

The Microeconomics of Household Collection of Wild Coffee in Ethiopia: Some Policy Implications for In-situ Conservation of *Coffea arabica* Genetic Diversity¹

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Abstract

World-wide cultivated arabica coffee is a native plant to Ethiopian highlands. Its wild populations can still be found in the fragmented montane rainforests of the country. To halt degradation and loss of the forest coffee genetic resources, the Ethiopian Government has established in-situ conservation areas in the south and southwestern montane rain forest regions of the country. However, there are several thousands of people who have been and still are dependent on the wild coffee populations from these forests for direct consumption and/or market sales. Thus, policy makers need to consider the needs and economic options of the local people in the periphery, so as to create a win-win relationship between conservation and local agricultural development.

This paper substantiates the interface between the forest coffee genetic resources and the local agriculture by exploring the economic importance to farm families of wild coffee from the Geba-Dogi forest coffee conservation area, Southwest Ethiopia. A random sample of 121 farm families was used in this empirical study. Descriptive results demonstrate the very different resource use behavior of the population and the diversity of the (local) people living in the periphery in terms of socioeconomic interests, skills, culture, demographic history, resource use behavior and wealth. Probit regression indicates that household collection of wild coffee from the protected site is positively and significantly associated with family size, ownership of adjacent farm plot, and male-headship of the household. Number of economically active (adult) labor in the family, distances to the nearest market town and the edge of protected site are found to exert significant disincentives to wild coffee collection portfolio in the peasant household economy.

Keywords: Ethiopia, *in-situ* conservation, probit regression, wild populations of *Coffea arabica*

¹ The empirical data used in this paper were part of the data collected for the doctoral thesis of the first author.

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1. Introduction

The tropical rainforests are rich sources of genetic resources, more than any other terrestrial ecosystems. Maintaining of the tropical rainforests is vital for a host of reasons, but most critically, because these genetic materials are irreplaceable. However, mainly through human impact, these genetic resources are disappearing at a rapid rate (Gunatilake and Chakravorty, 2000). Millions of people are estimated to live in the periphery or in the forests and are making use of these rainforests for survival as well as for commercial purposes (Coomes *et al.*, 2001; Arnold and Perez, 2001). Population growth, market development, and migration, just to mention a few, put the sustainability of these traditional systems under question.

In response to the concern over the destruction of tropical rainforests, governments in developing countries, where most of these forests are located, have often reacted through policy measures that established certain forest areas as protected forests and have passed legislation that restrict use of these forest resources (Heltberg, 2001; Guntalake and Chakravorty, 2000). However, as argued in Maxted *et al.* (1997) the ultimate rationale behind conservation is the potential human utilization. Therefore, user communities must be considered when designing the reserve, whether in terms of permitting sustainable exploitation within the buffer or transition zone by traditional farmers, or building appropriate for revenue generating facilities by attracting ecotourists or scientific visitors. Each user community has a different view of the reserve and a different set of priorities. The requirements of each group of users should be surveyed before the reserve is established and their needs met as part of the management regime. Failure to understand the basic logic of forest people's livelihood practices limits the ability to develop appropriate strategies and institutional arrangements for local forest management, and thereby reduces the likelihood that conservation and development initiatives will achieve their desired goals (Takasaki *et al.*, 2001). This has been amply demonstrated in many countries in southern Africa, where conservation that does not consider social and economic factors of the population around or within the conservation sites is doomed to failure (Soto *et al.*, 2001). The Zimbabwean experience in wild life resource management

and conservation provides a successful experience and a good example for the case in point. Through CAMPFIRE⁴, Zimbabwe has involved rural communities in the management of protected areas (Shibru, 1995). In this program, the Government of Zimbabwe has ownership rights for the protected areas but has handed over part of the management to local communities. Communities are allowed to engage in a rational use of the natural resources in the protected area based on the rule of supply and demand. As lessons so far from protected area management show, there is a need to deal with the issue urgently through strategies that will address development priorities of the people on adjacent land parallel with protected areas (*ibid.*).

In line with these experiences and knowledge from other conservation activities, this paper focuses its attention on the issue of the sustainable utilization and conservation of wild coffee populations in the montane rain forest in the southwest of Ethiopia. The objective of this paper is to identify the pattern of the population around the rain forest conservation sites regarding their behavior to collect wild forest coffee, and in particular the fact that some households gather wild coffee while others do not. The paper distinguishes the profile of wild coffee collectors and empirically provides insight for integrating local needs and behavior with *in-situ* conservation of forest coffee genetic resources in Ethiopia.

