VALUING AGRICULTURAL BIODIVERSITY ON HOME GARDENS IN HUNGARY: AN APPLICATION OF STATED AND REVEALED PREFERENCE METHODS

submitted by

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To my beloved grandparents, Mrs. Bilge Birol and

Prof. Dr. İ. Kemal Birol.

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Canımdan çok sevdiğim babaannem Sayın Bilge Birol ve

dedem Sayın Prof. Dr. İ. Kemal Birol'a.

*"The LORD God then took the man
and settled him in the garden of
Eden, to cultivate and care for it."*
(Genesis 2:15)

"Cherish variation, for without it life will perish."
Sir Otto Frankel

ABSTRACT

This thesis contributes to the economics of conservation of agricultural biodiversity on farm with a case study on traditional Hungarian home gardens, which are micro-agroecosystems that are repositories of Hungary's remaining agricultural biodiversity riches, as well as of Hungarian cultural heritage. The aims of this thesis are to measure the private values of home gardens and agricultural biodiversity therein that accrue to farm families who manage them, and to investigate the effects of household, market, agro-ecological, cultural and economic factors on farm families' demand for and supply of agricultural biodiversity in their home gardens. Data on farm families' revealed and stated preferences for agricultural biodiversity in home gardens are collected from 323 farm households in 22 communities across 3 regions of Hungary, with an original farm household survey and an original choice experiment. Data are analysed with theoretical and empirical models from agricultural and environmental economics literature to identify those farm families, communities and regions that attach the highest values to agricultural biodiversity and that are most likely to conserve home gardens with high levels of agricultural biodiversity. The results disclose that the most isolated communities in the country, that are economically and environmentally marginalised, are most likely to sustain and attach the highest values to traditional, agricultural biodiversity rich home garden management practices. Within these communities, farm families that are larger, have elderly decision-makers, lower income levels and home gardens with unfavourable production conditions tend to conserve higher levels of and attach the highest values to agricultural biodiversity in home gardens. Since where private values of conservation are the highest the cost of conservation would be the least, the results of this thesis may assist the national policy makers in designing efficient and cost-effective agri-environmental policies for conservation of Hungary's agricultural biodiversity riches and cultural heritage.

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AnGR: Animal Genetic Resources

ASC: Alternative Specific Constant

CAP: Common Agricultural Policy

CBD: Convention on Biological Diversity

CS: Compensating Surplus

CVM: Contingent Valuation Method

EC: European Commission

ESA: Environmentally Sensitive Area

EU: European Union

FAO: Food and Agriculture Organisation of the United Nations

GDP: Gross Domestic Product

GM: Genetically Modified

GPA: Global Plan of Action for the Conservation and Sustainable Utilisation of Plant Genetic Resources for Food and Agriculture

GRFA: Genetic Resources for Food and Agriculture

HCSO: Hungarian Central Statistical Office

HDI: Human Development Index

HUF: Hungarian Forint

HYV: High Yielding Varieties

IIA: Independence of Irrelevant Alternatives

ITPGRFA: International Treaty on Plant Generic Resources for Food and Agriculture

NAEP: National Agri-Environmental Programme

OECD: Organisation of Economic Cooperation and Development

PDO: Protected Designation of Origin

PGI: Protected Geographical Indication

SAPARD: Special Accession Programme for Agriculture and Rural Development

TSG: Traditional Speciality Guaranteed

UNDP: United Nations Development Programme

UNEP: United Nations Environment Programme

VIF: Variance Inflation Factors

WTA: Willingness to Pay

WTP: Willingness to Accept

WHO: World Health Organisation

Chapter 1

Introduction to the thesis

1.1. Introduction

Agricultural biodiversity is one of the most crucial of environmental riches. It ensures the food and livelihood security of billions of people today as well as the resources for future agricultural innovations (FAO, 1999). It has been eroding at an unprecedented rate, especially throughout the 20th century, as a result of the value of this resource not being appreciated (Pretty, 1995). In recognition of its importance, several international agreements encourage the design of policies that convey economic incentives for farmers to conserve agricultural biodiversity.

Much of the agricultural biodiversity remaining today is found on the semi-subsistence farms of poorer countries, on the small-scale farms and in the home gardens of more industrialised nations, many of which are found in more economically marginalised areas (Brookfield, 2001; Brookfield *et al.*, 2002; IPGRI, 2003). The small family farms of Hungary, traditionally known as "home gardens" are an example. On these privately-owned, homestead fields, the use of labour-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 crop and livestock species, varieties and breeds, as well as in soil microorganisms that result from decades of production without chemicals (Már, 2002; Bela, 2003; Csizmadia, 2004; Már, personal communication, 2004). Home gardens play a significant cultural role in Hungarian society, by providing farm produce that contributes colour, flavour, and nutrients to the diets of rural population in time periods and locations when markets or state institutions do not (Seeth *et al.*, 1998; Már, 2002).

Hungary became an European Union (EU) member state in May 2004. As an EU member state, Hungary needs to comply with the regulations and laws of the EU, collectively known as the *acquis communautaire*. The national agri-environmental policies and programmes of Hungary are now being developed to promote multifunctional agriculture in accordance with the *acquis* (Juhász, 2000). These agri-environmental policies and programmes appear to neglect Hungarian home gardens, which in fact generate many multifunctional agricultural values, including conservation of agricultural biodiversity, Hungarian cultural heritage and rural settlements, as well as food safety and security. Policy oversight, coupled with the changing economic circumstances in this transitional country (OECD, 2002), home gardens may cease to exist (Vajda, 2003; Weingarten *et al.*, 2004) if agri-environmental policies do not recognise the public and private economic value generated by their multiple functions, much of which is understated in markets. This thesis argues that inclusion of home gardens in national agri-environmental policies is crucial to ensure their survival, as well as to provide of multifunctional agriculture in this country.

The remainder of this chapter expands on the concepts introduced in this introduction by providing formal definitions of agricultural biodiversity and *in situ* conservation on farm. The following subsections also briefly explain the reasons that have led to agricultural biodiversity erosion and the international and EU level efforts that attempt to halt this erosion. The role of home gardens in Hungarian society and economy, as well as the agricultural biodiversity values home gardens generate, and the national and EU level policies related to home gardens are also discussed.

