Using a Choice Experiment to Estimate the Demand of Hungarian Farmers for Food Security and Agrobiodiversity During Economic Transition*

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* We gratefully acknowledge the European Union's financial support via the 5th European Framework BIOECON project. We would like to thank Györgyi Bela, Timo Goeschl, Ágnes Gyovai, László Holly, Phoebe Koundouri, István Már, György Pataki, David Pearce, László Podmaniczky, Riccardo Scarpa, Timothy Swanson, Monika Szilagy, Eric Van Dusen and Mitsuyasu Yabe for useful comments, suggestions and fruitful discussions.
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Abstract

Hungarian home gardens are small farms that are repositories of agrobiodiversity and provide food security during economic transition. We use a choice experiment to test the hypothesis that farmer demand for home gardens will decrease as markets develop with European Union accession. Data represent 22 communities with varying levels of market and social infrastructure. We find that farmers located in more economically developed communities choose to be less dependent on small farms for food and prefer lower levels of agrobiodiversity. Findings indicate that the survival of small farms is jeopardized by economic change, but point to some conservation policy options.

Keywords: food security, agrobiodiversity, home gardens, choice experiment, multi-functional agriculture

JEL classifications: Q12, Q18, Q24, Q26

1. Introduction

Hungarian agriculture today has a dual structure consisting of large-scale, mechanised farms alongside semi-subsistence, small-scale farms managed by families using traditional farming practices. Dualism has persisted in some form throughout Hungarian history, especially during the socialist period of collectivised agriculture from 1955 to 1989 (Szelényi, 1998; Kovách, 1999; Swain, 2000; Szép, 2000; Meurs, 2001). Despite the changes engendered by transition to market economy during the past decade, the structure of agriculture remains dualistic. In 1994, less than 0.2 percent of farms (public, cooperative and private) in Hungary operated 84 percent of agricultural land, whereas 77 percent of them operated less than 4 percent of it on areas smaller than 0.5 ha (Sarris *et al.*, 1999).

One of the main reasons for the persistence of dual structure is the persistence of incomplete food markets. The formation of food markets in communities was discouraged during the period of state-controlled agriculture. Small-scale family farms in Hungary are heterogeneous in size and organization of production, but all have evolved from the "home gardens" that rural households were permitted to continue cultivating privately (Szelényi, 1998; Kovách, 1999; Swain, 2000; Szép, 2000; Meurs, 2001).

Several factors explain why food markets remain incomplete. In addition to lower agricultural incomes, high inflation and unemployment rates, consumers have difficulties obtaining reliable product information and predicting product availability (Feick *et al*. 1993). Transactions costs remain high, including search costs and transport costs to the nearest food market. The number of hypermarkets in Hungary has grown from only 5 in 1996 to 63 in 2003 (Hungarian Central Statistical Office (HCSO), 2003). A study by the World Health Organisation (WHO, 2000) found that these have contributed to the disappearance of the few extant local shops and markets[1].

[1] The power of the supermarket chains is increasing throughout Europe. Local shops are disappearing in a number of countries (e.g., France, Germany, Britain and Ireland) because they are less able to compete in terms of product availability, product range and price (Furey *et al*., 2001). In Britain, for example, 42 percent of English villages and Scottish towns with populations of less than 4000 have no local shops (Sheehy, 1998). Throughout Europe, food security is an issue of physical access and there are various examples of how food intake is affected by poverty and social inequalities (WHO, 2000). Furey *et al*. (2001) identify the potentially vulnerable consumer groups (i.e., elderly, car-less, isolated, unemployed,

Consequently, rural families continue to rely on their own production to meet their food needs and maintain diet quality. One fifth of the population produces agricultural goods for their own consumption and as a source of additional income on 697 336 small family farms with an average size of 591 m^2 (HSCO, 2001; Már, 2002). Szivós and Tóth (2000) estimated that 60 percent of the households in the lowest income quartiles consume food from own production, with a value amounting to 19277 Ft (€77.44) per month. Most of these households are located in rural Hungary. Szép (2000) found that income in kind generated by part-time agricultural production in small family farms amounts to 14% of total income of the households. Studies from other countries with economies in transition revealed that households engaging in subsistence agriculture on such small family farms have higher levels of real income and food consumption than others. This advantage enables them to combat poverty in an era of risky food prices, unreliable markets and low real incomes (Wyzan, 1996; Seeth *et al.*, 1998).

