Impact of Contract Farming on Profits and Yield of Smallholder Farms in Nepal: An Evidence from Lentil Cultivation

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Selected Paper prepared for presentation at the 2016 Agricultural & Applied Economics Association Annual Meeting, Boston, Massachusetts, July 31-August 2

Abstract

This study is undertaken to quantify the benefits of contract farming (CF) on farmers' income in a case where new market opportunities are emerging for smallholder farmers in Nepal. CF is emerging as an important form of vertical coordination in the agrifood supply chain. The prospect for CF in a country like Nepal with accessibility issues, underdeveloped markets, and lack of amenities remains ambiguous. On the one hand, contractors find it difficult to build links in these cases, particularly when final consumers have quality and safety requirements. On the other hand, lack of other market opportunities makes the contracts more sustainable. The latter happens if there are product-specific quality advantages because of agroecology and, more important, lack of side-selling opportunities. At the same time concerns remain about monoposonistic powers of the buyers when small farmers do not have outside options. Results of this study show that CF is significantly more profitable (81 percent greater net income) than independent production, the main pathway being higher yield and price realization. The positive impact of CF on farmers' profits can help Nepal in harnessing the growing demand for pulses, especially in neighboring international markets, like India.

Keywords: contract farming, lentil, income, small farmers, Nepal

JEL classification: Q12, Q13, Q17, Q18

1. Introduction

Lentil is Nepal's number one agricultural export commodity.[1] In Nepal it is the most significant pulse in terms of both area and production, and it constitutes more than 60 percent of the total pulses produced in the country. Lentil has a share of about 13 percent of total agricultural exports from Nepal. However, a vast majority of the 0.7 million farmers engaged in lentil cultivation are smallholders. Small farmer–dominated lentil production in Nepal has historically been characterized by traditional technologies and postharvest practices. More importantly, small farmers have been forced to sell to local traders, who enjoy significant market power, implying a low share in value for the farmers.

Because of these factors, profitability has traditionally been quite low for lentil growers in Nepal. In recent years, as global prices of pulses have been persistently high, including in India, the high value element in lentil has been elevated further by the ban on exports from India. This has opened up new avenues for Nepalese exports. With trade potentially expanding on both intensive and extensive margins, new opportunities for value addition and premium returns for higher quality of lentils has emerged for Nepali growers as processors, millers, and traders aim to expand production and improve quality and safety of the produce.

As the demand emerged for a greater volume of lentils with better quality and food safety, there was a need for vertical and horizontal coordination. Farmers formed cooperatives and have tried to link directly with firms or larger traders through contract farming (CF). By doing so, bypassing the traditional buyers, that is, traders, there has been a push towards commercialization of lentil production in Nepal. With coordination arrangements such as CF, yields in lentils seem to have improved with adoption of technology. Moreover, price realization of the farmers has been lifted with the compression of the chain and greater bargaining power of the farmers. This is probably due to the changed scenario wherein farmer groups instead of individual farmers form forward linkages with firms and traders. Higher prices for growers also could be due to improved product quality involving cleaning, grading, and sorting of lentils.

According to the Nepal Economic Agriculture and Trade (NEAT) report, due to interventions by NEAT, between 2011 and 2013, lentil yield increased by more than 50 percent and farmer sales by more than US$4.5 million[2] (United States Agency for International Development [USAID]/Nepal 2013). The share of farmers using improved seed increased from 4.4 percent to 92 percent, and the area under lentil cultivation increased by 25 percent over the baseline. The nature of contracting has been such that

[1] Globally, the most traded pulse is lentils.
[2] All dollars are US dollars.

farmer groups sell in bulk at a premium to processors or traders—whoever pays a higher price. The CF arrangement means that farmers now sell beyond the village trader's guild.

Elsewhere, a series of studies shows that market liberalization is transforming agricultural production patterns in developing countries and driving the emergence of several innovative models for linking farmers with markets (Simmons, Winters, and Patrick 2005). CF has emerged as an integral part of this agricultural transformation process, often facilitating direct firm-farm linkages. Though the potential benefits of CF in principle are significant for both contractors and contracted, particularly for the products where quality and safety are important, its role and possible impacts in the developing countries are often controversial. One of the most contentious issues in CF is the threat of exclusion of smallholders, particularly when the higher transaction cost, along with stringent demand for quality and safety, may preclude smallholder farmers from participating in CF (Pingali 2006).

With this in the backdrop, CF in lentil in Nepal is an ideal case to study from the point of view of small farmers' outcomes and delivery of product attributes such as food safety in an exportable crop. This is so because on the one hand a vast majority of lentil farmers in Nepal are small but on the other hand opportunities for exports are continuously emerging. These opportunities, however, require fundamental changes in the demand for quality and safety of the product. Overall the marginal and small famers have little marketable surplus, low education, inefficient production technologies, and underdeveloped infrastructure (for example, transportation, cold storage, and information channels), constraining their access to remunerative markets.

CF has indeed been shown to be a remedial institutional mechanism with the potential to increase productivity, reduce transaction costs, minimize risks for farmers, and enhance safety and quality of the produce for consumers (Minot 2011; Birthal, Joshi, and Gulati 2005; Ramaswami, Birthal, and Joshi 2006; Kutlu 2012; Jia and Bijman 2014; Kumar et al. 2016). How far this has been the case in lentil production in Nepal remains unanswered, the suitability of the case for such an investigation notwithstanding.

This study is aimed at identifying the factors that motivate farmers' participation in CF in an overwhelmingly smallholder-dominated context, that is, lentil production in Nepal. Next, it also assesses the impact on farmers' economic welfare, that is, on yield, cost of production, and profit. As discussed above, lentil is one of the high-value cash crops in Nepal with high export potential. If the farmers can link up with export markets and get a fair share in the value, given the large number of small farmers, it can be a significant contributor to poverty reduction. This study thus provides an empirical analysis of the impact of CF in lentil on outcomes such as farm profits, efficiency, yields, and production costs of smallholders in Nepal.

The precise research questions addressed in this paper are the following: What factors motivate farmers to participate in CF in lentil? Does CF raise profits, increase yield per hectare (ha), and reduce total cost of production?

These questions are quite important because they relate to the prospects of small farms. Greater efficiency and profitability in potentially high-value crops supported by coordination arrangements seem to be sine qua non for the survivability of a large number of small farms, as is the case in lentil production in Nepal. In Nepal, the average farm size is less than 0.7 ha, which is much smaller than in Thailand (3.4 ha), India (1.15 ha), and South Korea (1.5 ha).

On the policy side also the present study is quite pertinent. Nepal is one of the countries where policy makers are still uncertain about the promotion of CF. CF in Nepal is in its infancy, and given the pertinence of the case of lentil, an empirical analysis is useful to assess the role and impact of CF in Nepal. Since the government is still seeking evidence on CF while formulating a national policy on it, a proper and credible analysis can be really useful in crafting the appropriate agribusiness development policies in Nepal.

The paper is organized as follows. In Section 2, we provide a brief background on the lentil subsector in Nepal. In Section 3, we describe the survey data and the methodological approach. The estimation results are presented and discussed in Section 4, and Section 5 concludes and provides some policy implications.

2. Lentil Cultivation in Nepal

Lentil is the most important pulse and a key cash crop in Nepal. During triennium ending (TE) year 2013, Nepal, with its 4.6 percent share, was the sixth largest producer of lentil in the world, after Canada (35.1 percent), India (22.2 percent), Turkey (8.9 percent), Australia (8.3 percent), and the United States (4.8 percent). In TE 2013, Nepal produced 214,000 tons of lentil in an area of 207,300 ha with an average yield of 1,033 kilograms (kg)/ha.[3] Between TE 1981 and TE 2013, the share of lentil in the gross cropped area of Nepal increased from 3.4 percent in TE 1981 to 4.2 percent in TE 2013. The contribution of lentil to the agricultural value of production also has risen marginally from 2.4 percent in TE 1981 to 2.9 percent in TE 2013. Further, lentil emerged as the most valuable export commodity of Nepal with its 11.4 percent share in agricultural exports in TE 2013 (Table 1).

