

Title: Economic Analysis of Farm Labor and Profitability of Three Tribal Villages in Nepal

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Tribal villages in central Nepal practice traditional farming techniques that contribute to ongoing decreases in agricultural productivity. The introduction of conservation agriculture practices, such as strip tilling and intercropping with nitrogen-fixing legumes can increase long-term farm profitability and ensure long-term soil productivity. Survey and trial plot data from three tribal villages is used to provide an analysis of profitability and labor requirements associated with strip tillage, intercropping, and crop selection. Results have implications for food security, government policy, and regional agribusiness opportunities.

Introduction

International efforts to reduce the number of people facing threats to food security struggle against increasing populations and decreasing availability of productive farmland. Climate change exacerbates the problem for the majority of the world's rural poor who live in areas that have meager natural resources and are prone to climate risk (Hobbs et al., 2007). In these areas, minor climatic changes can have devastating consequences for their livelihoods and survival. Crop production in the near term will have to produce more food using less land by efficiently managing natural resources and minimizing harm to the environment. The introduction of conservation agriculture practices can help food production meet global demand and preserve land fertility (Hobbs et al., 2007). This makes the incorporation of agricultural sustainability practices into farming practices an imperative (Altieri and Koohafkan, 2008).

In Nepal, agricultural production is vital to the livelihoods of the rural poor who often live in isolated areas and experience considerable income disparity with those who live in urban environments. Traditional agriculture practices coupled with intensive farming has led to soil degradation, elevated erosion rates, and declines in agricultural productivity (Neupane et al, 2001). Modern conservation agriculture (CA) strategies, such as reduced tillage and legume intercropping have the potential to increase soil fertility and reduce soil loss, thereby increasing the food security and economic independence of rural farmers.

This paper presents household-level socio-economic data and the results of CA treatments on trial plots in three such villages and offers both near- and long-term recommendations for the improvement of regional livelihoods and food security.

Goals and Objectives

The primary goal of this study is to promote the adoption of conservation agriculture production systems (CAPS) in order to increase food security and improve the livelihoods of tribal subsistence farmers who intensively cultivate marginal lands using traditional practices. By conducting an economic analysis of survey data and trial plot results from three agrarian villages the Middle Hills region of Nepal, this study should help establish a case for the economic benefits, in terms of labor and profitability, of adopting one or more CAPS in the region. The

secondary goal of this work is to report socio-economic conditions of village communities for the purpose of aiding regional policymakers, extension agents, and researchers.

Specific objectives are:

1. Build a household-level budget enterprise model using survey and experimental plot data to determine the total crop value and labor required for current farmer practice and three selected CAPS.
2. Compare strategies and rank each by economic benefit in terms of profitability, labor required and disproportional changes in labor for either gender.
3. Explore avenues for further research and provide recommendations for policy makers.

Procedures

The methodological framework of this study was carried out in the following 5 steps:

1. Three villages in Nepal's Himalayan foothills (Thumka, Hyakrang, and Khola Gaun) were selected based on site accessibility and predominance of shifting cultivation and sloped plots.
2. 50% of heads of household (39 out of 77) were surveyed using comprehensive socio-economic assessments.
3. Farmer focus groups, literature review, and expert opinion were used to select one control and three CA treatments (Table 1, below).
4. Nine 80 m² trial fields were established in each village. Each field consists of four 4x5 m plots and each plot contains one of four treatments.
5. A farm budget model using plot and survey data was developed to determine potential profitability and labor required for each of the four treatments.

Household data used specifically in this study include household size, education levels, farm plot size, cropping patterns, production costs, yields, market transactions and income. Surveys were conducted in January, March, and August of 2011.

A traditional production system using conventional tillage to produce maize (*Zea mays*) and millet (*Eleusine coracana*) in succession was chosen as a control (T1) and was compared to three CA treatments that incorporate cowpea (*Vigna unguiculata*), a nitrogen-fixing legume (T2, T3, and T4). These treatments were designed to test the effects of legume intercropping and strip tillage on profitability as well as gender-specific and total labor requirements.

In each treatment, maize was cultivated in the first growing season beginning in mid to late spring. This was followed in late summer by the second season crops: millet, cowpea, or both. The third growing season begins in fall and fields are typically left fallow or a cover crop is used. This analysis was conducted in the third growing season, the results of which are not considered here.

Table 1: Conservation Agriculture (CA) Treatments, Thumka, Hyakrang, and Khola Gaun.

