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An Analysis of Labour Use Pattern in Thirappane Village Tank Cascade System in Sri Lanka: Determinants and Potential Effects of Off-farm Employment

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ABSTRACT

Participation in off-farm employment is a strategy adopted by farmers in many developing countries to increase and stabilize their incomes. However, empirical evidence on its effects on management of natural resources is context specific. This study examines the pattern on labor use with special emphasis on determinants and potential effects of participation in off-farm employment by the villagers reside in Thirappane tank cascade system in Sri Lanka. Data gathered from a primary survey conducted among 134 households were used for analysis. The results of probit models revealed that the farmers who possess agricultural assets have a higher probability of joining employment in other-farms and those who are educated and own large farms participate in non-farm sector employment. Community management of the village tank cascade systems will be challenging owing to the increased interest in off-farm activities by the able.

Keywords: Agriculture, Irrigation, Natural Resource Management, Probit Model, Off-farm Employment

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Introduction

The sites with outstanding landscapes of aesthetic beauty that combine agricultural biodiversity, resilient ecosystems and a valuable cultural heritage are being listed as Globally Important Agricultural Heritage Systems (GIAHS) by the Food and Agriculture Organization (FAO, 2017). The Village Tank Cascade Systems (VTCSs) of Sri Lanka are the newest addition to GIAHS. VTCSs are rainwater harvesting models that efficiently store, convey and utilize rainwater for agricultural and other purposes. They are characterized by a collection of a connected series of tanks organized within a micro catchment. The total number of both functioning and abandoned tanks in the Dry Zone is 18,387 according to Panabokke *et al.*, (2002) and the extent under VTCSs is 246,000 ha as reported by IUCN (2015). VTCSs are proven to be drought-prone systems that are worthy of preservation, enhancement and popularization to combat climate change. According to Madduma Bandara (1985), sustainable use of VTCSs however requires regular maintenance of each tank and channel in the VTCS, conservation and utilization of agro-biodiversity, use of appropriate varieties and animal species, allocation of lands and water exclusively for animals and birds, etc. In ancient times, the majority of the residents were full-time farmers and VTCSs were well managed by the village communities. According to the historical evidences, a semi-feudal system known as "*Rajakariya*" was the initial communal management practice in the VTCSs. After abolishing this system in 1957, a power transition took place and state agencies were given some authority and recognition. At present, different institutions from the national to village level have been made responsible for developing, using, investigating, and protecting water resources in Sri Lanka (Dharmasena, 2004).

A negligence in maintenance of certain components of VTCSs is observed in the present era leading to accumulation of pollutants and degradation of the eco-system services provision. Since the excess water flows from upper tanks to the lower tanks, in the absence of wetlands with plants to capture heavy metals, the pollutants could run through the system, causing a cumulatively increase in pollutants in the tail-end tank of this sequence leading to eutrophication. Once a tank is subjected to eutrophication, its water cannot be used for household uses such as drinking and bathing.

Recognizing the above need, a few governmental and non-governmental agencies implemented several development projects to restore some selected VTCSs. Replanting the vegetation, partial de-siltation of the tanks, restoring the tank components etc. were the activities implemented by these projects. Further, awareness programmes were carried out, paying special attention to the importance of ecological functions provided by the cascade system, causes for the degradation, and human health effects of degradation. Strengthening of local institutions and development of capacity through training of farmers on soil and water conservation were also conducted. Organic farming in the cascade system was promoted through the training of farmers on the preparation of organic fertilizers and bio-pesticides. Cascade Management Committees were established to bring all stakeholders of cascade resources to one platform, discuss issues and make decisions on sustainable use and management of the natural resources of the cascade.