[3] Tons are metric tons.

Table 1. Share of lentil in GCA, agricultural VOP, and agricultural exports of Nepal, TE 1981–TE 2013

Year (TE)	Percentage share in GCA	Percentage share in agricultural VOP	Percentage share in total agricultural exports (in value terms)
1981	3.40	2.38	0.00
1991	2.97	2.25	11.46
2001	3.95	3.07	10.83
2013	4.16	2.94	11.35

Source: Authors' calculations based on FAOSTAT (FAO 2015).

Note: GCA = gross cropped area; TE = triennium ending; VOP = value of production.

Between TE 1981 and TE 2013, there was a significant increase in the area, yield, and production of lentil in Nepal. The area under lentil cultivation more than doubled from 97,000 ha to 207,000 ha, with an average annual growth of 2.5 percent (Table 2). The yield of lentil increased from 497 kg/ha to 1,033 kg/ha in the same time period. A more than twofold increase in the area as well as the yield of lentil has resulted in a rise in production by more than four times, from 48.7 tons to 214.0 tons.

Table 2. Trends in area, production, and yield of lentil in Nepal, 1979–2013

Year (TE)	Area (thousand ha)	Production (thousand metric tons)	Yield (kilograms/ha)
1981	98.0	48.7	497
1991	120.6	74.5	618
2001	178.0	137.6	773
2013	207.2	214.0	1,033
CAGR in % (1979 to 2013)	2.5	4.7	2.1

Source: Authors' calculations based on FAOSTAT (FAO 2015).

Note: ha = hectares; TE = triennium ending; CAGR = compound annual growth rate.

Over time the farmers adopted new technologies and took advantage of the remunerative export market (Shrestha, Neupane, and Adhikari 2011). Though the yield of lentil in Nepal is almost at par with the global average (1,097 kg/ha), it is far behind the yields of some major producers such as New Zealand (2,580 kg/ha), China (2,294 kg/ha), Australia (2,045 kg/ha), Turkey (1,719 kg/ha), Canada (1,674 kg/ha), and France (1,656 kg/ha).

Lentil is cultivated across all development regions in Nepal (Table 3). The share of the central region in production is the highest (32.0 percent), followed by the mid-western (28.0 percent), eastern (17.4 percent), far-western (13.1 percent), and western (9.6 percent) regions. In terms of agroclimatic zones, the cultivation of lentil is concentrated in the *terai* region with a share of greater than 95 percent in total

production. The contribution of the hills region is around 4 percent, and that of the mountains region is meagre (0.4 percent). The yield is also highest in the terai region (1,039 kg/ha), followed by the hills (939 kg/ha) and mountains (694 kg/ha) regions. The highly favourable agroclimatic conditions, suitable soil, and easy access to main highway routes are considered the major drivers for concentration of commercial cultivation of lentil in the terai region (USAID 2011). Lentil, a winter-season crop, is cultivated after harvesting paddy. The lentil plant uses residual moisture in the soil to meet its water requirement. The major lentil-producing districts in Nepal are Dang Deukhuri, Rautahat, Kailali, Bardiya, Bara, Siraha, Banke, Nawalparasi, Parsa, Rupandehi, Saptari, Sunsari, Kapilvastu, Chitwan, Kanchanpur, and Jhapa—all terai districts (Figure 1).

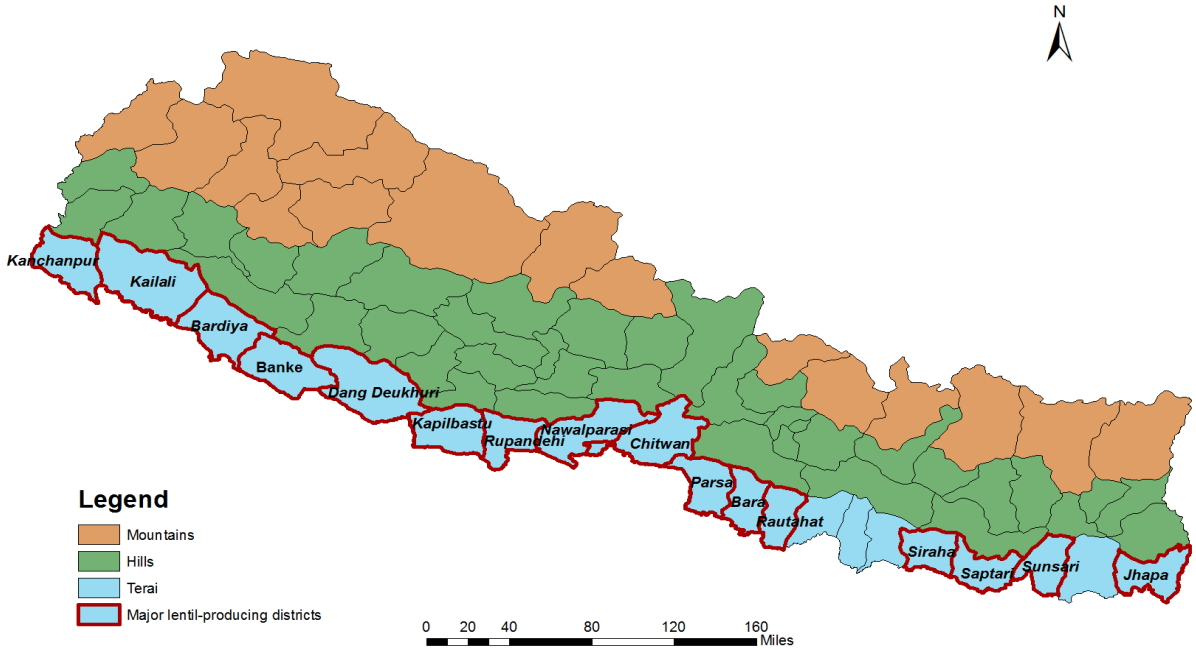
Table 3. Area, production, and yield of lentil across development and agroclimatic regions in Nepal, triennium ending 2013

Development region	Area (ha)	Production (metric tons)	Yield (kilograms /ha)	Percentage share area	Percentage share production
Eastern	34,480	37,302	1,082	16.6	17.4
Central	66,498	68,431	1,029	32.1	32.0
Western	20,740	20,466	987	10.0	9.6
Mid-western	58,314	59,861	1,027	28.1	28.0
Far-western	27,217	27,941	1,027	13.1	13.1
Agroclimatic region					
Hills	9,104	8,553	939	4.4	4.0
Terai	196,809	204,521	1,039	95.0	95.6
Mountains	1,335	927	694	0.6	0.4
Nepal	207,248	214,001	1,033	100.0	100.0

Source: Statistical information on Nepalese agriculture, 2011, 2012, 2013 (Nepal, MoAD2013).

Note: ha = hectare.

Figure 1. Map of major lentil-producing districts in Nepal



Source: Authors' work based on statistical information on Nepalese agriculture (Nepal, MoAD 2013).

