12 Exploring Environmental Services Incentive Policies for the Philippine Rice Sector: The Case of Intra-Species Agro Biodiversity Conservation

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Abstract: This chapter considers a hypothetical scheme of green payments to induce inter-specific agrobiodiversity in the context of Philippine rice farming. We empirically estimate a model of farmer behavior and then simulate the consequences of alternative (hypothetical) PES schemes under a fixed budget constraint. We find that, under this particular application, there is a clear trade-off between the two policy goals of enhancing biodiversity and poverty reduction. Even the totally untargeted lump-sum subsidy would have a larger poverty reduction impact than would the first-best conservation subsidy payment scheme. Therefore, policy-makers would be required to strike a delicate balance between the two competing policy objectives. In addition, there is also a clear trade-off between the efficiency of targeted conservation payment and the information requirement for implementing subsidy schemes.

12.1 Introduction

There has been an increasing recognition that agriculture or agricultural activity produces not only food and fibers but it also produces as joint products environmental services that are not traded in markets. These environmental services include climate regulation, carbon sequestration, waste absorption and breakdown, biodiversity and wildlife conservation, soil and water conservation, and a host of others. The recognition of such positive externalities has led to the attempts to correct the underprovision of these services through payments for environmental services (PES) or "green" subsidies. This market-based instrument has been used extensively in developed countries. For instance, the United States has a land retirement program under the Conservation Reserve Program (CRP) and Environmental Quality Incentives scheme aimed at providing incentives for sustainable agricultural practices, while countries like Canada (National Farm Stewardship Program) and the United Kingdom (Country Stewardship and Organic Farming Scheme) have similar incentive systems. It is ironic, however, that in agriculture-dependent developing countries like the Philippines these policy instruments have not yet been explored.

This chapter considers a hypothetical scheme of green payments to induce inter-specific agrobiodiversity in the context of Philippine rice farming. While most of the existing studies focus on efficiency aspects of agricultural environmental services payments (see Kurlakova et al., 2003; Feng et al., 2004; Feng et al., 2005; Lankoski & Ollikainen, 2003), this study explores potential trade-offs between biodiversity conservation and poverty reduction goals. We attempt to quantify the magnitude of such trade-offs by empirically estimating a model of farmer behavior and then simulating the consequences of alternative (hypothetical) PES schemes under a fixed budget constraint. PES schemes have been primarily designed with efficiency objectives in mind. However, a review by Pagiola et al. (2005) points to the possibility of synergies between poverty reduction and efficiency goals. They conclude that poverty impacts of these schemes depend on a number of technical and economic factors notably the population composition of target areas, targeting schemes, tenure security, and the size of the payments itself.

Casual reference to the poverty impacts of PES schemes abound in the literature,[1] but there have been relatively few empirical studies that examine PES for agriculture and its poverty alleviation implications. The intent of this study is similar to Alix-Garcia et al. (2004) who empirically addressed the conservation-poverty link in a different context, i.e., that of PES for watershed management. Antle and Stoorvogel (2006), on the other hand, looked at agricultural "green subsidies" and poverty, but the focus is on carbon sequestration functions of agriculture. They used a simulation model to explore the potential impacts of payments for agricultural soil carbon sequestration on poverty and farm households and the sustainability of agricultural systems. They find support for the claim that carbon payment contracts provide sufficient incentives for farmers to shift to sustainable systems while reducing poverty.

Using a nationwide data set from the Philippines, we focus on the farmer behavior of planting traditional rice varieties alongside modern rice varieties, and examine policy instruments that could potentially induce farmers to adopt this "environmentally friendly technology." This chapter addresses three issues: (1) How much would it cost to induce rice farmers to plant traditional varieties, i.e. implementation cost of an intra-species conservation payments scheme? (2) What would be the most effective form of payment scheme as an environmental policy instrument? (3) What are the poverty implications of these payment schemes? In addressing these issues, we pay particular attention to the potential trade-offs in-

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[1] See for instance the literature in PES for watershed management and biodiversity conservation. The article by Wu, Zilberman, and Babcock (2001), on the other hand, is a good theoretical paper on the distributional consequences of different conservation-targeting strategies.

volved between the higher farm profit from *not* planting traditional rice varieties (since modern rice varieties tend to allow farmers to obtain higher profit through their higher yields) and the potential benefits of maintaining biodiversity in rice farming that may not be captured (entirely) by individual farmers. Such trade-offs could be particularly acute for relatively poorer farmers. From policymakers' point of view, the potentially efficient (optimal) policies for the goal of environmental preservation may not be fully consistent with poverty reduction goals. Such potential trade-offs from a policymaking point of view is our major focus in the following analysis.

