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AGRI-ENVIRONMENTAL POLICIES IN A TRANSITIONAL ECONOMY: THE VALUE OF AGRICULTURAL BIODIVERSITY IN HUNGARIAN HOME GARDENS

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ABSTRACT

Agricultural biodiversity is an environmental resource. Much of the agricultural biodiversity remaining *in situ* today is found on the semi-subsistence farms of poorer countries and the small-scale farms or home gardens of more industrialized nations. The traditional small farms of Hungary are labelled "home gardens" as a reflection of their institutional identity during the collectivisation period. Homesteads managed with family labor, they continue to serve essential food security and diet quality functions during economic transition. Home gardens contribute to the preservation of rural settlements and cultural heritage, and they contain relatively high levels of several components of agricultural biodiversity. The role of home gardens in the agri-environmental program that is now being formulated by Hungary and the European Union has not been elucidated, though the stated goal of these policies is to support multifunctional agriculture. This study estimates the private value that Hungarian farmers assign to home gardens and their biodiversity attributes, and indicates how such information might be used in designing least-cost mechanisms to support their maintenance as part of the national agri-environmental program.

KEYWORDS: agricultural biodiversity, *in situ* conservation, choice experiment method, Hungary, home garden

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1. INTRODUCTION

Agricultural biodiversity is an environmental resource that ensures the food or livelihood security of billions of people today as well as the inputs for future agricultural innovations (FAO 1999). In recognition of its importance, international agreements such as the Convention on Biological Diversity (CBD) and the International Treaty on Plant Genetic Resources for Food and Agriculture encourage the design of policies that convey economic incentives for farmers to conserve agricultural biodiversity (CBD 2002).

Much of the agricultural biodiversity remaining today is found on the semi-subsistence farms of poorer countries. Some also persists on the small-scale farms and in the home gardens of more industrialized nations, and many of these are found in more economically marginalized areas (Brookfield 2001; Brookfield *et al*. 2002; IPGRI 2003). The traditional home gardens of Hungary are an example. On these privately-owned, homestead fields, the use of labor-intensive, traditional production techniques has persisted throughout the period of state farming and the subsequent transition to market-oriented, large-scale farming (Kovách 1999; Swain 2000; Meurs 2001). Many are rich in

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crop and livestock species, varieties and breeds, as well as in soil microorganisms that result from decades of production without chemicals (Már 2002; Csizmadia 2004; Már, personal communication 2004). Home gardens play a significant cultural role in Hungarian society, having provided farm produce that contributes color, flavor, and nutrients to the diets of both rural and urban people in time periods and locations when markets or state institutions did not (Már 2002).

Hungary is preparing to join the European Union (EU) in May 2004. To comply with the *acquis communautaire*, national agri-environmental policies and programs are now being developed to promote multifunctional agriculture (Juhász 2000). Current agri-environmental policies and programs appear to neglect Hungarian home gardens, though these generate multifunctional agricultural values related to conservation of agricultural biodiversity, cultural heritage, rural settlements, and food safety and security. Coupled with the changing economic circumstances in this transitional country, home gardens may cease to exist (Vajda 2003; Weingarten et al. 2004) if agri-environmental policies do not recognize the public and private economic value generated by their multiple functions, much of which is understated in markets.

To evaluate policy options, more information is needed about the benefits and costs of supporting Hungarian home gardens. Favorable benefit-cost ratios will occur in locations where both the public and private values of the resources to be conserved are high. Public benefits are high in locations of relatively abundant agricultural biodiversity; private benefits are high among the farmers who value it most. Where private benefits are high, the public costs of conservation programs will also be “least”—

though costs will vary depending on the support mechanism (Krutilla, 1967; Brown 1991).

In the study reported here, the choice experiment method is used to estimate the private value rural households assign to agricultural biodiversity in their home gardens, and to characterize those locations and households that value it most. The analysis presented here is part of a research project whose purpose is to generate information that is useful for the design of policies and programs for agricultural biodiversity conservation on home gardens in Hungary. The policy context is presented briefly in the next section. Section 3 summarizes the choice experiment approach, followed by a description of methods used to collect data, and an inventory of agricultural biodiversity values found in home gardens. Findings are presented in Section 5. Conclusions are drawn and policy implications stated in the final sections.

2. POLICY CONTEXT

Hungarian agriculture today has a dual structure consisting of large-scale, mechanized farms alongside semi-subsistence, small-scale farms operated with traditional practices. Dualism has persisted in some form throughout Hungarian history, and most recently during the socialist period of collectivized agriculture from 1955 to 1989 (Szelényi 1998; Kovách 1999; Swain 2000; Szép 2000; Meurs 2001). Of the about 10 million people now populating Hungary, it has been estimated that nearly 2 million Hungarians produce agricultural goods for their own consumption and as a source of additional income (Már 2002) on an estimated 800 000 home gardens of up to 1 ha (Simon 2001). The 1996 Microcensus implemented by the Hungarian Central Statistical

Office (HCSO) reported that 33 percent of people aged 14 and over were engaged in auxiliary agricultural work, although few relied on agriculture as a main occupation (HCS0 1996).

Home gardens played an important role in food security during the socialist period when families were permitted to cultivate privately the small plots located adjacent to dwellings (Szelényi 1998; Kovách 1999; Swain 2000; Szép 2000; Meurs 2001). Even today, village level markets remain thin in many areas of rural Hungary. Historically, food market formation was discouraged. Like most transition economies, that of Hungary is now characterized by high transaction costs, including costs of transportation to the town with the nearest food market, search costs, uncertain and variable food quality, and food price variability (Seeth et al. 1998). Consequently, rural households continue to rely on their home gardens for at least some of the foods they consume and to enhance the quality of their diet. Though there is wide variation among them, production in home gardens was and still is accomplished with family labor, traditional farming practices, ancestral crop varieties and livestock races, limited use of purchased inputs, and without machinery. These traditional home gardens not only serve as 'small repositories of agricultural biodiversity', but also contribute to Hungarian cultural heritage (Már 2002). In addition, home gardens play a part in protection of rural settlements and lifestyles by enabling people to remain in the countryside (Seeth et al. 1998; Juhász 2000).

This stylized depiction of Hungarian home gardens is consistent with the notion of multifunctional agriculture, which views agriculture as providing a bundle of public goods in addition to private goods (food and fiber). Public goods supplied by agriculture include rural settlement and economic activity, food security, safety and quality, biodiversity, cultural heritage, amenity and recreational values (Romstad *et al*. 2000; Lankoski 2000). The concept of multifunctional agriculture is embraced by the EU's reformed Common Agricultural Policy and is stated in the 2078/92 agri-environmental regulation of the EU. Each EU member country, including those preparing to become full members in May 2004, is expected to encourage production of agricultural public goods through the development of a National Agri-Environmental Programme (NAEP).

Hungary's NAEP proposes that the intensity of agricultural production in a region should depend on its natural and human resource endowments (Juhász 2000).[4] Several areas of Hungary with low agricultural productivity and high environmental value have been designated as environmentally sensitive areas (ESAs), in which NAEP seeks to conserve endangered plant and animal species. Direct payments, training programs and technical assistance are provided to the farmers who are willing to participate in agri-environmental schemes that promote the use of specified farming methods.