Proper implementation of these strategies requires community participation. A good knowledge of pattern of use of labor, which is the primary input for all production and conservation activities in VTCSs hence is required. According to Nanthakumaran et al. (2022), out-migration and engagement in non-farm and off-farm activities largely contributed to the degradation of environmental services provided by the VTCS. Though crop enterprise played a leading role in the income and income source of the rural villagers (Perera et al., 2005), farmers could not sustain their families on crop cultivation alone, as the extent of land was limited. Therefore, many of them engaged in several other income-generating activities even in the historical times. Cattle rearing, tank-fish harvesting, and lotus root and flower harvesting were some of the income sources of the communities of the VTCSs (Bandara *et al.*, 2010). Brick manufacturing, pottery and *cadjan* weaving were common non-farm activities present in VTCSs (Navaratne, 2000). The studies conducted on socio-economic aspects of VTCSs in Sri Lanka (Dayananda, 2020; Kahathuduwa and Prasada, 2022; Ratnayake et al., 2021; Sirimanna et al., 2022) however do not provide a detailed account of labor use pattern in the present era.

In light of the above discussion, this study assesses the labor use pattern with special emphasis on determinants and potential implications of off-farm employment in a selected VTCS of Sri Lanka. The objectives of this study are (i) to describe the pattern of labor usage in various on-farm and off-farm activities, (ii) to ascertain the likelihood and determinants of participation in various off-farm activities, and (iii) to identify likely effects of participation in off-farm employment on natural resource management.

This paper is organized as follows. The next section provides a review of literature related to off-farm employment and its determinants and effects. The following section provides the empirical approach. The study area and data are presented next. Results are discussed in the following section. The paper ends with conclusions.

Literature Review

Off-farm activities have been becoming an important component of livelihood strategies among rural households in most developing countries. Several studies have reported a substantial and increasing share of off-farm income in total household income (De Janvry & Sadoulet, 2001; Joshi et al., 2007; Ruben et al., 2001). It is evident that engagement in off-farm activities, be they non-farm or in farms other than own farm, has increased and stabilized rural residents' income, slowed down rural-urban migration, contributed to economic growth, and narrowed down income disparities by giving employment opportunities to the poor. A large body of literature is available in examining the labour market participation of farmers using alternative approaches. The agricultural household model, which describes how a farm household allocates its time (and other resources) among producing commodities, earning off-farm income, leisure, and home production, has been the predominant approach (Kimhi, 1994; Kimhi & Rapaport, 2004; Lass et al., 1989; Lass & Gempesaw, 1992; Singh et al., 1986). Kimhi (1996) modelled farmers' time allocation decisions between farm work and off-farm work and they were regressed with personal characteristics, farm activities and local labour market conditions using a fixed-effect model to capture the group effects. Weersink et al. (1998) evaluated the determinants of off-farm work using Heckman's two-stage model. van Leeuwen & Dekkers (2013) examined the determinants of off-farm employment, paying special attention to the spatial characteristics using a spatial microsimulation approach. Farquharson & Cook (2015) examined the financial and the opportunity cost of agriculture labour for rice in Cambodia using a Linear Programming approach. They generated crop choices under alternative opportunities for off-farm work for different land and family labour types.

Despite this growing body of literature on off-farm employment, the evidence on the effects of off-farm employment on the efficiency of farming and on-farm and off-farm environmental conservation are found to be mixed. In certain areas, participation in off-farm activities has led to a decline in own-farm agricultural production due to competition for family labour between farm and off-farm works. In some other areas, it was found that there exist elements of complementarities and positive spill-over effects between the farm and off-farm sectors of the rural economy. In a study conducted by Issahaku &Abdul-Rahaman (2019), using an agricultural household (bivariate probit) model, concluded that off-farm employment not only alleviates poverty but also helps in environmental conservation. Similar results were obtained by Pfeiffer et al. (2009) and Lien et al. (2010). They found significant positive impacts of off-farm income on-farm efficiency among Mexican and Norwegian farmers, respectively. Fernandez-Cornejo et al. (2007), who examined off-farm income, technology adoption and farm economic performance under alternative size classes, found that small farms improve their economic performance by compensating for scale disadvantage with more off-farm work. They found that off-farm reduces farm-level technical efficiency by improving household technical efficiency and adopting agricultural innovations that save managerial time is associated with higher off-farm income.

