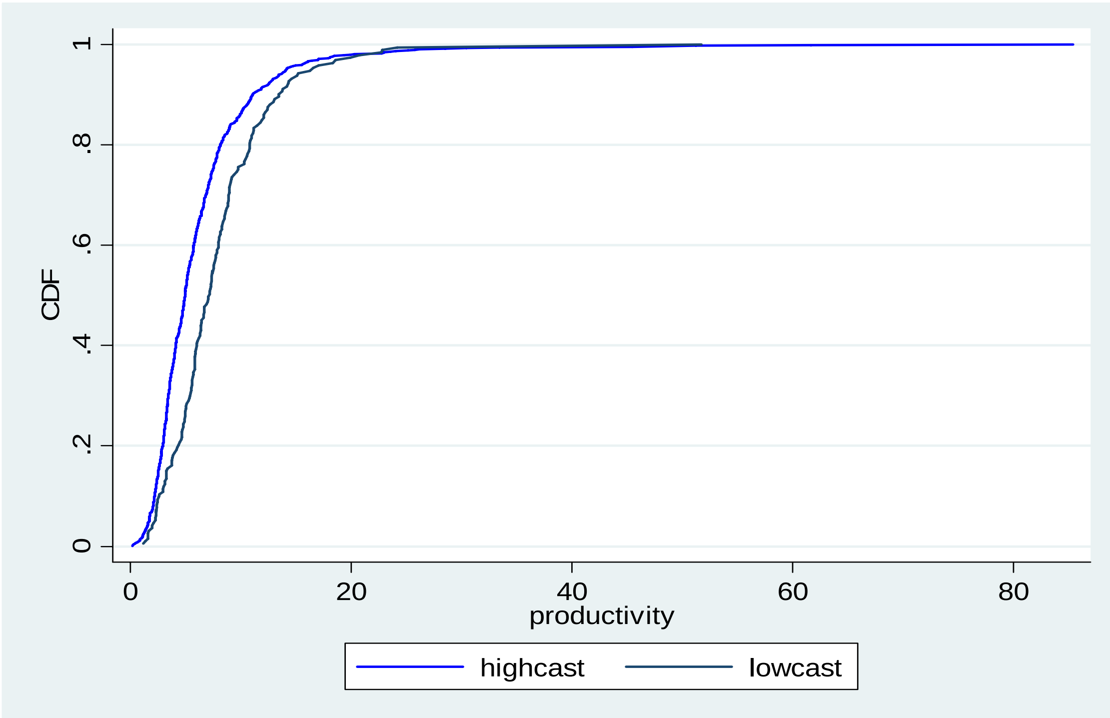
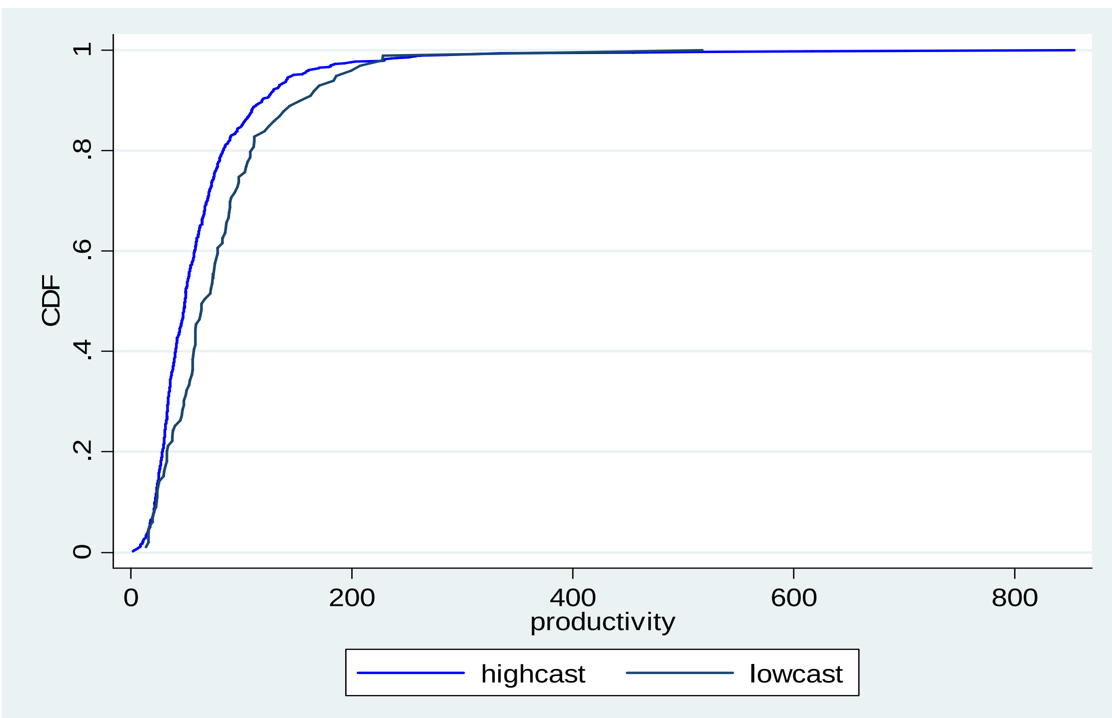