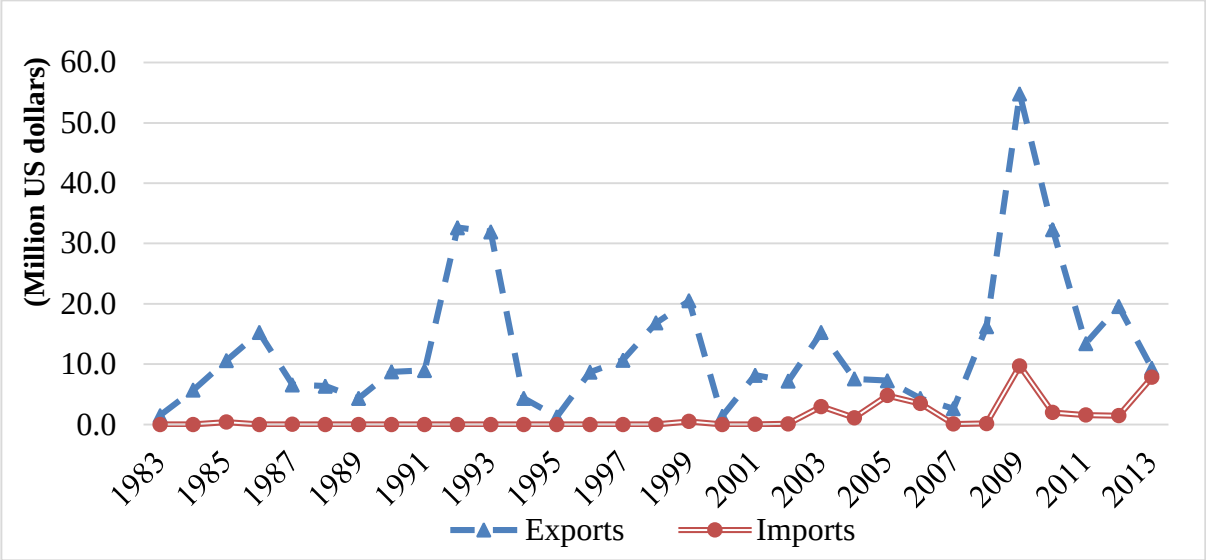
Lentil accounts for 90 percent of the total export of pulses from Nepal. Overall, there has been an increasing trend in lentil exports. The export of lentil from Nepal increased from 11,383 tons in 1991 to 22,890 tons in 2013, that is, an annual growth rate of 2.1 percent. In value terms at constant prices, the export of lentil has grown at 2.6 percent per year during the same period (Table 4, Figure 2).

Table 4. Export and import of lentil in Nepal, 1989–2013 (constant 2005 US dollars)

Year (triennium ending)	Export			Import			Trade surplus/ deficit
	Tons	Thousands US dollars	Unit value (US dollars/ton)	Tons	Thousands US dollars	Unit value (US dollars/ton)	Thousands US dollars
1991	11,383	7,349	646	4	1	176	7,349
2001	18,138	10,019	552	280	176	627	9,843
2013	22,890	14,111	616	10,227	3,610	353	10,500
Percentage CAGR (1989–2013)	2.1	2.6	0.5	60.9	53.9	7.2	–0.5

Source: Authors' calculations based on FAOSTAT (FAO 2015).
Note: CAGR = compound annual growth rate.

Figure 2. Nepal's export and import of lentil (million US dollars)



Source: Authors' calculations based on FAOSTAT (FAO 2015).

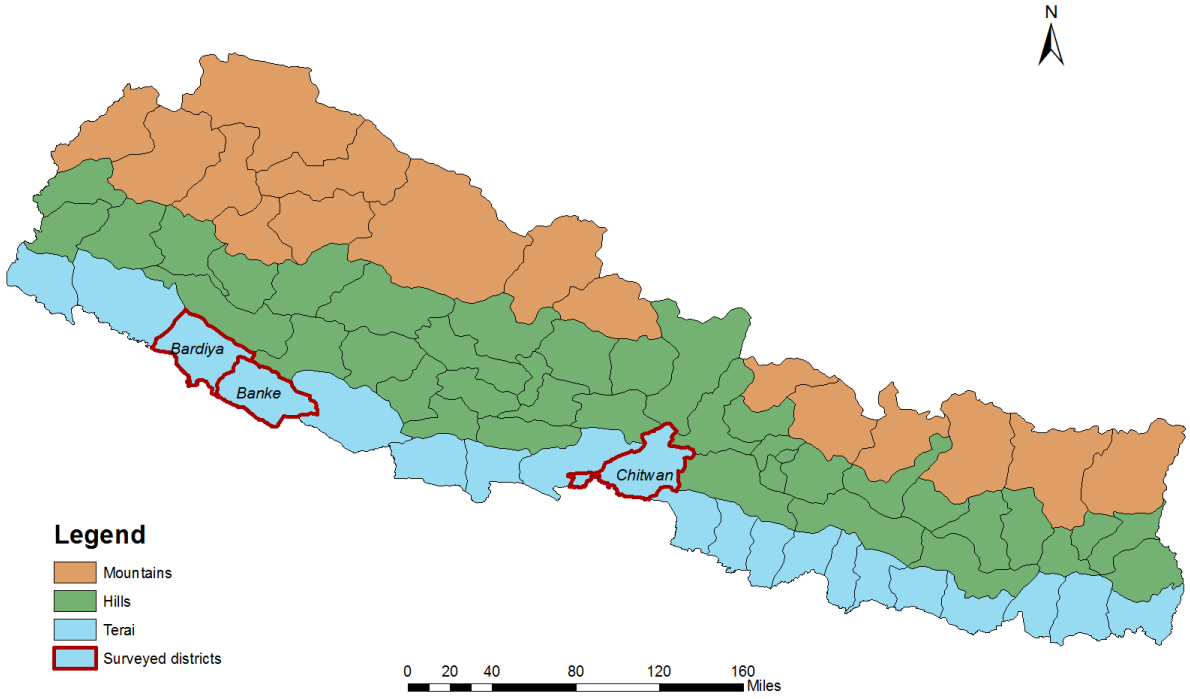
The unit value (in constant dollars) of lentil exports has hovered between $616 per ton and $646 per ton between 1991 and 2013. This means that the Nepalese lentil has been fetching a stable price in the international market in the long run. Despite being a major producer and exporter, Nepal imports lentil to meet domestic demand, especially during off-seasons. In recent years, the import of lentil has significantly increased from a mere 4 tons in TE 1991 to 280 tons in TE 2001 and further to 6,744 tons in TE 2013. Despite a rise in Nepal's import of lentil in recent years, its trade surplus has increased from $7.3 million in 1991 to $10.5 million in 2013. Moreover, unit values in exports have been higher than in imports in most years as the lentil from Nepal is perceived as better in quality (USAID 2011).

3. Data and Methodology

Data

The study is based on a primary survey of lentil-cultivating farm households in Nepal. The data were collected using a pretested structured questionnaire. The data collected at the farm-household level include farm and farmer characteristics, cropping patterns and economics of cultivation, marketing channels, and adoption of good agricultural practices. The survey was conducted from January to March 2015 in the three terai districts of Bardiya, Banke, and Chitwan, located in the mid-western and central regions of Nepal (Figure 3).

Figure 3. Agroclimatic zones in Nepal and surveyed districts



Source: Authors' work based on statistical information on Nepalese agriculture (Nepal, MoAD 2013)

We selected these districts due to a high concentration of lentil contract farmers and the presence of a number of firms and cooperatives that procure lentil for processing. The firms and cooperatives that establish vertical and horizontal coordination with farmers include Durali Cooperative, Hare Krishna Cooperative, Komal Cooperative, Janmukhi Cooperative, and Sidharth Mills in the Bardiya district; Krishak Upkaar Cooperative and Banke Daal Factory in the Banke district; and Shri Ram Farmer Cooperative in the Chitwan district.

We surveyed 602 lentil farmers comprising 300 contract farmers and 302 noncontract farmers, chosen randomly from 27 wards under seven village development councils from the three sample districts. The

share of sample size allocated to each sample district was in proportion to the number of contract farmers. Hence, the number of farmers identified for survey from Bardiya, Banke, and Chitwan districts were 300, 201, and 101, respectively. The village development councils within districts were also selected based on the presence of contract farmers specializing in lentil production. The distribution of sample households from each district is given in Table A.1.