In contrast, Mduma (2007), Kilic et al. (2009), Goodwin & Mishra (2004), Chang &Wen (2011) and Chavas et al. (2005) showed that off-farm income impacted negatively on-farm efficiency in different settings. Mduma (2007) specified the soil conservation problem as an optimal control problem and evaluated technological adoption treating farmer characteristics, plot characteristics and off-farm work as potential determinants in Tanzania. It was found that those who engage in off-farm activities associated with less adoption of terraces, hedge-rows and cut-offs. According to the findings of Holden et al. (2004), in Ethiopia, access to non-farm income reduces farm households' incentives to invest in conservation, leading to more overall soil erosion and more rapid land degradation even though the intensity of production is reduced. Nedumaran &Singh (2017) assessed the trade-off between non-farm income and on-farm soil and water conservation investment by smallholder farmers in the semi-arid tropics of India using a dynamic bioeconomic model. The simulation results revealed improved non-farm employment opportunities in the village increase household welfare but reduce the households' incentive to use labor for conservation, leading to higher levels of soil erosion and rapid land degradation in the watershed. This indicates that returns to labor are higher in non-farm than on-farm employment opportunities in the village. This appears to be no win-win benefits from improving access to non-farm income in Semi-Arid Tropics rain-fed farming villages.

McNally (2002) addressed whether the Other Gainful Activities (OGA) are good for the environment by testing two hypotheses, i.e., (i) OGAs are associated with the adoption of less intensive enterprises and farm practices, and (ii) OGA engaged farmers might be having values and objectives that are more environmentally friendly than full-time farmers. It was found that OGA engaged farmers to tend to attempt to improve bio-diversity in their farms deliberately, but the effects on cropping intensities are either small and positive or negative. More recently, Chang et al. (2022) assessed the effects of off-farm employment on agricultural productivity (APE) efficiency and found that off-farm employment contributed to a low level of APE and both self-employed off-farm employment and wage-based off-farm employment result in lower APE.It is clear from the above discussion that despite beneficial economic effects of off-farm employment, participation in such has the ability to reduce time allocated for sustainable land management both in private and communal lands. Since time allocation data is not available for many researchers, they relied on resulting outcomes such as non-farm income, off-farm income, degradation of agricultural lands, perceptions on environmental conservation etc. to investigate inter-relationships across these activities in many regions in the world.

Empirical Approach

Pattern of Labour Use

In this study, labor use for on-farm activities is presented using labor use in different crop management practices. Off-farm employment, which involves activities other than in own farm, were identified under two categories; other-farm and non-farm. The ‘other-farm’ employment includes employment in farms other than the own farm and it includes wage work, renting of agricultural machinery, and selling other agricultural inputs (seeds, organic fertilizers, etc.). Non-farm employment involves all the engagements in non-farm activities and they include employment in the government and private sector and self-employment.

Determinants of Off-farm Employment

As stated earlier, a large body of literature addresses participation decisions in various off-farm and non-farm activities. According to FAO (1998), two major categories of factors determine a household decision to participate in off-farm activities. The first comprises factors that influence the relative returns to agricultural production and related risks, while the second includes factors that affect the household's participation capability. These categories coincide with the distress-push and demand-pull diversification strategies discussed above, and they are certainly interrelated. Farm and household characteristics, such as the asset position and human capital endowment, as well as contextual and institutional variables, such as access to markets and infrastructure conditions, have been considered as the key determinants (De Janvry & Sadoulet, 2001; Ruben et al., 2001; Woldenhanna & Oskam, 2001).

Accordingly, the determinants of off-farm and non-farm labour market participation were estimated using the following probit model.

Probability of engagement in off-farm work = f (age, gender, education level, farming experience, family size, land extent, relative earnings from farm and off-farm, asset ownership)

Three models were estimated treating employment in other-farms, non-farm sector and off-farm as dependent variables. They were measured as binary variables; a value of 1 was given for those who engaged in the activity and 0 otherwise. Age was measured in years, gender was considered as a binary variable treating female as 1, the farming experience was measured by a number of years and land extent was measured by acres. Asset ownership was measured as a binary variable and small tractor, large tractor, plough, hoes sprayers and pumps were considered as the key assets (1 if owned and 0 otherwise). Education was measured as a rank variable with six (6) categories, namely no school education, up-to grade 5, up-to O/L, up-to A/L, diploma and bachelor.