Comment: Own production is very important fro poor people

Small-scale farms are also refuges for much of the domesticated crop and livestock biodiversity that remains *in situ* in rural Hungary. Crop and livestock genetic resources kept on family farms are potentially important to agricultural research and future generations of farmers and consumers. Small family farms have been described by agricultural scientists as micro-agro-ecosystems that are rich in numbers of crop species, varieties, and livestock races, as well as soil micro-organisms (Már and Juhász, 2002; Csizmadia, 2004).

Many expect that as a result of continued economic transition and the nation's accession to the European Union (EU), the dual structure of Hungarian agriculture, and semi-subsistence farms, will eventually disappear (Sarris *et al.*, 1999; Vajda, 2003; Weingarten *et al.*, 2004). The share of own-produced food in household food consumption has already decreased from 24.5 percent in 1989, to 10 percent in 2004, although there is significant regional variation (Fertő *et al.*, 2004). EU accession could lead to improved rural infrastructure, along with rural development and the growth of employment opportunities outside agriculture (Weingarten *et al.*, 2004). The rural

low-income households) in Northern Ireland, and find that these are excluded from equitable shopping because they do not have physical access to fresh, quality, nutritious food at affordable prices.

population is expected to continue to decline and age as younger generations migrate to urban areas (Harcsa *et al.*, 1994; Sarris *et al.*, 1999; Juhász, 2001).

Such changes will incur both private and public costs. In recognition of this fact, the reformed Common Agricultural Policy (CAP) of the EU aims to promote agrobiodiversity and other public goods generated by agricultural production (e.g., food security, safety and quality, and cultural heritage) through multi-functional agriculture (Romstad *et al*., 2000; Lankoski, 2000). The contribution of small-scale farms to multifunctional agriculture in Hungary appears to have been overlooked in other EU and national policies, however. The EU's Special Accession Programme for Agriculture and Rural Development (SAPARD) labels small-scale farms as inefficient. SAPARD proposes either subsidies to transform them into commercially viable units or direct payments to cease their production altogether (Commission of the European Communities, 2002). Hungary's National Rural Development Plan (NRDP) implements several agri-environmental schemes to advance the use of specified farming methods in environmentally sensitive areas (ESAs), by providing direct payments, training programmes and technical assistance (Juhász *et al.*, 2000). So far, the role of semi-subsistence small family farms within these schemes has not been elucidated.

In this paper, we test the hypotheses that farmer demand for food security and agrobiodiversity in small family farms decrease with economic change. The choice experiment method is applied with primary data collected through personal interviews with 277 farm families across 22 communities in three ESAs of Hungary. Factor analysis and other methods are applied to secondary data to compute community-specific indices of economic development and market integration. To test hypotheses, conditional logit models were fitted to choice experiment data interacted with indices measuring: community development; consumption risk; rural development; food markets; and population density.

The contribution of this paper is threefold. First, it provides a unique empirical case study about the relationship between the demand for domesticated crop and livestock biodiversity and economic change in a higher income, transitional economy, using a stated preference method, namely a choice experiment. Most related case studies have been implemented in lower income countries, on crop or livestock components

alone, using revealed preference approaches such as farm household models (e.g., Brush *et al*., 1992; Van Dusen, 2000; Smale *et al.*, 2001; Gauchan, 2004, Nagarajan, 2004). Second, the study contributes to the set of choice experiments applied in the agricultural context by estimating farmer demand for an entire micro-agro-ecosystem. Other choice experiments have investigated consumer demand for food produced with specific techniques (Lusk *et al*., 2003; Kontoleon and Yabe, 2004; Enneking, 2004; Hu *et al.*, 2004), or farmer demand for crop or livestock traits (Scarpa *et al*., 2003a,b; Ndjeunga and Nelson, 2005). Finally, findings have policy implications for design of efficient, cost effective and equitable agri-environmental programmes, in Hungary as well as in other EU member Central and Eastern European Countries (CEECs) with similar dual agricultural structures, such as Slovenia and Poland.

2. Methods and Data

2.1. The Choice Experiment Approach

Most of the outputs, functions and services that small-scale family farms generate, such as food security and agrobiodiversity, are not traded in markets. Non-market valuation methods can be used to determine the value of their benefits. Farmers earn non-market benefits in terms of utility rather than market prices. The preferences of farmers, who are both producers and consumers of outputs, determine the implicit values of the farm, its goods, functions and services.

