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**Sustainable Use and Management of Crop
Genetic Resources:
Landraces on Hungarian Small Farms**

by

Birol, E., Smale, M., and Gyovai, Á.

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Sustainable Use and Management of Crop Genetic Resources: Landraces on Hungarian Small Farms

Birol, E.^a, Smale, M.^b, and Gyovai, Á.^c

^a Department of Land Economy and Homerton College, University of Cambridge, Cambridge, CB2 2PH

^b International Food Policy Research Institute, Washington DC, USA and International Plant Genetic Resources Institute, Rome, Italy.

^c Institute for Agrobotany, Tápiószéle, Hungary and Institute of Environmental and Landscape Management, Szent István University, Gödöllő, Hungary.

Abstract

Crop genetic resources are natural assets that are necessary for future crop improvement. In isolated, marginal production environments where markets function imperfectly, farm families depend on them directly for food. In recognition of their importance, international agreements such as the Convention on Biological Diversity and the International Treaty on Plant Genetic Resources for Food and Agriculture encourage national governments to support their sustainable use and management, on farms and in gene bank collections. Hungary is a signatory to these international agreements. The aim of this study is to contribute research-based information to support the design of efficient and equitable conservation programmes for socially valuable crop landraces still found on small farms in Hungary. Landrace cultivation and richness is predicted with a Poisson hurdle model applied to data from a statistical survey of 323 households in three pilot conservation sites. Poorer, larger farm families with older decision-makers, who are more isolated from market infrastructure, are more likely to grow landraces and maintain greater landrace richness. Those managing smaller farms with lower quality soils and less irrigation have higher predicted probabilities of growing landraces. Findings suggest that the development of market infrastructure may contribute to abandonment of landraces, although specialised markets for high-quality products merit further investigation. Where economic development opportunities remain limited, supporting the continued management of crop genetic resources on farms could have positive equity implications and address other social goals, although the full cost and benefit implications of relevant policy instruments would need to be assessed in the context of Hungary's national agri-environmental programme.

Keywords: crop genetic resources, landraces, farm household model, Poisson Hurdle model, sustainable use and management,.

Address for correspondence

Birol, E.

Homerton College, University of Cambridge
Hills Road, Cambridge, CB2 2PH, UK

E-mail: eb337@cam.ac.uk

1 Introduction and policy context

Crop genetic resources are natural assets that are necessary for future crop improvement. Farm families in isolated, marginal production environments where markets function poorly continue to depend on them directly for food. In recognition of their importance, international agreements have been made to encourage national governments to support their sustainable use and management, on farms and in gene bank collections. Global initiatives include the International Convention on Biological Diversity (CBD, 1992), the Global Plan of Action for the Conservation and Sustainable Use of Plant Genetic Resources for Food and Agriculture (GPA, 1997), and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA, 2001). The Rural Development Regulation of the European Union (EU, 1999) also calls for the sustainable use and management of crop genetic resources. As a signatory to these international agreements and as an EU accession state, Hungary is obliged to develop policies to incorporate the commitments they entail (Bela et al., 2003).

Hungary is home to a great diversity of potentially valuable plant and animal landraces whose conservation is of national value (Bela et al., 2003). Definitions of landraces in the international scientific literature are numerous (Zeven 1998), and research with Hungarian stakeholders reveals multiple perspectives and terms used to describe them (Bela et al., forthcoming). In a broad sense, the term “landraces” refers to crop genetic resources that have evolved continuously under natural and farmer selection practices rather than in the collections of gene banks or plant breeding programs. Historically, landraces were the progenitors of the modern crop varieties that have generated productivity gains and lower food prices during this century in many countries. They continue to contribute unique traits needed by plant breeders, such as genetic resistance to certain plant diseases, pests and abiotic stresses (Harlan, 1992; Kloppenburg, 1988; Fowler

1994). Widely cultivated in some poorer countries and regions of the world, landraces are grown rarely in advanced agricultural economies, where they are sometimes known as “heirloom varieties” maintained through seed savers’ associations.

In the modern, intensive agricultural system that dominates much of Hungary’s landscape today, landraces have survived on the semi-subsistence, small-scale farms, traditionally known as ‘home gardens’. Home gardens played a historical role in food security during the socialist period (Szelényi, 1998; Kovách, 1999; Swain, 2000; Szép, 2000; Meurs, 2001), and still serve a vital function in more isolated locations with thin markets and poor growing conditions (Birol, Kontoleon and Smale, forthcoming). Continued management and use of this local crop genetic resource stock is believed to be crucial to future plant breeding activities in Hungary and for sustaining a rural way of life, eco-system health and services (Már, 2002). In agri-environmental policies to promote sustainable agricultural production in Hungary, however, neither the role of the crop genetic resources found on these small-scale farms, nor that of those farmers who maintain them, has yet been elucidated.