Figure 2: CDF for impact of cast on yield: First order stochastic dominance analysis (Owner cultivated plots



only).

Figure 3: CDF for impact of cast on yield: First order stochastic dominance analysis (Rented in plots only).

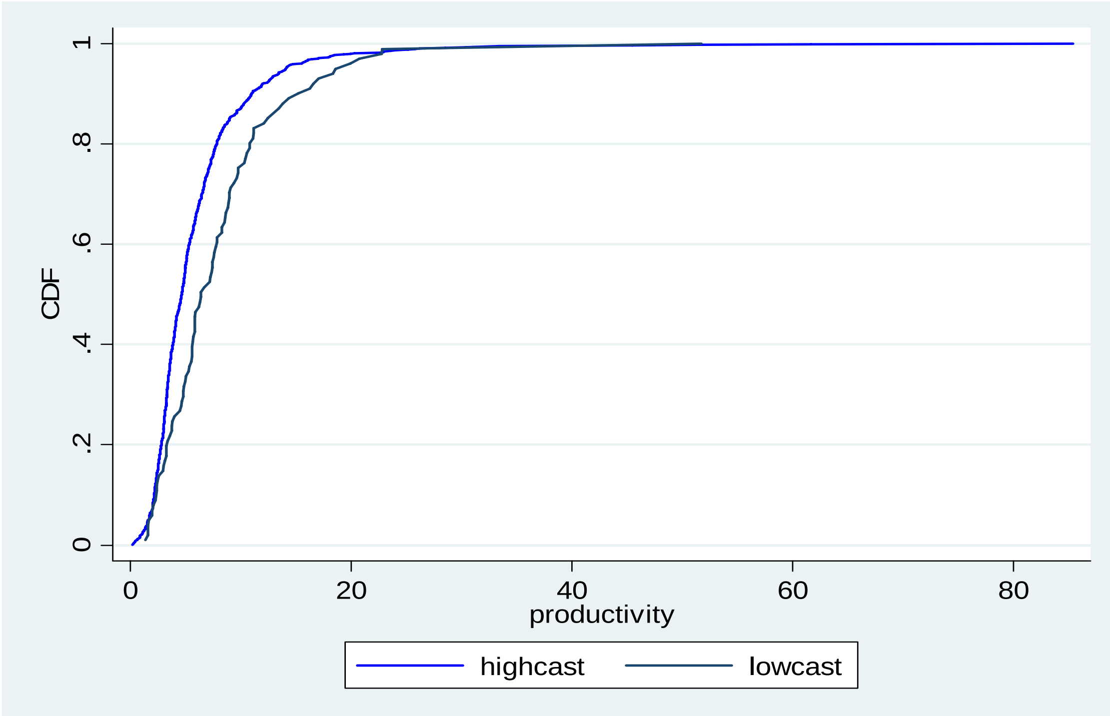


Table 9 Caste and land productivity (Random Effects Model) for all plots: Dependent variable- log of total value product per hectare. (All continuous variables are in logarithms)