Of the approaches for valuing non-market goods, the choice experiment method is the most appropriate because it enables estimation not only of the value of the non-market good as a whole, but also of the implicit value of its multiple attributes. A choice experiment is a highly structured method of data generation, which relies on carefully designed tasks or experiments to reveal the factors that influence choice. The good is defined in terms of its attributes and the levels these attributes would take under different management scenarios. One of the attributes is a monetary one, which enables estimation of the welfare measure, or value. Experimental design theory is used to construct profiles of the good in terms of its attributes and attribute levels. Two or three alternative profiles

are then assembled in choice sets and presented to respondents, who are asked to state their preferred profile in each choice set (Hanley *et al.,* 1998; Louviere *et al.*, 2000; Bennett and Blamey, 2001; Bateman *et al.*, 2003).

The choice experiment method is grounded theoretically in Lancaster's attribute theory of consumer choice (Lancaster, 1966) and has an econometric basis in models of random utility (Luce, 1959; McFadden, 1974). Lancaster proposed that consumers derive satisfaction not from goods themselves but from the attributes they provide. Consider a farmer's choice for a small farm, and assume that utility depends on choices made from a set C. A choice set, C includes all possible small farm options. The farmer is assumed to have a utility function of the form

$$U_{ij} = V(Z_{ij}, F_i, E_i) + e_i \,. \qquad (1)$$

For any farmer *i,* a given level of utility will be associated with any alternative small farm *j*. Utility derived from any of the small farm alternatives is comprised of (i) a systematic component, which depends on the attributes (Z) of the farm, the social and economic characteristics of the farmer (F), and the farmer's social and economic environment (E); and (ii) an error component, e_i, which is independent of the systematic component and follows a predetermined distribution. 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. Assuming that the relationship between utility and characteristics is linear in the parameters and variables function, and assuming that the error terms are identically and independently distributed with a Weibull distribution, the probability of any particular alternative *j* being chosen can be expressed in terms of logistic distribution. Equation (1) can be estimated with a conditional logit model (McFadden, 1974, Greene, 1997; Maddala, 1999), resulting in a conditional indirect utility function

$$V_j = \beta + \sum_k \beta_k Z_k + \sum_{kn} \gamma_{kn} Z_k * F_n + \sum_{km} \delta_{km} Z_k * E_m \qquad (2)$$

The alternative specific constant term, β, captures the effects on utility from a change in any attribute not included in choice-specific attributes. The vectors of coefficients β_k, γ_{kn} and δ_{km} are attached to: a) the vector of attributes of the small farm (Z); b) the vector of interaction terms between the farm attributes and social and economic characteristics relating to the farmer (F); and c) the vector of interaction terms between the farm attributes and social and economic characteristics of the community in which the farmer is located (E). Social and economic characteristics enter the utility function as interaction terms with the choice attributes since they are constant across choice occasions for any given farmer.

2.2. Data Sources

2.2.1. Secondary Data

The sample design for the choice experiment consisted of two stages. In the first stage, secondary data from HCSO (2001) and NRDP were used to select three ESAs (Dévaványa, Őrség-Vend and Szatmár-Bereg) amongst 11 ESAs identified by the NRDP (Figure 1). These three ESAs were purposively selected to represent contrasting levels of market development and varying agro-ecologies associated with different farming systems and land-use intensity. The stratified design enables testing of the hypotheses about the effects of market integration and economic development on farmer demand for food security and agrobiodiversity on their holdings. In each selected site, pilot agri-environmental programmes were underway and high levels of agricultural biodiversity (in terms of crop genetic diversity) have been identified (Már, 2002).

[Figure 1]

Twenty-two communities (5 in Dévaványa, 11 in Őrség-Vend and 6 in Szatmár-Bereg) were included in the sample. Secondary data on the community characteristics are summarized in Table 1.Dévaványa, located on the Hungarian Great Plain, is closest to the economic centre of the country of the three ESAs. Soil and climatic conditions are well suited to intensive agricultural production. Populations, areas, and population density are relatively high. Labour migration is not a major problem, although the number of inhabitants is stagnating. The unemployment rate in this region (12.4 percent) is slightly higher than the Hungarian average. Dévaványa is statistically different from the

other two ESAs in most indicators of urbanisation and market integration, including: presence of a train station; distance to the nearest market (both in km and minutes by car); number of primary and secondary schools; food markets; and the number of shops and enterprises.