Part of a broader research project¹, this paper seeks to contribute information for the design of either market-based or publicly financed mechanisms to support sustainable use and management of national crop genetic resources. Data were generated through a sample survey of households conducted in sites representing three distinct regions of the country where pilot conservation programmes have been undertaken. The following section provides a statistical description of the small farms and crop genetic resources maintained in the three sites targeted for study. Section 3 develops a theoretical model of a household’s motivation for managing crop genetic resources on small farms in Hungary, explaining their demand for (and therefore supply of) crop landraces. Section 5 draws out the policy implications for

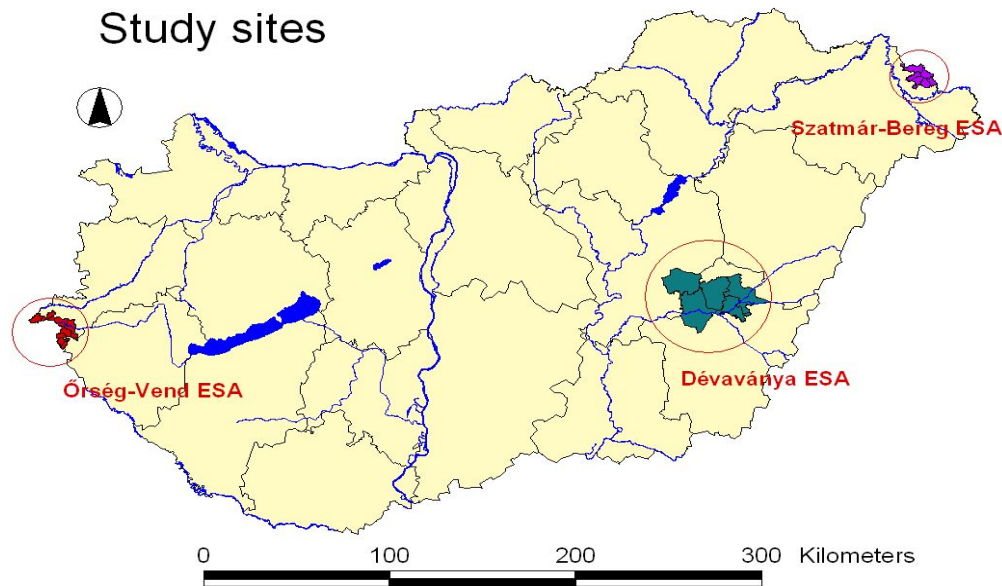
sustainable use and management of crop genetic resources on traditional Hungarian small farms.

2 Description of survey sites and farmers

Since 1997 the Institute for Agrobotany has carried out collection missions across Hungary to appraise the extent to which landraces are still cultivated in farmers' fields and home gardens. Two salient findings of these missions were that 1) landraces could almost always only be found in home gardens (as compared to farm fields) and 2), only maize and bean landraces were identified in large numbers across the country (Már, 2002). For this reason, the Hungarian On-Farm Conservation of Agricultural Biodiversity Project has targeted these crop landraces, though current scientific knowledge confirms that maize and beans were originally domesticated in the Americas.

The study was conducted in three pilot sites of Hungary's National Agri-Environment Programme (NAEP), namely, Dévaványa, Őrség-Vend, and Szatmár-Bereg, covering 22 settlements. These sites were purposively selected to represent contrasting levels of market development and agro-ecological features that are associated with farming system and intensity of land use.

Figure I Location of study sites



Of the three sites, Dévaványa region is closest to the center of the country, on the Hungarian Great Plain. The landscape is a flat mosaic of cultivated lands and grasslands, and soil and climatic conditions are well suited to intensive agricultural production. This site is the most urbanized among the three, with the highest population density and well-developed road and market infrastructure. Migration from Dévaványa region is not a major problem, although the number of inhabitants is stagnating (Gyovai, 2002). The unemployment rate in this region is slightly higher than the Hungarian average at 12.4% (National Labour Centre, 2000).

Located in the southwest, Órség-Vend region has a heterogeneous agricultural landscape with knolls, valleys, forests, grasslands and arable lands. Poor soil conditions in this site render intensive agricultural production methods impossible. Settlements are very small in area as well as in population, and most are far from towns (Gyovai, 2002). The population is declining and aging in Órség-Vend region, though the unemployment rate of 4.8% is one of the lowest in the country (National Labour Centre, 2000).

Szatmár-Bereg region is situated in the northeast, far from the economic centre of the country. The landscape consists of moors, grasslands, forests, and arable lands. Settlements are also small and the population is declining and aging, due to lack of public investment in this region (Gyovai, 2002). Roads are of poor quality and the regional unemployment rate is the highest in the country at 19% (National Labour Centre, 2000).