Methodology

The data collected through field surveys in the three terai districts were used for empirical analysis. One of the main objectives of the study is to estimate and compare profits for contract and independent lentil growers. Profits are used as a proxy for farmer's welfare. Measurement of farm profits, however, is complex because of incomplete markets and unobserved transaction costs that make it difficult to properly price inputs and outputs (Barrett 1997). We try to build up information about profits by collecting disaggregated information about elements of cost through presurvey interactions to try to minimize measurement errors.

Specifically, the components of costs of lentil production comprise labor (own and hired), rental value of land, seed (including seed treatment), fertilizer and manure (if used), pesticide (if applied), and rental for machinery (if employed). Tax on land also was considered part of the costs. In addition, there are postharvest costs related mainly to transport of the produce to market. In the broad costing group, information was collected at a detailed level to get as accurate an estimate of costs as possible. For example, labor costs were obtained for different activities such as land preparation, farm yard manure application, mulch collection, plantation/sowing, irrigation, weeding, spraying, harvesting, and cleaning. Information about different inputs used and their prices was obtained from the respondents separately to estimate the cost of cultivation of lentil. Profits of the farmers were then calculated as the difference between total revenue and total costs. Partial budget analysis was carried out to estimate the costs and returns for both contract and independent growers.

As part of the implications of CF on the well-being of farmers, we attempt to answer two specific research questions through econometric methods. The first question is about identifying characteristics of farmer households that are associated with whether a farmer is part of a CF arrangement, that is, the issue of participation. Note that we put the issue forward as one of participation and not selection since several of the characteristics of the farmers that we observe now would be different at the time of selection. The second question pertains to assessing the impact of CF on the farmers' economic welfare (profits).

One of the big problems in the CF literature is the identification of the causal impact of participation in CF on farm profits. It is straightforward to see that several of the observed and unobserved characteristics that result in positive or negative selection into participation in CF are also likely to have

an effect on farm profits (such as skills in farming or social connectedness). Alternatively, participation in CF is usually not random but based on specific characteristics including location. To the extent that we include all three districts from the terai areas, we mitigate the problem of the location effect in contracting to some degree. Yet with the possibility of omitted variables, this implies that simple linear estimates of the effect of contracting on profits can be biased.

To try to address the issue of the nonrandom nature of participation in CF, several papers have used a two-step procedure (for example, Bellemare 2012; Ito, Bao, and Sun 2012; Katchova and Miranda 2004; Miyata, Minot, and Hu 2009; Simmons, Winters, and Patrick 2005; Wang, Zhang, and Wu 2011; Gupta and Roy 2012) in assessing the impact of CF on farm returns. We also involve a two-step procedure using instrumental variables (IVs) to address the issue of endogeneity of the contracting variable.

In the first stage, the dependent variable is binary (farmers' participation in contracts = 1, otherwise = 0), and the independent variables are a mix of qualitative and quantitative variables; we use a logit model to examine the role of factors associated with a farmer's being in contract or being independent. Specifically, the logistic regression is given by the following:

$$Y = \ln[p/(1-p)] = \beta_o + \sum \beta_j X_j , \quad (1)$$

where p represents the probability that the farmer participates in CF and β_j are regression coefficients estimated by the maximum likelihood method. X_j represents the vector of characteristics of farmer□. These include several socioeconomic and demographic characteristics of the farm households. The details of the variables are given in Appendix Table A.2.

In the second stage, to assess the impact of CF on the farmers' profits, the profit function can be represented as

$$\pi_i = \alpha + \delta d_i + \gamma X_i + \varepsilon_i , \quad (2)$$

where, π_i is net profit per kg received by a farm household from cultivation of lentil, d_i is a dummy variable (= 1 if farmer is in contract, 0 otherwise), X_i is a vector of observable farm and operator characteristics, and ε_i is an error term.

As discussed above, estimation of equation 2 using a simple ordinary least squares (OLS) regression may result in biased estimates of the impact of contracting on farm profits. This is because farmers are not randomly chosen in contracts. Farmers either are selected for contract by contractors or decide to participate in contracts of their own accord. Both of these possibilities signify nonrandom selection. Hence, the unobserved factors could be guiding farmers' decisions to enter into contracts. Thus, d_i, the

variable representing participation of farmers in contracts, is likely endogenous and could be correlated with the error term ε_i.

Without the benefit of a randomized assignment of lentil farmers into contracts, we rely on IV techniques given that unobserved characteristics such as hidden entrepreneurial ability of a farmer can play a role in the decision to participate in a contract. Therefore, we use the IV technique to minimize bias in the estimates of the impact of CF on farm profits. An ideal IV should not correlate with the dependent variable in equation 1; however, it should be correlated with d_i, the variable representing participation in CF. In addition, the variable should not be from the vector of farm and operator characteristics, X_i. It is indeed hard to find an ideal instrument in this setting.

We identify three IVs, namely, (1) the proportion of contract farmers in each ward for all households, (2) the proportion of contract farmers by caste group in each ward for all households, and (3) a categorical variable representing farmers producing organically certified produce, in the survey database. These three variables are network variables. We hypothesize that given a location, as a greater proportion of the farmers in the geographical and social neighborhood who are contracting increases, it would increase the likelihood of a particular farmer's getting into contract him- or herself. We take care to define the neighborhood as minutely as possible to avoid the relationship of the instrument to the dependent variable through alternative channels.

Consider, for example, networks defined at a broader level: say, the district level. Here, owing to the size, the network measure could lead to effects on profits through channels such as prices of inputs and outputs faced by a farmer. Hence, our network variables based solely on geographical proximity or augmented with social proximity are defined at the ward level, that is, a subdistrict region. Defined so minutely, we can argue that profits per kg from lentil cultivation would likely be independent of the geography- or geography-plus-social-identity-based proportions of the farmers contracting. Further, we believe that social proximity based on caste is quite important in rural settings of Nepal. It is possible that households from the same village might not mingle with each other if they have different castes while farmers from different villages could interact if they belonged to the same caste. In the context of rural Nepal, homophily based on caste is likely to be important, which motivates us to create network measures by going beyond geographical proximity per se.

To get the share of contract farmers in each ward, we take the number of contract farmers in a particular ward (while excluding from it the respective farmer for whom the network measure is being created) and divide it by the total number of farmers in that ward. The share of contract farmers is determined for all the households under respective wards whether or not that particular farmer is contracting. Similarly, the share of contract farmers by caste group in each ward is equal to the number of contract

farmers of a caste group in a particular ward divided by the total number of farmers in that ward. We conducted Hausman's test for endogeneity and found CF to be endogenous, which indicates nonrandomness in the selection of farmers for contracting.

We check for the strength of these instruments in the first stage by including them in the regression of participation in CF on its determinants. If the network variables as constructed above are strongly correlated with d_i, that is, if participation in CF and our argument of their not being systematically related with per unit profit in lentil cultivation holds, the required conditions for an instrument would be met.

In the first stage, the binary variable *participation in CF* is regressed on characteristics and the IVs *share of contract farmers in wards, share of contract farmers by caste group in wards,* and *share of organically certified producers.* The second stage estimates the contribution of *participation in CF* on profits instrumented from the first-stage regression.

4. Results and Discussions

General Characteristics of Farmer Households

In this section we try to find whether general characteristics of contract farmers of lentil in Nepal differ from those of noncontract farmers. A simple look at the data in Table 5 reveals significant differences in some characteristics and small differences in others. For example, these two groups of farmers differ significantly from each other in terms of operational holding size, gross cultivated area, cropping intensity, and household size. The average household size of CF households is 6.7 as compared to 6.2 of non-CF households. The average size of operational land holding of contract farmers (1.0 ha) is significantly higher than that of noncontract farmers (0.6 ha). Similarly, contract farmers have a higher average cultivated area (2.0 ha) than independent farmers (1.3 ha). On the other hand, cropping intensity was higher among independent farmers than among contract farmers. Also, the proportion of households headed by females is significantly higher among independent farming households than among CF households. On the other hand, CF and non-CF households did not differ significantly in terms of age, education, occupation, household size, irrigation, experience in farming, incidence of migration, and monthly remittances.