The two isolated ESAs are more similar to each other than either is to Dévaványa. Located in the southwest, Őrség-Vend has a heterogeneous agricultural landscape with poor soil conditions that render intensive agricultural production methods impossible. Communities are very small in area and most are far from towns. Of the three ESAs, Őrség-Vend is the least urbanised with fewest shops and enterprises. Its small population is declining and ageing, though the unemployment rate of this region is lowest in the country at 4.8 percent. Őrség-Vend supports the lowest dependency ratio. Szatmár-Bereg is situated in the northeast, far from the economic centre of the country. Communities 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). Szatmár-Bereg also has a significantly higher inactive ratio than either of the other two ESAs (National Labour Centre, 2000; Juhász *et al.*, 2000; Gyovai, 2002).

[Table 1]

Exposure to consumption risk, which gives rise to the demand for food security from small farm production, is investigated by studying the household's expenditure on food both in real terms and as a percentage of total household income over an eleven-year period (HCSO, 1992-2003). It is observed that between 1992 and 2000, food expenditure has increased at an increasing rate, both for Hungary and for each of the three ESAs. The rates of increase have, however, decreased from 2000 onwards. From 2002 to 2003, food expenditure has decreased for Dévaványa, the ESA with the most developed markets and Őrség-Vend, the ESA with the lowest unemployment rate among the three. Households in the three ESAs are observed to spend higher shares of their total income on food compared to the average Hungarian households. The trend for ratio of food expenditure to total income has been decreasing both for Hungary and for each of the three ESAs since 1998, exactly ten years after the transition to market economy has begun.

2.2.2. Primary Data

In the second stage of the sample design, all communities within each ESA were sorted based on population sizes, and an initial sample of 1800 households (600 households per ESA) was sampled randomly from a complete list of all households compiled from telephone books and village maps. A screening survey was sent to all of the 1800 households to identify all those engaged in small family farm management. The response rate to the screening survey was only 13 percent, but the final sample was augmented through personal visits to listed sample households with the assistance of key informants in each community. A total of 323 farm households were personally interviewed in August 2002 with a household survey instrument (Birol *et al.*, 2005), 277 (85.8 percent) of which agreed to take part in the choice experiment. All households sampled had small family farms. Findings reported in this paper are statistically representative of the selected ESAs and other ESAs in rural Hungary to the extent that they share characteristics in common.

The attributes and levels used in the choice experiment were identified with NRDP experts and agricultural scientists, drawing on the results of informal and focus group interviews with farmers in each ESA (Table 2). Each attribute represents a different component of agrobiodiversity. The total number of crop varieties grown in a small farm of fixed size is an indicator of crop variety richness. In this choice experiment both inter- and infra-species diversity of field crops, trees and vegetables are considered. Crop variety diversity is one of the most crucial components of agricultural biodiversity (FAO, 1999). Presence of a landrace or a local variety in the small farm expresses crop genetic diversity[2]. Preliminary molecular analysis and agro-morphological evaluation conducted on bean landrace samples collected from the sampled households' small family farms reveal that the majority of these landraces are distinct and identifiable and contain rare and adaptive traits, and are genetically heterogeneous (Már and Juhász, 2002). The traditional method of integrated crop and livestock production represents agro-diversity, or diversity in agricultural management practices (Brookfield and Stocking, 1999). Organic production takes place if crops are grown without any

[2] Landraces, or local varieties, are variants, varieties, or populations of crops, with plants that are often highly variable in appearance, whose genetic structure is shaped by farmers' seed selection practices and management, as well as natural selection processes, over generations of cultivation.

industrially produced and marketed chemicals, such as pesticides, herbicides, insecticides, fungicides or soil disinfectants. Previous experiments found that use of organic production methods resulted in soil microorganism diversity (e.g. Lupwayi *et al.*, 1997; Mäder *et al.*, 2002). The expected percentage of the annual household food consumption supplied by the small family farm, i.e. food security, represents the family's dependence on its own production (Table 2).

[Table 2]

A large number of unique small family farm prototypes can be constructed from this number of attributes and levels[3]. Using SPSS Conjoint 8.0 software and experimental design theory, main effects, consisting of 32 pair wise comparisons of small farm prototypes, were recovered with an orthogonalisation procedure[4]. 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 farmer was presented with 5 or 6 choice sets, each containing two small family farms and an option to select neither. The farmers who took part in the choice experiment were those responsible for making decisions in the small farm. Enumerators explained the context in which choices were to be made (a 500 m^2 farm); that attributes of the small farm had been selected as a result of prior research and were combined artificially. Overall, a total of 1487 choices were elicited from 277 farmers taking part in the choice experiment. Figure 2 demonstrates an example of one of the choice sets presented to the farmers.