The paper is organized as follows. The second section gives background information on the situation of the wild coffee populations and the montane rain forest of Ethiopia as well as describes the study area and the survey design. Section 3 presents an overview of the sample and hypotheses of the study. Theoretical framework is in section 4. Section 5 offers the analytical findings of the study. Conclusions and policy implications of the study are outlined in section 6.

⁴ CAMPFIRE: Communal Areas Management Programme for Indigenous Resources.

2. Background of the study

2.1 Threat to the wild coffee populations

Ethiopia has a rich diversity of crops, among which *Coffea arabica* is one. The world-wide domesticated arabica coffee originates from the Ethiopian highlands where it still grows wild in the montane rain forest. The beans of the wild *Coffea arabica* are picked virtually by anyone wherever accessible, but often by the local people living in the area for income and family consumption⁵. This forest coffee system contributes about 6% to the total coffee production in Ethiopia (Demel, 1999). Furthermore, there are wild coffee trees in inaccessible forest areas, which are not utilized at all.

The wild populations of *Coffea arabica* form an irreplaceable genetic resources that is great value to the coffee-producing and coffee-drinking world (Agrisystems Limited, 2001). The value of these wild populations of arabica coffee are many-fold. For instance, the direct benefit for the population around the conservation sites (and for the Ethiopian Economy) is the private consumption of the coffee as well as harvesting the coffee as cash crop. Beyond it, and even more significant in aspect of utilization of genetic resources, is the wild coffee's breeding value. The increasing demand for high-yielding and disease resistant coffee varieties underline the importance of the wild coffee populations as genetic resources for present and future breeding.

Despite their value, the wild coffee populations are under sever pressure. The Ethiopian forest surface diminishes by human impacts (Tadesse, *et al.*, 2001) thus threatening the still existing wild populations of *Coffea arabica*. The threat of extinction for the wild coffee populations is based on the fact that the remaining natural montane rain forests of Ethiopia, the habitat of the wild coffee populations, are under constant pressure due to land use conflicts in forests and forest fringes. Hundred years ago, the natural forest

⁵ There are three types of regimes in which wild forest coffee is held in the study areas. These include the state forests, communal forests and the private forest. The area that has been demarcated for forest coffee conservation mainly falls within the first category of forest management. Nonetheless, some households reported that they have lost land during the demarcation of the conservation site.

covered more than 40% of the country's highland area. Now, it has decreased to less than 3% (Gebre and Deribe, 2003). Ethiopia's forests are threatened by demand for forest products on the one hand and by the conversion of forest areas into agricultural land or settlement on the other hand. Furthermore, the wild coffee populations are also threatened through the intensification of the forest coffee production system by replacing the wild coffee trees through more productive coffee trees from nurseries (Tadesse and Demel, 2001).

The underlying factors exacerbating the threat of extinction of the natural habitat of wild coffee and hence the wild coffee populations are many and interwoven. For instance, lacking appropriate forest policy, population pressure, unstudied resettlement programs, and weak inter-sectoral relationships between forest conservation and agricultural development in Ethiopia, are the major reasons cited in this regard (see Berhanu and Million, 2001; Tadesse *et al.*, 2002; Yonas; 2001; Alemneh, 1990; Richerzhagen and Virchow, 2002; Kumilachew, 2001).

Despite lacking coherent policies, to date initiatives to conserve wild coffee genetic diversity are in progress. For instance, the Ethiopian Government, with the financial support of the European Union, has launched some conservation projects for wild populations of *Coffea arabica* in some selected areas. On the other hand, the Center for Development Research (ZEF) of the Bonn University (Germany), in collaboration with the Ethiopian Agricultural Research Organization (EARO), has recently started an interdisciplinary research project to create a more scientific basis for *in-situ* conservation of coffee genetic diversity in the montane rain forests and sustainable utilization (ZEF and EARO, 2002). These projects share similar premises that active involvement of the local people in the project is crucial for its ultimate success. Top-down enforcement of rules in such a vast protected area may be financially expensive, or unachievable in poor economies like Ethiopia. As such, incorporation of their views and needs will be useful to enhance ecological and economic sustainability of the region where the forest resource offers an array of local benefits to the people.