Table 5. Characteristics of contract and noncontract cultivators of lentil in Nepal

Characteristic	Contract	Noncontract	Difference	*t* test of difference
Age of respondent (years)	44.2	42.8	1.4	1.2
Number of years of education (highest educated HH member)	9.5	9.2	0.3	1.0
HH size (number)	6.7	6.2	0.5*	1.7
HH headed by female (%)	18.3	24.8	–6.5*	1.9
Size of operational land (ha)	1.0	0.6	0.4***	7.7
Gross cultivated area (ha)	2.0	1.3	0.7***	7.4
Cropping intensity (%)	198.0	205.0	–7.0***	3.1
Irrigated area (% of cropped area)	92.7	92.5	0.2	1.0
HHs having farming as primary occupation (%)	98.7	96.4	2.3	1.8
Migration for employment (number per HH)	0.3	0.4	–0.1	0.9
Monthly remittance (Nepalese rupees)	4,832	5,324	–492	0.6
Experience in farming (years)	24.1	25	–0.9	0.7
Number of plots per HH	8.3	6.9	1.4***	5.8

Source: Authors' calculations based on 2015 field survey.

Note: ha = hectare; HH = household.

*Significant at the 10 percent level. ***Significant at the 1 percent level.

One of the apprehensions related to CF in developing countries stems from the threat of exclusion of smallholders. The critics of CF argue that to reduce their transaction costs, firms can prefer to tie up with a few large farmers instead of dealing with a large number of smallholders. The distribution of sample households contracting in lentil indicates a reasonable presence of smallholders in the contractual arrangements. In the sample of contract farmers, around 60 percent are marginal and small with less than 1 ha of land, while this share for noncontract farmers is 85 percent (Table 6). The distribution of sample households based on caste also does not reveal any bias against lower-caste farmers. Tribals, Other Backward Castes, and Dalit castes constitute 78 percent of contract farmers and 76 percent of noncontract farmers. A similar pattern is evident in the case of education. Thus, the distribution of households does not reveal existence of any systemic bias against farmers on the basis of farm size, social caste group, or education.

Table 6. Distribution of sample households based on caste, education, and farm size (percentages)

Category	Contract	Noncontract
Education		
Illiterate	1.3	3.0
Primary	17.3	17.6
Middle	25.0	19.9
Secondary	44.0	49.7
Graduate and greater	12.3	9.9
Farm size***		
Marginal (< 0.5 ha)	17.7	39.7
Small (0.5–1.0 ha)	42.0	45.7
Medium (1.0–2.0 ha)	31.3	12.9
Large (≥ 2.0 ha)	9.00	1.7
Social group (caste)***		
Dalit castes	13.7	20.5
Tribal castes	35.7	38.7
Other Backward Castes	28.7	17.2
General castes	22.0	23.5

Source: Authors' calculations based on 2015 field survey.

Note: ha = hectare.

***Significant at the 1 percent level.

Costs and Returns in Lentil Cultivation

This section assesses the impact of CF on yield, production cost, output prices, and profits of lentil cultivators. The average yield of lentil is higher for contract growers (11.4 quintals/ha) than for noncontract producers (10.1 quintals/ha), and it differed significantly at the 1 percent level (Table 7). In addition, the average price realized by the contract farmers (NPR 8,886/quintal) was significantly

higher in relation to independent farmers (NPR 7,528/quintal). However, there is not much difference in the cost of cultivation between contract and independent farmers.

Table 7. Economics of cultivation of lentil for contract and noncontract farmers

Economics of cultivation	Contract	Noncontract	Percentage difference	Difference	*t* test of difference
Yield (Q/ha)	11.4	10.1	12.9	1.3***	4.5
Price (NPR/Q)	8,886	7,528	18.0	1,358***	15.5
Value of production (NPR/ha)	102,461	75,714	35.3	26,747***	11.5
Cost of cultivation (NPR/ha)	54,333	52,231	4.0	2,102	1.2
Cost of production (NPR/Q)	4,759	5,171	–8.0	–412*	1.7
Profit (NPR/ha)	48,128	23,482	105.0	24,646***	10.5
Profit (NPR/Q)	4,216	2,325	81.3	1,891***	10.2

Source: Authors' calculations based on 2015 field survey.

Note: Price represents average weighted price received by farmer by selling produce to various marketing channels or avenues. ha = hectare; NPR = Nepalese rupees; Q = quintal.
*Significant at the 10 percent level. ***Significant at the 1 percent level.

On average, contract farmers realize around 80 percent higher profits than do independent lentil growers. Moreover, the higher profit realization holds for all categories of farmers except large farmers (Table A.3). Important to note, marginal farmers seem to derive the greatest benefit from CF. The per unit profit for marginal contract farmers (NPR 4,440/quintal) is more than two times that of marginal independent farmers (NPR 2,059/quintal). In fact, per unit profit from participation in CF depicts an inverse relationship with farm size. Several studies examine the effects of CF. In general, studies report substantial positive impact on gross margins, crop income, or total household income (Wainaina, Okello, and Nzuma 2012; Kalamkar 2012; Ramaswami, Birthal, and Joshi 2006; Tripathi, Singh, and Singh 2005; Birthal, Joshi, and Gulati 2005; Singh 2002; Warning and Key 2002; Leung, Sethboonsarng, and Stefan 2008; Bellemare 2012; Michelson 2013; Miyata, Minot, and Hu 2009; Xu and Wang 2009; Zhu 2007; Simmons, Winters, and Patrick 2005). Our findings are consistent with the findings of the cited studies.

There can be several factors behind the observed increase in farmers' income from CF, such as better quality inputs, choice of appropriate technologies, and better realized price. CF in our case seems to make a significant difference in yield, price realization of the produce, and reduced cost of production. Consequently, contract farmers—especially smallholders—have improved profitability from lentil cultivation.

Note that the composition of cost of cultivation is similar for both contract and independent farmers. Labor expenses account for more than 24 percent of the total costs of lentil cultivation for contract

farmers and 27 percent for noncontract farmers (Table 8). Harvesting and threshing together constitute more than three-fourths of the labor costs for both categories of farmers. The input costs (predominantly seed cost) have a share of more than 10 percent in total costs. However, contract farmers have a relatively higher share of fertilizers (2.74 percent) in overall expenses than do noncontract farmers (1.89 percent). Also, there is more expenditure on using machinery and equipment among contract farmers (14.8 percent) than among their independent counterparts (12.1 percent). The details of costs by farm size for both contract and independent farmers are given in Table A.4.

Table 8. Composition of cost of cultivation of lentil in Nepal (percentages)

Head of costs	Percentage share in total cost of cultivation	
	Contract	Noncontract
Input costs		
Seed	8.6	8.9
Fertilizers	2.7	1.9
Farm yard manure	0.1	0.1
Labor costs		
Human labor	24.0	27.0
Bullock labor	0.9	2.2
Machine labor		
Ploughing	7.7	5.2
Threshing	6.4	5.4
Fixed costs		
Rental value of owned land	44.7	43.2
Rent for leased-in land	1.7	3.2
Land revenue tax	0.4	0.4
Other costs	0.1	0.0
Transport of produce to market	2.7	2.6

Source: Authors' calculations based on 2015 field survey.

Determinants of Participation in CF

This section identifies the determinants of lentil farmers' participation in CF using a logit model for this purpose. The dependent variable is the binary variable *participation in CF*, and explanatory variables include a variety of sociodemographic and economic characteristics such as age, gender, household size, education, caste, migration, access to mobile phone connectivity, and location (district) of the village. The choice of the explanatory variables was guided by previous empirical literature on the subject (for example, Bellemare 2012; Roy and Thorat 2008; Kumar, Shinoj, and Shivjee 2013; Fischer and Qaim 2012; Miyata, Minot, and Hu 2007).