Small farms in Hungary often include both home gardens and more extensive areas of fields or orchards. Maize and bean landraces are found only in home gardens. Household lists were compiled for each site and a screening questionnaire was sent to identify those with home gardens on their farms. The response rate was augmented through key informants and household visits. A total of 323 respondents were interviewed in August 2002. Of these, 142 of them stated that they cultivated landraces of beans or maize. By region, 26.9%, 52.3% and 52.7% of all households in Dévaványa, Órség-Vend and Szatmár-Bereg regions respectively have at least one landrace of maize or bean in their home gardens. Households in Dévaványa are about half as likely to grow landraces as those in the other less urbanized, less densely populated study sites.

Households growing landraces and those who do not are compared with descriptive statistics in Table I, by region. In Dévaványa, landrace-cultivating households have smaller total areas of fields and spend a greater percentage of their income on food. Therefore, landraces are found among less wealthy farm families in this region. In Órség-Vend, the households that cultivate landraces have less educated decision-makers but farm more extensive fields. They are also poorer, as well as more agriculturally-based, spending larger proportions of their budgets on food. In Szatmár-Bereg households who manage landraces have older and less educated farm decision-makers than those who do not, and are located in more isolated settlements of the region. Relative to those who do not cultivate landraces, a smaller percentage of households who do own a car, which is a wealth indicator.

The spatial diversity concept of “richness” refers to the numbers of species or sub-species per unit of area (Magurran, 1988). In all three regions, farmers who manage home gardens that are landrace-rich also manage home gardens with greater richness of crop species. In Szatmár-Bereg and Órség-Vend, a higher proportion of those who grow landraces also manage livestock (93 and 90 percent, respectively). That is, genetic diversity in maize and bean landraces seems to be associated with both diversity among crops and mixed crop and livestock production. The total number of crops grown per home garden range from an average of 14 to 21 in the regions studied.

When landrace growing farmers are compared across regions, it is revealed that Szatmári decision-makers are clearly less educated than their counterparts in the other two regions. Dévaványai households that cultivate crop genetic resources in home gardens have fewer members who participate in home garden production compared to the other two regions. Income levels of the landrace-cultivating households differ across regions significantly. Szatmári households that manage landraces on their small farms not only have the lowest incomes across the three regions, but also spend the highest percentages of their income on food. A higher percentage of órségi landrace growers own cars compared to the other two regions, and considering all three regions, they are the most isolated of households. Landrace growers in Dévaványa tend the smallest areas and those in Szatmár-Bereg farm the largest. Szatmári home gardens that contain a landrace have the lowest irrigated area percentages compared to the home gardens in the other two sites. The percentage with good quality soils in their home gardens is the highest in Szatmár-Bereg compared to the other two sites. On average, Dévaványai home gardens have the lower landrace count (1.6) than those in the other two areas (2 and 2.3).

Table I Descriptive statistics for households with and without landraces, by site

	Dévaványa		Őrség-Vend		Szatmár-Bereg	
	With landrace	Without landrace	With landrace	Without landrace	With landrace	Without landrace
No. households	28	76	57	52	57	53
Decision maker characteristics						
Age (yrs)	60.4 (8.6)	57.8 (14.4)	59.1 (11.8)	56.4 (13)	59.1* (13.9)	53.7* (15.6)
Education (yrs) ^{aa}	10.1 (2.5)	10 (2.9)	9.4** (2)	10.5** (3)	8.6*** (3.1)	10.1*** (3.7)
Household characteristics						
No. members participating in home garden production ^{aaa}	1.9 (0.7)	2.1 (1.1)	2.7 (1.4)	2.4 (1.2)	2.5 (1.3)	2.3 (1.3)
Nonfarm income (HUF) ^{aaa}	77182.8 (25303.5)	74147.1 (24913.8)	89534 (43372.9)	94685 (43224)	66355.4 (31507.9)	77567.7 (48093.3)
Car (0,1) ^{aaa}	39.3% (14.3)	39% (14.8)	61.4% (17.9)	65.4% (14.9)	30% ^{\$\$\$} (11.1)	56.6% ^{\$\$\$} (12.3)
Food expenditure share of income. ^{aaa}	43.4* (14.3)	37.5* (14.8)	42* (17.9)	37.1* (14.9)	31.3 (11.1)	34.6 (12.3)
Distance to nearest food market (km) ^{aaa}	0 (0)	0 (0)	21 (6.5)	20.4 (6.8)	18.9** (2.8)	17.8** (3.2)
Farm characteristics						
Home garden area ^{aaa}	570.9* (445)	571.3* (760.5)	1353.6 (2657.5)	1921.8 (3089)	2844.2 (3251.1)	2439.5 (2815.4)
Total field area ^{aaa}	4596.2 (12256.2)	44018.2 (245818.9)	15059.3* (33824.9)	4695.2** (8660.8)	16718.4 (44010)	21546.9 (50272.8)
Farm sales in HUF/m ²	14.1 (53.3)	2.2 (11.2)	12.5 (68.5)	0.04 (0.2)	30.8 (97.4)	35.3 (110.3)
No. of crop species ^{aaa}	16.4*** (7)	12.8*** (5.6)	21.4*** (6.4)	18.5*** (6.5)	16.4*** (4.5)	14*** (6.6)
Good quality soil (0,1)%	11	19	8.8	9.6	30.4	32
Organic production in home garden (0,1)%	7	20	16	19	9	8
Livestock production in home garden (0,1)%	75	74	90	65	93	79
Irrigated land in home garden (%)	53.9 (40.1)	36.2 (45.7)	42.9 (39.4)	49.4 (41.6)	17.3 (27.3)	16.6 (29.2)
No. of landraces ^{aaa}	1.6 (0.9)	0 (0)	2 (1)	0 (0)	2.3 (1.1)	0 (0)
No. bean landraces	1.5 (1)	0 (0)	1.9 (1)	0 (0)	2.1 (1.1)	0 (0)
No. maize landraces	0.11 (0.3)	0 (0)	0.11 (0.3)	0 (0)	0.2 (0.4)	0 (0)