Hence, this paper demonstrates the socio-economic and demographic structure of local people settling in the frontier regions of the montane rainforests of southwest Ethiopia particularly focusing on its linkages with extraction of forest *Coffea arabica* from areas reserved for its conservation. The main aim is to explain the pattern of wild coffee collection behavior, and in particular the fact that some households gather wild coffee while others do not.

2. 2. Description of the study area and resource use

Yayu-Hurumu district, located some 520 kilo meters from Addis Ababa, is one of the most known coffee growing places in the southwestern Ethiopia. The natural environment is considered to be very favorable for coffee cultivation. The average annual rainfall and temperature are, respectively, about 1600 mili meter and 23 celcius. The elevation of the area ranges between 1,160 to 2,580 m.a.s.l. The study area is known to be rich in biodiversity. Besides, being the gene pool of arabica coffee, the montane rain forests in the region offer a natural habitat for various plant and animal species. Geba-Dogi, and Saki are important rivers in the district. Like in any other parts of the country, land is owned by the state and individuals have only usufruct right. About 10,000 hectares of primary forest in the Geba-Dogi⁶ watershed, which is rich in wild coffee resources, was demarcated in 1998 and conservation efforts are underway at present. However, concrete and formal access rules, regulations and enforcement mechanisms are either lacking or still inefficient⁷.

⁶ With the help of forestry extension workers, and under the auspices of the Third Coffee Improvement Project, the Ethiopia's Institute of Biodiversity Conservation and Research (IBCR) through Ethiopian Agricultural Research Organization (EARO), has identified and demarcated three sections of primary forest that are rich in wild coffee resources. Further preservation work on these three forest sections lies at the heart of the conservation component. The two conservation areas, namely, Boginda-Yeba (2764 ha), and Kontir-Berhan (9025 ha) are located in the Southern-Nations, Nationalities and People's (SNNP) Region, whereas the Geba-Dogi lies in the Oromiya Region. More conservation areas would be added in the near future (see for details, Agrisystems, 2001)

⁷ So far, non-destructive use of resources, such as collection of wild coffee and spices, and harvesting wild honey in the protected reserve is not prohibited. But, activities such as livestock grazing, settlement, agricultural cultivation, logging and charcoal making inside the conservation site are seriously prohibited.

Most of the local users engaged in collecting wild coffee are also agriculturalists. Mixed farming system is the main source of livelihood. Coffee is the most important cash crop in the area followed by *chat*⁸. Maize is the most dominant cereal crop followed by sorghum and *teff*⁹. Livestock husbandry is an integral component of the farming system. Despite many efforts made by the Government, International Livestock Research Institute (ILRI), and Non-government Organizations, *trypanosomiasis* still remains to be one of the critical challenges to cattle production in the area. According to the Oromiya Bureau of Planning and Economic Development (2000), 44% of the farmers in the district had no farm oxen in 1994.

Table 1. Some of the physical characteristics of the Yayu-Hurumu District

Physical features	Proportion
Total area of the district	1,353 km ²
Arable land as percent of total	63.1%
Cultivated land as percent of total arable land	34.8%
Pasture land area out of the entire district area	9.6%
Forests and shrubs	19.3%
Degraded land and others	8.0%
Orthic soils coverage in the district	90.0%
Dystric soils	10.0%

Source: The Oromia Bureau of Planning and Economic Development, 2000

2.3. Survey design and data

The data used in this study were collected from both primary and secondary sources. A two-stage random sampling technique was employed to draw 130 farm families in the region. Because some household heads were either not willing to be interviewed, or not available during the survey, the study has focused effectively on 121 farm families. The primary data collected comprises of household's farm production and consumption characteristics, attitudes to and management of wild *Coffea arabica*, risk perceptions and responses, residence history and so on. The farm household data collection lasted between July 2002 to April 2003. Exploratory survey was conducted during Mid-July to

⁸ *Catha edulis*, is a perennial crop whose leaves are chewed for its stimulant effect.

⁹ *Eragrostis tef*, is a cereal crop and a staple food in Ethiopia.

August 2002 to the montane rain forest regions of southwest Ethiopia where the wild populations of *Coffea arabica* still exists.