The rest of this chapter is organized as follows. The next section briefly introduces the issue of biodiversity conservation in the context of rice farming, in general, and the issue of traditional rice variety, in particular. Section 12.3 presents the empirical model to be used for the analysis. Section 12.4 is a short description of the dataset used. The next three sections present our results; section 12.5 presents our results on the determinants of the adoption of traditional variety cultivation, while section 12.6 discusses our results on the determinants of farm profit and the effects of traditional variety cultivation on farm profit. Section 12.7 presents the results of our policy simulations, with a focus on the impact of environmental service payment schemes on poverty outcomes. The final section concludes.

12.2 Biodiversity Benefits of *In Situ* Conservation of Traditional Rice Varieties

Any loss of biodiversity is irreversible, and such losses have been increasingly recognized as a major policy issue in developing countries. Genetic diversity is an important component for the continuous improvements of rice crops, as cultivars need to be invigorated every 5 to 15 years to better protect them against diseases and pests (IRRI, 2004). Furthermore, the recent advances in biotechnology have led to a renewed recognition of the importance of maintaining biodiversity as the basis for technological breakthroughs. Commercial rice production also relies heavily on the genetic diversity of rice as a source of material for plant breeding and improvement (IRRI, 2004, p. 25). In addition to the potential roles of traditional rice varieties as raw materials for genetic improvements, the use of traditional varieties has been found to be potentially effective in controlling certain types of pests. For example, recent experiments conducted in the southwestern province of Yunnan, China, have found that intercropping rows of different rice varieties can control the rice blast disease "that costs the rice industry millions of dollars annually." The cropping practice allows blast-susceptible traditional varieties to be conserved *in situ* and also reduces the cost of pesticides (IRRI, 2004, p. 27).

While there exist some estimated 140,000 rice varieties, it is widely recognized that the number of rice varieties has declined dramatically, especially since the introduction of the high-yielding rice varieties (HYVs) in the 1960s. In the Philippines alone, there were "more than a few thousand" rice varieties grown in the 1950s. Today, only two varieties cover 98% of the land planted with rice (IRRI 2004, pp. 24-25).

In the following analysis, we focus on the practice of growing "traditional" rice varieties, i.e., *in situ* on-farm conservation of traditional varieties, as an environmentally friendly agricultural technology that the government might consider encouraging farmers to "adopt." The potential advantages of on-farm (*in situ*) conservation of biodiversity, in contrast with *ex situ* conservation—such as a gene bank—can be summarized as follows (Tuan et al., 2003):

- On-farm conservation conserves the evolutionary processes of local adaptation of crops to their environments.
- It conserves diversity at all levels—the ecosystem, the species, and the genetic diversity within species.
- It conserves ecosystem services critical to the functioning of the Earth's life-support system, thus improving the livelihoods for resource-poor farmers through economic and social development.
- It maintains or increases farmers' control over and access to crop genetic resources.
- It ensures farmers' efforts are an integral part of national Plant Genetic Resources (PGR) systems and involves farmers directly in developing options for adding benefits of local crop diversity.
- It links the farming community to gene banks for conservation and utilization.

However, due to the absence of sufficient information that would allow us to estimate potential values of biodiversity conservation from paddy rice cultivation in the Philippine context, our focus here is exclusively on the cost side (i.e., the amount it would cost to induce farmers to adopt farming practices that provide certain environmental services as externalities) and not on the benefit side (e.g., valuation of environmental services). Needless to say, policy decisions would need to be based on both the cost (as pursued here) and the benefit (not pursued here) sides of alternative policy instruments.

12.3 The Empirical Model: Treatment Effects and the Choice of Cultivating Traditional Rice Variety

In light of the potential trade-offs between farm profit and conservation, we first estimate the likely losses in farm profits due to the adoption of traditional rice variety cultivation, and then discuss the potential amount of subsidies that need to be provided to the farmers as an environmental service payment under alternative policy scenarios. The general model that we use in this case study is the following endogenous switching model:

$$\pi^{a}_{i} = X_i\beta^{a} + u^{a}_{i} \quad \text{if TV cultivation adopted} \tag{12.1a}$$

$$\pi^{na}_{i,} = X_i\beta^{na} + u^{na}_{i} \quad \text{if TV cultivation not adopted} \tag{12.1b}$$

$$I^{*}_{i} = Z_i\gamma + \varepsilon_i \tag{12.1c}$$

$$I_i = 1 \text{ (TV cultivation adopted) if } I^{*}_{i} > 0$$

$$0 \text{ (TV cultivation not adopted) if } I^{*}_{i} < 0,$$

where π^{a}_{i} is the profit of parcel *i* adopting traditional varieties, while π^{na}_{i} is the profit of parcel *i* not adopting traditional varieties. X_i is the respective matrices of independent variables. I_i is the indicator variable representing the adoption decision of the farm household on parcel *i*. Households adopt traditional varieties (I = 1) if and only if $I^{*} > 0$, otherwise the farmers plant modern varieties only ($I = 0$). The endogenous switching regression model is appropriate if the participation or adoption decision is an endogenous choice. Simple OLS estimation is likely to yield inconsistent estimates.