Table 9 reports estimates of the regression model. The results reveal that household size, farm size, caste, location of village, and mobile phone connectivity are significantly associated with farmers' participation in CF. Households with small family sizes have a higher propensity to participate in CF. The relationship between land size and participation in CF is positive. Important to note, households with large farm sizes are significantly more likely to engage in CF. Other Backward Castes households are more likely to participate in CF than are Dalit households.

Table 9. Determinants of farmers' participation in contract farming in lentil

Dependent variable: Participation in contract				
Variable	Coefficient	Standard error	Marginal effect	Standard error
Sociodemographic variable				
Ln(age of household head)	0.237	(0.243)	0.059	(0.061)
Ln(household size)	–0.410*	(0.214)	–0.103*	(0.053)
Gender	0.012	(0.202)	0.003	(0.051)
Ln(operational land)	1.132***	(0.278)	0.283***	(0.069)
Migration	–0.910	(1.496)	–0.227	(0.374)
Caste				
General	0.106	(0.292)	0.026	(0.073)
Other Backward Castes	0.514*	(0.269)	0.129*	(0.067)
Tribal	–0.027	(0.385)	–0.007	(0.096)
Education level (highest in the family)				
Primary	0.151	(1.183)	0.038	(0.296)
Middle	0.693	(1.087)	0.173	(0.272)
Secondary	0.181	(1.042)	0.045	(0.260)
Graduate	0.558	(1.051)	0.139	(0.263)
Economic variable				
Main occupation	0.011	(0.829)	0.003	(0.207)
Ln(remittance)	0.062	(0.153)	0.016	(0.038)
Mobile phone	0.498**	(0.206)	0.124**	(0.051)
District dummy variable				
District dummy (Bardiya)	0.644*	(0.374)	0.161*	(0.094)
District dummy (Banke)	0.964**	(0.375)	0.241**	(0.093)
Constant	–0.964	(2.333)		
Pseudo R^2	.117			
Number of observations	602			
Log pseudo likelihood	–368.624			

Source: Authors'analysis based on field survey, 2015.

Note: Robust standard errors are in parentheses. Cluster is used on *village development council* variable.

*Significant at the 10 percent level. **Significant at the 5 percent level. ***Significant at the 1 percent level.

Education did not show any significant association with participation in CF. Many papers posit a positive relationship between education and CF (Zhu and Wang 2007; Arumugam et al. 2011; Hu 2012); a number of studies show a negative or insignificant relationship (Guo, Jolly, and Zhu 2005; Ramaswami, Birthal, and Joshi 2006; Miyata, Minot, and Hu 2009; Wang, Zhang, and Wu 2011;

Bellemare 2012; Ito, Bao, and Sun 2012; Wainaina, Okello, and Nzuma 2012; Wang, Yu, and Li 2013). Farmers who have access to mobile phones have a better chance of participating in CF. Age, gender, incidence of migration, education, main occupation, and remittance do not have any effect on households' participation in CF.

Determinants of Profitability: Role of CF

This section presents the results of the estimation of the impact of CF on net profits of lentil farmers in Nepal. Table 10 reports parameter estimates for both IV and OLS regressions. The first column reports parameter estimates of the first stage, similar to the coefficients reported in Table 9 except for the inclusion of the IVs as regressors. All the regressions include district fixed effects, and standard errors are clustered at the district level. The Hausman test shows endogeneity when IVs are *proportion of contract farmers in a ward* and *proportion of contract farmers by caste* (Table A.5). The second column of each specification in Table 10 shows that the contract has a significant positive impact on the unit profit of lentil farmers.

Table 10. Determinants of profit for lentil cultivators in Nepal

Dependent variable: Unit profit in lentil production (Nepalese rupees/kilogram)

Variable	Simple ordinary least squares	Two-stage least squares									
		Specification 1		Specification 2		Specification 3		Specification 4		Specification 5	
		First stage	Second stage	First stage	Second stage	First stage	Second stage	First stage	Second stage	First stage	Second stage
Contract farming	17.01***		35.73***		13.27*		36.65***		36.56***		22.82***
	(4.09)		(8.42)		(6.70)		(5.12)		(5.15)		(5.53)
Sociodemographic variable											
Ln(age of household head)	0.07	0.04	–0.85	0.06	0.25	0.01	–0.89	0.02	–0.89	0.05	–0.22
	(4.79)	(0.04)	(4.71)	(0.05)	(5.07)	(0.04)	(4.53)	(0.04)	(4.54)	(0.04)	(4.80)
Ln(household size)	–2.04	–0.06	–0.48	–0.07*	–2.36	–0.08**	–0.40	–0.08**	–0.41	–0.05	–1.56
	(1.77)	(0.04)	(1.64)	(0.04)	(1.56)	(0.03)	(1.28)	(0.03)	(1.31)	(0.04)	(1.46)
Gender	0.55	0.03	0.54	–0.01	0.55	0.03	0.54	0.03	0.54	0.02	0.55
	(1.42)	(0.04)	(1.51)	(0.04)	(1.46)	(0.04)	(1.53)	(0.04)	(1.53)	(0.05)	(1.40)
Ln(operational land)	0.98	0.21***	–3.49	0.18***	1.88	0.24***	–3.71	0.23***	–3.69	0.15***	–0.41
	(2.33)	(0.03)	(2.94)	(0.03)	(2.49)	(0.03)	(2.09)	(0.03)	(2.13)	(0.03)	(2.22)
Migration	4.79	–0.21	7.96	–0.10	4.12	–0.09	8.11	–0.10	8.10	–0.13	5.77
	(11.65)	(0.24)	(14.50)	(0.23)	(10.62)	(0.21)	(15.25)	(0.22)	(15.18)	(0.23)	(12.32)
Caste											
General	5.55	–0.14	5.23*	0.02	5.61	–0.06	5.21	–0.08	5.21	–0.12	5.45
	(3.06)	(0.09)	(2.60)	(0.05)	(3.20)	(0.04)	(2.69)	(0.07)	(2.69)	(0.08)	(2.91)
Other Backward Castes	–1.56	0.02	–3.62	0.10**	–1.15	0.11**	–3.72	0.09**	–3.72	0.02	–2.20
	(2.95)	(0.06)	(2.75)	(0.04)	(3.20)	(0.05)	(2.33)	(0.04)	(2.37)	(0.05)	(2.68)
Tribal	0.53	–0.21**	0.72	0.02	0.50	0.02	0.73	–0.02	0.73	–0.17*	0.59
	(3.05)	(0.10)	(2.47)	(0.09)	(3.26)	(0.04)	(2.51)	(0.09)	(2.50)	(0.09)	(2.81)
Education level (highest in the family)											
Primary	–5.56	0.05	–5.99	0.03	–5.47	0.04	–6.02	0.04	–6.02	0.05	–5.70
	(4.37)	(0.21)	(5.53)	(0.23)	(4.6)	(0.20)	(5.67)	(0.20)	(5.66)	(0.23)	(4.32)
Middle	–5.87	0.15	–8.42	0.11	–5.36	0.16	–8.55	0.16	–8.53	0.12	–6.66
	(6.93)	(0.19)	(7.32)	(0.22)	(7.02)	(0.18)	(7.27)	(0.18)	(7.27)	(0.22)	(6.66)
Secondary	–4.84	0.08	–5.36	0.06	–4.73	0.11	–5.39	0.11	–5.38	0.10	–5.0
	(6.85)	(0.18)	(6.31)	(0.19)	(7.10)	(0.16)	(6.30)	(0.17)	(6.30)	(0.19)	(6.42)
Graduate	–4.11	0.16	–6.03	0.13	–3.73	0.17	–6.13	0.17	–6.12	0.19	–4.71
	(8.89)	(0.18)	(8.80)	(0.20)	(8.72)	(0.16)	(8.61)	(0.17)	(8.63)	(0.20)	(8.36)
Economic variable											
Main occupation	10.37	0.03	10.51	–0.00	10.34	–0.02	10.52	–0.01	10.52	0.03	10.41
	(6.54)	(0.12)	(8.44)	(0.14)	(6.27)	(0.11)	(8.53)	(0.12)	(8.52)	(0.12)	(7.08)
Ln(Remittance)	–0.67	0.01	–0.88	0.00	–0.63	0.00	–0.89	0.00	–0.89	0.01	–0.74
	(1.15)	(0.02)	(1.45)	(0.02)	(1.07)	(0.02)	(1.51)	(0.02)	(1.51)	(0.02)	(1.23)
Mobile phone	–1.90	0.10**	–3.86	0.11***	–1.50	0.11**	–3.96	0.11**	–3.95	0.10**	–2.51
	(2.78)	(0.04)	(4.07)	(0.04)	(2.82)	(0.04)	(3.82)	(0.05)	(3.8)	(0.04)	(3.24)
Instrumental variable											
Proportion of contract farmers						0.01***		0.01***			
						(0.00)		(0.00)			
Proportion of contract farmers		0.01***						0.00		0.011***	
		(0.00)						(0.00)		(0.00)	
Organically certified produce				0.428***						0.41***	
				(0.092)						(0.09)	
Constant	20.11	0.23	–6.09	0.16	1.12	0.18	–6.38	0.17	–6.35	0.08	–1.94
	(24.88)	(0.37)	(18.60)	(0.43)	(20.54)	(0.30)	(19.20)	(0.30)	(19.14)	(0.38)	(19.49)