Relationships among Off-farm Employment and Natural Resource Management

This study related agricultural input intensities and perceptions on the status of natural resources and environmental conservation with participation of off farm employment using a correlational analysis. Usage of hired labour and fertilizer per unit area were the intensity measures used. In absence of data on community management of natural resources, four variables namely (i) perception about the quality of water in tanks, (ii) importance of improvement of water quality of tanks, (iii) perception about the functioning of tank cascade system, and (iv) need for improvement in the functioning of the tank cascade were considered. Responses to these variables were obtained from a Likert scale. This analysis was conducted following McNally (2002) who mainly used expenditures on fertilizers and pesticides per unit area as the crop intensity measures and "attempts to improve environmental quality" for the analysis.

Study Area and Data

The location of the study is the Thirappane tank cascade located in the Dry Zone of Sri Lanka within the Anuradhapura. The cascade is 30km south of Anuradhapura (the main city of North Central province in Sri Lanka). Figure 1 provides a map.

Thirappane tank cascade is a linear cascade with six interconnected (6) tanks, namely Thirappane tank, Alisthan tank, Vendarankulama tank, Meegassagama tank, Bulankulama tank and Badugama Tank. The distance between most upstream to downstream is 8 km while 2 km wide. The cascade covers around 2,200 ha with a command (irrigable) area of 207 ha. The total capacity of the tanks is 1,988,373 m^3. Land is allocated for cropland, forest land, Barren land and teak plantations. Table 1 provides the basic characteristics of the system.

Figure 1. ***Location of the Study Area***
Source: Kanthilanka (2022)

Note: (a) Location of Anuradhpura district
(b) Map of Divisional secretory divisions in Anuradhapura district, A; Thirappane divisional secretary division (DS division)
(c) Map of GramaNiladhri divisions in Thirappane DS division, A; Thirapanagama, B; Alisthna, C; Diyagama, D; WanamalUyana

Table 1. Land Use within Thirappane Tank Cascade

Land Use Category	Land Use	Area	
		Acres	Percentage
Agriculture	Chena	709.82	13.02
	Homestead	723.98	13.28
	Other plantation	198.69	3.65
	Paddy	511.60	9.38
	Sub Total	**2,144.09**	**39.33**
Natural Vegetation	Forest	1,611.09	29.55
	Scrubland	894.55	16.41
	Sub Total	**2,505.59**	**45.97**
Other	Road	204.38	3.75
	Rock	0.82	0.01
	Sub Total	**205.19**	**3.76**
Water	Stream		
	Tank area	596.25	10.94
	Sub Total	**596.25**	**10.94**
Grand Total		**5,451.17**	**100.00**

Source: NRMC, Peradeniya (2017)

Rice is the main crop cultivated in lowland within the tank cascade system in both seasons (*Yala* and *Maha*). It is cultivated under flooding conditions and the tanks provide the required water for irrigation throughout the growing season. Farmers cultivate short term (3 months), medium-term (3.5 months) and long term (4 months) rice varieties based on the availability of allocated water for rice cultivation. Other field crops, including vegetables, fruits and other perennial crops, are cultivated in the upland areas. Small patch of Chena cultivation, a rainfed upland crop cultivation system with limited inputs, is observed. Land use details within the cascade are given in table 1. Data was collected from 134 farming households in the Thirappane VTCS. Face to face interviews were conducted with heads of farming households with the CommCare tool to collect necessary data (https://www.dimagi.com/commcare/). The questions were related to socio-economic details of farming family, farming activities, labor use, farm financing, livestock, farm assets and perception about the water quality of the tanks. Socio-economic and demographic data (age, education, farming experience and sources of income), characteristics of the farm (farm size and number of plots), input usage (fertilizer, seed, labor etc.) were obtained. Data on labor use was obtained for land preparation, planting, fertilizer application, weed management, pest management, irrigation and harvesting.