The approach used in this chapter draws from the literature on microeconometric evaluation of programs and policies (see the work of Heckman, 1974; Heckman, 1976; Heckman & Robb, 1985). These studies have used alternative methods to estimate the value of green subsidies. For example, Kurkalova et al. (2003) estimated the incentive payments in the form of an irreversibility and risk premium needed to induce the adoption of conservation tillage. They estimate this premium as one that is over and above the compensation for expected profit losses. Other studies have resorted to direct questioning or CVM type of techniques to estimate adoption subsidies (see Lohr & Park, 1995). Unlike the Antle and Stoorvogel (2006) study that used a simulation model to study carbon soil sequestration contracts, we use a revealed preference approach in the estimation of green subsidies for rice intra-specific agrobiodiversity. We employ similar concepts as with Kurkalova et al. (2003), but limited only to compensation for expected profit loss.

The first step in calculating incentive payments for technology adoption is to identify factors that affect the level of rice farming profits, i.e., estimation of equation (12.1a)-(12.1c) through a two-stage estimation. Following Maddala (1983, pp. 224-225), we initially estimate (12.1c) using the probit maximum likelihood method. We then use the estimated coefficient vector $\hat{\gamma}$ to calculate the inverse Mills ratios:

$$E(u^{a}_{i} \mid \varepsilon_i \leq Z_i\gamma) = -\sigma^{a}_{u} \frac{\phi(Z_i\gamma)}{\Phi(Z_i\gamma)} \text{ and}$$

$$E(u^{na}_{i} \mid \varepsilon_i \geq Z_i\gamma) = \sigma^{na}_{u} \frac{\phi(Z_i\gamma)}{1-\Phi(Z_i\gamma)},$$

which are added to estimate equations (12.1a) and (12.1b), respectively, to estimate β^{a} and β^{na} by ordinary least squares:

$$\pi^{a}_{i} = X_i\beta^{a} - \sigma^{a}_{u} \frac{\phi(Z_i\gamma)}{\Phi(Z_i\gamma)} + u^{a}_{i} \quad \text{for } I_i = 1 \tag{12.1a'}$$

$$\pi^{na}_{i,} = X_i\beta^{na} + \sigma^{na}_{u} \frac{\phi(Z_i\gamma)}{1-\Phi(Z_i\gamma)} + u^{na}_{i} \quad \text{for } I_i = 0. \tag{12.1b'}$$

The vector of the determinants of profit X_i includes: the age of the household head, its square, years of schooling of the head, household size, demographic composition of the household members, the distance from the nearest market, and the size of landholding and regional dummy variables. In addition to the variables included in the vector X_i, the determinants of technology adoption (Z_i) include, as identifying instruments, dummy variables for access to drying facilities, access to storage facilities, and access to extension services. The underlying assumption is that access to those postharvest facilities and access to extension services affect the decision to plant traditional varieties but do not directly affect farm profit.

The net benefits from planting traditional varieties then are obtained by calculating the counterfactual profit. The counterfactual profit is the expected income if, for instance, a non-adopting or pure modern variety farmer is forced to plant traditional varieties on their farm. In equation form the subsidy or the net benefit required to compensate a farmer for technology shifts can be obtained by:

$$\Delta = E[\pi_{na} \mid I^*_i < 0]\pi_{na} - E[\pi_{a} \mid I^*_i < 0]. \tag{12.2}$$

Since there is the possibility of having negative profits, i.e., the actual profit being less than the counterfactual profit, then the required subsidy or conservation payments to promote agrobiodiversity in the farm is simply: $\text{subsidy} = \min(0, \Delta)$.

The next step in our analysis is to assess the likely impact of conservation payments on the levels of poverty. The headcount poverty ratio is used to assess the changes in the poverty levels with and without the conservation payment scheme. The official provincial poverty lines constructed by the National Statistical Coordination Board are used as the basis for computing the headcount poverty ratio.

12.4 The Data Set

The data set for our analysis is taken from the DAR-UPLB[2] Comprehensive Agrarian Reform Program Impact Assessment Project. This data set came from a nationwide survey of 1,855 household beneficiaries of the Comprehensive Agrarian Reform Program. It contains detailed demographic, socioeconomic, and farm production data. A total subsample of 1,041 *rice*-farming households was used.