Source: Household Sample Survey, Hungarian On-Farm Conservation of Agricultural Biodiversity Project, 2002. Total sample size=332. Pairwise t-tests between households that cultivate landraces and those who do not within each region show significant differences at ***1% significance level, **5% significance level and *10% significance level. Pearson Chi-square tests between households that cultivate landraces and those who do not within each region show significant differences at ^{\$\$\$} 1% significance level. Pairwise t-tests between households that cultivate landraces across regions show significant differences at ^{aaa}1% significance level, ^{aa}5% significance level.

As a part of the research project, the Institute of Agrobotany collected maize and bean landraces from farm households in each site. Preliminary molecular biological analyses of seed samples reveal that their genetic diversity consists of a range of alleles that can be differentiated in terms of local and general adaptation. Most of the landraces exhibit adaptive traits for local agro-ecological conditions, but some also display them for agro-ecological conditions that differ substantially from those found at the point of collection. This quality suggests that they can survive even if external conditions change over time (Már and Juhász, 2002). Landraces sampled also contain alleles that confer quality traits of nutritional importance, for which consumers may be willing to pay. For example, SDS-electrophoresis analyses of *Fürjbab* and *Pacsibab* bean landraces reveal three-banded euphaseolin content (Már and Juhász, 2002), which is directly correlated with the content of an essential aminoacid, metionin (Unk, 1984).

3 Theoretical model

The model is based on the theoretical framework of semi-subsistence farm household with missing markets (Singh, Squire and Strauss, 1986; de Janvry, Fafchamps and Sadoulet, 1991; Taylor and Adelman, 2002). The framework has been applied to the study of crop genetic resource management on farms in developing countries by Van Dusen (2000; Van Dusen and Taylor, forthcoming). Other related models are found in Brush, Taylor and Bellon (1992), Meng (1997), Smale, Bellon and Aguirre Gómez (2001) and Gauchan (2004). Although Hungary is a high income country with developed markets, food markets for products made from landraces are missing or thin for many farmers in the study sites, and because of high transaction costs, they are motivated to produce for their own subsistence. Rainfall is reliable, however, and production sources of risk are minimal. The model presented here differs from Van Dusen and Taylor (forthcoming) by focusing on the supply and demand for landraces specifically.

Following Singh, Squire and Strauss (1986) and Van Dusen and Taylor (forthcoming) the farm household is assumed to maximise the following utility function:

$$U = U(C_k, C_t, C_m, C_l; \Omega_{HH}) \quad (1)$$

where the arguments are vectors of consumption of home garden output the household produces, C_k , subscripted with a 'k' for *kert* (home garden in Hungarian); consumption of landraces, for which the markets are missing, C_t , subscripted 't' for *tájfajta* (landraces in Hungarian); market purchased commodities, C_m , and total leisure, C_l . Household utility is influenced by Ω_{HH} , denoting a vector of household characteristics of the farm household that condition consumption preferences and choices. The utility function is assumed to be quasi-concave with positive partial derivatives.

The household maximises utility subject to a full income constraint

$$Y = w(T - H) + E + [p_k(Q_k - C_k) - p_v V] \quad (2)$$

where full income is composed of value of stock of total time owned by the household (T), exogenous income (E), which is non-wage, non-household production income such as direct assistance or pensions, and any profits from home garden output sales. Profits are equal to the value of farm output sales less the values of household labour and management input used in the home garden production (H), and other variable inputs required for production of home garden outputs (V)². For cultivation of home garden plots, household labour and management input (H) is a necessary and also sufficient input, since home gardens are typically managed by family labour alone.