[Figure 2]

2.3. Construction of Indices

The first index developed is a community development index (CDI) that is similar in its construction to the human development index (HDI) used by the United Nations (UNDP,

[3] The number of small family farm prototypes that can be generated from 5 attributes (2 with 4 levels and 3 with 2 levels) is $4^2*2^3=128$.

[4] Although exclusion of interaction effects in the experimental design may introduce bias into main effects estimations, main effects usually account for more than 80% of the explained variance in a model (Louviere, 1988; Louviere *et al.*, 2000). Moreover, the aim of this choice experiment was to investigate farmer demand for each small farm attribute independently of the others. An advantage of the choice experiment approach relative to revealed preference approaches is that the effects of each attribute on respondents' demand for the good can be separated, avoiding collinearity between the attributes (Adamowicz *et al.*, 1994; Adamowicz *et al.*, 1997; Adamowicz and Boxall, 2001).

2003). First each community was assigned a score for each characteristic reported in Table 1. The highest achieving community was awarded a score of 100 and others were ranked proportionately in descending order. The CDI was then calculated for each community by averaging over the characteristics indices. According to this index, the most developed community is located in Dévaványa (i.e., Gyomaendrőd), while the least developed one is located in Őrség-Vend (i.e., Kerkáskápolna).

The second index is developed to measure the consumption risk (CRI). Data on the percentage of total income spent on food for each ESA was used for the period 1993 to 2002 (the year in which the choice experiment was carried out). The coefficient of variation of the percentage of income spent on food for each ESA was measured using an adjusted coefficient method, namely the Cuddy-Della Valle Index, which measures the variation about a trend line for the period rather than about the period's mean (Cuddy and Della Valle, 1978). Following this method, first the coefficient of variation was calculated as the ratio of the standard deviation for the time period over the average of the data points for the time period. Then a trend was fitted to the data with a regression, and finally the coefficient of variation in the first step was multiplied by the square root of (1-the adjusted R-squared from the trend regression) to obtain a trend-adjusted coefficient of variation. According to these calculations, Szatmár-Bereg, the most isolated ESA, has the highest variation in percentage of income spent on food among the three ESAs, while Dévaványa, the region most integrated into the markets has the lowest variation in percentage of income spent on food.

The final three indices are the rural development index (RDI), food market index (FMI) and a population density index (PDI). These were derived from a factor analysis of the community characteristics reported in Table 1. Factor analysis collapses the number of variables, classifying them according to their correlations and structure. Though common in social statistics, the approach has been used only recently to assess heterogeneity in stated preference methods (Kontoleon, 2003; Nunes and Schokkaert, 2003). The factor analysis in this paper is undertaken using the principal factor extraction method in STATA 8.0. Factors with an eigenvalue above one were retained. Varimax rotation suggested the existence of three factors. The factors were named on the basis of the variables that ‘factored’ together as well as the relative magnitude of the factor

loadings. The first factor, labelled "rural development" consisted of number of secondary schools, shops and enterprises in the community, area, and population. The second factor, named "food market," was composed of the distance to the nearest market and the presence of food markets in the communities. The final factor, called "population density," included the number of train stations and population density[5]. The indices of these factors were created by calculating the factor scores of each index for each community using the factor score command in STATA 8.0.

3. Results

Conditional logit models with logarithmic and linear specifications were compared using LIMDEP 7.0 NLOGIT 2.0, and data from all three ESAs[6]. The highest value of the log-likelihood function was found for the specification with crop variety diversity attribute in logarithmic form. This finding suggests that the marginal value of this attribute diminishes with increasing richness of crop varieties. For the population represented by the sample, indirect utility from small farm attributes takes the form

$$V_j = \beta + \beta_1 \ln(Z_{cropdiversity}) + \beta_2 (Z_{landrace}) + \beta_3 (Z_{agro-diversity}) + \beta_4 (Z_{organic}) + \beta_5 (Z_{food\ security}) \quad (3)$$

The coefficient β refers to the alternative specific constant and β_{1-5} refers to the vector of coefficients associated with the vector of attributes representing agrobiodiversity and food security.