Tables 12.1 and 12.2 are cross-tabulations that describe the data set in terms of the number of households and parcels under traditional and modern variety cultivation. Around 42% of all households planted only modern varieties while 25% were pure traditional variety cultivators. The same percentages are observed for the parcels. This means that modern varieties are more widely cultivated by households and that more plots are planted solely for modern varieties. On the other hand, households who cultivate both traditional and modern varieties account for only 23% of the sample. In terms of parcels, only 20% of all parcels are planted with both modern and traditional varieties. This means that there is a relatively lower level of agrobiodiversity within parcels and geographically.

Table 12.1 Number of Households, by Type of Rice Variety Cultivation

	No. of Households Not Planting Modern Varieties	No. of Households Planting Modern Varieties	Total
No. of households not planting traditional varieties	108	436	544
No. of households planting traditional varieties	262	235	497
Total	370	671	1,041

Table 12.2 Number of Parcels, by Type of Rice Variety Cultivation

	No. of Parcels Not Planted with Modern Varieties	No. of Parcels Planted with Modern Varieties	Total
No. of parcels not planted with traditional varieties	258	1,075	1,333
No. of parcels planted with traditional varieties	569	485	1,054
Total	827	1,560	2,387

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Table 12.3 summarizes household characteristics by household types of rice variety adoption. We can see that pure traditional variety cultivators tend to have lower incomes, lower level of education, fewer productive assets, less access to postharvest facilities, and are farther away from markets but have larger farms compared to both pure modern variety cultivator. In terms of these same characteristics, agrodiverse rice farming households fall in between pure modern variety and traditional cultivators. The overall trend is that for most of the mentioned variables, agrodiverse farming households are better than pure traditional cultivators but are relatively worst off compared to pure modern variety cultivators. These observations suggest that there would be potential opportunity costs in any scheme that attempts to induce pure modern variety users to adopt traditional varieties in their farms.

Table 12.3 Mean Values of Relevant Household Characteristics, by Type of Rice Variety Cultivation

Variable	Pure Traditional Rice Farming Household (N = 262)	Pure Modern Rice Farming Household (N = 436)	Both Modern and Traditional Varieties Farming Household (N = 235)
Total income (pesos)	77,182	131,632	101,970
Age of household head (years)	55.6	55.9	56.7
Education level of household head (years)	2.1	2.7	2.4
Household size	5.3	5.4	5.2
Productive assets (pesos)	15,245	23,047	26,640
Distance to market (km)	0.44	0.34	0.42
Access to drying facilities (dummy)	0.21	0.69	0.72
Access to storage facilities (dummy)	0.05	0.14	0.08
Extension services (dummy)	0.67	0.82	0.75
Male household members (0 - 15 years old)	0.85	0.84	0.81
Female household members (0 - 15 years old)	0.79	0.70	0.66
Male household members (15 - 60 years old)	1.46	1.57	1.50
Female household members (15 - 60 years old)	1.39	1.53	1.43
Male household members above 60 years old	0.35	0.32	0.34
Total farm area (hectares)	6.33	3.38	2.12

12.5 Factors Affecting Rice Variety Choice Among Farmers

The results of the probit estimation of adopting traditional rice variety cultivation are shown in Table 12.4. Households with better-educated household heads tend to have lower probability of adopting traditional rice varieties in their parcels. Households with larger amounts of productive assets are also more likely to adopt traditional rice variety, which is rather surprising. Demographic composition of the household also has some effects on the decision to adopt traditional rice varieties. In particular, households with more female members between the working ages of 15 to 60 are less likely to adopt traditional variety. Exposure to extension services also reduces the probability of traditional variety adoption. This is not surprising since most extension agents have encouraged adoption of modern rice varieties. Furthermore, private seed suppliers and input dealers often provide extension services that also promote modern varieties through various contractual arrangements. Access to storage facilities also reduces the probability of adoption of traditional varieties. This probably just captures the fact that postharvest facilities in the Philippines are not very efficient. Lastly, regional locations also have significant effects. Households in Regions 7, 8, and 11 are more predisposed to planting traditional varieties, compared to those in the Central Luzon region (Region 3), which has traditionally been regarded as "the rice bowl of the Philippines." Households in Regions 0, 2, 6, 9, and 13, on the other hand, have lower adoption compared to Central Luzon (Region 3).

Also shown in Table 12.4 are the computed marginal effects of each of the variables. The dummy variables for the regions seem to have relatively large effects on the probability of adoption. These effects reflect the combined effects of geographical/location specific variations in natural environment (climate, topographic, soil, etc.) and in socioeconomic conditions (e.g., infrastructure access, opportunities in non-agricultural economic activities, distance from large cities, etc.). The largest marginal effect among regional dummy variables is found for Region 0. This implies that the farmers living in Region 0 (Cordillera region) have the probability of adoption of 58 percentage points higher, on average, than that of the farmers living in Central Luzon, after controlling for the household-level characteristics. Similarly, the farmers living in Region 7 have the adoption probability of 18 percentage points higher than do the farmers in Central Luzon. Among the household characteristics, having an additional 100,000 peso worth of productive assets is associated with 5 percentage point increase in the probability of adopting traditional varieties, while additional years of schooling lower the adoption probability by 2 percentage points. Exposure to extension services is associated with a 9 percentage-point increase in the probability of adoption.