The household faces a production constraint for production technology in the home garden, depicting the relationship between home garden inputs (H, V) and all outputs (Q) by an implicit production function (G) that is quasi-convex, increasing in outputs and decreasing in inputs. The vector Ω_K in the production function represents the fixed agro-ecological features of the home garden, such as soil quality. The household also faces a time constraint, and cannot allocate more time to home garden cultivation (H), off home garden employment (L_o , including employment either in other forms of agricultural production, such as field production or in off farm employment) and leisure (C_l), than the total time available to the household.

$$\begin{aligned} G(Q, H, V; \Omega_K) &= 0 \\ H + L_o + C_l &= T \end{aligned} \tag{3}$$

Missing markets for crop landraces lead to the equality of household demand and supply for related outputs:

$$Q_i = C_i(\Omega_M) \tag{4}$$

Q_i and C_i denote the quantity demanded and supplied of landraces, and Ω_M is a vector of exogenous characteristics related to availability of and access to markets. This equality condition implicitly defines the shadow price for such goods, which is a function of both preferences of the farm household and technology of home garden production. The endogenous shadow price implies that production decisions are not separable from consumption decisions.

The household maximises its utility (equation (1)) subject to its cash income, production technology, time endowment, and equality of production and consumption for landraces constraints (equations (2), (3) and (4)), and to

exogenous prices being fixed. This maximisation results in the following Lagrangian.

$$\mathcal{L} = U(C_k, C_m, C_l; \Omega_{HH}) + \lambda[w(T - H) + E + (p_k(Q_k - C_k) - p_v V)] + \rho(Q_{lr} - C_{lr}(\Omega_M)) + \mu G(Q, H, V; \Omega_K) \quad (5)$$

Assuming interior solutions exist, the optimal set of output and consumption levels and endogenous prices for the home garden products are given by the solutions of the first order conditions.

$$\begin{aligned} \partial \mathcal{L} / \partial C_k &= \partial U / \partial C_k - \lambda p_k = 0 \\ \partial \mathcal{L} / \partial C_m &= \partial U / \partial C_m - \lambda p_m = 0 \\ \partial \mathcal{L} / \partial C_l &= \partial U / \partial C_l - \lambda p_l = 0 \\ \partial \mathcal{L} / \partial \lambda &= w(T - H) + E + (p_k(Q_k - C_k) - p_v V) = 0 \\ \partial \mathcal{L} / \partial Q_k &= \lambda p_k - \mu G_k = 0 \\ \partial \mathcal{L} / \partial H &= -\lambda w + \mu G_h = 0 \\ \partial \mathcal{L} / \partial V &= -\lambda p_v + \mu G_v = 0 \\ \partial \mathcal{L} / \partial \mu &= G(Q, H, V; \Omega_K) = 0 \end{aligned} \quad (6)$$

where the first three equations imply that the marginal utility the household receives from each commodity equals its market price, p_k , p_m and w respectively. The fourth, the full income constraint, insures that the net full income received is expended. The fifth implies that for tradable home garden outputs, optimal production choices are those that equate price to the marginal cost of production. The next two equate input prices to their marginal value products. The final equation defines the transformation function.

The prices of landrace outputs are endogenous because markets are missing. The first-order condition states that at the optimum, the marginal utility from consuming landraces equals a shadow price, ρ :

$$\partial \mathcal{L} / \partial C_t = \partial U / \partial C_t - \rho = 0 \quad (7)$$

The supply of the landrace production is given by

$$\partial \mathcal{L} / \partial Q_t = \rho - \mu G_t = 0 \quad (8)$$

where the marginal cost of producing landraces equals their shadow price. Substituting for the shadow price ρ in (7) and (8), the demand for (marginal utility of) landraces equals their supply (marginal cost) and the shadow price.

$$\frac{\partial U}{\partial C_t} = \mu G_t = \rho \quad (9)$$

Hence the shadow price of the landraces depends on the household characteristics, characteristics of the home garden technology, market infrastructure and household access to food markets. The solution to the household maximisation with missing markets for home garden products becomes

$$Q_k = Q_k^*(\rho, p_k, p_v, w; \Omega_K) \quad (10)$$

$$Q_t = Q_t^*(\rho, p_k, p_v, w; \Omega_K) \quad (11)$$

$$H = H^*(\rho, p_k, p_v, w; \Omega_K) \quad (12)$$

$$V = V^*(\rho, p_k, p_v, w; \Omega_K) \quad (13)$$

$$C_i = C_i^*(\rho, p_k, p_m, w, Y; \Omega_{HH}) \quad i = k, t, m, l \quad (14)$$