3. Overview of the sample and hypotheses of the study

Survey households show a great deal of variation in resource endowments, demographic and geographic factors. The sample households are composed of Oromos (76.86%), Amharas (15.70%), Tigres (4.96%) and other ethnic groups (2.5%). As indicated in Table 2, forty four households included in the sample (36%) are immigrant farmers. About 36.36% of them came in 1984 when the then Military Government opted for large scale resettlement programs in the country¹⁰. The rest came to this place mainly driven by several personal, social, and economic reasons. Family labor is the principal source of agricultural labor in the study area. Like in other parts of the country, labor market incomplete and farmers cannot hire in or hire out labor as wish. For example among 60 households, who reported facing seasonal labor shortage during the 2001/2002 production season, only 32 households were able to use hired casual labor. Oxen are the most important draught power to crop cultivation. However, 59 households (49%) in the sample reported having no ox, and as such 32 households (26.45%) do not have ox-plough. As in most other parts of the country in general and in this region in particular, firewood is the single most important source of household energy. However, only 43 households (35.5%) reported planting trees during the last five years on their private land holdings. Most households are virtually asset-poor and the distributions of key assets are unequal. For instance, migrant and non-migrant farmers reveal unequal access to per capita land holding, with the latter having more than the former.

45 (37.1%) households in the sample admitted to gathering wild coffee the year just before the survey from the area demarcated by the Ethiopian Government for the *in-situ* conservation of forest coffee genetic resources. On the average, households in the sample operate, respectively, 1.37 and 1.38 hectares of coffee and annual food crops. A

household in the sample, on average, cultivates 3.84 farm plots, have 5.5 family members, and 3.02 adult labor force. An average point of 3.56 on the 5-point Likert-scale reflects that farmers in the sample feel highly exposed to price risk in their coffee market.

Table 2. Variables and summary statistics of the sample

Variables	Descriptions and measurements	Mean	Std.Dev.	Expected sign
Dependent variable:				
C_i	Whether or not the household collected wild coffee from forest coffee conservation areas, 1 if yes	0.371	0.485	
Explanatory variables:				
AGE	Age of household head in years	42.88	13.625	+
ADUL	number of family members greater than 15 years old	3.02	1.846	+
SEX	sex of the household head, 1 if male	0.86	0.340	+
FMSZ	number of persons in the household	5.50	2.255	+
RESID	whether or not the household is native to the area, 1 if yes	0.64	0.483	-
ANNC	landholding covered with annual crops in hectare ¹¹	1.37	0.953	-/+
PERC	coffee holding in hectare	1.38	1.167	-/+
ADJC	whether or not the household has landholding adjacent to forest coffee sites, 1 if yes	0.39	0.489	+
PRISK	farmer perception of exposure to market price risk in a 5-point Likert scale, 1 = very low to 5 = very high	3.56	1.246	+
ASSET1	value of farm equipment in birr	63.02	57.420	-
ASSET2	value of livestock in birr	833.86	948.940	-
DIVER	number of crops grown during 2001/02	3.21	1.737	-
DISTW	minutes required to reach the nearest market town on foot	122.81	101.509	-
DISFR	minutes required to reach the forest coffee reserve on foot	50.40	27.713	-

Source: Our survey result

The mean traveling time to the boundary of the protected forest coffee conservation area from respondents' houses is 50 minutes. About 39% of households in the sample reported having forest holdings and/or coffee farms close to this conservation area, whereas about 12 of the sample households reported losing land during the demarcation. Factors expected to influence household collection of wild coffee along with their *a priori* signs are found in Table 2.

¹⁰ From November 1984 until March 1986, 594,190 family members were resettled in Illubabour, Wellega, Keffa, Gojam and Gonder regions. The majority of the settlers (81%) went to the southwestern regions of Wellega, Illubaour and Keffa (see Alemneh, 1990 for details).

4. Theoretical framework and analytical model

Conservation of plant genetic resources, such as the wild populations of coffee *arabica* in its natural habitat, may provide local people with short-term and long-term benefits. Elsewhere in the tropics, forest-based activities and extraction of non-timber forest products are important for subsistence needs and commercial purposes (see for example, Coomes et al., 2001; Banana and Turiho-Habwe, 1997). The challenge facing conservation of natural resources in these places is then how to create a sustainable conservation outcome without hurting the welfare of the local people, who depend on the forest. In other words, conservation policies should consider and work towards attaining a win-win situation of enhancing the livelihood of the local people and protecting biodiversity (Coomes et al., 2001). The World Conservation Union and the United Nations Environment Program's Global Biodiversity Strategy (1992) also underlines clearly the concern and ethics for sustainable development: development has to be people-centered and conservation based (Westley et al., 1998).