1.2. Agricultural biodiversity and its erosion

Agricultural biodiversity provides the basis of the food and livelihood security and safety of billions of people and the development of all food production, including for industrial agriculture and for the biotechnology industries. It results from the interaction between the environment, genetic resources and the management systems and practices used by culturally diverse peoples resulting in the different ways land and water resources are used for production. Agricultural biodiversity, which is also often referred to as genetic resources for food and agriculture (GRFA), encompasses the variety and variability of animals, plants and microorganisms used directly or indirectly for food and agriculture (e.g. crops, livestock, forestry and fisheries). It comprises the diversity of genetic resources (e.g. varieties, breeds) and species used for food, fodder, fibre, fuel and pharmaceuticals. It also includes the diversity of non-harvested species that support production (e.g. soil microorganisms, predators and pollinators) and those in the wider environment that support agroecosystems (agricultural, pastoral, forest and aquatic), as well as the diversity of the agroecosystems themselves[1] (FAO, 1999).

As vital as for our existence this environmental resource is, it has been left to erode at an unprecedented rate throughout the 20th century. Pretty (1995) estimated that some 75% of the genetic diversity of crops has been lost in the past hundred years[2] (Brookfield *et al.*, 2002). One of the main sources of erosion of this resource is considered to be the divergence between the social and private optima for agricultural biodiversity (Swanson, 1997; Drucker *et al.*, 2001; Pearce and Moran, 2001; Smale, 2002).

The private costs and benefits of agricultural biodiversity that accrue to farmers determine the private optima of agricultural biodiversity. The benefits farmers receive from agricultural biodiversity include production and consumption benefits. Production benefits consist of increased productivity, resilience, resistance of the agroecosystems, production complementarities and spreading of yield risks (Lipton, 1968; Clawson, 1985; Altieri and Merrick 1988; Traxler and Byerlee, 1993; Tilman and Downing 1994; Naeem *et al.*, 1995). Consumption benefits include food safety and security especially when facing market imperfections (Brush, Taylor and Bellon, 1992) as well as cultural, religious, culinary benefits (Sutlive, 1978; Brush, 1986; Hernandez, 1989; Bellon and Taylor, 1993; Perales *et al.*, 1998). These benefits are

[1] An agroecosystem is defined as an ecological, social and economic system, comprising domesticated plants and or animals and the people who manage them, intended for the purpose of producing food, fibre or other agricultural products (Conway, 1993).

[2] Statistics on the loss of agricultural biodiversity reveal that only about 150 plant species are now commonly cultivated for food and just three of these supply nearly 60% calories derived from plants (Fowler and Mooney, 1990a). Similarly, the Secretariat of the Convention on Biodiversity (2002) state that of the about 7000 plant species that have been cultivated and collected for food by humans since agriculture began 12000 years ago, only about 15 plant species and 8 animal species supply 90% of our food today.

weighted against the costs of managing agricultural biodiversity, which include the opportunity costs of foregone economic development (Smale, 2002).

Agricultural biodiversity also generates inter and intragenerational benefits that determine the social optima for these resources. The benefits of agricultural biodiversity that accrue to global society today, as well as to future generations, include insurance, information and option values, which embody their uses for enhancement and maintenance of agricultural production (Swanson, 1997; Smale *et al.*, 2001b; Evenson and Gollin, 2003). Agricultural biodiversity contributes to the increased productivity, resistance and resilience of modern crop varieties and animal breeds, providing improved returns to agricultural industry all around the world, while benefiting consumers with lower food prices, food safety and security (Kloppenburg, 1988; Fowler, 1994; Swanson and Goeschl, 2000; Evenson and Gollin, 2003). Several studies demonstrated the need of agricultural R&D industry for continuous injections of germplasm[3] from natural resources as a result of depreciating impact of R&D with changes in the environment due to ever-evolving pests and pathogens[4] (Fowler and Mooney, 1990b; Swanson 1996a; 1996b; Swanson and Goeschl, 2000). The need to maintain a wide portfolio of agricultural biodiversity to ensure sustainable agricultural production is globally recognised.

Economic theory suggests that economic agents make choices about private goods but agricultural biodiversity also has public good[5] attributes as mentioned in the above paragraph, making it an 'impure public' good. Economic theory predicts that to the extent that a good is public and is a 'good' it will be underproduced. This is because pure private goods can be efficiently allocated through market mechanisms -

[3] 'Germplasm' refers to seeds, plants or plant parts that are useful in crop breeding, research or conservation because of their genetic attributes (Fowler *et al.*, 2001)

[4] The required annual crop genetic resource injection to the agricultural R&D industry is estimated to amount to 7% of the stock of the material already in use in the system (Swanson 1996a) and the commercial life of a crop variety is estimated to be no longer than five to seven years (Goeschl and Swanson, 2001; Swanson, 2002a).

[5] A good is public to the extent that one person's consumption does not reduce the amount available to others (non-rival), and the costs of excluding those who do not choose to pay for it are high (non-excludable) (Varian, 1992).

given that markets function perfectly- but this is not the case for public goods. Producers of the public good cannot withhold it for non-payment and there is no basis for establishing a market price because the quantity a person consumes of the public good cannot be measured. The market 'fails' to signal the appropriate signals and as a result the public good is underproduced (Cornes and Sandler, 1996).

Farmers therefore supply less than socially optimal levels of agricultural biodiversity since they cannot appropriate these public or global benefits that agricultural biodiversity generates (Pearce and Moran, 2001; Smale, 2002). This global appropriation failure is a result of failure of the market to capture the value of agricultural biodiversity and it is often exacerbated by the government failures, which distort values of agricultural inputs and outputs by hindering reflection of their economic scarcity (Pearce and Moran, 2001). When goods have global importance and their conservation has intergenerational consequences, institutions with larger jurisdictions, such as regional and international institutions, may need to intervene to correct for this 'global appropriation failure'. This failure may be corrected for by implementing policies that take into consideration the total economic value of the resources and channel these values to farmers to create economic incentives for farmers to invest in their conservation (Juma, 1989; Swanson 1993; Swanson *et al.*, 1994; Swanson 1995; 1996a; 1996b; Swanson and Goeschl, 2000; Drucker *et al.*, 2001; Pearce and Moran 2001; Smale, 2002).

1.3. Global efforts for *in situ* conservation of agricultural biodiversity on farm

One way of conserving the remaining agricultural biodiversity riches is through conservation of the still existing traditional agroecosystems that serve as havens for agricultural biodiversity. This method of conservation is known as *in situ* conservation of agricultural biodiversity on farm. It can be defined as the choice by farmers to continue managing agricultural biodiversity in their communities, in the agroecosystems, where the agricultural biodiversity has evolved historically through processes of human and natural selection (Bellon *et al.*, 1997; Smale and Jarvis, 2002). Through *in situ* conservation on farm not only the materials are conserved but also are the processes of evolution and adoption of agricultural biodiversity to the environment[6] (Jackson, 1995; Smale, Bellon and Pingali, 1998; Smale and Jarvis, 2002).