The Hungarian NAEP recognizes that extensive agricultural methods are the most suitable for conserving biodiversity of endangered wildlife and providing other agricultural public goods, but the role of home gardens in the program has not yet been elucidated. Proposed EU agricultural policies designed for accession states also fail to recognize public goods home gardens provide. The Special Accession Programme for Agriculture and Rural Development (SAPARD), prepared for countries that will become EU members in 2004, considers the dual structure of agriculture that exists in several of

[4] The programme was accepted by the Ministry of Agriculture and Regional Development in 2000 and launched experimentally in 2002.

the accession states as inefficient and proposes measures to eliminate the semi-subsistence small farms, such as home gardens.[5]

The expected loss of these traditional home gardens has been cited by many experts as one of the costs of EU accession, economic transition and development (Vajda 2003; Weingarten et al. 2004). High consumption risks, transaction costs and low wages that bring about dependency on home-grown food are expected to decrease as a result of increasing availability and accessibility of markets and price stability. EU accession could lead to improved rural infrastructure through SAPARD, along with rural development and the growth of employment opportunities outside agriculture (Weingarten et al. 2004). All of these developments could result in the demise of Hungarian home gardens and the agricultural biodiversity and other multifunctional agriculture values they contain. Several studies have found negative relationships between agricultural biodiversity on farms and economic development indicators, such as market integration and infrastructure development (see for example Brush, Taylor and Bellon 1992; Meng 1997; Meng, Taylor and Brush 1998; Van Dusen 2000; Smale, Bellon and Aguirre Gómez 2001; Van Dusen and Taylor 2003; Gauchan 2004). In addition to these, recent findings reveal that Hungarian farmers' demand for agricultural biodiversity on home gardens and dependence on home garden produce decrease in the development and market integration level of the settlement in which the farmers are located (Birol, Kontoleon, and Smale 2004).

[5] SAPARD proposes either a) subsidies for transformation of semi-subsistence small farms to commercial farms, or b) direct payments to land-holdings larger than 0.3 ha on the condition that the land is managed in a way compatible with protection of the environment, as suggested by the NAEP of the member country (Commission of the European Communities, 2002).

Agri-environmental policies must be developed to recognize the public and private economic values generated by multiple functions of home gardens. Though the benefits of home gardens accrue first to the farmers that cultivate them, they are national, intergenerational and potentially global in nature. Excluding home gardens from any agri-environmental program that supports multifunctional agriculture could in fact result in diversion of incentives, loss of agricultural biodiversity, and economic inefficiencies. The next section presents the analytical approach employed in this paper.

3. THE CHOICE EXPERIMENT APPROACH

Since most of the outputs, functions and services that home gardens generate are not traded in the markets, non-market valuation methods must be used to determine the value of their benefits. These benefits primarily accrue to home garden farmers in non-market use values, or utility. The preferences of home garden farmers, who are both producers and consumers, determine the implicit values these farmers attach to home gardens and their attributes (Scarpa et al. 2003).

Of environmental valuation approaches, the choice experiment method is most appropriate for valuing home gardens since it allows for estimation not only of the value of the environmental asset as a whole, but also of the implicit value of its attributes (Hanley et al. 1998; Bateman et al. 2003). This approach is a relatively new addition to the portfolio of stated preference methods, with a theoretical grounding in Lancaster's model of consumer choice (Lancaster, 1966), and an econometric basis in models of random utility (Luce, 1958, McFadden, 1974).

Lancaster proposed that consumers derive satisfaction not from goods themselves but from the attributes they provide. For illustration of the basic model behind the choice experiment, consider a respondent's choice of a home garden. Assume that utility depends on choices made from a set C. Set C, referred to as the choice set, includes all possible home garden options that are available to the respondent. The respondent is assumed to have a utility function of the form

$$U_{ij} = U(Z_{ij}, S_i) . \qquad (1)$$

For any respondent *i,* a given level of utility will be associated with any alternative home garden *j*. Utility derived from any of the home garden alternatives depends on the attributes (Z) of the home garden and the social and economic characteristics (S) of the farmer.

The random utility approach is the theoretical basis for integrating behavior with economic valuation in the choice experiment. In this approach, the utility of a choice is comprised of a systematic (explainable or deterministic) component and an error (unexplainable or random) component. The error component is independent of the deterministic part and follows a predetermined distribution. The systematic component can be explained as a function of characteristics of the relevant good (represented by Z_{ij}) and the social and economic characteristics of the individual (represented by S_i)

$$U_{ij} = V(Z_{ij}, S_i) + e_i \qquad (2)$$

Given that there is an error part in the utility function, predictions cannot be made with certainty and analysis becomes one of probabilistic choice. Consequently, choices made between alternatives will be a function of the probability that the utility associated with a particular option (*j*) is higher than that for other alternatives. That is to say, the probability that individual *i* will choose home garden *j* over all other options *h* is given by

$$P_{ij} = Prob\{V_{ij} + e_{ij} > V_{ih} + e_{ih}; \forall j \neq h, \forall h \in C\} \tag{3}$$

The parameters for the relationship can be introduced by assuming that the relationship between utility and attributes and characteristics follows a linear path in the parameters and variables function, and by assuming that the error terms are identically and independently distributed with a Weibull distribution. These assumptions ensure that the probability of any particular alternative *j* being chosen can be expressed in terms of logistic distribution. The specification is the conditional logit model (McFadden, 1974; Greene 1997a) of the general form

$$P_{ij} = \frac{e^{v_{ij}}}{\sum_{h \in C} e^{v_{ih}}} \tag{4}$$

The conditional indirect utility function that is generally estimated is

$$V_{ij} = \beta + \beta_1 Z_1 + \beta_2 Z_2 + \ldots + \beta_n Z_n + \beta_a S_1 + \beta_b S_2 + \ldots + \beta_m S_k \,. \tag{5}$$

The number of home garden attributes considered is *n* and the number of social and economic characteristics of the farmer that is used to explain farmers' choices is *k*. The vectors of coefficients β_1 to β_n and β_a to β_m are attached to the vector of attributes (Z) and to vector of interaction terms (S) that influence utility, respectively. Since social and economic characteristics are constant across choice occasions for any given farmer, they can only enter as interaction terms with the home garden attributes.

The choice experiment method is consistent with utility maximization and demand theory (Bateman et al. 2003). When parameter estimates are obtained, welfare measures can be estimated from the conditional logit model using the following formula:

$$CS = \frac{\ln \sum_i \exp(V_{i1}) - \ln \sum_i \exp(V_{i0})}{\alpha} \qquad (6)$$

CS is the compensating surplus welfare measure, α is the marginal utility of income (generally represented by the coefficient of the monetary opportunity cost attribute in the choice experiment) and V_{i0} and V_{i1} represent indirect utility functions before and after the change under consideration. For the linear utility index the marginal value of change in a single attribute can be represented as a ratio of coefficients, reducing equation (6) to

$$W = -1\left(\frac{\beta_{attribute}}{\beta_{monetary\ variable}}\right) \qquad (7)$$

This part-worth (or implicit price) formula represents the marginal rate of substitution between income and the attribute in question, or the willingness to pay (or willingness to accept compensation) for a change in any of the attributes.