Observations	602	602	602	602	602	602	602	602	602	602	602
R^2	.25	.22	.13	.24	.24	.28	.12	.28	.12	.30	.23
Root MSE	22.24	0.45	23.91	0.44	22.31	0.432	24.07	0.43	24.06	0.42	22.41
District fixed effect	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Source: Authors'analysis based on field survey, 2015.

Note: Robust standard errors are in parentheses. Cluster is used on *village development council* variable. MSE = mean squared error.

*Significant at the 10 percent level. **Significant at the 5 percent level. ***Significant at the 1 percent level.

Contract farmers earn a higher profit ranging from NPR 13.27 per kg to NPR 35.72 per kg of production. Both the OLS and the two-stage least squares regression models provide evidence for significantly higher profits for contract farmers. While the OLS estimate shows an average increase of NPR 17.01 per kg of lentil in operating profits, the IV estimates show an increase ranging from NPR 13.27 per kg to NPR 35.73 per kg for different specifications. These figures come from our specifications, including district fixed effects, to account for observed and unobserved characteristics of locations.

Specification 1 makes use of *proportion of contract farmers by caste in a ward* as the IV. Specification 2 involves *a categorical variable representing farmers producing organically certified produce* as the IV. Specification 3 uses *proportion of contract farmers in a ward* as the IV. Specification 4 has two IVs: *proportion of contract farmers in a ward* and *proportion of contract farmers by caste in a ward*. Specification 5 uses two IVs: *proportion of contract farmers by caste in a ward* and *a categorical variable representing farmers producing organically certified produce* (please refer to equations 1 and 2 in the Methodology subsection).

5. Conclusions

Using data collected in 2015, this study quantifies the impacts of participation in CF in lentil on farmers' returns, yields, cost of production, and adoption of food safety measures at the farm level. Our results show that farm size and access to mobile phones are significant determinants of participation in CF. Family size and caste attributes also are related to participation in CF. Though an overwhelming majority of farmers in lentil cultivation are small farmers, there still is stratification, with land size positively associated; comparatively large farmers have a greater chance of participating in CF. Conditional on participation, contract farmers earn significantly higher profits, realize higher yields, and register lower costs of production.

These findings potentially have significant policy implications. One of the strongest criticisms of CF in developing countries stems from the perception that small farmers will be exploited by the "big" integrators (Gupta and Roy 2012). In fact, there has been an intense debate in the formal literature. Some researchers and policy makers perceive that CF is close to bonded labor, while the other group perceives that CF is the way out for promoting agricultural commercialization (Bellemare 2012). The (ADS 2014) has adequately emphasized promotion of agricultural commercialization and CF.

In this context, these findings suggest that CF can increase households' income substantially with minimum stratification among small farmers in terms of participation. Further, Nepal has the opportunity to exploit the huge Indian pulse market, which imports 2 to 3 million metric tons of pulses annually to meet its domestic demand. CF through a collective mechanism could be one of the most promising vehicles to increase lentil production and enhance quality to harness the potential of the neighboring international market. The Agribusiness Promotion Act, which is in the offing, can further give a boost to promote CF to harness this potential. The legal system for export licensing is in place, but adequate attention needs to be given to ensure the quality and safety of the produce. Policy makers in Nepal should devise appropriate strategies and mechanisms to promote CF in such commodities, which can contribute to enhancing farmers' welfare and mitigating poverty.

Appendix: Supplementary Tables

Table A.1 Distribution of sample households

District/village development council	Number of sample households	
	Contract farmers	**Noncontract farmers**
1. Banke	**112**	**89**
1.1 Bethani	68	56
1.2 Holiya	44	33
2. Bardia	**155**	**145**
2.1 Manpur	32	78
2.2 Sorhawa	123	67
3. Chitwan	**33**	**68**
3.1 Jagatpur	14	16
3.2 Parbatipur	9	27
3.3 Patihani	10	25
Total	**300**	**302**

Source: Authors' calculations based on field survey, 2015.

Table A.2 Description of variables used in the analysis

Sociodemographic variable	Specification
Ln(age of the household head)	Natural logarithm of age of the household head in years
Ln(household size)	Natural logarithm of number of persons in the household
Gender	= 1 if household headed by male; = 0 otherwise
Ln(operational land)	Natural logarithm of operated land by household in hectares
Migration	= 1 if any household member migrated for work; = 0 otherwise
Caste	
General	= 1 if the household belongs to general caste; = 0 otherwise
Other Backward Castes	= 1 if the household belongs to Other Backward Castes; = 0 otherwise
Tribal	= 1 if the household belongs to tribal caste; = 0 otherwise
Dalit: base category	
Education level (highest in the family)	
Illiterate: base category	
Primary	= 1 if any member of the household has 5 years of schooling; = 0 otherwise
Middle	= 1 if any member of the household has 8 years of schooling; = 0 otherwise
Secondary	= 1 if any member of the household has secondary or greater than secondary level of education; = 0 otherwise
Graduate	= 1 if any member of the household is a graduate or above; = 0 otherwise
Economic variable	
Main occupation	= 1 if main occupation is agriculture; = 0 otherwise
Ln(remittance)	Natural logarithm of monthly remittance of household in Nepalese rupees
Mobile phone	= 1 if household has mobile phone; 0 otherwise

Source: Authors' calculations based on field survey, 2015..