As discussed in 1.2 above, there is an urgent need for international action and public policies, which can generate incentive mechanisms and institutions that encourage farmers to conserve the remaining agricultural biodiversity resources on farm. In realisation of this urgent need a number of voluntary and legally binding agreements have been adopted or are under discussion. The major international agreements that advocate *in situ* conservation of agricultural biodiversity on farm include the Convention on Biological Diversity (CBD), the International Treaty on Plant Generic Resources for Food and Agriculture (IT) and the Global Plan of Action for the Conservation and Sustainable Utilisation of Plant Genetic Resources for Food and Agriculture (GPA).

In the CBD the main obligations relevant to the conservation and sustainable use of agricultural biodiversity on farm are specified in Articles 7, 8 and 10 (CBD, 1992). Article 7 orders identification and monitoring of genetic resources for food and agriculture for their conservation and sustainable use, paying particular attention to those requiring urgent conservation measures and those which offer the greatest potential for sustainable use. Article 8 calls for regulation and management of genetic resources *in situ* to ensure their conservation and sustainable use. The CBD especially emphasises linking *in situ* conservation efforts with social and economic benefits that accrue to the local people (UNEP, 1995). Article 10 advocates sustainable use and conservation of genetic resources for food and agriculture by integrating them into national decision-making; by adopting measures to minimise their erosion and by

[6] The other method of agricultural biodiversity conservation is *ex situ* conservation. This method involves conservation of agricultural biodiversity components outside their natural habitats, i.e. off farm, generally in gene banks. This method is considered as an imperfect substitute for *in situ* conservation methods (Smale *et al.*, 2001b) but also as complementary (Brush, Taylor and Bellon, 1992; Maxted *et al.*, 1997) or as 'an integrated phases of continuum' of conservation methods (Bretting and Duvick, 1997).

protecting and encouraging their customary use in accordance with traditional cultural practices that are compatible with conservation and sustainable use requirements.

The GPA presents the most comprehensive strategy for the conservation and sustainable use of crop genetic resources component of genetic resources for food and agriculture (FAO, 1997; Swaminathan, 2002; Gauchan, 2004). It states *in situ* conservation, development and utilisation of crop genetic resources as its priority activities. The GPA specifically calls for supporting on farm management and improvement of crop genetic resources. It strongly emphasises building up of national programmes to promote sustainable agriculture, and to develop new markets for local varieties and diversity rich products for conservation and sustainable use of crop genetic resources (FAO, 1997).

The objectives of the IT include conservation and sustainable use of crop genetic resources and fair and equitable sharing of benefits that arise from them, to achieve sustainable agriculture and world food security (Wilding, 2002). The key obligations of the signatories with regards to conservation and sustainable use of crop genetic resources include Articles 5, 6 and 7. Article 5 calls for promotion of *in situ* conservation actions. Article 6 orders encouragement of sustainable use of crop genetic resources by promoting measures such as diverse farming systems and expanded use of locally adapted crops and varieties. Article 7 calls for integration of these measures into agriculture and rural development policies. This treaty highlights the unique future and public good nature of crop genetic resources and recognises the present and past contributions of farmers in developing crop genetic resources and rendering them available (Gauchan, 2003). The IT with its recognition of farmers' rights is expected to provide incentives for farmers to invest in conservation and sustainable use of crop genetic resources (Gauchan, 2004).

In addition to these international agreements there are also EU level obligations that require its members to adopt measures for conservation and sustainable use of agricultural biodiversity. The most notable one is the Article 13 of the implementation regulation of the Rural Development Regulation EC No 1257/99, which makes provisions for payments in support of continued production and hence *in situ* conservation of rare breeds and landraces. This Article also states that payments can be made to farmers in support of "preserving agricultural biodiversity resources naturally adapted to the local and regional conditions and under threat of genetic erosion". According to this Article, the genetic resources must play a role in maintaining the environment of the area (Wilding, 2002).

1.4. Role of home gardens in Hungary

Hungarian agriculture has a dual structure that consists of large, mass-produced, specialised, industrialised and mechanised farms alongside subsistence or semi-subsistence small-scale farms, traditionally known as home gardens. These home gardens are produced with traditional and labour intensive methods. This dual structure has persisted since the time of the feudal period through the middle of the 19th century, and most recently during the socialist period of collectivised agriculture from 1958 to1989 (Szelényi, 1998; Kovách, 1999; Meurs, 2001; Swain, 2000; Szép, 2000). During this latter era the dual structure of Hungarian agriculture became even more evident. Larger pieces of land were confiscated by the state to be used in intensive agricultural production by the agricultural cooperatives, while smaller plots, located adjacent to the households' dwellings, were left for use of the rural families for their food consumption needs. Recent statistics reveal that of the about 10 million people now populating Hungary, there are still nearly 2 million Hungarians producing agricultural goods for their own consumption in about 800 000 home gardens across the country (Swain, 2000; Simon, 2001; Már, 2002).

Home gardens have played an important role in food security and safety during the socialist period (Szelényi, 1998; Kovách, 1999; Swain, 2000; Szép, 2000; Meurs, 2001). Even today rural households continue to rely on their home gardens for their families' food consumption for at least some of the foods they consume and to enhance the quality of their diet as community level food markets remain thin in many areas of rural Hungary. It has been over a decade since the transition to market economy has started, however rural food markets still remain thin as a result of a combination of several reasons. These reasons include historical discouragement of food market formation and high transaction costs of market participation, including costs of transportation to the town with the nearest food market, search costs, uncertain and variable food quality and quality, and risk in food prices[7]. In addition, the increasing number of super and hypermarkets in the country since the transition to market economy in 1989, is found to cause disappearance of existing few local shops and markets (WHO, 2000).