Table 12.4 Probit Estimation of the Choice of Planting Traditional Rice Varieties

Variable	Coefficient	P-value	Marginal Effects
Age of household head (year)	-0.006	0.745	0.003
Age of household head squared (year)	0.000	0.573	-0.000
Education of household head (year)	-0.048**	0.004	-0.019
Household size	0.028	0.463	0.011
Assets (pesos)	1.21e-06**	0.048	0.0483 (per 100,000)
Male household members (0-15 years old)	-0.033	0.473	-0.013
Female household members (0-15 years old)	0.030	0.524	0.012
Male household members (15-60 years old)	-0.043	0.318	-0.017
Female household members (15-60 years old)	-0.111**	0.010	-0.044
Male household members above 60 years old	0.068	0.419	0.027
Distance to market (km)	0.017	0.317	0.007
Access to drying facilities (dummy)	-0.165**	0.008	-0.066
Access to storage facilities (dummy)	-0.284**	0.004	-0.113
Extension services (dummy)	-0.221**	0.001	-0.088
Land allocation (hectare)	-0.022	0.369	0.009
Region 0 dummy[a]	-1.446**	0.005	-0.575
Region 1 dummy	0.010	0.936	0.004
Region 2 dummy	-0.171**	0.045	-0.068
Region 4 dummy	0.054	0.628	0.022
Region 5 dummy	-0.174	0.132	-0.069
Region 6 dummy	-0.457**	0.000	-0.182
Region 7 dummy	0.456**	0.013	0.181
Region 8 dummy	0.330**	0.023	0.132
Region 9 dummy	-0.618**	0.001	-0.246
Region 10 dummy	-0.158	0.693	-0.063
Region 11 dummy	0.431**	0.006	0.172
Region 12 dummy	-0.021	0.932	-0.008
Region 13 dummy	-0.627**	0.002	-0.249
Constant	0.421	0.455	
Log likelihood	-1487.44		

**Significant at 5% level.
*Significant at 10% level.
[a] The Central Luzon (Region 3), which is often called the “Rice Bowl of the Philippines,” is set as the reference region.

12.6 Rice Farming Profits and Traditional Varieties

Tables 12.5 and 12.6 show the estimation results of the determinants of farm profit using endogenous switching regression model (i.e., equations 12.1a' and 12.1b', respectively). Table 12.2 shows the parcels planted with traditional varieties (TV "regime") and the parcels *not* planted with traditional varieties. The signs of the coefficients are mostly the same between the two "regimes." One contrasting point estimate is the education of household head, where the estimated coefficient is negative for TV parcels while it is positive for non-TV parcels although neither is statistically significant. Also the negative coefficient on the size of land, under both "regimes," suggests diminishing returns to scale, in line with the often-found empirical regularity in developing agriculture of the "inverse relationship between land size and productivity." The point estimate of the magnitude of the inverse relations, however, is about twice as large on TV parcels as it is on non-TV parcels. Since the Central Luzon region, the base region, is among the wealthiest regions in the country, with favorable agricultural conditions, most of the regional dummies are negative and significant. As we can also see that coefficients on the Mill's ratio is statistically significant in both "regimes," implying that the error terms of the profit determination functions (i.e., equations 12.1a' and 12.1b') are both correlated with the error term of the determinants of the traditional variety adoption (i.e., equation 12.1c).

12.7 Conservation Payments and Their Impacts on Poverty Levels

The counterfactual rice profit based on equation (12.1a') above can provide the necessary conservation payment that would compensate households for shifting to more agrodiverse rice farms. Under the hypothetical (first-best) subsidy for the traditional variety introduction scheme, each household currently *not* planting traditional varieties is assumed to be paid a subsidy to compensate for the losses due to the adoption of traditional varieties. The estimated subsidy needed for each household is calculated based on the counterfactual profit obtained as the fitted value using the regression equation in Table 12.5 applied to the plots currently not planted with traditional varieties (i.e., those observations with $I = 0$, which are the observations used to estimate equation (12.1b') as reported in Table 12.6). The mean subsidy payment based on the scheme is estimated to be 15,601 pesos per parcel. This direct payment scheme would cost the total of around 18,767,923 pesos to implement in total.