Table 2 provides individual tanks with respective GN divisions covered in the survey. The total number of farmers in the cascade was 272. The list of farmers was obtained from Agrarian Services Center, Thirappane. The map of plots which are fed by each tank was available in the same centre with a farmer identification number. The distribution of plots and number of farmers varied among the tanks. From the farmer's list, farmers were randomly selected for the survey. The sample was 50% of the population.

Table 2. Study Population and GN Divisions

Grama Niladhari **Divison**	**Name of the Tank**	**Farmer Population**	**Sample Size**
533 Thirappane	Thirappane	98	40
548 Allisthana	Allisthana	68	33
	Meegassagama	54	31
562 Dayagama	Bulankulama	26	14

561 Wanamaluyana	Vendarnkulama	20	11
	Badugama	6	5
Total		**272**	**134**

Results and Discussion

General Description of the Sample

Figure 2 ((a)-(c)) presents the age profile, education and farming experience of the household heads in the Thirappane cascade. The majority of them were in the age range of 52-62 years old. Among them, 81% of the respondents were educated up to ordinary level (O/L). Experience of farming ranges between 3 years to 57 years with an average years of experience of 27 years. Approximately 75% of respondents own less than 1-acre upland and 2 acres of lowlands for cultivation (Figure 2; (d) and (e)). Almost all the households are owners of the hoes and only a few households own large tractors and ploughs (Figure 2(e)).

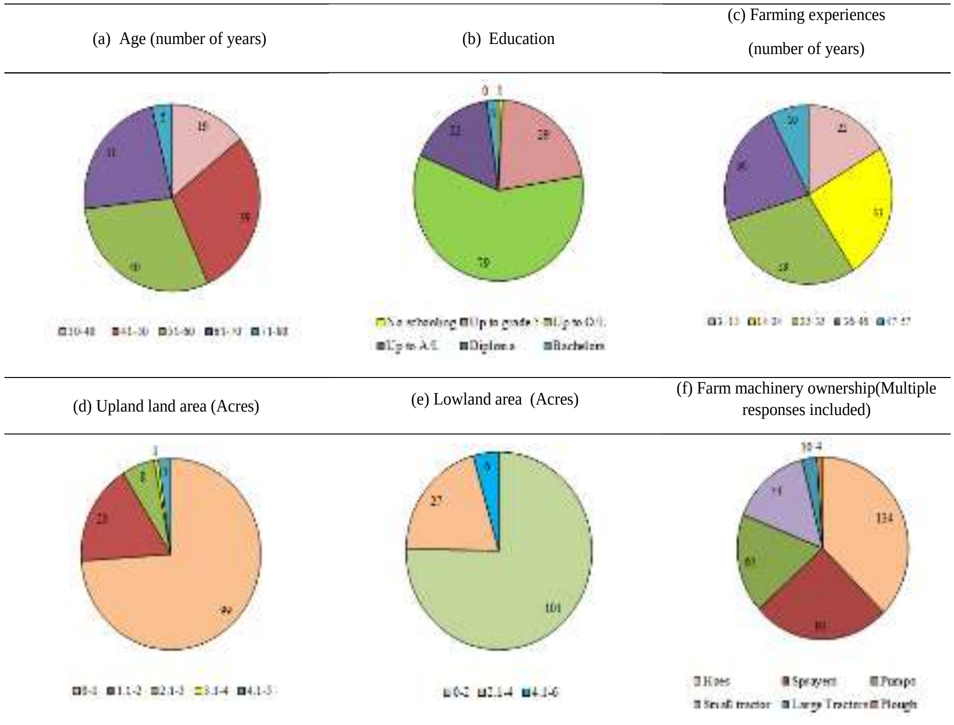

Figure 2. Key Socio-Economic Characteristics of the Household Heads and Asset Ownership

On-farm Labour Requirement

The pattern of labor use for different agricultural practices such as land preparation, planting, fertilizer application, weeding and harvesting for paddy, sesame, maize, thai brinjal and long bean is presented in Table 3. It is clear that over 70% of the labor requirement is fulfilled by family labor.