There have been a few studies that investigated the economic importance of home gardens in the livelihoods of rural families in transitional countries. Szép (2000) observes that home gardens in Hungary have typically been part time farms since families who cultivate them have some form of income from outside, such as wages or pensions. She finds that income in kind generated by home garden production amounts to 14% of total income of the household. Seeth *et al.* (1998) draw attention to the role of home gardens in alleviation of rural poverty in Russia, during the early stages of the economic transition process. They find that the households that engaged in subsistence agriculture in their garden plots had higher levels of real income and food consumption. Seeth *et al.* (1998) state that home gardens have been instrumental in combating of poverty during an era in which risk in food prices and household income were prevalent and real incomes declined dramatically. Similarly, Wyzan (1996) studies income inequality and poverty across several transitional economies and finds that during economic transition, families' survival mechanisms are similar to those in developing countries, as they rely on home produced agricultural products for household's food consumption. As a result of their ability to supply food security and safety to rural families, home garden production creates incentives for rural people to remain in the countryside. Therefore, even if indirectly,

[7] A market research was conducted in Hungary during the early phases of economic transition by Feick *et al* (1993). The findings disclose that along with high inflation and unemployment rates, difficulty of obtaining reliable product information and the unpredictable availability of products are among the many difficulties Hungarian consumers face during the transition period.

home gardens play a part in conservation of the countryside (Seeth *et al.*, 1998; Juhász, 2000).

1.5. Agricultural biodiversity in home gardens

Home gardens are sound, efficient and sustainable land use systems, which meet a number of farm families' needs without negatively affecting the resources base, and in many cases even improving it (Fernandes and Nair, 1986; Landauer and Brazil, 1990; Torquebiau, 1992). They are found to provide several ecosystem services to larger agricultural systems, including preservation of resilience, soil enrichment, improved water retention and habitat for pollinators (Eyzaguirre and Watson, 2002; Engels 2002). In addition to their ecosystem services, home gardens are considered as important centres for crop and animal domestication[8], development, improvement, introduction, distribution and experimentation[9] (Engels, 2002). Scientists have found that home gardens act as refuges for agricultural biodiversity at the ecosystem, species and genes level and they harbour significant amounts of unique and rare genetic diversity of crops and animal breeds (Engels, 2002; Hodgkin, 2002). In many developing countries scientists have identified these micro-agroecosystems to be important targets for *in situ* conservation of agricultural biodiversity on farm (Hodgkin, 2002). Aside from being a refuge for agricultural biodiversity and providing a wide range of ecological services, home gardens also contribute to the livelihoods of the families and conserve cultural values and indigenous, traditional knowledge that is passed through generations in families (Engels, 2002; Eyzaguirre and Watson, 200; Hodgkin, 2002).

Even though the home garden characterisation described in the above paragraph is based on home gardens in the developing countries, the traditional home gardens of Hungary are not too different from their developing country counterparts. Though

[8] Plant domestication is thought to have started in home gardens (Harlan, 1975), where many new crops are still being developed and introduced (Engels, 2002)

there is wide variation among them, production in Hungarian home gardens was and still is accomplished with family labour[10], traditional farming practices, ancestral crop varieties and livestock races, limited use of purchased inputs, and without machinery. As a result, Hungarian home gardens became to be 'repositories of agricultural biodiversity'. They are defined by agricultural scientists as micro-agroecosystems that are rich in intra and inter-species diversity, including crop genetic resources in landraces, and other microorganisms in the soil (Már, 2002; Csizmadia, 2004). Bela *et al.* (2003) note that the remaining Hungarian crop genetic resources (many of which have originated from the ancient times of Bronze age and Roman era), as well as animal genetic resources of domesticated animals (e.g. cattle, pig and chicken) can only be found in the country's home gardens. In addition to their function as havens for agricultural biodiversity, home gardens also contribute to conservation of Hungarian cultural heritage. Traditional farming methods and accompanying traditional and indigenous knowledge employed to manage home gardens generate traditional varieties of crops and breeds (Már, 2002; Gyovai, personal communication, 2004).

1.6. Agri-environmental policies and the future of Hungarian home gardens

Hungary is a signatory to all of the international agreements discussed in section 1.3. Many of the obligations of the CBD and IT are not specific obligations as such, and are conditioned by phrases such as "as far as possible" and "as appropriate", and the GPA is a voluntary agreement (Wilding, 2002). However, having signed to these instruments Hungary has undertaken to implement them. Consequently, the country has been making efforts to develop its regulations in order to incorporate the

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[9] The groundbreaking research of Gregor Mendel was conducted in the home garden of a monastery and resulted in formulation of the genetic laws, which among other advances, greatly facilitated plant breeding (Engels, 2002).

[10] Traditionally, pensioners, housewives and dependants performed most of the work on household plots and small-scale farms. During the collectivisation era, on average, the man-hours spent by these farmers on household plots annually outstripped the total number of man-hours worked in large-scale farming. http://www.1upinfo.com/country-guide-study/hungary/hungary114.html. This fact points out to the labour intensive and other input extensive nature of home garden production compared to industrialised agricultural production.

commitments stemming from these agreements (Bela *et al.*, 2003). In accordance with the Article 6 of CBD, a draft Action Plan for Agro-Biodiversity Conservation has been prepared (Ángyán, 2000). This action plan is still at a preliminary stage and demands development of an efficient and effective strategy on conservation and sustainable use of crop genetic resources of the country, much of which is located in the home gardens as discussed in 1.5.

The stylised depiction of Hungarian home gardens presented in subsections 1.4 and 1.5 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 fibre). Public goods supplied by agriculture include rural settlement and economic activity, food security, safety and quality, biodiversity, agricultural biodiversity, cultural heritage, amenity and recreational values (Romstad *et al.*, 2000; Lankoski, 2000). The European Union's reformed Common Agricultural Policy (CAP) advocates conservation of the values of agricultural land (e.g. cultural, environmental, assimilative, historical). The reformed CAP promotes gradually shifting the focus of support away from the price supports that encouraged intensive agricultural production past forty years towards the non-productive (environmental, social, employment, cultural) functions of agricultural production. In other words, the EU embraces the concept of multifunctional agriculture and it is explicitly spelled out in its EC No. 2078/92 agri-environmental regulation. This regulation states that EU countries should "support agricultural production methods that are environmentally friendly and aim conservation of the rural areas". Consequently, 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).

As Hungary was an accession state that became an EU member in May 2004, it is obliged to adopt to EU laws and regulations, i.e. *acquis communautaire*, including the EC No 2078/92 agri-environmental regulation. Consequently, Hungary has developed a NAEP in 1999, which was accepted by the Ministry of Agriculture and

Regional Development in 2000 and launched experimentally in 2002. The NAEP proposes that the intensity of agricultural production in a region should depend on its natural and human resource endowments. As a result of thorough social, economic, agro-ecological and environmental considerations, several areas of Hungary with low agricultural productivity, high labour endowments and high environmental value have been designated as environmentally sensitive areas (ESAs). In these ESAs NAEP aims to establish sustainable agricultural production for conservation of the environment (especially of habitats for endangered plant and animal species). At the same time NAEP also aims to create income and rural employment in these ESAs by promoting labour intensive agricultural production methods, and income diversification through introduction of economic activities such as ecotourism and agro-ecotourism (Juhász, 2000; Már, 2002). Direct payments, training programmes 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[11].