	Linear relation		With plot characteristics variables		Both plot & household characteristics variables	
	only caste	caste and plot size	without caste	with caste	without caste	with caste
Low caste D(1)	0.297***	0.304***		0.169**		0.103**
	(0.073)	(0.062)		(0.073)		(0.048)
Plot size		0.028	-0.059	-0.051	0.039	0.060
		(0.046)	(0.053)	(0.047)	(0.107)	(0.118)
Village2			0.048	0.038	0.073	0.066
			(0.117)	(0.118)	(0.113)	(0.115)
Village3			0.140***	0.122**	0.135***	0.123***
			(0.041)	(0.049)	(0.040)	(0.047)
Distance to plot			-0.049***	-0.047***	-0.058***	-0.055***
			(0.008)	(0.010)	(0.009)	(0.010)
Slope2			0.066	0.067	0.045	0.046
			(0.062)	(0.065)	(0.061)	(0.061)
Slope3			-0.113	-0.110	-0.111	-0.109
			(0.079)	(0.075)	(0.074)	(0.071)
Slope4			-0.213***	-0.213***	-0.224***	-0.224***
			(0.076)	(0.071)	(0.086)	(0.084)
Soil2			-0.089	-0.112	-0.089	-0.100
			(0.069)	(0.079)	(0.065)	(0.071)
Soil3			-0.292***	-0.294***	-0.351***	-0.355***
			(0.032)	(0.034)	(0.061)	(0.060)
Soil4			0.016	0.036	0.098	0.104
			(0.197)	(0.194)	(0.190)	(0.189)
Soil5			-0.069***	-0.065***	-0.062*	-0.062*
			(0.006)	(0.012)	(0.034)	(0.036)
No. of crops 2/year			0.173***	0.174***	0.183***	0.175***
			(0.016)	(0.018)	(0.024)	(0.029)
No. of crops 3/year			0.142***	0.141***	0.116**	0.105**
			(0.026)	(0.026)	(0.046)	(0.057)
Irrigated plot D(1)			0.083**	0.144**	0.145***	0.169***
			(0.037)	(0.069)	(0.037)	(0.050)
Soil depth (Low)			-0.632***	-0.580***	-0.574***	-0.551***
			(0.029)	(0.014)	(0.016)	(0.013)
Soil depth (Medium)			0.037	0.043	0.045	0.047
			(0.057)	(0.050)	(0.046)	(0.043)
Tenure (1=rented in)					0.151***	0.153***
					(0.032)	(0.033)

Oxen holding/ha					0.032***	0.030***
					(0.004)	(0.004)
Value of asset/ha					-0.015	0.007
					(0.024)	(0.019)
Share of offfarm income					-0.012***	-0.004**
					(0.003)	(0.002)
Food requirement					0.201***	0.191***
					(0.051)	(0.048)
No. adult female/ha					0.124***	0.135***
					(0.040)	(0.044)
No. adult male/ha					0.089***	0.097***
					(0.011)	(0.011)
Male Headed(1)					0.056	0.020
					(0.054)	(0.043)
Predicted fertilizer					-0.015	-0.046
					(0.029)	(0.028)
Predicted manure					0.046	0.042
					(0.362)	(0.376)
Constant	10.808***	10.855***	11.332***	11.254***	10.855***	10.865***
	(0.067)	(0.128)	(0.037)	(0.058)	(2.436)	(2.519)
N	825	825	825	825	825	825

Table 10 Caste and land productivity (Random Effects Model) for only rented-in plots: Dependent variable-log of total value product per hectare. (All continuous variables are in logarithms)

	Linear relation		With plot characteristics variables		Both plot & household characteristics variables	
	only caste	caste and plot size	without caste	with caste	without caste	with caste
Low caste D(1)	0.351***	0.366***		0.166***		0.117***
	(0.061)	(0.064)		(0.033)		(0.022)
Plot size		0.163***	0.070	0.070	-0.122	-0.088
		(0.025)	(0.056)	(0.055)	(0.125)	(0.113)
Village2			0.068	0.037	0.132	0.123
			(0.094)	(0.103)	(0.121)	(0.124)
Village3			0.216***	0.188***	0.326***	0.317***
			(0.049)	(0.052)	(0.073)	(0.071)
Distance to plot			-0.013	-0.012	-0.021	-0.019
			(0.029)	(0.026)	(0.025)	(0.024)
Slope2			0.065	0.073	0.076	0.074
			(0.086)	(0.109)	(0.110)	(0.118)
Slope3			-0.077**	-0.068	-0.105***	-0.096***
			(0.035)	(0.044)	(0.024)	(0.026)