Treatments	CA Practices (Abbreviations)
Maize to Millet, Conventional Tillage	T1: CONTROL: CT M

Maize to Cowpea, Conventional Tillage	T2: CT CP
Maize to Cowpea/Millet Intercrop Conventional Tillage	T3: CT CP/M
Maize to Cowpea/Millet Intercrop Strip Tillage	T4: ST CP/M

(Source: Survey Data 2011)

Results and Discussion

Table 2 presents several important socio-demographic features of the sample population. Average household size varies considerably among villages, possibly due in part to varying distances of off-farm employment opportunities, access to external resources and availability of exchange labor. Primary education is most common although each household typically has at least one member with a middle or high school education.

Average annual income is slightly lower in Thumka than in the other villages. Factors influencing annual income include age and gender of household members, farm size, number and type of livestock, alternative employment opportunities, crop yields, and distance to markets.

Approximately 32% of total household income in Thumka and Khola Gaun comes from the sale of crops, as does half (51%) of the total household income for Hykrang. The majority of remaining income comes from remittance although nearby off-farm employment and livestock sales can contribute up to 40% of total household income in some cases (Survey data, 2011). Occasionally, there is a need for skilled labor (such as welding) in or around the village with compensation sometimes taking the form of exchange agricultural labor.

Table 2: Selected Socio-economic Factors of Three Villages in U.S. Dollars (USD) and hectares (ha).

Village (# of households)	Annual Income	Size of Household	Highest level of Education	Farm Size (ha)	Major Staple Crops Grown	Maize Yield (MT/ha)
Thumka (25)	USD \$554	10	Primary	.62	Rice, Maize	2.3
Hykrang (36)	USD \$622	7	Primary	.63	Rice, Maize	2.6
Khola Gaun (16)	USD \$627	6	Primary	.58	Rice, Maize	2.7

(Source: Survey data, 2011). Values are averages. Maize yields are net of cob weight.

Agricultural input costs are nearly zero due to the prevalent use of retained seeds and farmyard manure fertilization. For this reason, labor is considered the primary cost driver for production. In analyzing labor input, it is important to consider opportunity costs as they relate to gender; females have little or no opportunity costs due to lack of employment opportunities.

In season one, maize was grown on all plots and all variation in labor hours is a result of strip tillage (vs. conventional tillage) on plots T3 and T4. In season two, millet and cowpea were monocropped for the T1 and T2 plots, respectively, and intercropped for T3 and T4 plots (Table 3). Labor hours for land preparation, weeding, and harvest activities are significantly different among treatments while sowing and fertilization labor hours show little no change.

Table 3: Labor Hours Required (ha⁻¹) by Gender for select activities*

Treatment	Land Preparation		Sowing Cowpea		Sowing Millet		Fertilization		Weeding		Harvest		Total by Gender		TOTAL
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	
T1**	127.43	32.82			50.57	42.93	3.36	59.50	71.67	103.10	77.30	200.22	388.44	503.01	891.44
T2	109.34	17.46	26.94	22.87			3.36	59.50	62.39	86.61	119.81	192.26	379.96	443.14	823.10
	-14.19%	-46.80%							▼12.94%	▼16.00%	55.00%	-3.97%	-2.18%	-11.90%	-7.67%
T3	129.67	34.73	26.75	22.70	26.75	22.70	3.36	59.50	72.80	105.16	126.55	234.29	444.00	543.53	987.53
	1.76%	5.82%							▼1.58%	▼1.99%	63.71%	17.02%	14.30%	8.06%	10.78%
T4	127.20	33.30	25.66	21.78	25.66	21.78	3.36	59.50	60.69	92.96	117.27	197.00	417.97	490.77	908.74
	-0.18%	1.47%							▼15.31%	▼9.83%	51.71%	-1.60%	7.60%	-2.43%	1.94%

Source: Household Survey Data, 2011 and Farm Trial Data, LI-BIRD 2011.

* Some activities, such as sowing maize, are not shown in Table 3 but are included in the Total by Gender and TOTAL calculations.

** T1 is traditional farmer practice and serves as an experimental control.

Blank cells indicate activities that were not conducted per treatment plan.

T2 (cowpea monocrop) requires the least amount of labor of all treatments, reduces the labor burden on household females by close to 12% and reduces the total labor burden by 7.67% compared to current farmer practice, T1 (millet monocrop with conventional tillage). A significant factor contributing to higher labor requirements for other treatments (T1, T3 and T4) is that millet must first be planted in a nursery then transplanted to the field by hand once it sprouts.