Table 3. Labour Requirement for Different Management Practices (Person-Days)

Plot Type	Crop	Activity	*Maha*		*Yala*	
			Family Labour	**Hired Labour**	**Family Labour**	**Hired Labour**
Lowland	Paddy	Land preparation	6	1	5	1
		Planting	1	2	2	2
		Irrigation	1	0	1	0
		Fertiliser application	2	0	2	0
		Weeding	2	0	2	0
		Weedicide application	1	0	2	0
		Harvesting	5	1	7	1
		Total	18	4	21	4
Upland	Sesame	Land preparation	3	3	3	3
		Planting	1	0	1	0
		Harvesting	8	1	5	3
		Total	12	4	9	6
	Maize	Land preparation	3	3	3	3
		Planting	4	1	5	0
		Fertiliser application	1	1	2	0
		Harvesting	4	2	4	0
		Total	12	7	14	3
	Thai Brinjal	Land preparation	0	0	3	3
		Planting	0	0	3	0
		Fertiliser application	0	0	21	25
		Harvesting	0	0	80	13
		Total	0	0	107	*41*
	Long bean	Land preparation	3	3	0	0
		Planting	5	2	0	0
		Fertiliser application	2	0	0	0
		Harvesting	17	7	0	0

	Total	27	12	0	0

Nature of Off-farm Employment: Engagement of Other-farm and Non-farm Activities

Table 4 shows the average income earned from the supply of labor, machinery and agricultural inputs to the other farms in the area and non-farm average income by the different categories. It is visible that out of the 134 farming households, only 27 engaged in such activities. This is consistent with the results presented in table 3 which shows that the demand for hired labor for cropping operations is small. Even though most of them are engaged in labour supply, the income earned from machinery rentals is higher than that of wage income.

Three major non-farm income categories, i.e., government, private sector, and self-employment, were evident. Of those who engaged in non-farm employment, 52% were government employees whose average income is higher.

Table 4. Average income by category- other-farm income and non-farm income

Category	Sub Category	Number of Farmers	Average Income by Category
Other-farm income	1.Labour supply	13	20,615
	2.Machinery income	9	58,667
	3.Input sales	5	16,000
	Total average income	**27**	**32,444**
Non-farm income	1.Government employment	43	42,535
	2.Private sector employment	28	37,964
	3.Self employment	12	33,333
	Total average income	**83**	**39,663**

Table 5 cross tabulates the participation in other-farm and non-farm activities. Among the respondents, only 27 of them participated in other-farm activities, but 78 engaged in non-farm activities. Only 14 engaged in both other-farm activities and non-farm activities and 43 participated in none of the activities.

Table 5. Participation in Other-farm and Non-farm Activities

Other-farm participation	Non – farm participation		Total
	0 (No)	1 (Yes)	
0 (No)	43	64	107
1 (Yes)	13	14	27
Total	56	78	134

Results of Probit Analysis: Determinants of Participation inOother-farm, Non-farm and Off-farm Activities

The results of the probit estimations are presented in Table 6. The results clearly indicate that level of education is the main driver of non-farm employment. Those who are experienced in farming, earning large fraction of income from agricultural activities[1], and possess large agricultural assets are less likely to engage in non-farm employment. Those who own small agricultural assets namely ploughs and sprayers are more likely to join other farm employment. The likelihood of engaging in off-farm employment has a quadratic relationship with land size. The likelihood decreases as land size increases until 3.2 and thereafter it increases, suggesting very small land owners and large land owners likely to engage in off-farm work. Similar findings were reported by Fernandez-Cornejo et al. (2007) who indicated that small farms improve their economic performance through working off-farm. The results also show that farming experience, contribution of agricultural income and ownership of large tractors negatively affect the participation of off-farm employment. These results suggest that non-farm employment is practiced by those who are in upper social classes, i.e., the able. The villagers who own medium sized land pieces and small agricultural assets who are experienced in farming mostly engage in on-farm and other-farm work.