Table 12.5 Determinants of Rice Farm Profit: Traditional Variety Adopters

Variable	Coefficient	P-value
Age of household head (year)	8.013	0.98
Age of household head (squared (year)	0.677	0.78
Education of household head (year)	-195.678	0.50
Household size	-316.8929	0.53
Assets (pesos)	0.0157**	0.045
Male household members (0-15 years old)	418.285	0.50
Female household members (0-15 years old)	1522.289**	0.02
Male household members (15-60 years old)	296.150	0.64
Female household members (15-60 years old)	516.191	0.43
Male household members above 60 years old	507.846	0.67
Distance to market (km)	-360.684*	0.08
Land allocation (hectare)	-3602.293**	0.00
Region 0 dummy [a]	-7466.403	0.16
Region 1 dummy	855.239	0.58
Region 2 dummy	-5793.535**	0.00
Region 4 dummy	-4471.86**	0.00
Region 5 dummy	-4169.953**	0.01
Region 6 dummy	-8389.748**	0.00
Region 7 dummy	-5316.260**	0.02
Region 8 dummy	-5364.069**	0.00
Region 9 dummy	-12867.700**	0.00
Region 10 dummy	-12892.040**	0.04
Region 11 dummy	-503.421	0.81
Region 12 dummy	-430.866	0.90
Region 13 dummy	-10419.610**	0.01
Mills ratio	9109.964**	0.02
Constant	8159.567	0.33

**Significant at 5% level.

*Significant at 10% level.

[a] The Central Luzon (Region 3), which is often called the "Rice Bowl of the Philippines," is set as the reference region.

Table 12.6 Determinants of Rice Farm Profit: Traditional Variety Non-Adopters

Variable	Coefficient	P-value
Age of household head (year)	518.489**	0.05
Age of household head (squared (year)	-4.513*	0.05
Education of household head (year)	256.921	0.31
Household size	-9.592	0.99
Assets (pesos)	0.051**	0.00
Male household members (0-15 years old)	94.119	0.88
Female household members (0-15 years old)	1198.578*	0.07
Male household members (15-60 years old)	190.131	0.75
Female household members (15-60 years old)	-891.254	0.15
Male household members above 60 years old	1420.093	0.21
Distance to market (km)	-434.288*	0.09
Land allocation (hectares)	-1613.869**	0.00
Region 0 dummy [a]	-4382.6	0.32
Region 1 dummy	-3093.919*	0.07
Region 2 dummy	-3348.368**	0.01
Region 4 dummy	-3047.287**	0.05
Region 5 dummy	-5013.542**	0.00
Region 6 dummy	-8047.464**	0.00
Region 7 dummy	-4668.445	0.16
Region 8 dummy	-5171.136**	0.04
Region 9 dummy	-4768.957**	0.05
Region 10 dummy	-1898.011	0.35
Region 11 dummy	-4677.608	0.48
Region 12 dummy	-6924.852	0.19
Region 13 dummy	-6924.852**	0.01
Mills ratio	6856.129*	0.08
Constant	6098.135	0.47

**Significant at 5% level.

*Significant at 10% level.

[a] The Central Luzon (Region 3), which is often called the "Rice Bowl of the Philippines," is set as the reference region.

Under the hypothetical policy scheme of providing subsidies to convert farms exclusively planted with modern rice varieties to plant (at least partially) traditional varieties, a total of 544 or 52% of the sample (of 1,041) households in our data set would be eligible to receive such subsidies. Most of these households, on average, have significantly higher pre-subsidy incomes, and slightly larger farms than their non-eligible counterparts as shown in Table 12.7. Other household characteristics, such as schooling, age, the value of productive assets, and household size, are roughly the same between the two groups. These comparisons again emanates from the fact that most of pure modern variety cultivators are found in the low lands. Here government support for agriculture tends to be more intense than that in less favorable upper lands, with its emphasis on modern agriculture. In addition, lowland rice farmers likewise have more access to extension agents and thus are more knowledgeable in productivity-increasing technologies.

Under this subsidy scheme, the total of 18,767,923 pesos is distributed among 544 eligible households (1st column in Table 12.8). Since some of the beneficiary households live below the poverty line, this hypothetical subsidy scheme contributes to a modest decline in the headcount poverty ratio from 39.0% to 32.2%, a 17% decline in the headcount poverty ratio (the 1st row of the 2nd and 3rd columns in Table 12.9). As we have seen, however, those households that are not currently planting traditional varieties tend to be slightly better educated and to have higher profit and income, thus those households who are likely to be the subsidy recipients tend to be relatively better-off households. This suggests a likely trade-off between the policy goals of pursuing biodiversity and that of poverty reduction, in this particular context. As a benchmark to see such a trade-off, we could consider an alternative hypothetical subsidy scheme where the same total amount of 18,767,923 pesos would be distributed equally among all households (18,029 pesos each), a totally untargeted lump-sum subsidy scheme (2nd column in Table 12.8).