The Hungarian NAEP recognises that extensive agricultural production methods are most suitable for promotion of multifunctional agriculture, however the role of home gardens in the NAEP has not yet been elucidated. Proposed EU agricultural policies designed for accession states also fail to recognise the importance of home gardens for provision of public goods. The Special Accession Programme for Agriculture and Rural Development (SAPARD), prepared for countries that will become EU members in May 2004, considers the dual structure of agriculture that exists in several of the accession states as inefficient. SAPARD proposes either subsidies for transformation of semi-subsistence small farms, such as home gardens, to commercial farms, or direct payments to land-holdings larger than 0.3 ha. These direct payments are 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).

[11] Schemes under NAEP include agri-environment basic scheme, integrated production scheme, organic production scheme, grassland scheme and wetland scheme. In addition to these schemes, NAEP also has several zonal objective programmes in environmentally sensitive areas, which include

At the moment there are financial (i.e. shortage of capital) and market barriers to extension of home gardens into commercial farms (Szép, 2000). However, it should be expected that as efficient factor and output markets develop with economic transition and capital constraints are overcome with proposed EU direct aids, home gardens might either develop into commercialised farms or cease to perform agricultural activity (Szép, 2000; Petrick and Tyran, 2001). On the demand side, it is expected that high consumption risks, transaction costs and low wages that bring about dependency on home-grown food will decrease as a result of increasing availability and accessibility of markets and price stability. EU accession is expected to lead to improved rural infrastructure through SAPARD, along with 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 agricultural values they contain. In fact, 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).

If the NAEP does not include home garden production as a means of supporting multifunctional agriculture or no other specific mechanisms are developed to conserve them, the survival of these repositories of agricultural biodiversity and cultural heritage is threatened by the structure of incentives as they stand. 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 policy that supports multifunctional agriculture could in fact result in loss of agricultural biodiversity and cultural heritage, as well as economic inefficiencies.

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air protection, nature protection, landscape protection, soil protection and water protection schemes (Juhász, 2000)

1.7. Aim and overview of the thesis

To evaluate policy options for conservation of home gardens and the agricultural biodiversity therein, more information is needed about the benefits and costs of supporting Hungarian home gardens. Favourable 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, and 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; Meng, 1997; Smale *et al.*, forthcoming).

The aims of this thesis are twofold. Firstly to measure the private values of agricultural biodiversity that accrue to farm families that cultivate home gardens, and to identify those farm families and farming communities that attach the highest private values to agricultural biodiversity and to home gardens. And secondly to disclose the characteristics of those farm families and farming communities that are most likely to maintain agricultural biodiversity rich home gardens.

These aims are reached by bringing together a portfolio of economic tools from agricultural and environmental economics literature, in the form of a farm household survey and a choice experiment. These two original data sets are collected from 323 home garden producing farm families in 22 communities across 3 regions of Hungary, which are considered by scientists as agricultural biodiversity 'hotspots'. The econometric analyses of the data sets disclose the stated and revealed private economic value Hungarian farm families assign to agricultural biodiversity in their home gardens and enable characterisation of those communities and farm families that value it the most and that are most likely to conserve it. When the farmers that manage high values of agricultural biodiversity in their home gardens and attach high values to agricultural biodiversity are identified, they can be targeted for least cost and most efficient on farm agricultural biodiversity conservation programmes.

To this end, the next chapter, entitled "Description of the survey sites and sample" presents the design of the sample for the farm household survey and the choice experiment. As a prelude to the econometric analyses in the following chapters, chapter 2 reports the descriptive statistics of the characteristics of the communities and farm families in the sample. This chapter also reveals the agricultural biodiversity levels found on the home gardens of the families that took part in the farm household survey and choice experiment.

Chapter 3 employs an environmental or non-market valuation method, namely a choice experiment, to measure the private values of several components of agricultural biodiversity that accrue to the farm families who manage home gardens. This chapter, entitled "Using a choice experiment to value agricultural biodiversity in Hungarian home gardens", estimates farmers' willingness to accept compensation for several components agricultural biodiversity found in the home gardens. The results of the econometric analyses reveal the characteristics and location of the farm families that attach the highest private values to home gardens and to the agricultural biodiversity found therein.

Chapter 4 is entitled "Economic transition, development and farmers' demand for agricultural biodiversity in Hungarian home gardens". This chapter employs the choice experiment data and community level data, to investigate the relationship between economic development indicators (such as market integration, education, infrastructure) and farmers' demand for agricultural biodiversity in home gardens, as well as for food that the home garden provides for the family. The aim of this chapter is to make predictions about the future of home gardens –as Hungarian economy grows and EU accession brings about increased market integration- in the absence of any policies or programmes that support them.

Theoretical and applied methods from agricultural economics literature are used in chapter 5, entitled "Managing agricultural biodiversity on Hungarian home gardens:

A farm household level analysis". This chapter employs the agricultural farm household model with missing markets to explain farmers' choices of undertaking agricultural activities that result in the observed and measured agricultural biodiversity levels found in home gardens. The effects (direction and magnitude) of agro-ecological, market and household level factors on the agricultural biodiversity levels that farm families choose to manage in their home gardens are investigated. This chapter reveals those farm families, in terms of their household and home garden characteristics and those farming communities that are most likely to continue to manage home gardens that are rich in agricultural biodiversity values.

Chapter 6, as an extension to chapter 5, focuses on private provision of crop genetic resources, which contain high public values as demonstrated by the results of genetic analyses. This chapter is entitled "Sustainable use and management of crop genetic resources: Landraces in Hungarian home gardens" and it scrutinises the data on crop genetic resources present in the home gardens, as well as qualitative information from informal and focus group interviews with farmers, who cultivate these landraces. The aim of this chapter is to explain the reasons (cultural, culinary, market, family and production related) for continued cultivation of these traditional varieties and to draw attention the several values (e.g. option value and cultural value) they generate.

The thesis is concluded with Chapter 7, "Conclusions, policy implications, contributions to the literature and directions for future research". This chapter restates the major findings of the thesis and discusses their implications for design of mechanisms that would ensure continued management of these havens of agricultural biodiversity while contributing to the incomes of the rural poor. Contributions of this thesis to economics of agricultural biodiversity conservation on farm are also discussed. Finally, this chapter draws directions for future economics research to further assist policy makers in designing policies and programmes for conservation of home gardens, agricultural biodiversity values therein and provision of multifunctional agriculture in Hungary.