[1] *Agricultural income was included in the probit estimations to test whether economic size of the farm affect the decision to join off-farm activities. However, the inclusion of agricultural income in the regression might have caused some endogeneity issues as agricultural income is also affected by the decision to join off-farm employment.*

Table 6. Results of Probit Etimations

Category	Characteristics of the household head	Off-farm Loglikelihood=-71.70		Non-farm Loglikelihood=-77.93		Other- farm Loglikelihood= --54.61	
		Co-efficient	**Z**	**Co-efficient**	**Z**	**Co-efficient**	**Z**
	Intercept	-1.273	-0.95	**-2.057***	**-1.63**	-0.344	-0.26
Household characteristics	Age	0.254	1.22	0.031	1.56	0.003	0.16
	Education	**0.373**	**1.87**	**0.476***	**2.44**	-0.052	-0.27
	Gender (Female=1)	0.051	0.02	-0.041	-0.15	-0.299	-0.90
	Experience	**-0.029***	**-1.65**	**-0.029***	**-1.79**	-0.009	-0.54
	Family size	0.126	1.11	0.122	1.16	0.892	0.71
	Agri Income	**-0.000002***	**-2.09**	**-0.000002***	**-1.93**	-0.000002	-1.232
Ownership of agricultural assets	Total landholding	**-0.378**	**-1.71**	-0.246	-1.17	0.068	0.20
	land extent[2]	**0.058**	**1.97**	**0.049**	**1.77**	-0.043	-0.74
	Small tractor	-0.008	-0.08	0.069	0.66	-0.104	-0.78
	Large tractor	**-1.576***	**-2.52**	**-1.358***	**-2.25**	-0.151	-0.21
	Plough	1.627	0.97	-0.429	-0.44	**2.259***	**2.34**
	Hoes	0.019	0.18	0.041	0.39	-0.240	-1.55
	Sprayer	0.477	1.56	-0.029	-0.10	**0.958***	**2.71**
	Pump	-0.879	-0.35	-0.094	-0.40	0.116	0.453

Number of observations =134 ***statistically significant in 10% level*

We also estimated a few models to ascertain whether off-farm employment is influenced by different perceptions i.e. condition of tank water quality, cascade functioning, and whether improvements to such are needed. However, no apparent associations between off-farm employment and perceptions on quality of the services or importance to such have been observed.

Results of Correlation Analysis: Relationships among Participation in Off-farm Employment, On-farm Activities and Environmental Conservation

Table 7 presents labour use pattern and chemical fertilizer (urea, TSP and MOP) by engagement in off-farm employment. The labour use pattern is presented using the fraction of hired labour out of total labour and usage of chemical fertilizer is presented using the amounts applied over and above recommendations. The fraction of hired labour use pattern for on-farm activities is the same among all categories except for those who participate in non-farm activities. They use slightly more hired labour compared to others. The results clearly show that those who do not seek employment on other-farm or non-farm sectors apply more urea in *Maha* season. Further, urea, TSP and MOP application is higher among those who do not engage in off-farm activities. In *Yala*, where over application is smaller or no pattern can be recognized with respect to fertilizer type, though slightly higher levels of TSP and MOP fertilizers are applied by those who do not engage in off-farm employment.

Table 7. Associations among Hired Labour Usage, Chemical Fertilizer Use and off-farm Employment

		Hired Labour /Total Labour		Fertilizer Application (kg/ac Over and Above the Recommendations)					
				Maha			*Yala*		
		Maha	*Yala*	Urea	TSP	MOP	Urea	TSP	MOP
Other - Farm	No	0.4	0.5	37.4	15.0	5.8	20.7	10.4	3.3
	Yes	0.4	0.5	22.9	18.4	4.1	14.8	13.1	2.9
Non-Farm	No	0.4	0.5	34.1	15.3	5.4	19.0	10.8	3.4
	Yes	0.5	0.6	32.8	18.4	2.7	22.2	12.1	1.6
Off-Farm	No	0.4	0.5	38.1	17.5	6.2	15.4	12.7	3.8
	Yes	0.4	0.5	32.8	14.8	5.1	21.5	10.1	2.9