Table A.3 Farm size–wise particulars of cost of cultivation

Land size category	Contract	Noncontract	Percentage difference	Difference	*t* test of difference
Yield (Q/ha)					
Marginal (< 0.5 ha)	11.8	9.9	18.5	1.8***	–2.7
Small (0.5–1.0 ha)	11.3	10.1	11.8	1.2***	–3.0
Medium (1.0–2.0 ha)	11.7	10.6	10.8	1.1	–0.6
Large (≥ 2.0 ha)	10.5	10.1	4.0	0.4	–1.0
All	11.4	10.1	13.0	1.3***	–4.5
Price (NPR/Q)					
Marginal (< 0.5 ha)	8,641	7,427	16.3	1,214***	–9.9
Small (0.5–1.0 ha)	9,051	7,574	19.5	1,476***	–11.0
Medium (1.0–2.0 ha)	8,894	7,474	19.0	1,420***	–5.9
Large (≥ 2.0 ha)	8,742	8,025	8.9	716	–1.3
All	8,886	7,528	18.0	1,358***	–15.5
Value of production (NPR/ha)					
Marginal (< 0.5 ha)	105,687	72,298	46.2	33,390***	–7.0
Small (0.5–1.0 ha)	102,649	76,269	34.6	26,379***	–7.9
Medium (1.0–2.0 ha)	104,693	77,840	34.5	26,853***	–3.3
Large (≥ 2.0 ha)	89,554	90,169	–0.7	–615	–1.3
All	102,461	75,714	35.3	26,747***	–11.5
Cost of cultivation (NPR/ha)					
Marginal (< 0.5 ha)	53,485	51,865	3.1	1,620	–1.1
Small (0.5–1.0 ha)	55,476	53,179	4.3	2,297	–0.2
Medium (1.0–2.0 ha)	53,900	50,639	6.4	3,262	–1.6
Large (≥ 2.0 ha)	51,855	49,133	5.5	2,721	–1.1
All	54,333	52,231	4.0	2,102	–1.2
Cost of production (NPR/Q)					
Marginal (< 0.5 ha)	4,549	5,228	–13.0	–678	1.1
Small (0.5–1.0 ha)	4,922	5,277	–6.7	–355	0.7
Medium (1.0–2.0 ha)	4,596	4,783	–3.9	–186	–0.6
Large (≥ 2.0 ha)	4,942	4,868	1.5	74	–0.3
All	4,759	5,171	–8.0	–411*	1.7
Profit (NPR/ha)					
Marginal (< 0.5 ha)	52,203	20,433	155.5	31,770***	–6.5
Small (0.5–1.0 ha)	47,172	23,090	104.3	24,082***	–6.5
Medium (1.0–2.0 ha)	50,793	27,201	86.7	23,591***	–3.1
Large (≥ 2.0 ha)	37,700	41,036	–8.1	–3,336	–0.9
All	48,128	23,482	105.0	24,646***	–10.5
Profit (NPR/Q)					
Marginal (< 0.5 ha)	4,440	2,059	115.6	2,381***	–5.6
Small (0.5–1.0 ha)	4,185	2,291	82.7	1,894***	–6.4
Medium (1.0–2.0 ha)	4,331	2,569	68.6	1,762***	–3.5
Large (≥ 2.0 ha)	3,593	4,066	–11.6	–473	–0.5
All	4,216	2,325	81.3	1,891***	–10.2

Source: Authors' calculations based on field survey, 2015.Note: ha = hectare; NPR = Nepalese rupees; Q = quintal.

*Significant at the 10 percent level. ***Significant at the 1 percent level.

Table A.4 The economics of cultivation of lentil by contract and noncontract farmers

Particulars of cultivation (Nepalese rupees per hectare)	Contract	Noncontract	Difference	*t* test of difference
Labor costs	13,045	14,081	–1,036***	3.6
Seed	4,667	4,649	18	–0.1
Fertilizers	1,489	988	501**	–2.4
Farm yard manure	31	47	–16	0.5
Miscellaneous inputs	45	20	25	–1.3
Rent for machinery	8,166	6,673	1,493***	–3.3
Rental value of owned land	25,293	24,103	1,190	–1.2
Rent for leased-in land	27,070	29,531	–2,461	–0.1
Land revenue tax	197	231	–34	1.3
Transportation cost	1,448	1,330	118	0.4
Total cost of cultivation	54,333	52,231	2,102	–1.2

Source: Authors' calculations based on field survey, 2015.
**Significant at the 5 percent level. ***Significant at the 1 percent level.

Table A.5 Hausman's test for endogeneity in the profit equation using various specifications of instrumental variables

Dependent variable: Unit profit in lentil production (Nepalese rupees per kilogram)					
Variable	Specification 1 IV = proportion of contract farmers by caste in a ward	Specification 2 IV = organically certified produce	Specification 3 IV = proportion of contract farmers in a ward	Specification 4 IVs = 1. proportion of contract farmers in a ward, and 2. proportion of contract farmers by caste in a ward	Specification 5 IVs = 1. organically certified produce, and 2. proportion of contract farmers by caste in a ward
Contract farming	34.74*** (6.48)	14.01*** (4.92)	36.75*** (5.01)	35.90*** (4.88)	21.38*** (4.30)
Sociodemographic variable					
Ln(age of HH head)	–0.04 –3.06	–0.01 (3.08)	–0.56 (3.03)	–0.47 (3.03)	0.15 (3.07)
Ln(HH size)	–1.71 (2.35)	–2.05 (2.36)	–2.31 (2.32)	–2.12 (2.32)	–1.95 (2.36)
Gender	1.13 (2.45)	0.58 (2.46)	1.27 (2.42)	1.35 (2.43)	0.65 (2.45)
Ln(operational land)	0.70 (1.66)	1.13 (1.69)	1.72 (1.65)	1.45 (1.65)	0.70 (1.69)
Migration	3.79 (12.69)	4.55 (12.77)	5.97 (12.58)	5.32 (12.58)	4.89 (12.76)
Caste					
General	2.37 (4.34)	5.52 (4.22)	3.89 (4.18)	2.94 (4.21)	4.84 (4.26)
Other Backward Castes	–3.27 (3.07)	–1.57 (3.03)	–1.29 (2.99)	–2.04 (2.99)	–1.96 (3.05)
Tribal	–3.52 (4.09)	0.42 (3.87)	1.11 (3.81)	–0.66 (3.82)	–0.28 (3.92)
Education level (highest in the family)					
Primary	–5.05 (6.74)	–5.58 (6.78)	–5.13 (6.68)	–5.01 (6.68)	–5.41 (6.78)
Middle	–5.42 (6.67)	–5.83 (6.72)	–4.94 (6.62)	–4.95 (6.62)	–5.82 (6.71)
Secondary	–3.72 (6.61)	–4.97 (6.65)	–2.97 (6.56)	–2.90 (6.56)	–4.38 (6.65)
Graduate	–2.72 (7.28)	–4.29 (7.32)	–2.31 (7.22)	–2.12 (7.22)	–3.53 (7.33)
Economic variable					
Main occupation	11.09* (6.09)	10.35* (6.13)	10.17* (6.04)	10.51* (6.04)	10.57* (6.13)
Ln(remittance)	–0.62 (1.31)	–0.65 (1.32)	–0.84 (1.30)	–0.78 (1.30)	–0.70 (1.32)
Mobile phone	–1.88 (2.04)	–1.95 (2.06)	–1.44 (2.03)	–1.53 (2.03)	–1.82 (2.06)
Ehat	**–19.41***** (6.76)	**3.47** (5.20)	**–23.22***** (5.40)	**–22.32***** (5.29)	**–5.41** (4.74)
Constant	10.67 (15.35)	21.98 (15.36)	10.85 (15.03)	10.91 (15.04)	17.25 (15.29)
Observations	602	602	602	602	602
R^2	.26	.25	.27	.27	.25
Root MSE	22.10	22.25	21.92	21.93	22.23
District fixed effect	Y	Y	Y	Y	Y

Source: Authors' calculations based on field survey, 2015.
Note: HH = household; IV = instrumental variable; MSE = mean squared error.
*Significant at the 10 percent level. ***Significant at the 1 percent level.

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Acknowledgments

We are grateful to the United States Agency for International Development for extending financial support to conduct this study through the Policy Reform Initiative Project in Nepal. We thank Dr. Bishnu Dev Pant, executive director of the Institute for Integrated Development Studies (IIDS), Kathmandu, Nepal, and other staff of IIDS for their support in conducting the field survey successfully. We are grateful to Dr. Deva Bhakta Shakya for his expert advice and guidance during the study. We express our sincere thanks to all the farmers who provided the needed information for accomplishment of this study.