Chapter 2

Description of the survey sites and sample

2.1. Introduction

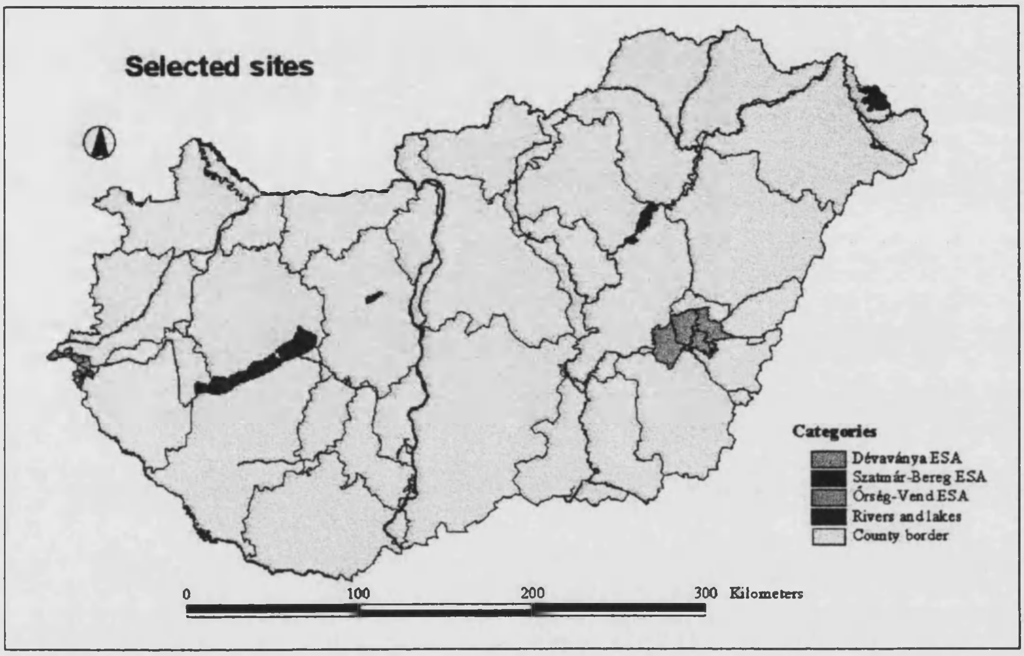
This chapter explains the choice of the study sites and survey sample design for the collection of the farm household and choice experiment data that are used in this thesis. It describes briefly the three ESAs in which the data were collected and gives an overview of the agro-ecological and economic development indicators of these sites. As a prelude to the econometric analyses undertaken in the following chapters, this chapter presents the descriptive data on regional, community and farm family level variables, as well as on home garden and agricultural characteristics. The agricultural biodiversity riches found in the home gardens of the random survey sample are also reported in this chapter.

2.2. Selection of study sites

The survey design consisted of two stages. In the first stage, three sites were selected among several sites located in the buffer zones of ESAs identified by the NAEP, where the Institute for Agrobotany had found high levels of agricultural biodiversity (in terms of historical landraces that are rich in crop genetic diversity) during collection missions. These sites are therefore 'hotspots' for agricultural biodiversity, as well as for other environmental values. Secondary data from the Hungarian Central Statistics Office (HCSO) and NAEP were used to purposively select three ESAs with contrasting levels of market development and varying agro-ecologies associated with different farming systems and land use intensity.

The three study sites, namely Dévaványa, Őrség-Vend and Szatmár-Bereg, are depicted in Figure 2.1. The stratified design enables testing of hypotheses in the following chapters about the impacts of market integration, agro-ecological conditions, other economic development indicators, such as availability of off farm employment, on the agricultural biodiversity values farmers choose to maintain on farms.

Figure 2.1 Location of selected ESAs



The survey sample in each ESA covered a number of communities, which is 5 for Dévaványa, 11 for Őrség-Vend and 6 for Szatmár-Bereg. The community names are presented in Table 2.1. Secondary data for community level characteristics are drawn from the HCSO National Census (2001) and Statistical Yearbooks (2001), and are reported in Table 2.2.

Dévaványa ESA, located on the Hungarian Great Plain, is closest to the economic centre of the country of the three sites. The agricultural landscape is flat and consists of a mosaic of cultivated lands and grasslands. Soil and climatic conditions of this region are well suited to intensive agricultural production, hence this ESA is also known as the grain basket of the country. Unlike the other two selected sites, migration from the region is not a major problem, though the number of inhabitants is stagnating (Gyovai, 2002). However, the unemployment rate in Dévaványa is slightly higher than the Hungarian average at 12.4% (National Labour Centre, 2000). Populations, areas, and population density in this ESA are highest among the three ESAs. The communities in Dévaványa are statistically different from those in 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); number of primary and secondary schools; food markets; shops and enterprises. The aim of NAEP in Dévaványa ESA is to protect the rich wildlife of the area, especially of the great bustard (*Otis tarda*) population, which is of European as well as global importance[12] (Kollar, 1996; Juhász, 2000; The Guardian, 2004).

Located in the Southwest, the forested Őrség-Vend ESA borders Austria and Slovenia. This region has a heterogeneous agricultural landscape and poor soil conditions with its heavy clay soil, which render intensive agricultural production methods impossible (Juhász, 2000; Gyovai, 2002). Settlements are very small in

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[12] The Great Bustard is a globally threatened bird specie, classified as vulnerable (Collar *et al.*, 1994). In Central Europe the Great Bustard is on the threshold of a minimum viable population, though the greatest part of the breeding population is in the Hungarian basin (Dévaványa ESA). Intensive

area, most are far from towns and road density is low. Őrségi settlements are made up of groups of houses (*szer*) build on ridges[13] (Hebbert *et al.*, 2002). The population is declining and ageing, though the unemployment rate of this region is lowest in the country at 4.8% (National Labour Centre, 2000). Of the three, Őrség-Vend is the least urbanised with fewest shops and enterprises. Communities studied in this ESA also support the lowest dependency ratio across the three ESAs. In Őrség-Vend ESA NAEP aims to conserve its unique landscape, which is a domestic and foreign tourist attraction, for both ecotourism and agro-ecotourism activities.