Behavior of local users of genetic resources from bio-diverse hot-spots and the motivations and incentives propelling household collection or use of these resources could be conceptualized using a household production theory (Gunatileke and Chakravorty, 2003; Pattanayak and Sills, 2001; Köhlin and Parks, 2001). Due to the wide-spread existence of several market imperfections and uninsured risks in the developing countries of the tropics, factors shaping livelihood choices reflect both consumption and production needs of the household (Kurosaki, 1995; Takasaki et al., 2001; Cavendish, 1998). Hence, a farm household model, following (Singh et al., 1986), is employed in the present investigation of factors influencing household choice of wild coffee collection in the montane rain forest region of southwestern Ethiopia.

¹¹ Primarily data on farm size was obtained in terms of a local unit called *timad* in which 4 *timads* are approximately equal to 1 hectare.

A reduced form equation is used in this paper to shed light on the underlying factors inducing households to be involved in gathering coffee beans from the wild populations of arabica coffee in the region¹². Socioeconomic attributes, risk perception, demographic and geographic factors were simultaneously used to predict whether or not a given farm household collects wild coffee from the protected area of forest coffee. Following Green (2000), this choice of activity portfolio by the local household is analyzed by a probit model specification as:

$$C_i^* = \mathbf{b}'X + \mathbf{e}_i$$

$$C_i = 1 \text{ if } C_i^* > 0 \text{ and}$$

$$C_i = 0 \text{ if } C_i^* \leq 0$$

where C_i^* is a latent variable affecting the expected utility by the i^{th} family of choosing the activity ($C_i = 1$). \mathbf{b}' is a vector of parameters to be estimated and X is a vector of explanatory variables. \mathbf{e} is the disturbance term. The probit model assumes that C^* is a normally distributed random variable. The probability that a household participates in wild coffee collection would then be expressed by the equation:

$$P_i = \text{Prob}(C_i = 1) = \int_{-\infty}^{\mathbf{b}'X} (2\Pi)^{-1/2} \exp\left(\frac{-s^2}{2}\right) ds = \Phi(\mathbf{b}'X).$$

The likelihood function accompanying the probit model is as follows:

$$\ln L = \sum_{c_i=0} \ln(1 - \Phi_i) + \sum_{c_i=1} \ln(\Phi_i).$$

5. Analytical results

As indicated in Table 3, several factors are responsible for inter-household variations in the wild forest coffee collection decisions. The probit model has enabled to identify and

¹² Mathematical details and intermediate derivates are omitted to save space.

quantify the contributions of several factors in motivating and conditioning the probability that the household enters the wild forest coffee collection activity portfolio.

Diagnostic analysis using variance inflation factor shows that there is no severe multicollinearity among the explanatory variables. About 74% of the original observations were correctly classified and the probit regression fits the theoretical predictions at less than 0.001 probability level.

The analysis shows that statistically significant differences exist between collectors and non-collectors of wild coffee. These factors mainly include demographic, socioeconomic and geographical attributes. The correlation between the number of adults in the household (ADUL) and the likelihood of wild coffee collection are statistically significant and negative. That means that the probability of entry to wild coffee collection activity declines by 10.87% as adult labor increases by one unit in the household. This is a result contrary to the *a priori* anticipation.

Though it is not statistically significant, the negative effect of age of the household head (AGE) on the household's propensity to enter collection of wild coffee was not expected *a priori*. Young households are more likely to have the wild coffee collection in their activity portfolio than old farmers. This may be due to one's declining mobility as age increases. Köhlin and Parks (2001) reports similar findings for fuelwood collection in South Asia.

The sign of the variable sex of the household head (SEX), was not anticipated *a priori*.

The result reveals that the effect of gender of household head on the household's entry to wild coffee collection is positive and statistically significant. This points to the fact that male-headed farmers are more likely to be collectors of wild coffee than female-headed farmers.