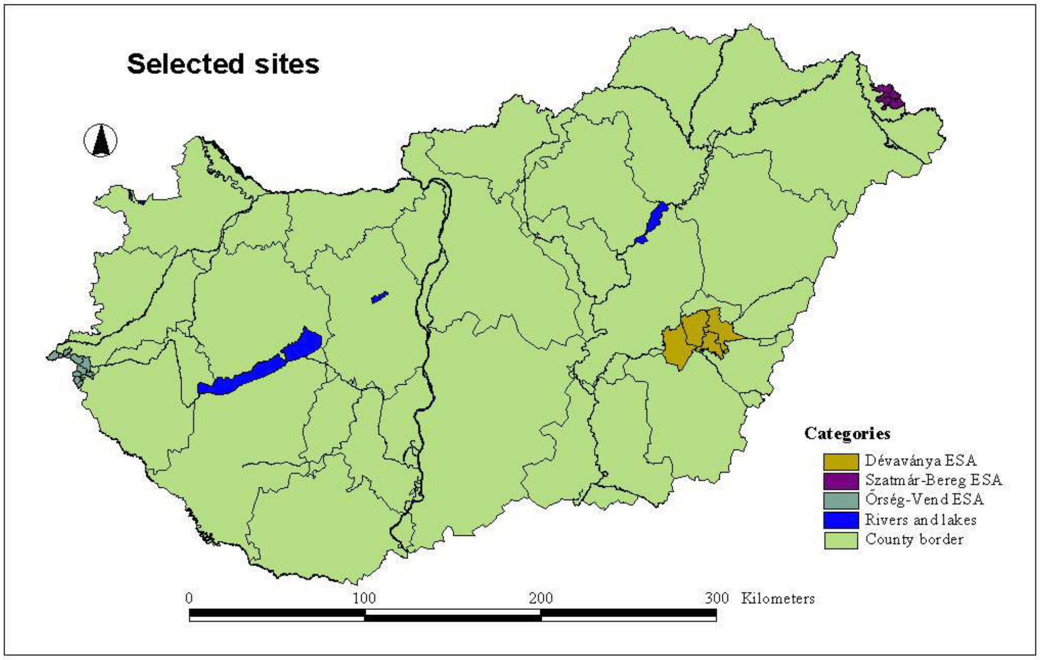
4. DATA COLLECTION

SELECTION OF STUDY SITES

The survey design consisted of two stages. In the first stage, three sites were selected. The sites are located in the buffer zones of ESAs identified by the NAEP, where the Institute of Agrobotany had already identified high levels of agricultural biodiversity (in terms of crop genetic diversity) during collection missions. Secondary data from the Hungarian Central Statistics Office (HCSO) and NAEP were used to purposively select areas with contrasting levels of market development and varying agro-ecologies associated with different farming systems and land-use intensity

The three study sites (Dévaványa, Őrség-Vend and Szatmár-Bereg) are depicted in Figure 1. The stratified design enables testing of hypotheses about the impacts of market integration, agro-ecological conditions, other economic development indicators, such as availability of off farm employment, on farmers' preferences for the agricultural biodiversity levels to maintain on home gardens.

Figure 1--Location of selected ESAs



Twenty-two settlements (5 in Dévaványa, 11 in Őrség-Vend and 6 in Szatmár-Bereg) were included in the study. Secondary data for settlement characteristics were drawn from the HCSO National Census (2001) and Statistical Yearbook (2001), and are presented in Table 1.

Table 1--Settlement and ESA level characteristics

	Dévaványa N=5	Őrség-Vend N=11	Szatmár-Bereg N=6
Settlement and ESA level characteristics		Mean	
Presence of train station	0.8	0.18	0
Distance to nearest food market (km)	0	19.85	18.35
Distance to nearest food market (minutes)	0	20.36	17.83
Number of primary schools	2.4	0.36	0.83
Number of secondary schools	1	0	0
Number of food markets	1	0	0
Population	9928.6	373.36	659
Area (km^2)	21964.6	1636.18	2407
Population density	0.45	0.20	0.28
Regional unemployment rate (%)	12.4	4.8	19.0
Inactive ratio (person on pensions or maternity leave/population)	0.37	0.40	0.48
Dependency ratio (inactive, children, housewives, students/population)	0.28	0.22	0.27
Number of shops	140.8	4.18	9.67
Number of enterprises	491.2	21.55	22.83
Regional road network (km)	6118.6	8678	3593
Regional area of total road network (km^2)	5621.2	5936	3337

Source: Hungarian Central Statistical Office Census (2001), Statistical Yearbooks for counties of Békés, Jász-Nagykun-Szolnok, Vas and Szabolcs-Szatmár-Bereg (2001) and Hungarian Ministry of Transport and Water, Road Department Main Data on Roads (2001). Road data is reported at the regional level.

Dévaványa, located on the Hungarian Great Plain, is closest to the economic center of the country of the three sites. Soil and climatic conditions of this region are well suited to intensive agricultural production. Populations, areas, and population density are relatively high. Labor migration is not a major problem in Dévaványa, although the number of inhabitants is stagnating. The unemployment rate in Dévaványa (12.4 percent) is slightly higher than the Hungarian average (National Labor Center 2000; Juhász 2000; Gyovai 2002). Dévaványa is statistically different from the other two ESAs in most indicators of urbanization and market integration, including: presence of a train station; distance to the nearest market (both in km and minutes); number of primary and secondary schools; food markets; and the number of shops and enterprises.

The two isolated ESAs are more similar. Located in the Southwest, Őrség-Vend has a heterogeneous agricultural landscape with poor soil conditions that render intensive agricultural production methods impossible (Juhász 2000; Gyovai 2002). Settlements are very small in area and most are far from towns. Population sizes are small. Of the three, Őrség-Vend is the least urbanized with fewest shops and enterprises. The population is declining and ageing, though the unemployment rate of this region is lowest in the country at 4.8 percent (National Labor Center 2000). Őrség-Vend supports the lowest dependency ratio across sites (HCSO 2001).

Szatmár-Bereg is situated in the Northeast, far from the economic center of the country. Settlements in this ESA are also small. The declining, ageing population reflects a lack of public investments in infrastructure and employment generation. Roads are of poor quality and the regional unemployment rate is the highest in the country (19 percent) (National Labor Center 2000; Juhász 2000; Gyovai 2002). Szatmár-Bereg also has a significantly higher ratio of inactive to total population than either of the other ESAs.

SAMPLE SURVEY OF FARM HOUSEHOLDS

Households were selected in the second stage of sampling from a list frame. Village authorities were unwilling to provide a list of households in the settlemenets because of concerns for personal privacy. Existing databases from the Ministry of the Interior were too costly to obtain. The list was therefore compiled by combining information from detailed maps drawn by the NAEP, telephone books, and the Hungarian Central Statistical Office TSTAR database. Because little was known about the characteristics of the households in the survey sites and the extent of their involvement in agricultural production or home gardens, a brief screening questionnaire was designed. Since a minimum final sample of 100 per site was thought necessary for data analysis, and the response rate to a mail survey was expected to be low, the team decided to include 600 households per site (1,800) in the screening survey. All administrative units within the sites were sorted based on population sizes and the initial sample was distributed proportionally. To augment the low response rate to the screening survey (13 percent), the sample of households with home gardens was then expanded through key informants. A total of 323 farm households were interviewed in August 2002 for the household survey and a subset of 277 farm households were interviewed for the choice experiment.

The average family size is 3 persons and children are few in all sites, with Őrségi households having larger families and more children than those in Dévaványa. Households in Őrség-Vend have significantly higher levels of income than those in Dévaványa and Szatmár-Bereg, but the difference between Dévaványa and Szatmár-Bereg is insignificant. The number of family members employed off-farm is higher in Őrség-Vend than in Szatmár-Bereg but similar between Őrség-Vend and Dévaványa. On average, households in Dévaványa and Őrség-Vend spend approximately the same percentage of their income on food and but this percentage is statistically higher than in Szatmár-Bereg. Home garden decision-makers are elderly, and their average age does not differ statistically among the three regions. Dévaványa has statistically more experienced and educated home garden decision-makers compared to Szatmár-Bereg. Őrség-Vend has the smallest percentage of decision-makers that have less than eight years of education across the three ESAs. A large proportion is retired, though the percentage is statistically lower in Dévaványa. The percentage of home garden decision-makers with off farm employment is higher in Dévaványa than Szatmár-Bereg. A higher percentage of Őrségi households own cars compared to the other two regions (Table 2).