T3 requires the highest amount of labor and T4 follows, reflecting reduced labor associated with strip tillage (T4) versus conventional tillage (T3). High labor requirements for these two treatments are primarily attributed to the difficulty of harvesting intercropped plants. Both intercrop treatments require more male labor compared to farmer practice. Notably, T4 has the least effect on division of labor by gender and on total labor requirement, both of which are important considerations in terms of adoptability.

Three measures of profitability are used in this analysis and are based off of the total value of all yields if sold at current market prices. Profit, Family Labor is the profit that can be expected if only family labor is used, which is typical, while Profit, Hired Labor is the profit that can be expected if only hired labor from the community is used. However, the most accurate measure of profitability is Profit with Opportunity Costs, which adjusts profitability for the availability of higher paying off-farm work for young, able-bodied males who, for this analysis, are defined as males between 18 and 35 years of age that are living in the household (average of 14.5% per household; Survey Data, 2011). This figure is labeled Labor O.C. in Table 4.

Table 4. Projected Profitability of Trial Plot Treatments in USD ha⁻¹.

Treatment	Maize Yield (kg)	Cowpea Yield (kg)	Millet Yield (kg)	Revenue	Hired Labor Cost	Labor O.C.	Profit, Family Labor	Profit, Hired Labor	Profit w/ O.C.
T1	1107.00		665.75	\$ 822.85	\$339.19	\$59.02	\$822.85	\$483.66	\$763.83
T2	1161.00	695.57		\$ 1,327.66	\$313.18	\$54.49	\$1,327.66	\$1,014.47	\$1,273.16
	4.88%			61.35%	-7.67%	-7.67%	61.35%	109.75%	66.68%
T3	1147.50	491.64	321.44	\$ 1,234.59	\$375.74	\$65.38	\$1,234.59	\$858.84	\$1,169.21
	3.66%			50.04%	10.78%	10.78%	50.04%	77.57%	53.07%
T4	1129.95	448.73	260.58	\$ 1,153.09	\$345.77	\$60.16	\$1,153.09	\$807.32	\$1,092.92
	2.07%			40.13%	1.94%	1.94%	40.13%	66.92%	43.09%

Conversion Rate: 1 Nepalese Rupee (NPR) to USD 0.0120 (Last updated 30 April 2012).

In terms of overall profitability, T2 is the highest and farmer practice (T1) is the lowest among all treatments. The reason for this is twofold; cowpea prices are more than double that of millet (\$1.10 and \$0.54 kg⁻¹, respectively) and total labor costs for cowpea production are lowest.

Among the intercropped treatments, T3 is the most profitable. This reflects reduced crop yields and labor requirements resulting from strip tillage (T4). Although the introduction of strip tillage has shown no significant reduction of yields in some cases (Lithourgidis *et al.*, 2005), it often reduces yields in the short term. It is expected that the benefits of legume intercropping and strip tillage, chiefly increased soil fertility, will be realized only after several seasons.

Conclusion

The results of this study support the notion that modern conservation agriculture systems can improve the livelihoods of subsistence farmers by increasing profitability and long-term yields. Of the production systems studied, the current farmer practice of millet monocropping was least profitable while cowpea monocropping was most profitable and required the least amount of labor. However, in the long term, strip tillage with millet and cowpea intercropping may prove the most suitable for adoption as its labor requirement is most in line with current gender-specific division of labor and its profitability may exceed other treatments once the benefits of strip tillage take effect over the long-term.

Strip tillage and millet/cowpea intercrop not only optimize and conserve soil quality, they provide farmers with more diverse yields. Although millet prices are lower than cowpea, its value to farmers may not be fully reflected in market price as it is rarely grown specifically for sale, provides vital livestock fodder in the winter and is used in most cultural and social functions.

Based on these results, the provision of high-quality, high-value legume seeds for intercropping and cover cropping are recommended in the near term to improve regional food security and smallholder livelihoods. Once field trials are complete, this analysis should be repeated to determine the effectiveness and profitability of long-term strategies such as strip tillage. If strip tillage and intercropping treatment (T4) proves the most profitable in the long term, the government could offer subsidies in the form of yield offset payments or improved seeds. This might also provide opportunities for agribusinesses to supply new seeds and provide training for their use.

Suggested avenues for further research include a non-market valuation of traditional crops, such as millet, an in-depth analysis of gender roles as they relate to agricultural production and a search for alternative crop varieties that may be targeted for CAPS trials.

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