The demand for small-scale farms and their attributes depends on the social and economic characteristics of the farm households who manage them and on social and economic characteristics of the communities in which the farmers are located. The effects of this first set of factors on the demand for small farm attributes are investigated

[5] Note that the second and third factors only consist of two variables. In some cases this may be indicative of a spurious factor. However in each case the eigenvalues are all above one and the factor loadings are high, providing assurance that these can be considered as legitimate factors (Kontoleon, 2003)

[6] The data were also estimated with a random parameter logit model, in which parameters have individual specific errors, allowing for random taste variation and correlation in unobserved factors (McFadden and Train, 2000). The data did not support choice-specific, unconditional and unobserved heterogeneity. A Swait-Louviere log likelihood ratio test resulted in failure to reject the null hypothesis that the estimated random parameter logit model was equal to conditional logit model (Birol, 2004)

in Birol *et al*. (2004)[7]. The demand for attributes of small farms also depends on the social and economic characteristics of the communities in which the farm families are located. Community characteristics cannot be affected by the decision of any individual family in the community during the short term. The analysis in this paper holds characteristics of farm families constant, focusing instead on the effects of economic development factors that vary among communities and are "exogenous" to individual farm families at any specific point in time.

In random utility models the effects of social and economic characteristics cannot be examined in isolation but in the form of interaction terms with the attributes. The number of terms proliferates with additional vectors of explanatory variables. Including interactions of each characteristic shown in Table 1 with five small farm attributes in one conditional logit estimation would generate multicollinearity (Breffle and Morey, 2000). Initially, for each community level characteristic introduced in Table 1, a separate conditional logit model with interactions between the five small farm attributes and the characteristic was estimated. Choosing one interaction over another based on results introduces test bias. To resolve this problem, the following conditional logit model was estimated using interactions with the five indices constructed through factor analysis.

$$\begin{aligned} V_j &= \beta + \beta_1 \ln(Z_{cropdiversity}) + \beta_2(Z_{landrace}) + \beta_3(Z_{agro-diversity}) + \beta_4(Z_{organic}) + \beta_5(Z_{food\ security}) \\ &\delta_1(Z_{cropdiversity} \times E_{index}) + \delta_2(Z_{landrace} \times E_{index}) + \delta_3(Z_{agro-diversity} \times E_{index}) \\ &+ \delta_4(Z_{organic} \times E_{index}) + \delta_5(Z_{food\ security} \times E_{index}) \end{aligned} \qquad (3')$$

The results of the conditional logit regression estimating the demand for small farms, including all interactions between the community development index (CDI) and small farm attributes, can be seen in the first column of Table 3. Significant interactions are evident between farmer demand for crop biodiversity (crop variety diversity and landraces) and community development, and between the level of food security attained through small farm production and community development. All coefficients have

[7] The findings of Birol *et al*. (2004) are fourfold. First, crop variety diversity is valued most highly by those families that are located further away from markets. Second, elderly farmers attach the highest values to landraces. Third, agro-diversity is valued most highly by elderly farmers as well as with younger ones

negative signs. The demand for crop biodiversity, as expressed by the richness of crop varieties and presence of landraces, declines as the local market economy develops. Reliance on small farm produce for food security also declines.

The results of the conditional logit regression estimating the demand for small farms, including interactions between the consumption risk index (CRI) and farm attributes, can be seen in the second column of Table 3. Significant interactions are evident between farmer demand for crop variety diversity and consumption risk, and between the level of food security attained through small farm production and consumption risk. That is, the higher the consumption risk the more crop variety diversity farmers prefer in the small farms, and the higher the level of food security the farmers demand that the small farm provide. The coefficients on the interactions between consumption risk and other attributes of small farms have the expected signs, although they are insignificant.

Estimated coefficients on interactions between the indices constructed through factor analysis and farmer demand for farm attributes are reported in the last three columns of Table 3. The third column reports the coefficients on interaction terms for rural development index (RDI). Significant interactions are apparent between rural development and farmer demand for crop biodiversity (crop variety diversity and landraces), and between rural development and the level of food security demanded from the small farm. These findings reinforce those observed for the community development index, reported above.

Estimated coefficients on interactions between the food market index (FMI) and the demand for small farm attributes are reported in the fourth column of Table 3. The significant interactions between the food market index and small farm attributes are the same as those observed for the community and rural development indices. The more food markets a community has, the less the households in that community depend on their small farms for food security and the less crop biodiversity they want to manage on farm.

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who also cultivate fields. Finally, elderly farmers, who lack access to markets, as well as younger families with higher income and more education attach the highest value to organic production methods.

The interactions between the demand for small farm attributes and the population density index (PDI) are presented in the last column of Table 3. The results indicate that reliance on small farms for household food consumption as well as farmer demand for landraces decreases with the density of the community population. However, the interactions of population density with agro-diversity (crop and livestock production) and organic production are positive. These results underscore the notion that these forms of production are relatively labour intensive. Organic production also exhibits some luxury good properties.