Table 2--Characteristics of households and home garden decision-makers by ESA

Variable	DEFINITION	Dévaványa N=104	Őrség-Vend N=109	Szatmár-Bereg N=110
			Mean (s.e.)	
Family size**	Number of family members	2.7 (1.2)	3.1 (1.6)	2.8 (1.5)
Home garden participants**	Number of family members that work in home garden	2.1 (1)	2.5 (1.3)	2.4 (1.3)
Children*	Number of family members =< 12 years	0.3 (0.7)	0.5 (0.8)	0.4 (0.8)
Off farm employment**	Number of family members employed off farm	0.8 (1)	1 (1.1)	(0.7) (1)
Income***	Average monthly income from off-farm employment, pensions, rents, gifts or other benefits	747778.2 (25413.2)	92341.5 (19986.3)	71685.6 (40740.4)
Food expenditure***	Stated % of income spent on food consumption	39.2 (15.1)	39.7 (16.8)	32.8 (11.8)
Age	Average age of home garden decision-makers	58.5 (13.1)	57.8 (12.4)	56.6 (15)
Experience*	Average years farming experience of home garden decision-makers	42.8 (17.6)	40.7 (17.1)	38.4 (19.6)
Education*	Years of formal education the home garden decision-makers have received	10 (2.8)	9.9 (2.7)	9.3 (3.3)
			Percent	
Off farm*	Decision-makers with off farm employment	39.4	33.9	30
Retired	Retired decision-makers	66.3	72.5	72.7
Less than minimum education**	Decision-makers with less than 8 years of education	13.5	4.6	21.3
Car ***	The household owns a car	41.7	64.2	44.6

Source: Hungarian Home Garden Diversity Household Survey, Hungarian On-Farm Conservation of Agricultural Biodiversity Project 2002.
(*) T-tests and Pearson Chi square tests show significant differences among at least one pair of ESAs at 10% significance level; (**) at 5% significance level, and (***) at 1% significance level.

The likelihood that a farm household cultivates a field in addition to a home garden is greater in Őrség-Vend than in either of the other ESAs, though the areas of land owned and cultivated, and cultivated that is also owned, are less. The smallest home gardens and the largest total areas owned and cultivated are in Dévaványa, the most favored ESA in terms of either soils or infrastructure. In terms of home garden characteristics, home gardens with least irrigation and best soil quality are in Szatmár-Bereg. Őrségi home gardens have more irrigation than those in Dévaványa, but the worse soil quality across regions. Dévaványa households are closest to food markets, though no significant differences are observable between the other two regions. Szatmári households are more integrated into markets as sellers of home garden produce compared to either of the other two ESAs (Table 3).

Table 3--Home garden, field and market integration characteristics of the households by ESA

Variable	Definition	Dévaványa N=104	Őrség-Vendvidék N=109	Szatmár-Bereg N=110
Work Shelter			Mean (s.e.)	
Home garden area**	in m^2	560.9 (683)	1624.6 (2872.1)	2649.2 (3041.9)
Total field land owned***	in m^2	86215.7 (319476.5)	24561.3 (36780.2)	40300.9 (62608.4)
Total field land cultivated***	in m^2	83709.1 (321854)	21657.7 (43372)	61323 (103984)
Total field land cultivated and owned ***	Total land cultivated by the household that is also owned by the household in m^2	78956.2 (320233.3)	16962 (31441.5)	42753.7 (64057.4)
Irrigation**	Percentage of home garden land irrigated	36.1 (45.5)	46 (40.4)	16.6 (28.2)
Sales**	Value of total home garden output sold in market prices in Hungarian Forint per m^2 of home garden	5.5 (29.6)	6.6 (49.7)	33 (103.3)
Distance***	Distance of the settlement in which the household is located to the nearest market in km	0 (0)	19.9 (6.8)	18.4 (3.2)
			Percentage	
Household cultivates a field**	Household cultivates a field along with the home garden	42.3	59.6	44.5
Good soil**	Home garden soil is of good quality	16.8	9.2	31.2

Source: Hungarian Home Garden Diversity Household Survey, Hungarian On-Farm Conservation of Agricultural Biodiversity Project 2002.
(*) T-tests and Pearson Chi square tests show significant differences among at least one pair of ESAs at 10% significance level; (**) at 5% significance level, and (***) at 1% significance level.

AGRICULTURAL BIODIVERSITY FOUND IN HOME GARDENS

Four components of agricultural biodiversity were identified for study in the choice experiment: crop species diversity; crop genetic diversity, agro-diversity, and soil micro-organism diversity. Crop species diversity, one of the most crucial components of agricultural biodiversity (FAO 1999), is indicated by the richness (count) of the number of species that the household plants in the home garden. Crop genetic diversity is represented by the cultivation of landraces (Már 2002). Use of organic production methods is used as a proxy for soil micro-organism diversity (Mäder et al. 2002). Agro-diversity, or diversity in agricultural management practices (Brookfield and Stocking 1999), is measured by integrated crops and livestock production in the homestead plot.

The mean level of crop species richness maintained by farm families in home gardens is significantly higher in Őrség-Vend than in the other two sites (20 as compared to 14-15). In Dévaványa, the percent of households growing landraces is half of that found in the other two. Use of organic methods is similarly represented in Dévaványa and Őrség-Vend regions. Only 8 percent of farmers in Szatmár-Bereg apply organic practices, which is significantly lower than in the other regions. Across the three sites, roughly 50-60 percent of households tend livestock along with crops in their homestead plots across the three sites, with no statistically significant differences (Table 4).

Table 4--Agricultural biodiversity found in home gardens

Component of agricultural biodiversity	Dévaványa N=104	Őrség-Vendvidék N=109	Szatmár-Bereg N=110
		Mean (s.e.)	
Crop species diversity***	13.75 (6.17)	20 (6.6)	15.2 (5.7)
		Percentage	
Landrace cultivation***	27	52	52
Agro-diversity	51	62	55
Organic Production *	16	17	8

Source: Hungarian Home Garden Diversity Household Survey, Hungarian On-Farm Conservation of Agricultural Biodiversity Project 2002.
(*) T-tests and Pearson Chi square tests show significant differences among at least one pair of ESAs at 10% significance level; (**) at 5% significance level, and (***) at 1% significance level.

Scientific analyses provide further evidence that home gardens contribute to Hungary's agricultural biodiversity endowment. Preliminary molecular biological research conducted on landraces sampled from the home gardens of households surveyed reveals that they are genetically heterogeneous, and many contain rare and adaptive traits that might be useful for development of modern varieties that are suitable for Hungarian agro-ecological conditions (Már, personal communication 2004).[6] Analysis conducted at the Institute for Agrobotany demonstrate that soil nutrient contents of home garden soils are far superior to those of farm fields in each ESA. Home gardens with the highest soil nutrient content are found in Dévaványa and the worst soils are found in Őrség-Vend (Csizmadia 2004).

[6] The landraces considered in this study are those of bean and maize. The Institute for Agrobotany has been conducting collection missions across Hungary since 1997, but has found few remaining landraces of any crops other than maize or beans (Már, 2002)

CHOICE SETS

A choice experiment is a highly 'structured method of data generation' (Hanley et al. 1998), relying on carefully designed tasks or "experiments" to reveal the factors that influence choice. Experimental design theory is used to construct profiles of the environmental good in terms of its attributes and levels of these attributes. Profiles are assembled in choice sets. Choice sets are presented to the respondents, who are asked to state their preferences.

The first step is to define the good in terms of attributes and levels of attributes. Attributes and levels were identified with NAEP experts and agricultural scientists, drawing on the results of informal and focus group interviews with farmers in each ESA. Each attribute represents one of the four components of agricultural biodiversity described above. A proxy monetary attribute necessary for estimating welfare changes is also included as one of the home garden attributes. This attribute is the expected percentage of the annual household food consumption that is expected the home garden will supply (Table 5).

Table 5--Home garden attributes and attribute levels used in the choice experiment

Home garden attribute	Definition	Attribute levels
Crop Species Diversity	The total number of crops that are grown in the garden.	6, 13, 20, 25
Agro-diversity	Mixed crop and livestock production, representing diversity in agricultural management system.	Mixed crop and livestock production vs. Specialized crop production
Organic Production	Whether or not industrially produced and marketed chemical inputs are applied in farm production.	Organic production vs. Non-organic production
Landrace	Whether or not the home garden contains a crop variety that has been passed down from the previous generation and/or has not been purchased from a commercial seed supplier.	Home garden contains a landrace vs. Home garden does not contain a landrace
Self-sufficiency	The percentage of annual household food consumption that it is expected the home garden will supply.	15%, 45%, 60%, 75%

A large number of unique home garden descriptions (combinations of attributes) can be constructed from this number of attributes and levels.[7] An orthogonalization procedure was used to recover only the main effects, consisting of 32 pair wise comparisons of home garden profiles. These were randomly blocked to 6 different versions, two with 6 choice sets and the remaining four with 5 choice sets. In face-to-face interviews, each respondent was presented with 5 or 6 choice sets. Each set contained two home gardens and an option to select neither garden. Respondents were generally those responsible for making decisions in the home garden. Enumerators explained the context in which choices were to be made (a 0.5-ha garden), explained that attributes of home gardens had been selected as a result of prior research and were combined artificially, and defined each attribute to ensure uniformity. Overall, a total of 1487 choices were elicited from 277 respondents.