The positive sign of the variable residence history of the household (RESID) contradicted the initial anticipation. It is, however, suggestive that, *ceteris paribus*, native farmers are more likely to enter wild coffee collection than the non-natives (immigrant farmers). This may be due to the immigrants' lack of wild coffee extraction experience and familiarity

with it in their source areas. Differences in the socioeconomic interests and livelihood strategies between natives and immigrant reflect norms and cultural differences they experienced over long time period. Household activity analysis in the Ecuadorian Amazon, reflects that migrants bring to the frontiers the cultural norms and customs of their origin area (Meertens, 1993 cited in Thapa, et al., 1996).

Family size (FMSZ) and plot holding adjacent to the forest coffee reserve (ADJAC) were directly and significantly associated with household collection of wild coffee from this site. The effect on the probability of wild coffee utilization (collection) of increased family size is further pronounced when the household lacks other economic options employment and income generation. This result complies with the findings reported by Köhlin and Parks (2001), for fuelwood collection. The negative effect of the number of adults in the household and the positive influence of the family size may be attributed to the role of non-adult family members in the collection of wild coffee and other environmental goods. The opportunity cost of time spent in wild coffee collection may be higher for adults than for non-adults. This suggests that it could be easier for the former to find alternative economic activities than the latter.

Asset-endowment of the farm household was included in this analysis using two variables: in terms of value of farm equipment (ASSET1) and value of livestock held (ASSET2). The expected signs of these variables on the household collection of wild coffee were negative. However, analysis showed that the magnitudes of their coefficients were insignificant and the sign to ASSET2 contradicted with the *a priori* expectation. The positive effect of livestock asset ownership on wild coffee collection may be because the same labor may be used for picking wild coffee beans while attending livestock, especially cattle and small ruminants, in grazing sites adjacent to the protected forest coffee site.

The marginal value productivity of labor in wild coffee collection depends on the market price of coffee. But, the market price of coffee is highly unpredictable and volatile, and farmers are price takers when it prevails. Therefore, a farmer's perception of price risk

(PRISK) may motivate or discourage household collection of wild coffee from the montane rain forests. We did not assign any *a priori* sign to this variable because it depends on the relative riskiness of alternative activities available to the farmer and the purpose of wild coffee collection. However, the analysis shows that high risk perception by a household (PRISK), induces a disincentive to the farmer and his/her family members to pursue wild coffee extraction in the nearby protected forest coffee area. As such, this uncertainty of return reduces the likelihood of labor use for wild coffee collection. This signals, however, a danger that the resulting disappointments from this venture may induce households to switch to alternative timber or non-timber forest extraction ventures to the detriment of wild coffee habitat itself.

A negative coefficient to crop enterprise diversification (DIVERS), *albeit* insignificant, suggests that diversified farming systems in the periphery are useful to reduce the pressure on the wild coffee populations in the protected forests. Put another way, the financial attractiveness of the wild coffee populations is more important to less diversified households than to more diversified farmers, perhaps as the means of portfolio diversification.

Interestingly enough, geographical factors played significant roles in analyzing why some households collect wild coffee and others do not. Geographical factors were used as proxies for transaction costs. Households living close to the *in-situ Coffea arabica* conservation site were more likely to participate in the collection of wild coffee than those located far away. In other words, the propensity to harvest wild coffee from the forest, as expected, increases as one lives nearby the montane rainforest. This is economically meaningful because long distance traveled increases the cost of extraction and serves as a natural disincentive household collection of wild coffee. A similar result was reported elsewhere (Gunatilake and Chakravorty, 2000). As distance traveled declines by a minute, participation in wild coffee extraction falls by 0.20%. This is suggestive that households located near to the montane rain forest find it easier to utilize the wild coffee populations. In another perspective, access to market is assumed to be an important input for agricultural intensification and commercialization of farming. As

such farmers located farther away from market centers will face difficulties in modernizing their farms. They rather tend to pursue farming in a more traditional way, getting more inputs and outputs from their natural environment than from the market. Due to lack of household-specific agricultural input prices in the sample, distance from the market is used as a proxy for agricultural input prices, following Gunatilake and Chakravorty (2000). In other words, given all other factors held constant, labor allocation in agriculture fetches higher marginal returns than its allocation in extraction of non-timber forest products. However, the result in Table 3 demonstrates the opposite that households located farther away from the market town are less inclined to collect wild coffee than those located nearby, *ceteris paribus*. This may be due to the fact that wild coffee itself may be a commercial activity to the farmers included in this study.