Szatmár-Bereg ESA is the most isolated region in Hungary, located in the Northeast part of the country, bordering Ukraine (Hebbert *et al.*, 2002). This ESA supports a diverse landscape with a mosaic of grasslands, forests, arable lands and moors. Szatmár-Bereg consists of communities that are small in both area and population. The population of this ESA is declining and ageing, mainly due to lack of investment in this isolated region, which is distant from the economic centre of the country (Gyovai, 2002). Consequently, this region supports low quality roads and the highest unemployment rate in the country, at 19% (National Labour Centre, 2000). The communities studied in Szatmár-Bereg have the lowest quality roads and the highest ratio of inactive to total population across the communities in the three ESAs. The NAEP aims to promote nature conservation in this region by establishment of a national park (Juhász, 2000).

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agricultural production methods in this ESA destroy the breeding population's habitat and threaten its decline below the threshold of viable minimum population (Kollar, 1996).

[13] *Szer* refers to a settlement form of group of houses on well-protected hilltops. *Szers* existed in this region since the 10th century, when Hungarians first settled in Őrség-Vend.

Table 2.1.Community names in each ESA

ESA Name	Community Name	Community No
Dévaványa	Dévaványa	1
Dévaványa	Gyomaendrőd	2
Dévaványa	Körösladány	3
Dévaványa	Szeghalom	4
Dévaványa	Túrkeve	5
Szatmár-Bereg	Barabás	6
Szatmár-Bereg	Beregdaróc	7
Szatmár-Bereg	Beregsurány	8
Szatmár-Bereg	Csaroda	9
Szatmár-Bereg	Gelénes	10
Szatmár-Bereg	Márokpapi	11
Őrség-Vend	Apátistvánfalva	12
Őrség-Vend	Bajánsenye	13
Őrség-Vend	Felsőszölnök	14
Őrség-Vend	Kercaszomor	15
Őrség-Vend	Kerkáskápolna	16
Őrség-Vend	Kétvölgy	17
Őrség-Vend	Magyarszombatfa	18
Őrség-Vend	Orfalu	19
Őrség-Vend	Őriszentpéter	20
Őrség-Vend	Szalafő	21
Őrség-Vend	Velemér	22

Table 2.2. Community and ESA level characteristics

Community and ESA level characteristics	Dévaványa N=5	Őrség-Vend N=11	Szatmár-Bereg N=6
	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.

2.3. Sample survey of farm households

In the second stage of the sample design, household lists were compiled for each ESA from detailed community level maps already drawn for design of the NAEP, as well as from telephone books and HCSO TSTAR database[14]. All communities within the ESAs were sorted based on population sizes and an initial sample of 1800 households were chosen randomly from the household lists to mail a screening questionnaire to in order to identify those with home gardens. This random sample size of 1800 households (600 households per ESA) was chosen since a minimum final sample of 100 per ESA was thought sufficient for data analysis and was within the budget, and the response rate to a mail survey was expected to be low. The initial response rate to the screening questionairre was low[15] (13.3%), and was augmented by randomly selecting and visiting the households from the initial household lists, with the help of the 'key informant' farmers Institute for Agrobotany had already connections with in each community. These key informant farmers facilitated enumerators' access to the farm families that are in the household lists.

Twenty-two enumerators were employed to conduct the farm household survey and the choice experiment, with face to face interviews at the farmers' dwellings and most of the time in their home gardens. The enumerators were university students, specialising in the fields of agricultural engineering and social and economic disciplines, who were trained thoroughly prior to the fieldwork. A total of 323 farm households were interviewed in August 2002 for the farm household survey and a subset of 277 farm households took part in the choice experiment. The farm family members that took part in both the choice experiment and the farm household survey were generally those responsible for making home garden production decision and/or

[14] Community authorities were reluctant to supply us with the lists of households in the communities due to privacy concerns. Hungarian Ministry of Interior database would have served the purpose, however its cost was beyond the budget of the research project.
[15] It is about a third of the response rate that might be acceptable for mail surveys in developed countries (Gyovai, 2002).

those who actively participated in home garden production[16]. When both husband and wife are responsible for home garden decision-making they were jointly interviewed, where possible.

2.3.1. Household and home garden decision-maker characteristics

The descriptive statistics for the entire sample of 323 farm families are reported in Table 2.3. The average family size is about 3 persons and children are few in all sites, with Őrségi households having larger families and more children than those in Dévaványa. A higher number of household members participate in home garden cultivation in Őrség-Vend and Szatmár-Bereg compared to Dévaványa ESA. The number of family members employed off-farm is higher in Őrség-Vend than in Szatmár-Bereg but similar between Őrség-Vend and Dévaványa. A larger number of household members are on unemployment benefit in Szatmár-Bereg compared to the other two ESAs. Households in Őrség-Vend have significantly higher levels of income and income per household capita than those in Dévaványa and Szatmár-Bereg, but the difference between Dévaványa and Szatmár-Bereg is insignificant. 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. A higher percentage of őrségi households own cars and microwave ovens compared to the other two regions. A smaller percentage of Szatmári households own colour televisions compared to those in Őrség-Vend ESA. Across the three ESAs Szatmár-Bereg supports the highest percentage of households that do not have any of the wealth indicators across the three ESAs.

Home garden decision-makers are elderly but 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

[16] Of all the respondents 86% were the main home garden decision-makers and 100% stated that they engaged actively in home garden production.

of education across the three ESAs. Across ESAs a large proportion of home garden decision-makers is retired. Percentage of home garden decision-makers with off farm employment is higher in Dévaványa than Szatmár-Bereg.

Table 2.3. Characteristics of the households and home garden decision-makers by ESA

Variable	Definition	Dévaványa N=104	Őrség-Vend N=109	Szatmár-Bereg N=110
Household characteristics				
			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 the 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)
On benefit	Number of family members that are on unemployment benefit	0.07 (0.29)	0.10 (0.36)	0.23 (0.48)
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)
Income per household capita***	Income divided by the family size	30330 (25313.2)	33048.3 (12287.4)	29267.9 (14938.9)
Food expenditure***	Stated % of income spent on food consumption	39.2 (15.1)	39.7 (16.8)	32.8 (11.8)
			Percent	
Car ***	The household owns a car	41.7	64.2	44.6
Colour television*	The household owns a colour television	92.2	98.2	90
Microwave oven***	The household owns a microwave oven	44.7	70.1	45.5
No wealth indicator***	The household owns none of these: car, colour television, computer, microwave oven, other property, and has had no holiday abroad or in Hungary in the past two years	4.9	1.8	7.3
Home garden decision-maker characteristics				
			Mean (s.e.)	
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

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.