5. RESULTS

Using the complete data set from all three regions, conditional logit models with logarithmic and linear specifications were compared. The highest value of the log-likelihood function was found for the specification with the crop species diversity variable in logarithmic form, indicating that the marginal willingness to accept compensation for this attribute is diminishing. For the population represented by the sample, indirect utility from home garden attributes takes the form

$$V_{ij} = \beta + \beta_1 \ln(Z_{diversity}) + \beta_2 (Z_{agro-diversity}) + \beta_3 (Z_{organic}) + \beta_4 (Z_{landrace}) + \beta_5 (Z_{selfsufficiency}) \qquad (8)$$

[7] The number of home gardens that can be generated from 5 attributes, 2 with 4 levels and the remaining 3 with 2 levels is $4^2 * 2^3 = 128$.

where β refers to the alternative specific constant and β_{1-5} refers to the vector of coefficients associated with the vector of attributes describing home garden characteristics.

TARGETING REGIONS

As hypothesized in the survey design and supported by the descriptive statistics, households in the three ESAs are likely to value home garden attributes differently. The null hypothesis that the separate effects of ESA are equal to zero was rejected with a Swait-Louviere log-likelihood ratio test at the 0.5% significance level, based on regressions with the pooled and regional samples (Table 6). This result suggests that underlying parameters are distinctive for each ESA.

Table 6--Demand for home garden attributes in each ESA

	Dévaványa		Őrség-Vend		Szatmár-Bereg	
Attribute	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Constant	0.050	0.399	-1.475	0.450	-0.685	-1.544
Crop Species Diversity	-0.031	0.123	0.284	0.135	0.295	0.130
Agro-diversity	0.504	0.070	0.256	0.077	0.414	0.073
Organic Production	0.293	0.072	0.116	0.077	0.158	0.073
Landrace	0.085	0.065	0.241	0.071	0.174	0.067
Self-sufficiency	0.014	0.003	0.029	0.004	0.024	0.035
Sample size	533		455		499	
ρ^2	0.10915		0.12533		0.18471	
Log likelihood	-521.6492		-430.4925		-446.9454	

Source: Hungarian Home Garden Choice Experiment, Hungarian On-Farm Conservation of Agricultural Biodiversity Project 2002.

In Dévaványa ESA, where food markets as well as road infrastructure are fully developed, farmers' demand for either crop species diversity or landraces is insignificant. There is a significant and relatively large demand for organic production. The demand for agro-diversity variable is also large and significant owing to some complementarity between field crop production and animal husbandry in the home garden. In the isolated region of Őrség-Vend, where food markets are absent in the settlements, distance to the nearest towns are up to 33 km far and road infrastructure is poor, the demand for crop species diversity and landraces are each significant and nearly as large in magnitude as the demand for agro-diversity. No demand for organic production is evident, reflecting poor soil quality in this region. In the isolated ESA of Szatmár-Bereg, where market infrastructure is poor, home garden farmers demand crop species diversity and landraces. Farmers in this region also place great importance on agro-diversity, perhaps in part because unemployment rates are high and labor intensive animal husbandry practices are less costly in terms of the opportunity cost of time.

The monetary attribute in this choice experiment is a benefit rather than a cost since the property rights to gardens, their produce and functions reside with those who were surveyed (Freeman 2002). Secondary data on the annual expenditure of average Hungarian household on food consumption (HCSO 2002) was combined with the regression coefficients to compute equation (7), interpreted here as the willingness to accept (WTA) compensation for a possible loss (Table 7).

Table 7-- WTA estimates for each home garden attribute per ESA (in € per household per annum)

Attribute	Dévaványa	Őrség-Vend	Szatmár-Bereg
Crop Species Diversity	--	-111	-141
Agro-diversity	-404	-100	-198
Organic Production	-235	--	-76
Landrace	--	-95	-83

Source: Hungarian Home Garden Choice Experiment, Hungarian On-Farm Conservation of Agricultural Biodiversity Project 2002.
*Figures in €, converted from Hungarian Forints (HUF) (1 € = 267.52 HUF, June 2003)
(--) Demand for the attribute is not statistically significant at 10% level with one-tailed test.

Farmers in Őrség-Vend and Szatmár-Bereg regions attach the highest values to crop species diversity, crop genetic diversity as well as substantial values to agro-diversity. These regions are the sites in which high levels of crop species diversity, crop genetic diversity as well as agro-diversity have already been found as explained in Table 4. Findings suggest that public investments to conserve crop diversity in home gardens would cost least and be most effective in Őrség-Vend and Szatmár-Bereg compared to Dévaványa.

TARGETING HOUSEHOLDS

The basic conditional logit model assumes homogeneous preferences across farm households. However, preferences across farmers are in fact heterogeneous. Accounting for this heterogeneity enables estimation of unbiased estimates of individual preferences and enhances the accuracy and reliability of estimates of demand, participation, marginal and total welfare (Greene 1997a). Furthermore, accounting for heterogeneity enables prescription of policies that take equity concerns into account. An understanding of who will be affected by the policy change in addition to understanding the aggregate economic value associated with these changes is necessary (Adamowicz and Boxall 2001). Determination of respondent heterogeneity is of particular relevance when knowledge of population segments is crucial for assessment of existence and nature of niche consumers or producers (Kontoleon 2003).

One way of accounting for preference heterogeneity is by separating the respondents into various groups and by estimating the demand function for each group separately. Estimating the conditional logit model for each ESA accomplishes this accounting. As shown, the parameters of each regional regression are distinct, confirming that the way households value home gardens and their attributes depends on regional membership.

To account for individual heterogeneity the effects of household and home garden decision-maker level characteristics on household demand for home gardens and home garden attributes must also be investigated. In random utility models the effects of household characteristics cannot be examined in isolation but in the form of interaction terms with home garden attributes.

Multicollinearity problems result from including all the interactions between the 20 household and decision-maker characteristics measured in our survey and the five home garden attributes (Breffle and Morey 2000). To address this limitation, independent variables were eliminated based on Variance Inflation Factors (VIF) calculated by running "artificial" OLS regressions between each independent variable (i.e. the household and decision-maker characteristics) as the "dependent" variable and the remaining independent variables.[8] Those independent variables for which the VIF_j exceed 5 indicate that the estimation of the characteristic is being affected by multicollinearity (Maddala 2000). Five independent variables remained: 1) the number of household members with off-farm employment; 2) the experience of the home garden decision maker(s); 3) the percentage of household income spent on food; 4) the number of household members that participate in home garden cultivation; and 5), whether or not the household also cultivates a farm field.

The indirect utility function in equation (8) was then extended to include the 25 interactions between the 5 home garden attributes and the 5 household and decision-maker characteristics. The final conditional logit function that was estimated is:

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[8] Variance Inflation Factors (VIF_j) for each such regression are calculated as: $VIF_j = \frac{1}{1-R_j^2}$, where R_j^2 is the R^2 of the artificial regression with the jth independent variable as a "dependent" variable.

$$V_{ij} = \beta + \beta_1 \ln(Z_{diversity}) + \beta_2(Z_{agro-diversity}) + \beta_3(Z_{organic}) + \beta_4(Z_{landrace}) + \beta_5(Z_{selfsufficiency}) +$$

$$\delta_1(Z_{diversity} \times S_{offfarm}) + \delta_2(Z_{agro-diversity} \times S_{offfarm}) + ... + \delta_5(Z_{selfsufficiency} \times S_{offfarm}) + \delta_6(Z_{diversity} \times S_{experience}) +$$
$$...... + \delta_{10}(Z_{selfsufficiency} \times S_{experience}) + ... + \delta_{21}(Z_{diversity} \times S_{cultivatefield}) + ... + \delta_{25}(Z_{selfsufficiency} \times S_{cultivatefield}) \quad (8')$$

The effects of interactions on farm households' demand for home garden attributes are reported for each ESA in Tables 8 through 10. Even though all the 25 interactions were included in the estimation of the conditional logit model, only those interactions that are statistically significant are reported.