Note: Rate provided under subsidy for Yala and Maha seasons in 2018/ 19 - Urea =76 kg/ac, TSP = 20 kg/ac, Mop=22kg/ac

Farmer perceptions about cascade water quality, functioning of the cascade, and need for improvement for water quality and the cascade functions are presented in Table 8. According to the modes of the responses, majority of the farmers in the cascade perceive the tank water quality is in very good condition and the cascade is functioning at a good level. All the farmers have considered that the improvement of water quality at the tanks is somewhat important or very important.

Table 8. Perception on Condition of Water Quality and Cascade Functioning and the Importance Given to their Improvement

		Mode of the Responses			
		Condition of Tank Water Quality	**Improvement in Tank Water Quality**	**Cascade Functioning**	**Improvement in Cascade Functioning**
Other-Farm	No	4 (3.29)	4 (3.58)	4 (2.82)	4 (3.71)
	Yes	4 (3.37)	4 (3.40)	4 (3.00)	3 (3.59)
Non-Farm	No	4 (3.46)	4 (3.45)	4 (2.92)	4 (3.71)
	Yes	4 (3.20)	4 (3.61)	4 (2.80)	4 (3.66)
Off-Farm	No	4 (3.58)	3 (3.45)	4 (2.95)	4 (3.67)
	Yes	4 (3.18)	4 (3.58)	4 (2.81)	4 (3.69)

Note: *Condition of tank water quality:1- Not good at all, 2- Poor, 3- Medium,4-good and 5- Very good Improvement tank water quality: 1- not important at all, 2-not important, 3- somewhat important, 4- very important and 5- Extremely important,*
Cascade functioning: 1- not functioning well, 2-poor level of functioning, 3-Medium level of functioning, 4-Good level of functioning and 5- Very Good level of functioning
Cascade functioning: Improvement cascade: 1- not important at all, 2-not important, 3-somewhat important, 4- very important and 5- Extremely important
(Modes are in the first line; Means are presented in the parenthesis)

Table 8 also presents the mean values of the scale which show an interesting pattern. Those who work for off-farm consider that conditions on tank water quality and cascade functioning as poorer compared to those who do not work off-farm. They also consider that improvement are important than those who do not engage in off-farm work. A completely opposite patterns is observed between the two groups within other-farm employment category. Contrary to findings of Holden et al. (2004) and Mduma (2007), these observations indicate that over application of chemical fertilizer is less predominant among those who work off-farm. Their perceptions on environmental conservation is also favorable.

Conclusions and Policy Implications

Family workers largely fulfil on-farm labour requirements in Thirappane VTCS and the demand for hired workers from the farms in the site is small. Approximately two third of the farmers engage in off-farm employment and a large majority of them engage in non-farm activities. Farmers having relatively small farm machinery have a significantly higher probability of engaging in other-farm activities. The probability of educated people and land owners to engage in non-farm activities is statistically higher. Those who are experienced in farming have lower likelihood of engaging in non-farm work. Those indicate that the suppliers of non-farm labor are the able in the community. Even though evidence related to the relationship among participation of off-farm work and perceptions on conditions prevailed and improvements made to natural resources is not robust in a statistical sense, a relatively lower intensity of fertilizer application, over and above the recommended dosage, is visible among those who engage in off-farm work. Contrary to expectations, those who work off-farm seem to be more environmental cognizant. Overall, these results imply a threat to the sustainability of the VTCS as community management is neglected with increased attention on off-farm work by the educated group. The government of Sri Lanka and the global agencies need to devise appropriate strategies to conserve the GIAHS rather than expecting the local communities to become custodians as out-migration of the abled workforce can be expected in the near future. Even though the village community is aware of the status of degradation and importance of conservation, they tend to find employment in other sectors as means to improve and stabilize their incomes. Awareness building alone will not be sufficient to arrest degradation of the VTCSs in Sri

Lanka in light of increased likelihood of joining the non-farm employment by the able.

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