Table 12.7 Mean Values of Characteristics of Eligible and Non-Eligible Farmers

Variable	Eligible household (N = 544)	Non-eligible household (N = 497)
Total income (pesos)	123,231	88,902
Total rice profit (pesos)	29,918	22,682
Age of household head (years)	56.2	56.1
Education level of household head (years)	2.5	2.3
Household size	5.3	5.3
Productive assets (pesos)	21,395	20,633
Distance to market (km)	0.48	0.43
Access to drying facilities (dummy)	0.40	0.30
Access to storage facilities (dummy)	0.12	0.06
Extension services (dummy)	0.80	0.71
Total area (hectares)	2.97	2.65

Table 12.8 Alterative Policy Scenarios for Conservation/Poverty Subsidy Payment

	(1) Household-Specific Payment	(2) Untargeted Lump-Sum Subsidy	(3) Uniform Poverty Subsidy	(4) Uniform Conservation Payment
Total subsidy cost (pesos)	18,767,923			
Eligibility criterion	Non-TV cultivators expected to incur losses from TV adoption	None	Below poverty line	Currently not planting traditional varieties
Number of beneficiaries	544	1,041	406	544
Subsidy amount	Parcel specific	Uniform among households	Uniform among poor households	Uniform among MV households
Amount per beneficiary	34,499 (average)	18,029	46,226	34,499
Leakage (land areas not planted TV) (hectares)	0	382.2	567.3	126.8
(% of eligible land)	0	(23.6)	(35.1)	(7.8)

Table 12.9 Headcount Poverty Ratio under Alternative Policy Scenarios

Region	Status Quo	Household-Specific Payment	% Change	Untargeted Lump-Sum Subsidy	% Change	Uniform Poverty Subsidy	% Change	Uniform Conservation Payment	% Change
All regions	39.0	32.2	-17.4	24.0	-38.5	9.7	-75.1	28.1	-28.0
Region 0	50.0	37.5	-25.0	29.2	-41.6	12.5	-75.0	37.5	-25.00
Region 1	50.6	42.3	-16.4	32.9	-35.0	16.5	-67.39	38.8	-23.32
Region 2	30.7	26.4	-14.0	18.9	-38.4	7.1	-76.9	25.0	-18.6
Region 3	37.1	34.0	-8.4	27.8	-25.1	16.5	-55.5	32.0	-13.9
Region 4	39.8	34.4	-13.6	28.0	-29.7	16.1	-59.6	31.2	-21.6
Region 5	47.6	44.0	-7.6	28.6	-39.9	13.3	-72.1	35.2	-26.1
Region 6	37.1	29.7	-20.0	20.6	-44.6	5.7	-84.6	22.3	-39.9
Region 7	46.9	34.7	-26.0	26.5	-43.4	4.1	-91.3	28.6	-39.1
Region 8	48.3	40.5	-16.3	29.2	-39.5	7.9	-83.7	37.1	-23.3
Region 9	40.5	32.6	-19.5	18.9	-53.3	8.1	-80.0	16.2	-60.0
Region 10	42.9	42.9	-0.1	28.6	42.9	0	-100.0	28.6	-33.4
Region 11	17.6	8.8	-49.9	8.8	-49.9	2.9	-83.3	8.8	-49.9
Region 12	25.0	25.0	0.00	16.7	-33.3	8.3	-66.7	16.7	-33.3
Region 13	22.7	22.7	0.00	9.1	-60.0	0	-100.0	9.1	-60.0

Such a subsidy scheme would reduce the headcount poverty ratio to 24.0%, leading to a roughly 40% decline, compared to the 17% decline under the conservation subsidy scheme, in the headcount ratio (the 1st row of the 4th and 5th columns in Table 12.9). Under this scheme, however, traditional varieties would be introduced only a fraction of the lands; there would be an estimated "leakage" of 382 hectares or 24% of the land that would not be converted (at least partially) to traditional rice varieties, while 100% of the eligible parcels, by design, would be planted (at least partially) with traditional varieties under the first-best subsidy scheme. Thus, even the totally untargeted subsidy payment is much more "pro-poor" than the hypothetical conservation payment scheme considered here.

In order to assess the potential opportunity costs of the conservation payment scheme in terms of poverty reduction, we can alternatively consider a poverty-focused uniform payment scheme, holding the total subsidy budget constant at 18,767,923 pesos, where all the households living below the poverty line would receive a uniform amount of 46,226 pesos. This would obviously be much preferred from poverty reduction standpoint compared to the totally untargeted subsidy. Under this payment scheme, the headcount poverty ratio would decline to 9.7%, a 75% decline compared to the pre-subsidy poverty incidence (the 1st row of the 6th and 7th columns in Table 12.9). Comparing the headcount poverty ratio under the first-best subsidy scheme, 32.2% (found in the 2nd column of the first row of Table 12.9), and the poverty ratio under the "uniform poverty subsidy," 9.7% (found in the 6th column of the first row of Table 12.9), the difference between the two poverty ratios (i.e., 22.5 percentage points) can roughly be seen as the opportunity costs *in terms of poverty reduction (forgone)* for policymakers associated with the conservation subsidy payment (a PES) scheme under consideration.