Table 3. Probit regression coefficients on likelihood of wild coffee collection, 2001/2002

Explanatory variables ⁺	Coefficients (standard errors)	Marginal effects
AGEHH	-0.17057 (0.01265)	
ADUL	-0.30272** (0.14875)	-0.10865
SEX	0.90194* (0.52552)	0.32372
FMSZ	0.14854* (0.08872)	0.05331
RESID	0.29463 (0.30241)	
ANNC	0.34626 (0.21167)	
PERN	0.13421 (0.15237)	
ADJAC	0.56941* (0.29869)	0.20437
PRISK	-0.00034 (0.00132)	
ASSET1	-0.00027 (0.00312)	
ASSET2	0.00001 (0.00076)	
DIVER	-0.10155 (0.10182)	
DISTWN	-0.00169** (0.00076)	-0.00061
DISTFOR	-0.00984* (0.00578)	-0.00353
Intercept	-0.49119 (0.80402)	
Number of observations	121	
Log likelihood	-62.76	
Mcfadden R^2	0.21	
Chi-squared	34.19***	
Correctly predicted observations	74.38%	

***, **, and * refer to significance at 1%, 5% and 10% levels, respectively.

⁺refer, Table 2, for variable descriptions

6. Conclusions and policy implications

Reducing the human pressure on biologically rich hot-spots and conserving valuable genetic resources has been and still is a fundamental policy concern in many countries. In

the face of rapidly growing human population in and around the bio-diverse regions of the humid tropical forests, sustainable use of forest products, both timber and non-timber forests products is not easy however. This study has used the case of *Coffea arabica* genetic diversity in the montane rain forests of Ethiopia and highlighted some policy mechanisms to synthesize a win-win relation between conservation of this resource and peasant agricultural development in the peripheral region. The analysis reveals that wild coffee populations in the protected montane rain forest area are an important component of Ethiopian peasant household's activity portfolio. For example, around 37% of the sample farm households reported collecting wild coffee beans from this area for home consumption and/or generating cash.

Protection and management of the montane rain forests and the wild arabica coffee it contains needs a good understanding of the local people and their socioeconomic, geographic and demographic attributes. The present study indicates that gathering wild coffee beans is positively and significantly associated with family size, male-headed households, and ownership of cultivated agricultural land close to the protected area of forest coffee. Number of adults in the household, distance to market towns, and distance to the edge of the forest coffee conservation area reduced the local peoples dependency on the extraction (utilization) of wild coffee from this site. The impact of spatial variation on households dependency on wild coffee collection from the protected area signals the importance of considering human settlement in buffer-zone demarcation and agricultural land use in the periphery. The negative effect of adults and the positive effect of family size on household reliance on wild coffee implies the effect of family composition on the choice of household livelihood portfolios.

Controlling household/family size through the provision of favorable policy incentives could help reduce farmers' dependence and extraction pressure on the wild coffee populations being conserved in the protected areas. Special attention here needs to be given to households with large number of non-adult family members. The negative effect of adults, a proxy for labor endowment, in a family on household collection of wild

coffee reminds more attention and effort need to be given directly to non-adult members of a family or indirectly through the principal decision makers of farm households.

Why a farmer operating plots adjacent to the protected area is more likely to participate in wild coffee collection than others? This may be due to the reduced transaction costs of traveling to, searching for and picking of wild coffee that emerges out of having a plot nearby to the protected forest edge. This is the most difficult, if not impossible, to monitor and discover whether or not the farmer collects wild coffee and other non-timber forest products from its neighboring protected area. One policy tool to minimize this neighborhood or edge-effect externality of cultivated agricultural land is to formulate a feasible land use strategy in the buffer zone of the protected area of forest and offer proper compensations if agricultural investments are to be minimized or avoided at all. This paper has also found that households settled nearby the protected area of forest coffee are more likely to participate in wild coffee collection than families located farther away. Thus, local and regional administrators and planners should be very careful in intra- or interregional resettlement planning and implementation.

Last, but not least, governments should consider and act upon creating alternative employment and income sources while enhancing market access of the peripheral region. If not, household access to market, as shown in this paper, provides incentive for increased wild coffee extraction through its effect on reducing the transaction costs of wild coffee marketing

In sum, to enhance greater cooperation from the local people and achieve a sustainable conservation and utilization of wild coffee populations, policy makers need to consider more and mutually re-enforcing instruments than just focusing on a fence-and-fine rule. However, this requires critical consideration and integration of conservation of the resource with peasant household development in the region.

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