Equation (10) is the optimal supply of small farm outputs that can be traded in the markets; (11) is the optimal supply of landraces; (12) is the optimal demand of household labour in the home garden production; (13) is the optimal demand for all other inputs to small farm production; and (14) is the optimal demand for each commodity. Substituting the solution for the shadow price in equation into (10) to (14), the optimal quantity of landrace output (supply and demand) is a function of all exogenous variables, including all prices, household, market and home garden characteristics. Equation (11) can then be written as

$$Q_t = Q_t^*(p_m, p_k, p_v, w; \Omega_{HH}, \Omega_K, \Omega_M) \quad (15)$$

Following Van Dusen and Taylor (forthcoming), the level of landrace richness maintained on the home gardens in Hungary is a metric defined over a set of optimal output choices, and is in turn a function of all prices, and characteristics of the households, markets, and home garden plots

$$LR = LR(Q_t^*(p_m, p_k, p_v, w; \Omega_{HH}, \Omega_K, \Omega_M)). \quad (16)$$

4 Econometric Estimation

4.1 Approach

The reduced form equation (16) is the basis of an econometric estimation using a count model. The dependent variable, landrace richness, is an integer greater than or equal to zero. Four count models were considered: the Poisson, Poisson Selection, Poisson Hurdle and Zero Inflated Poisson. Zero is observed for households that did not grow a landrace in the survey season, representing over half of the sample. The descriptive statistics presented above and histograms of the dependent variables suggested the need to correct for selection bias. However, the coefficient on the estimated inverse Mills ratio had no statistically

significant effect on landrace richness and the null hypothesis of no selection bias could not be rejected. Next, the Zero Inflated Poisson (ZIP) model was estimated to account for stated non-participation in landrace cultivation only in the year in which the survey is conducted (Greene, 1998). The ZIP model failed to converge.

Finally, the Poisson Hurdle model and Poisson models were estimated. Log-likelihood ratio tests conducted at the 0.5% significance level confirmed that the Poisson Hurdle compared favourably with the Poisson model for two of the three regions (Őrség-Vend and Szatmár-Bereg). While the Poisson model assumes that the same underlying process generates the data recording the decision to grow a landrace and the number of landraces to grow, the Poisson Hurdle model allows for independent processes, incorporating a selection effect through the estimation of separate regressions. In Dévaványa region, where far fewer farmers choose to cultivate landraces, the null hypothesis that two independent processes generated the data was rejected and the Poisson model was used instead.

The two-step Poisson Hurdle model for selectivity is formerly generalised by Mullahy (1986), discussed in the context of two-part decision-making by Pohlmeier and Ulrich (1995), and has been applied in analysing crop diversity by Van Dusen (2000). Edmeades et al. (2004) have recently applied a Poisson Hurdle system to analyse farmer demand for cultivars. The first stage of the model is a binary (0,1) choice to grow a landrace or not. The second stage of the model is a truncated Poisson model ($LR > 0$), which considers the number of landraces cultivated or their richness. The likelihood function is specified as a combination of two independent processes over two different domains. That is

$$L = \prod_{i=1}^{N1} P(y_i = 0 | x_i' \beta_1)^{d_i} (1 - P(y_i = 0 | x_i' \beta_1))^{1-d_i} \times \prod_{i=1}^{N2} \frac{P(y_i | x_i' \beta_2)}{P(y_i \geq 1 | x_i' \beta_2)} \quad (17)$$

where N_1 represents the full sample of the households and N_2 is the restricted sample of only those households who choose to cultivate at least one landrace. The variable d represents the binary variable of the first stage discrete choice. Given that the two processes are independent, the log likelihood functions are additive and the two equations can be estimated separately. The two separate parameter vectors β_1 and β_2 can be viewed individually for their effects on the crop landraces managed on Hungarian home gardens.

4.2 Results

Explanatory variables are defined in Table II and regression results are reported by site in Table III. In Dévaványa, as has been found in other studies (e.g. Meng, 1997 and Van Dusen and Taylor, forthcoming), it is the older generation of farmers that grows landraces. By implication, older farmers are more likely to farm in a traditional manner (Meng, 1997), following practices they learned before collectivisation and the current period. The fact that younger farmers do not continue this practice reveal that long-term sustainability of on farm conservation is in jeopardy (Van Dusen, 2000) unless specific measures are taken to ensure the continued cultivation of these landraces. The quadratic age variable is significant and negative, indicating that farmers are less likely to undertake landrace cultivation as their ability to work in labour intensive small-scale farm production decreases at an advanced age. On the other hand, landrace richness is low in this region and the opportunity costs of growing landraces higher given its greater productivity potential. The age-related pattern is not visible in the other regions studied, where the proportion of farmers growing landraces and landrace richness levels are higher.

The only fixed, agro-ecological factor that affects the number of landraces grown by dévaványai farmers is the quality of the home garden soil. Dévaványai landraces appear to be more suitable to poor soil conditions, i.e. to the marginal agro-ecological niches in this region characterised by relatively favourable

agricultural conditions. The relationship between the value of sales of the home garden produce and the number of landraces that the home gardeners produce is positive and significant. This result suggests that the farm families growing landraces in Dévaványa are mainly those who are engaged in intensive, market oriented small-scale farming, rather than those that are engaged in home garden cultivation just for household consumption. This implies that they are full-time farmers.