[Table 3]

5. Conclusions

The application of a stated preference method in rural Hungary confirms the predictions of economic theory and the empirical evidence from analysis of revealed preferences in a number of other countries with much lower national income levels. As the communities in which farmers reside develop and the physical infrastructure of their markets becomes denser, they rely less on their home-produced goods for food security, and the agrobiodiversity they prefer to maintain on their farms diminishes.

The principal conclusion of the study is that the farmers who value the agrobiodiversity and food security services of their small-scale family farms the most are located in the most economically marginalized communities in Hungary. These findings are similar to those obtained from other locations in the EU, such as Scotland, Denmark and Netherlands. These studies have demonstrated that the likelihood that farmers manage levels of biodiversity and participate in agri-environmental schemes are higher in those areas that are marginalised both agro-ecologically and economically (Crabtree *et al.*, 1998; Kristensen *et al.*, 2001; Wossink and van Wenum, 2003).

Farming communities such as these clearly constitute the least cost options for any agri-environmental programmes or incentive mechanisms aimed at sustaining current levels of agrobiodiversity. At present, the opportunity costs of doing so are negligible. Opportunity costs for these farmers of maintaining the small farms will change, however,

if incomes rise and employment opportunities expand with EU membership (Fischler, 2003). Market infrastructure in Hungary has expanded rapidly since transition to the market economy began in 1989. Infrastructure development and new employment opportunities proposed in SAPARD (Weingarten *et al.*, 2004) are expected to augment farmers' access to markets, reducing the dependence of farm families on their own produce for food security.

On the other hand, economic development typically progresses unevenly. The transition to market economy has so far resulted in growing income disparities and rising domestic prices (Wyzan, 1996; OECD, 2002). Reliance on already marginalized farmers for private provision of vital public goods, such as agrobiodiversity, is not equitable. As Trzeciak-Duval (1999) states, social measures for low-income households located in marginalised areas where prospects for economic diversification are limited are a key element for rural development strategies. Social equity issues might be suitably addressed through integrating certain farm management practices used on small-scale farms, such as management of certain crop and livestock genetic resources, into national conservation programmes in selected communities.

6. Policy options

One feasible, publicly financed mechanism is the set of agri-environmental measures undertaken as part of the National Rural Development Plan (NRDP). NRDP provides farmers with direct payments for undertaking agricultural production methods that provide public goods, such as conservation of agrobiodiversity. The agri-environmental measures proposed by these policies and programmes are already underway in the three environmentally sensitive areas where this research was conducted. As Kristensen *et al.* (2001) state, agri-environmental programmes and other initiatives aiming to influence the production methods of farmers have a higher chance of success if they are adopted to local conditions, in terms of the physical, social and economic environment.

Market-based mechanisms, such as organic or regional small farm products, may also be tractable, although these approaches are not necessarily less costly (Ferraro and Simpson, 2002). Trzeciak-Duval (1999) argue that Central and Eastern European

Countries such as Hungary should become producers and traders of such high value-added agricultural products to take advantage of consumers' rising incomes, increasingly diversified consumer preferences and growing demand for safer food. Very few of the small farmers surveyed have access to capital markets or the type of formal credit that is required to invest in such technologies (Saris *et al.*, 1999; Rizov and Mathijs, 2003). Solutions such as providing interest-free loans under the NRDP or contracting between farmers and the agri-food chain could induce farmers to invest in such production methods (Gow and Swinnen, 1998; Mathijs and Vranken, 1999). Before further recommendations can be made, the willingness of other agents in the agri-food industry, as well as of consumers *without* farms, to pay for small farms and their attributes must also be assessed.

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8. Tables

Table 1. Community and ESA Level Characteristics

Characteristics	Dévaványa (n=5)	Őrség-Vend (n=11)	Szatmár-Bereg (n=6)
		Mean	
Presence of train station =1, 0 else	0.8	0.18	0
Distance to nearest food market (km)	0	19.85	18.35
Distance to nearest food market (minutes by car)	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.

Table 2. Small farm attributes and attribute levels used in the choice experiment

Small farm attribute	Definition	Attribute levels
Crop variety diversity	The total number of different crop species and varieties that are grown in the farm.	6, 13, 20, 25
Landrace	Whether or not the small farm contains a crop variety that has been passed down from the previous generation and/or has not been purchased from a commercial seed supplier.	Small farm contains a landrace vs. Small farm does not contain a landrace
Agro-diversity	Integrated crop and livestock production on the small farm, representing diversity in agricultural management system.	Integrated crop and livestock production vs. Specialised crop production
Organic production	Whether or not industrially produced and marketed chemical inputs are applied in farm production.	Organic production vs. Non-organic production
Food security	The percentage of annual household food consumption that it is expected the small family farm will supply.	15%, 45%, 60%, 75%

Source: Hungarian Small Family Farm Choice Experiment, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002.