	(1)	(2)	(3)	(4)	(5)	(6)
Slope4			-0.131***	-0.137***	-0.200***	-0.192***
			(0.019)	(0.022)	(0.026)	(0.027)
Soil2			0.098	0.096	0.110	0.106
			(0.082)	(0.082)	(0.103)	(0.103)
Soil3			-0.645***	-0.633***	-0.609***	-0.617***
			(0.056)	(0.057)	(0.048)	(0.046)
Soil4			0.066	0.114	0.127	0.129
			(0.104)	(0.140)	(0.150)	(0.164)
Soil5			-0.025	-0.002	-0.013	-0.017
			(0.075)	(0.070)	(0.085)	(0.083)
No. of crops 2/year			0.118***	0.119***	0.134***	0.124**
			(0.031)	(0.031)	(0.044)	(0.049)
No. of crops 3/year			0.189***	0.123***	0.145***	0.132***
			(0.041)	(0.036)	(0.039)	(0.043)
Irrigated plot D(1)			0.220***	0.152***	0.176***	0.157***
			(0.037)	(0.042)	(0.049)	(0.048)
Soil depth (Low)			-0.181***	-0.114*	-0.137**	-0.120*
			(0.064)	(0.064)	(0.064)	(0.063)
Soil depth (Medium)			0.040	0.050	0.051	0.051
			(0.105)	(0.096)	(0.087)	(0.082)
Oxen holding/ha					0.054***	0.054***
					(0.019)	(0.020)
Value of asset/ha					0.003	0.028
					(0.040)	(0.042)
Share of offfarm income					0.006*	0.005
					(0.003)	(0.003)
Food requirement					0.172***	0.165***
					(0.024)	(0.019)
No. adult female/ha					0.126***	0.104***
					(0.053)	(0.055)
No. adult male/ha					0.174***	0.178***
					(0.063)	(0.060)
Male Headed(1)					0.162***	0.095**
					(0.041)	(0.042)
Predicted fertilizer					-0.052	-0.056
					(0.239)	(0.245)
Predicted manure					1.065***	1.026***
					(0.407)	(0.336)
Constant	10.773***	11.059***	11.353***	11.242***	4.597	4.605
	(0.072)	(0.093)	(0.155)	(0.141)	(4.074)	(3.618)
N	220	220	220	220	220	220

Table 11 Caste and land productivity (Random Effects Model) for only owner operated plots: Dependent variable- log of total value product per hectare. (All continuous variables are in logarithms).

	Linear relation		With plot characteristics variables		Both plot & household characteristics variables	
	only caste	caste and plot size	without caste	with caste	without caste	with caste
Low caste D(1)	0.262***	0.250***		0.158*		0.093
	(0.080)	(0.065)		(0.096)		(0.072)
Plot size		-0.010	-0.096	-0.087	-0.010	0.009
		(0.056)	(0.063)	(0.055)	(0.167)	(0.181)
Village2			0.040	0.041	0.091	0.087
			(0.163)	(0.160)	(0.127)	(0.131)
Village3			0.074	0.064	0.068	0.060
			(0.069)	(0.077)	(0.060)	(0.067)
Distance to plot			-0.060***	-0.057***	-0.066***	-0.064***
			(0.013)	(0.013)	(0.014)	(0.015)
Slope2			0.040	0.040	0.009	0.009
			(0.065)	(0.066)	(0.075)	(0.074)
Slope3			-0.168	-0.167	-0.160	-0.160
			(0.108)	(0.104)	(0.102)	(0.100)
Slope4			-0.179**	-0.176**	-0.202*	-0.200**
			(0.089)	(0.086)	(0.104)	(0.101)
Soil2			-0.097	-0.124	-0.101	-0.113
			(0.072)	(0.089)	(0.063)	(0.074)
Soil3			-0.096	-0.095	-0.077	-0.079
			(0.099)	(0.097)	(0.080)	(0.083)
Soil4			0.139	0.153	0.191	0.195
			(0.253)	(0.249)	(0.252)	(0.250)
Soil5			-0.025	-0.022	-0.002	-0.001
			(0.028)	(0.039)	(0.060)	(0.064)
No. of crops 2/year			0.186***	0.188***	0.213***	0.203**
			(0.038)	(0.042)	(0.081)	(0.091)
No. of crops 3/year			0.139***	0.138***	0.173***	0.146***
			(0.025)	(0.025)	(0.017)	(0.022)
Irrigated plot D(1)			0.202***	0.253***	0.168***	0.192***
			(0.038)	(0.072)	(0.043)	(0.062)
Soil depth (Low)			-0.715***	-0.676***	-0.697***	-0.677***
			(0.029)	(0.015)	(0.018)	(0.012)
Soil depth (Medium)			-0.103**	-0.107***	-0.121***	-0.122***
			(0.044)	(0.041)	(0.045)	(0.043)
Oxen holding/ha					0.052***	0.049***
					(0.014)	(0.011)

Value of asset/ha					-0.007	0.010
					(0.023)	(0.010)
Share of offfarm income					-0.004	-0.005**
					(0.003)	(0.003)
Food requirement					0.234***	0.226***
					(0.059)	(0.053)
No. adult female/ha					0.153***	0.142***
					(0.032)	(0.017)
No. adult male/ha					0.110***	0.116***
					(0.037)	(0.034)
Male Headed(1)					0.024	0.005
					(0.072)	(0.059)
Predicted fertilizer					0.085	0.042
					(0.131)	(0.157)
Predicted manure					-0.002	-0.014
					(0.668)	(0.673)
Constant	10.792***	10.798***	11.279***	11.217***	10.402*	10.606*
	(0.071)	(0.151)	(0.066)	(0.063)	(5.393)	(5.498)
N	605	605	605	605	605	605