Table 8--Effects of household and decision-maker characteristics on demand for home garden attributes in Dévaványa ESA*

Variable	Coefficient	s.e.
Constant	0.91953	0.5220
Crop Species Diversity	-0.6235	0.2657
Agro-diversity	0.5120	0.0724
Organic Production	0.1394	0.0986
Landraces	-0.1819	0.1766
Self sufficiency	$0.8729\text{x}10^{-6}$	$0.2316\text{x}10^{-5}$
Crop species diversity * no of off farm employed household members	-0.0153	0.0070
Crop species diversity * the household cultivates a field	-0.0317	0.0130
Crop species diversity * food expenditure of the household	0.0018	0.0004
Organic production * household members employed off-farm	0.1821	0.0711
Landraces * food expenditure of the household	0.0070	0.0041
Self sufficiency * food expenditure of the household	$0.791\text{ x}10^{-7}$	$0.484\text{ x}10^{-7}$
Sample size	533	
ρ^2	0.151	
Log likelihood	-486.6	

Source: Hungarian Home Garden Diversity Household Survey and Hungarian Home Garden Choice Experiment, Hungarian On-Farm Conservation of Agricultural Biodiversity Project 2002.
* Interactions with significance levels 10% with one-tailed tests based on apriori hypotheses are reported

Table 9--Effects of household and decision-maker characteristics on demand for home garden attributes in Őrség-Vend ESA

Variable	Coefficient	s.e.
Constant	-1.8277	0.5109
Crop Species Diversity	0.2739	0.1719
Agro-diversity	0.2636	0.0826
Organic Production	0.3026	0.2492
Landraces	0.4097	0.1070
Self sufficiency	0.7163×10^{-5}	0.209×10^{-5}
Crop species diversity * no of off farm employed household members	0.0115	0.0062
Organic Production * food expenditure	0.011	0.0052
Organic Production * experience	-0.149	0.0046
Landrace * household members employed off-farm	-0.1351	0.0670
Self sufficiency * food expenditure	0.8×10^{-7}	0.452×10^{-7}
Sample size	448	
ρ^2	0.147	
Log likelihood	-380.36	

Source: Hungarian Home Garden Diversity Household Survey and Hungarian Home Garden Choice Experiment, Hungarian On-Farm Conservation of Agricultural Biodiversity Project 2002.
* Interactions with significance levels 10% with one-tailed test are reported

Table 10--Effects of household and decision-maker characteristics on demand for home garden attributes in Szatmár-Bereg ESA

Variable	Coefficient	s.e.
Constant	-0.6705	0.4810
Crop Species Diversity	0.2747	0.1410
Agro-diversity	0.4102	0.1247
Organic Production	0.0859	0.0788
Landrace	0.2633	0.0957
Self sufficiency	0.1512×10^{-4}	0.3170×10^{-5}
Agro-diversity * household members employed off-farm	-0.01366	0.0788
Agro-diversity * household cultivates a field	0.2353	0.1574
Landrace * the household cultivates a field	-0.2470	0.1428
Self sufficiency * experience	-0.8548×10^{-7}	0.4551×10^{-7}
Self sufficiency * participants in home garden production	-0.1560×10^{-5}	0.6735×10^{-6}
Sample size	434	
ρ^2	0.192	
Log likelihood	-385.45	

Source: Hungarian Home Garden Diversity Household Survey and Hungarian Home Garden Choice Experiment, Hungarian On-Farm Conservation of Agricultural Biodiversity Project 2002.
*Interactions with significance levels 10% with one-tailed test are reported

In Dévaványa ESA, only the number of family members with off farm employment, food expenditure and field cultivation have statistically significant effects on the demand for home gardens. The demand for crop species diversity decreases with the number of household members employed off-farm. Households cultivating farm fields in addition to home gardens prefer lower levels of crop species diversity in the garden. These findings are consistent with the hypothesis that in this region, field crop production and off-farm activities yield higher returns compared to cultivating home gardens rich in crop species diversity.

Households spending a greater share of their income on food (poorer households) prefer more diverse home gardens in Dévaványa. Demand for landraces in the home garden also increases with food expenditure. The interaction between the demand for organically produced home gardens and the number of family members who are employed off-farm is also positive. Organic production can be a costly activity since chemical inputs that are certified as organic cost more than regular fertilizers. At the same time, organic methods might not produce all that is needed for the household's consumption. Households with off-farm income may have more means to purchase organic fertilizers and to supplement their output with items purchased at the local markets found in Dévaványa.

In Őrség-Vend, the number of family members with off farm employment, food expenditure, and experience of the home garden decision-maker affect the demand for home gardens and their attributes. The demand for crop species diversity increases with the number of household members employed off-farm, though the demand for landraces is negatively associated with the same characteristic. The more experienced the primary decision-maker, the lower the demand for an organically produced home garden. Demand for organic production method rises with the food expenditure of the household, perhaps because less wealthy households lack the funds to acquire complementary inputs that are required for non-organic production. Demand for the level of self-sufficiency provided by the garden increases with the share of the food in household expenditures, indicating that poorer households rely more on home garden production for food.

In Szatmár-Bereg region, the demand for home gardens and their attributes is affected significantly by the number of family members with off-farm employment, number of household members participating in the home garden, whether or not the household engages in field cultivation, and the experience of the home garden decision-maker. Households cultivating a field also demand agro-diversity in the home garden. Demand for agro-diversity decreases with the number of household members that is employed off farm because animal husbandry requires a lot of labor with high opportunity costs. Preferences for home gardens without landraces may reflect government subsidies for purchasing the seed of modern varieties in Szatmár-Bereg. Demand for the level of self-sufficiency expected from the home garden decreases with the experience of the primary decision-maker. The more experienced decision-makers are generally those who are older, who may choose to retire from home garden production if given the choice. The greater the number of participants in home garden production, the lower the level of self-sufficiency they demand that it provide. Household income and the number of members employed off-farm increase with the number of home garden participants (who are usually adults), and households with higher incomes rely less on the home garden output for their livelihoods.

The conditional demand functions reported in Tables 7-9 can be used to calculate the value assigned by the household to home garden attribute (Scarpa, et al. 2003), by modifying Equation (7):

$$W = -1\left(\frac{\hat{\beta}_{attribute} + \delta_{atribute} \times S_1 ... + \delta_{attribute} \times S_5}{\hat{\beta}_{monetaryattribute} + \delta_{monetaryatribute} \times S_1 + ... + \delta_{monetaryattribute} \times S_5}\right) \quad (7')$$

Variables S_{1-5} are the social and economic factors under consideration. The compensation payments that households are willing to accept for giving up their home gardens are shown in Tables 11, according to three social and economic "profiles," representing prototype families found in rural Hungary.

Table 11--WTA compensation values by household profiles and ESA (in € per household per annum)

Region and Attribute	Profile 1	Profile 2	Profile 3
Dévaványa			
Crop Species Diversity	+405	+408	+429
Agro-diversity	-346	-391	-367
Organic Production	-338	-107	-230
Landrace	-19	-128	-71
Őrség-Vend			
Crop Species Diversity	-116	-92	-103
Agro-diversity	-103	-88	-95
Organic Production	-133	-39	-109
Landrace	-55	-137	-99
Szatmár-Bereg			
Crop Species Diversity	-134	-136	-286
Agro-diversity	-64	-201	-530
Organic Production	-42	-43	-89
Landrace	-127	-138	-17

Source: Hungarian Home Garden Diversity Household Survey and Hungarian Home Garden Choice Experiment, Hungarian On-Farm Conservation of Agricultural Biodiversity Project 2002.