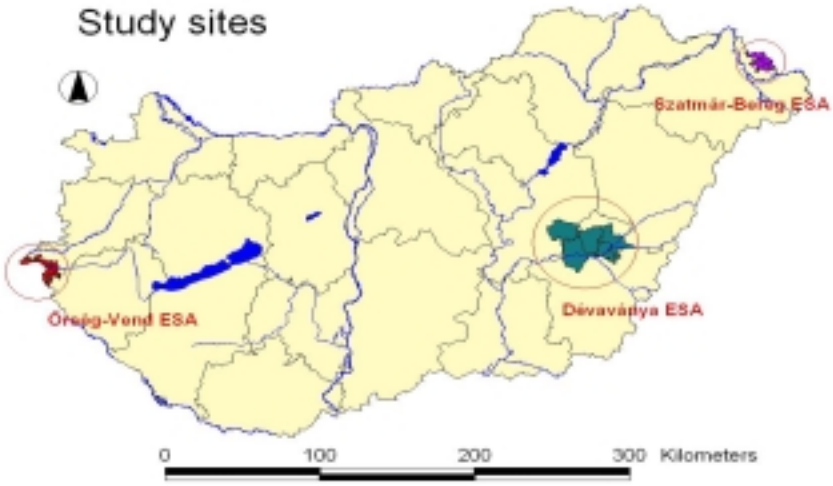
Table 3. Interactions between indices and demand for small farm attributes

Variable	Community Development Index (CDI)	Consumption Risk Index (CRI)	Rural Development Index (RDI)	Food Market Index (FMI)	Population Density Index (PDI)
Constant	-0.81***	-1.92***	-0.77***	-0.56**	-0.75***
Crop variety diversity	0.30***	1.12**	0.27***	0.103	0.24***
Landrace	0.23***	0.23	0.22***	0.14**	0.24***
Agro-diversity	6.34***	0.71*	0.36***	0.45***	0.31***
Organic Production	0.15**	0.1	0.17***	0.25***	0.12**
Self sufficiency	$0.81x10^{-5}$***	$0.16x10^{-4}$***	$0.78X10^{-5}$***	$0.63x10^{-5}$***	$0.83x10^{-5}$***
Crop variety diversity x Index	$-0.32x10^{-3}$**	1.39***	$-0.26X10^{-5}$***	$-0.99x10^{-3}$*	-0.02
Landrace x Index	$-0.21x10^{-2}$*	1.57	$-0.18X10^{-4}$**	-0.01*	-0.21*
Agro-diversity x Index	$0.17x10^{-2}$	5.85	$0.14X10^{-4}$	$0.96x10^{-2}$	0.25*
Organic production x Index	$0.14x10^{-2}$	-1.79*	$0.85X10^{-5}$	$0.93x10^{-2}$	0.23*
Food security x Index	$-0.31x10^{-7}$**	$0.17x10^{-3}$**	$-0.23X10^{-9}$**	$-0.15x10^{-6}$**	$-0.35x10^{-5}$**
ρ^2	0.135	0.133	0.135	0.132	0.133
Log likelihood	-1407.09	-1410.6	-1406.43	-1411.95	-1410.40

Source: Hungarian Small Family Farm Choice Experiment, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002.
*Statistically significant with one-tailed test (a priori hypothesis) at 10% level; ** at the 5% level; *** at 1% level. N= 1487

9. Figures

Figure 1. Location of the selected ESAs



Source: GIS Laboratory, Institute of Environmental and Landscape Management, Szent István University, Gödöllő, Hungary.

Figure 2. Sample choice set

Assuming that the following small farms were the ONLY choices you have, which one would you prefer to cultivate?

Small farm characteristics	Farm A	Farm B	
Total number of crop varieties grown in the small farm.	25	20	Neither farm A nor farm B: I will NOT cultivate a small farm.
Small farm has a landrace	No	Yes	
Crop production in the small farm is integrated with livestock production	Yes	Yes	
Small farm crops produced entirely with organic methods	No	No	
Expected proportion (in %) of annual household food consumption met through food production in the small family farm	45	75	

I prefer to cultivate Farm A……. Farm B…… Neither Farm ……
(please check (√) one option)

Source: Hungarian Small Family Farm Choice Experiment, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002.