At the same time, however, the likely "leakage" in land conversion to traditional rice varieties would increase to 35% of the eligible parcels from 24% under the totally untargeted subsidy scheme. Our example thus illustrates a case of direct trade-offs between the policy goals of biodiversity conservation and poverty reduction. This is essentially because (1) the kind of biodiversity we are considering here involves the adoption of a technology that would typically lead to loss in farm profit, (2) those households who are already practicing this ("environmentally friendly") technology tend to be less wealthy farmers while better-off farmers tend not be using the technology, and, therefore, (3) the environmental service payment would need to be targeted to those non-adopter farmers, who happen to be better-off farmers. As a result, given the same amount of budget, a subsidy scheme that is more efficient in inducing the adoption of traditional rice varieties is less pro-poor, while more pro-poor subsidy schemes tend to be less efficient as conservation payment schemes. In this particular application, therefore, policymakers would need to strike a balance between the two competing policy objectives.

Apart from the possible trade-offs between the environment and poverty reduction goals, another potential trade-off that policymakers are likely to face is the possible trade-off between the efficiency of payment scheme and the increase in the cost of information required for implementing subsidy schemes. The first-best subsidy scheme we considered above (i.e., 1st column of Table 12.8) assumes that the government is able to elicit the information on both the current and the counterfactual profit (where currently non-adopters of traditional varieties adopt such a technology) from each household. Since this is rather unrealistic, we could consider some other subsidy schemes that are less stringent in information requirement. One alternative is to distribute a uniform among all the farmers who are currently not adopting traditional varieties. Such a subsidy, holding the total subsidy amount constant at 18,767,923 pesos, would amount to distributing a subsidy of 34,499 pesos (in lieu of parcel-specific subsidy corresponding prospective profit loss) to each eligible household (where the farmers are not currently planting traditional varieties). This subsidy scheme, not surprisingly, is less efficient than the first-best conservation subsidy scheme (where the expected leakage is zero by design), leading to a leakage in land conversion of 8% (4th column of Table 12.8). The poverty reduction impact under this scheme, however, is larger than that of the first-best conservation scheme considered above; this scheme would lead to a 28% reduction in poverty incidence, compared to the 17% reduction under the first-best scenario (the 1st row of the 8th and 9th columns in Table 12.9).

The leakage share of land conversion under this subsidy scheme (i.e., 8%), however, is still much lower compared to the 24% and 35% under the untargeted lump-sum subsidy and the poverty-targeted subsidy, respectively. At the same time, however, the poverty reduction impact under this subsidy scheme is smaller; the headcount poverty ratio after this subsidy scheme is implemented would be 28% compared to 8% under the poverty-focused subsidy scheme. This last scheme, therefore, might be seen as a middle-ground option among the alternative payment schemes we have considered here, with a moderate leakage in terms of biodiversity conservation, a relatively modest information requirement, and a better poverty reduction performance (compared to the first-best conservation payment scheme).[3]

12.8 Concluding Remarks

This case study has shown the poverty implications and the cost of promoting agrobiodiversity in rice farming. Poverty effects of a direct conservation scheme appear to be quite sensitive to how the specific subsidy scheme is designed. Under this particular application of preserving traditional rice varieties in the Philippines, there is a clear trade-off between the two policy goals of enhancing biodiversity and poverty reduction. Even the totally untargeted lump-sum subsidy would have a larger poverty reduction impact than would the first-best conservation subsidy payment scheme. There is also a clear trade-off between the efficiency of targeted

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[3]In fact, there would be another issue of potentially perverse incentive effects; the farmers currently planting traditional varieties may shift to modern varieties in order to (appear to) be “eligible" for the subsidy scheme, which would lead to even larger leakages. While this is a real possibility, this issue is not pursued further here.

conservation payment and the information requirement for implementing subsidy schemes. While compensating the exact amount of profit losses due to technology adoption is obviously more efficient in terms of eliminating possible "leakages," the information requirement for such scheme is perhaps unrealistically high. One interesting result of our analysis is that a less informationally stringent, thus less efficient from a conservation point of view, subsidy scheme is more pro-poor than the efficient subsidy scheme. Under this particular policy example, therefore, policymakers are likely to be required to strike a delicate balance between the two competing policy objectives.

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