Profile 1 represents a household of average size, with a relatively high income, two household members working off-farm, and three members participating in home garden production. This household does not engage in field cultivation and spends 30 percent of its income on food. The primary decision-maker in the garden has 20 years of experience. Profile 2 pertains to a small household with elderly members and no employment outside of the farm and no other farm fields. This household spends 50 percent of its income on food. Only two of its members work in the garden, and primary decision-maker has 50 years of experience. Profile 3 describes a relatively large household whose livelihood is agriculturally-based since its members cultivate at least one field along with the home garden. Five of its members work in the garden, one of its members works off farm and the household spends 40 percent of its income on food. The experience of the primary decision-maker in the home garden is 30 years.

This derivation of WTA estimates conditional on social and economic variables results in mainly negative WTA values (with the exception of crop species diversity for Dévaványa), an outcome which can be interpreted as a test for theoretical validity. The signs on the estimated coefficients of the interacted variables are consistent with expectations. WTA value estimates for the three household profiles in the three regions disclose four main results. First, households in Dévaványa express a positive WTA value for crop species diversity, indicating willingness to pay for an additional crop species. Second, the agro-diversity attribute is valued most highly in Dévaványa as a result of complementarity between animal husbandry and intensive feed production in fields. Though the traditional Hungarian practice of integrating livestock and crop production is especially important for older households, it is also observed among Szatmári households that are younger and farm-based.

Third, the demand for organically produced home gardens show the properties of an Environmental Kuznetz curve (EKC). That is, those home gardeners who are the poorest and oldest prefer these techniques as do younger home gardeners, but not those who are middle-aged and middle-income. Older gardeners may have less cash to purchase chemical inputs, but they also have long experience with labor-intensive, input- extensive production methods. Younger home gardeners that have off-farm occupations and more education also prefer organic production methods, possibly with organically certified inputs, compared to no inputs at all.

Middle-aged, middle-income households may prefer non-organic methods because of the high opportunity costs of their time, their ability and a habit of using chemical inputs (shaped during the chemical input-intensive period of collectivized agriculture). Fourth, in all three regions, the elderly household with longest years of experience in gardening values landraces the most.

6. CONCLUSIONS

The purpose of this study was to estimate the (use) values associated with traditional Hungarian home gardens and their multiple attributes. Data was collected in personal interviews with a random sample of farm households in three purposively selected, environmentally sensitive areas of Hungary that are included in the National Agri-Environment Programme (NAEP). The choice experiment method was applied to investigate farmers' demand for home gardens and their attributes conditional on the characteristics of the regions, households and primary decision-makers in the garden. Statistical analysis enabled hypothesis tests about the possible effects of economic change on the value of these attributes to home gardeners, and profiles of regions and households valuing them most.

In general, findings support the a priori assumption that home gardens and their multiple attributes contribute positively and significantly to the utility of home garden farmers in environmentally sensitive areas of Hungary. To the extent that they are representative of other environmentally sensitive areas in Hungary, they confirm that home gardens continue to be a vital national institution. Our estimates represent lower bounds since only the private, use values of home gardens were estimated. More specifically, the results confirm that the relative importance rural people ascribe to home gardens and their attributes depend on location, as well as the social and economic characteristics of the households. In our study, "location" represents a combination of factors related to market infrastructure, farming system, soils and landscape, and cultural references.

7. POLICY IMPLICATIONS

Profiling the ESAs and home gardeners with the highest demand for agricultural biodiversity, mapped on the agricultural biodiversity values found on these home gardens by agricultural scientists, may help in targeting conservation programs. Public investments to support conservation will be relatively less where the private value earned from conservation is high.

In Őrség-Vend and Szatmár-Bereg, where food markets are lacking, soils are poorer and landscapes are heterogeneous, home gardens that are rich in intra- and inter-species crop diversity are likely to be highly valued. Crop diversity is of no significance to home gardeners in Dévaványa, though organic methods are of recognized value. Dévaványa is the region with good soils that best supports intensive agricultural production in fields as well as gardens. Demand for agro-diversity is constant in significance but varies in magnitude across ESAs.

Elderly, experienced home gardeners, who are typically retired, attach the highest values to landraces in all three ESAs. Organic production is valued most highly by younger, more educated, households with higher income, followed by those that are older with lower income—and not at all by middle-aged, middle-income households. Home gardeners also engaged in field cultivation appear to attach very high values to integrated livestock and crop production.

The overriding policy concern in Hungary is whether or not public decision-makers are prepared to recognize the contribution of Hungarian home gardens to multifunctional agriculture. There is insufficient assurance that Hungarian society can rely indefinitely on its rural households to conserve these ‘small repositories of agricultural biodiversity’ and cultural heritage. Hungary is a transitional economy that will soon become a member of the European Union. When that happens, isolated regions are likely to be drawn into markets (Fischler 2003) and the opportunity costs of the labor now used in home garden production will probably rise. If home gardens are valuable to Hungarian society, a decision must now be made to develop a policy framework to ensure their continuity. The most proximate means to do so is the NAEP, which is structured around farmer contract payments. Other mechanisms for conveying economic incentives to smallholder farmers, such as niche markets, or farmer-owned brands conferred through denomination of geographic origin, producer co-operatives or trademarks, might also be assessed.

REFERENCES

Adamowicz, V. and P. Boxall. 2001. Future Directions of Stated Choice Methods for Environment Valuation', Paper prepared for: Choice Experiments: A New Approach to Environmental Valuation April 10, 2001 London, England.

Bateman, I.J., Carson, R.T., Day, B., Hanemann, W.M., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., Özdemiroğlu, E., Pearce, D.W., Sugden, R. and Swanson, S. 2003. *Guidelines for the use of stated preference techniques for the valuation of preferences for non-market goods.* Cheltenham, UK: Edward Elgar Publishing Limited.

Bennett, J.J. and R.K. Blamey. 2001. *The Choice of modelling approach to environmental valuation.* Cheltenham, UK. Edward Elgar Publishing Limited.

Birol, E., A. Kontoleon, and M. Smale. 2004. Economic transition and farmers' demand for agricultural biodiversity on Hungarian small farms: A choice experiment approach. Paper Presented at the IPGRI-IFPIR-FAO Workshop on Valuing the Biological Diversity of Crops in a Development Context, March 29-30. Rome, Italy.

Breffle, W.S. and E.R. Morey. 2000. Investigating preference heterogeneity in a repeated discrete-choice recreation demand model of Atlantic salmon fishing. *Marine Resource Economics,* 15: 1-20.

Brookfield, H., C. Padoch, H. Parsons and M. Stocking, eds. 2002. *Cultivating biodiversity: understanding, analysing and using agricultural diversity*. London, England: ITDG Publishing.

Brookfield, H. 2001. *Exploring agrodiversity*. New York: Columbia University Press.

Brookfield, H. and Stocking, M. 1999. Agrodiversity: definition, description and design. *Global Environmental Change* 9: 77-80.

Brown, G.M. 1991. Valuation of genetic resources. In *The preservation and valuation of biological resources*, ed. G. H. Orians, M. G. Brown, Jr., W.E. Kunin, and J.E. Swierzbinski. Seattle: University of Washington Press.

Brush, S., E. Taylor, and M. Bellon. 1992. Technology adoption and biological diversity in Andean potato agriculture. *Journal of Development Economics* 39 (2): 365-387.

Commission of the European Countries. 2002. Enlargement and agriculture: Successfully integrating the new member states into the CAP. Issues Paper. Brussels, 30.1.2002 SEC (2002) 95 Final. http://europa.eu.int/comm/enlargement/docs/financialpackage/sec2002-95_en.pdf

Convention on Biological Diversity. 2002. *Secretariat of the convention on biological diversity.* United Nations Environment Program. http://www.biodiv.org/programmes/areas/agro

Csizmadia, G. 2004. *Analysis of small farm useful soil nutritive matter from Dévaványa, Őrség-Vend and Szatmár-Bereg regions of Hungary*. Working Paper. Tápiószele, Hungary: Institute of Agrobotany.