In Őrség-Vend region, the higher the number of family members participating in home garden production and the lower the proportion of home garden land that is irrigated, the more likely that the household will choose to cultivate at least one landrace in its home garden. The truncated Poisson regression reveals that for those households who choose to cultivate a landrace, the only significant determinant of landrace richness is the number of home garden participants. Landrace cultivation is generally a labour intensive activity since the selection of seeds, tending and harvesting of these varieties require labour input rather than mechanical or market purchased inputs. This finding is in line with those of Gauchan (2004), who found a positive relationship between the number of household members that take part in agricultural production and the diversity of rice landraces managed by farmers in Nepal. It is also consistent with the observation that landraces tend to be conserved by more traditional of Hungarian families, which are extended families of three cohabiting generations³.

In Szatmár-Bereg region, the decision to cultivate landraces is influenced positively by the number of family members participating in home garden production. Wealthier households who own a car are less likely to cultivate a landrace. For the households who choose to cultivate a landrace the only significant determinant of the landrace richness is soil quality. In Szatmár-Bereg site, which is a more marginal production zone, home gardens with good quality soils have higher number of landraces.

In none of the site-specific regressions was the distance to the nearest food market a significant factor explaining the choice to grow landraces or landrace richness. One reason may be that the variation in this factor is partitioned more between sites than within them, an artifact of the sample design. In a regression pooling the sites, both the value of market sales and the distance to the food market were found to be statistically significant. The more a household sells home garden produce, the more likely it is to engage in landrace cultivation. This finding suggests niche market potential. The more isolated the household is from market infrastructure, however, the more likely it is to cultivate landraces, presumably to satisfy food consumption needs. Similar results have been reported in related literature for developing countries (Brush, Taylor and Bellon (1992), Meng (1997), Van Dusen (2000), Smale, Bellon and Aguirre Gómez (2001), Gauchan (2004) and Van Dusen and Taylor (forthcoming)).

Table II Definition of explanatory variables

Variable	Definition	Expected sign
AGE	Age of the home garden decision-maker in years	+
AGE2	Age squared	-
HGPAR	Number of household members that participate in small-scale farm production	+
TOTFOC	Total area of cultivated fields (in m ²) that are also owned by the household	+
CAR	Household owns car=1; 0 otherwise	-
HGAREA	Total home garden area (in m ²)	+
IRRPER	Percentage of small farm area that is irrigated	+, -
GOODSOIL	Soil is of good quality = 1, 0 else	+, -
SALEM2	Value of small farm outputs sold at the markets	+, -
DISTKM	Distance of the household (in km) from the nearest food market	-

Table III Determinants of landrace choice and richness, by site

Variable	Dévaványa		Őrség-Vend				Szatmár-Bereg			
	Poisson		Poisson Hurdle				Poisson Hurdle			
			Binary choice (0-1)		Count (>0)		Binary choice (0-1)		Count (>0)	
	Coeff.	Marginal effects	Coeff.	Marginal effects	Coeff.	Marginal effects	Coeff.	Marginal effects	Coeff.	Marginal effects
Constant	-21.14***	-8.57	-3.65	-1.08	-1.4	-1.68	-4.18*	-1.28	0.01	0.016
AGE	0.68***	0.27	0.10	0.031	0.035	0.04	0.051	0.015	0.028	0.043
AGE2	-0.005***	-0.002	-0.0007	-0.0002	-0.0002	-0.0003	-0.0003	-0.9x10 ⁻⁴	-0.0002	-0.0004
HGPAR	-0.11	-0.044	0.26***	0.078	0.13*	0.15	0.42***	0.13	0.024	0.037
TOTFOC	-0.9x10 ⁻⁵	-0.4x10 ⁻⁵	0.2x10 ⁻⁴	0.61x10 ⁻⁵	-0.7x10 ⁻⁶	-0.9x10 ⁻⁶	0.8x10 ⁻⁶	0.3x10 ⁻⁶	-0.2x10 ⁻⁵	-0.3x10 ⁻⁵
CAR	0.1	0.04	-0.3	-0.087	0.13	0.15	-1.21***	-0.37	0.14	0.22
HGAREA	-0.6x10 ⁻⁴	-0.2x10 ⁻⁴	-0.7x10 ⁻⁴	-0.2x10 ⁻⁴	-0.5x10 ⁻⁴	-0.6x10 ⁻⁴	0.5x10 ⁻⁴	0.15x10 ⁻⁴	-0.4x10 ⁻⁴	-0.6x10 ⁻⁴
IRRPER	-0.0033	-0.001	-0.006*	-0.0017	0.7x10 ⁻⁴	-0.9x10 ⁻⁴	0.004	0.0013	-0.0006	-0.001
GOODSOIL	-0.0014**	-0.0006	-0.25	-0.073	0.43	0.51	-0.06	-0.019	0.5*	0.74
SALEM2	0.0064***	0.003	0.33	0.098	-0.0019	-0.0023	0.0003	0.0001	-0.0012	-0.0019
DISTKM	-	-	-0.024	-0.007	0.009	0.01	0.07	0.021	-0.013	-0.02
Sample size	104		109		57		110		57	
Log likelihood	-76.02		-63.54		-70.79		-65.9		78.96	
Chi squared	39.85		60.82		27.54		57.15		21.53	
D.o.f	9		10		10		10		10	
Sig. Level	0.000008		0.00		0.002		0.00		0.018	

Source: Household Sample Survey, Hungarian On-Farm Conservation of Agricultural Biodiversity Project, 2002.

* significant at less than 10%, ** significant at less than 5%, *** significant at less than 1%

5 *Conclusions and policy implications*

Analysis of survey data reveals information about the farmers and locations where crop landrace richness is most likely to be found in rural Hungary. In this country, given the cultural and historical role of the small, family farms called “home gardens”, those farmers who maintain landraces are older, and the families that manage them have more members participating in farm production. They do sell their produce, but are more distant from food markets than other farmers. In the densely populated region with high productivity potential, crop landraces are found on the poorer soils; in the isolated region with low productivity potential, they are found on better soils on one region and on farms with less irrigation in the other.

The fact that these farmers already conserve crop genetic resources on farm implies that the opportunity costs of maintaining landraces are nil at present. Thus, the farmers and communities that constitute least cost options for any public programmes or incentive mechanisms aimed at managing Hungarian landraces on farms are also the most marginalized economically and environmentally. The opportunity costs for these farmers of maintaining landraces may change with economic development, rising incomes and the market integration that occurs in Hungary as a result of economic transition and EU membership. On the other hand, these localities may become increasingly marginalized with economic transition. Both concerns related to crop genetic resource management and those related to social equity might be addressed through integrating landrace cultivation practices into publicly-financed, national programmes in selected sites, with selected farmers. The most proximate means to subsidise home garden and landrace production is the National Agri-Environmental Programme of Hungary, which is structured around farmer

contract payments to those farmers that undertake sustainable, environmentally-friendly agricultural production methods.

Market based incentives are generally less costly than publicly funded conservation programmes. The high nutritional value and superior cooking qualities of these landraces might serve as a basis for development of niche markets (Már, 2002). Farmers would have economic incentives to grow landraces if urban consumers in Hungary or elsewhere are willing to pay premium for their products because they have unique attributes. Generally, however, governments also need to invest in developing the infrastructure to support the formation of niche markets.

Development of regulations and laws that grant farmers and their communities property rights by labelling or certification of agricultural products with high quality can create market based incentives for their continued cultivation (Blend and van Ravenswaay, 1999). A labelling/certification system may also educate consumers about agricultural biodiversity and cultural heritage, leading to a change in purchasing behaviour (Teisl et al., 1999). Moreover, the presence or absence of information on the crop landraces and cultural heritage attributes may have important welfare implications for certain consumers. To make utility-maximising decisions, consumers must have access to all information relevant to their decisions. Labelling/certification programmes therefore may offer an approach to provide consumers with such information (Wessells, et al. 1999).

The EU, which Hungary has joined to in May 2004, has already created one such necessary market mechanism for farmers and farming communities to appropriate the benefits of high cultural and environmental value products they produce. In 1992, with Council Regulations (EEC) No 2081/92 and (EEC) No 2082/92, the European Union created labels (systems) known as PDO (Protected Designation of Origin), PGI (Protected Geographical Indication) and TSG (Traditional Speciality Guaranteed) to promote and protect agricultural

products⁴. The EU acquired these systems with three main aims in mind (EU, Agriculture and Food web site, 2004): 1) encouraging diverse agricultural production in a rural development context; 2) protecting product names from misuse and imitation; 3) helping consumers by giving them product information. Consumer demand for such certified and labelled agricultural products has been found in the USA (Blend and van Ravenswaay, 1999) as well as in the EU (Kontoleon, 2003).

Agricultural industry responds to the demand of the society (Cuffaro, 2002) and there is evidence that both in Hungary and in the EU health concerns are growing as incomes rise. The demand for high quality, high nutritional value, organically produced foodstuffs is likely to increase. Hungary might legalise distribution of landraces and take advantage of PDO, PGI and TSG of the EU to promote and protect its high quality agricultural products. The results of the study presented here, once combined with the results of genetic analyses undertaken by the Institute for Agrobotany, can help identify the landraces, farming communities and farmers who are the most promising candidates to take part in such initiatives.

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