FAO. 1999. *Multifunctional character of agriculture and land.* Conference Background Paper. *Maastricht* 1: September.

Fischler, F. 2003. *Opportunities in an enlarged Europe.* 16th European Industry Strategy Symposium, February 10 in Villach, Austria.

Freeman, A. Myrick. 1993. *The measurement of environmental and resource values: Theory and methods.* Washington, D.C.: Resources for the Future.

Gauchan, D. 2004. Conserving crop genetic resources on-farm: The case of rice in Nepal. PhD Thesis. University of Birmingham, UK.

Greene, W.H. 1997a. *Econometric analysis*, 3rd Edition. Upper Saddle River, NJ, USA: Prentice Hall.

Greene, W.H. 1997. LIMDEP Version 7.0 NLogit Version 2.0. Plainview, N.Y.: Econometric Software, Inc.

Gyovai, Á. 2002. Site and sample selection for analysis of crop diversity on Hungarian small farms. In *The economics of conserving agricultural biodiversity on-farm: Research methods developed from IPGRI's Global Project 'Strengthening the Scientific Basis of In Situ Conservation of Agricultural Biodiversity,'* ed. Smale, M. I. Már and D.I. Jarvis. Rome, Italy: International Plant Genetic Resources Institute.

Hanley, N., R.E. Wright and V. Adamowicz. 1998. Using choice experiments to value the environmental. *Environmental and Resource Economics*, 11, (3-4), pp.413-428

Hungarian Central Statistical Office (HCSO). 2002. http://www.ksh.hu/pls/ksh/docs/index_eng.html

Hungarian Central Statistical Office (HCSO) TSTAR database. 2001.

IPGRI. 2003. *Home gardens and the in situ conservation of plant genetic resources.* http://www.ipgri.cgiar.org/system/page.asp?frame=publications/indexpub.htm

Juhász, I, J. Ángyán, I. Fesűs, L. Podmaniczky, F. Tar and A. Madarassy. 2000. *National agri-environment programme: For the support of environmentally friendly agricultural production methods ensuring the protection of the nature and the preservation of the landscape.* Ministry of Agriculture and Rural Development, Agri-environmental Studies, Budapest, 2000.

Kontoleon, A. 2003. Essays on non-market valuation of environmental resources: policy and technical explorations. Ph.D. Thesis Chapter. University College London, UK.

Kovách, I. 1999. Hungary: Cooperative farms and household plots. In *Many Shades of red: state policy and collective agriculture*, ed. Mieke Meurs. Boulder: Rowman and Littlefield.

Krutilla, J.V. 1967. Conservation reconsidered. *American Economic Review* 57 (3): 777-786.

Lancaster, K. 1971. *Consumer demand: a new approach*. New York: Columbia University Press.

Lankoski, J. (Ed.). 2000. *Multifunctional character of agriculture*. Research Reports 241. Agricultural Economics Research Institute, Finland.

Luce, D. 1959. *Individual choice behavior.* New York, NY: John Wiley.

McFadden, Daniel. 1974. Conditional logit analysis of qualitative choice behavior, in *Frontiers in econometrics*, ed. P. Zarembka. New York, NY: Academic Press.

Maddala, G.S. 2000. *Introduction to econometrics.* Third edition. Upper Saddle River, NJ, USA: Prentice-Hall, Inc.

Maddala, G.S. 1999. *Limited dependent and qualitative variables in econometrics.* Cambridge: Cambridge University Press.

Mäder, P., A. Fliessbach, D. Dubois, L. Gunst, P. Fried, and U. Niggli, 2002: Soil fertility and biodiversity in organic farming. *Science*, 296: 1694-1697

Már, I. 2002. Safeguarding agricultural biodiversity on-farms in Hungary. In *The economics of conserving agricultural biodiversity on-farm: Research methods developed from IPGRI's global project 'strengthening the scientific basis of in situ conservation of agricultural biodiversity'* ed. Smale, M. I. Már and D.I. Jarvis. Rome, Italy: International Plant Genetic Resources Institute.

Meng, E.C. 1997. Land Allocation Decisions and In Situ Conservation of Crop Genetic Resources: The Case of Wheat Landraces in Turkey. Ph.D. Dissertation, University of California at Davis, Davis, California, USA.

Meng, E.C, J.E. Taylor, and S.B. Brush. 1998. Implications for the conservation of wheat landraces in Turkey from a household model of varietal choice. In *Farmers, gene banks and crop breeding: Economic analyses of diversity in wheat, maize and rice,* ed. Smale, M. Boston: Kluwer Academic Press and CIMMYT.

Meurs, M. 2001. *The evolution of agrarian institutions: a comparative study of post-socialist Hungary and Bulgaria* . Ann Arbor: University of Michigan Press.

National Census, 2001, 6. Regional data, Békés County, HCSO, 2002

National Census, 2001, 6. Regional data, Jász-Nagykun-Szolnok County, HCSO, 2002

National Census, 2001, 6. Regional data, Vas County, HCSO, 2002

National Labor Centre. 2000. http://www.ikm.iif.hu/english/economy/labour.htm. Budapest, Hungary. Accessed December 2002.

Romstad, E., A. Vatn, P.K. Rørstad and V. Søyland. 2000. *Multifunctional agriculture: Implications for policy design*. Report No. 21. Department of Economics and Social Sciences. Ås, Norway: Agricultural University of Norway.

Scarpa, R., A.G. Drucker, S. Anderson, N. Ferraes-Ehuan, V. Gomez, C.R. Risopatron, and O. Rubio-Leonel. 2003. Valuing genetic resources in peasant economies: The case of `hairless' creole pigs in Yucatan. *Ecological Economics* 45 (3): 427-443.

Seeth, H.T., S. Chachnov, A. Surinov and J. von Braun. 1998. Russian poverty: Muddling Through economic transition with garden plots. *World Development*. Vol. 26. No. 9, pp. 1611-1623

Simon, Á. 2001. *Agricultural background for the on farm project.* Tápiószele, Hungary: Institute for Agrobotany.

Smale, M., Bellon, R.M. and J.A. Aguirre Gomez. 2001. Maize diversity, variety attributes, and farmers' choices in southeastern Guanajuato, Mexico. *Economic Development and Cultural Change,* 50 (1): October.

Swain, N. 2000. Post-Socialist Rural Economy and Society in the CEECs: the Socio-Economic Contest for SAPARD and EU Enlargement, Paper presented at the International Conference: European Rural Policy at the Crossroads, June 29 – July 1. The Arkleton Center for Rural Development Research, King's College, University of Aberdeen, Scotland.

Szelényi, I., ed. 1998. *Privatising the land*. London, UK: Routledge.

Szép, K. 2000. *The chance of agricultural work in the competition for time: Case of household plots in Hungary.* Society and Economy in Central And Eastern Europe, XXII (4).

Vajda. L. 2003. *The view from Central and Eastern Europe*. Agricultural outlook forum 2003, USDA. http://www.usda.gov/oce/waob/oc2003/speeches/vajda.pdf. Washington, DC: USDA.

Van Dusen, M.E. 2000. In situ conservation of crop genetic resources in the Mexican Milpa System. Ph.D. Dissertation, University of California at Davis, Davis, California, USA.

Van Dusen, E. and Taylor, J. E. 2003. *Missing markets and crop genetic resources: Evidence from Mexico.* A manuscript. Berkeley, California: University of California, Berkeley.

Weingarten et al. 2004. The future of rural areas in the CEE new member states. Network of Independent Agricultural Experts in the CEE Candidate Countries. http://europa.eu.int/comm/agriculture/publi/reports/ccrurdev/text_en.pdf. Accessed January 2004.

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