2.3.2. Home garden characteristics and field cultivation

Table 2.4. reports the home garden and agricultural characteristics of the farm families. The smallest home gardens are in Dévaványa, the most urbanised and densely populated ESA, where home gardens are mainly for supplying farm families' food needs. In Őrség-Vend ESA home gardens are larger, and most of time include field, orchard and/or grassland, as a result of the special settlement structure of *szer* in this ESA (Gyovai *et al.*, 2004). Home gardens are largest in Szatmár-Bereg ESA and they contain orchards and/or fields that supply not only the needs of the households but also enable sales out of the home garden.

Home gardens with least irrigation and best soil quality are in Szatmár-Bereg ESA. Őrségi home gardens have more irrigation than those in Dévaványa, however they also have the worst soil quality across regions. In terms of market integration characteristics, Dévaványai farm families have the closest distances to the food markets, whereas the other two regions do not differ. Szatmári households are more integrated into markets as sellers of home garden produce compared to the other two ESAs, which do not differ. This latter result can be explained by the orchards cultivated in large Szatmári home gardens, whose yield are purchased by the fruit juice industry that is located in this region[17].

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 largest total areas of field owned and cultivated are in Dévaványa, the most favoured ESA in terms of either soils or infrastructure, though dévaványai households cultivate a smaller number of field plots compared to their szatmári and őrségi counterparts, which do not differ. In terms of complementarities between feed production in the fields and livestock production in the home gardens, it can be seen that őrségi

[17] German fruit juice company WINK Kft. http://www.wink-co.de, which produces apple juice is located in Vásárosnamény, the closest town to most of the szatmári communities in the sample.

households' smaller plots do not allow them to meet the feed of their livestock from their field production, compared to the other two ESAs.

Table 2.4. Home garden, market integration and field characteristics of the households by ESA

Variable	Definition	Dévaványa N=104	Őrség-Vendvidék N=109	Szatmár-Bereg N=110
Home garden and market integration characteristics				
			Mean (s.e.)	
Home garden area**	in m^2	560.9 (683)	1624.6 (2872.1)	2649.2 (3041.9)
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 community in which the household is located to the nearest market in km	0 (0)	19.9 (6.8)	18.4 (3.2)
			Percent	
Household cultivates a field**	Household cultivates at least one 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
Field cultivation				
			Mean (s.e.)	
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)
Plots**	Number of plots cultivated by the household	1.4 (0.6)	1.6 (0.8)	1.8 (1.3)
			Percent	
Feed field**	Some of the feed for the livestock in the home garden comes from the households' fields	43	22	53

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.

2.3.3. Agricultural biodiversity found on home gardens

The descriptive statistics for agricultural biodiversity found on the home gardens of the 323 farm families in the sample are reported in Table 2.5. Inter- and intra-species diversity, or crop species diversity and crop varietal diversity are two of the most crucial components of agricultural biodiversity (FAO, 1999). Both indices are indicated by a simple richness index, i.e. a count of the number of species and varieties that the household plants in the home garden. Both inter and intra-species diversity are highest in Őrség-Vend and lowest in Dévaványa. In addition, a higher proportion of the species cultivated in őrségi home gardens are specific to that ESA, compared to the species cultivated in szatmári and dévaványai home gardens, which are more common across ESAs[18] (Gyovai *et al.*, 2004).

Landraces, also called traditional varieties, heirloom varieties, farmers' varieties or ancestral crop varieties, are those varieties that have been passed down from generation to generation. They can be defined as variable populations that are adapted to local growing conditions and consumption preferences (Smale, 2000) and they are an important part of crop genetic resources. Landraces have been the source of almost all the modern crop varieties developed and diffused among farmers around the world (Evenson and Lemarié, 1998; Evenson and Gollin, 2003). Hungarian landraces grown on the home gardens are found to be rich in crop genetic diversity (Már, 2002; 2004), and they are still being cultivated by nearly half of all the households that took part in the survey. The landraces that are studied in this research project are bean and maize landraces only[19]. The percentage of dévaványai households that cultivate landraces of at least one of these crops in the home garden is

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[18] Frequency of the most widely cultivated fruit and vegetable species in each region as well the specificity of vegetable and fruit species to that ESA are reported in the appendix to this chapter in Tables 2.A.1 through 2.A.6. and Figure 2.A.1.

[19] Since 1997 the Institute for Agrobotany has been conducting collection missions across Hungary to appraise the extent to which landraces are still being cultivated in farmers' fields and home gardens. The major findings of these missions were that landraces could almost always only be found in the home gardens and that only maize and bean landraces were identified in large numbers across the country (Már, 2002). For this reason the Hungarian On Farm Conservation of Agricultural Biodiversity Project, of which this thesis is an output, has targeted these crops.

statistically the lowest across regions, whereas the other two ESAs do not differ. The numbers of bean and maize landraces cultivated in the home gardens in Őrség-Vend and Szatmár-Bereg ESAs do not differ, however they are statistically higher compared to the numbers of bean and maize landraces in dévaványai home gardens.

The traditional method of integrated crops and livestock management that results in agro-diversity, or diversity in agricultural management practices (Brookfield and Stocking, 1999), in the home gardens. Across the three ESAs studied, this traditional method of integrated management is the chosen one for over three quarters of all home garden farmers, when both small and large livestock are taken into consideration, and over half of all home garden farmers when only large livestock is considered. There are no statistical differences across regions. The number of both large and small animals is least in Őrség-Vend, whereas dévaványai home gardens contain the highest number of large animals, and szatmári ones the highest number of small animals. This emphasis on animal breeding reveals the dependence of Hungarian diet on meat, especially on pork and salami.

In this thesis organic production method is a crude measure for soil microorganism diversity. This proxy is based on the results of several experiments conducted by scientists comparing conventional, chemical input intensive agricultural practices with organic agricultural production found that organically managed plots exhibited higher soil-organism activity, soil fertility and greater diversity of soil microorganisms (e.g. Lupwayi *et al.*, 1997; Mäder *et al.*, 2002). Organic production is not a highly favoured home garden production method by farm families across the three study sites. Statistically fewer households employ organic production methods in Szatmár-Bereg ESA, which supports the largest home garden areas, compared to the other two ESAs.

Table 2.5. Agricultural biodiversity found on Hungarian home gardens by ESA

Component of agricultural biodiversity	Definition	Dévaványa N=104	Őrség-Vend N=109	Szatmár-Bereg N=110
			Mean (s.e.)	
Crop species diversity***	Number of crop species	13.75 (6.17)	20 (6.6)	15.2 (5.7)
Crop varietal diversity***	Number of crop varieties	17 (8.9)	28.1 (12.5)	18.6 (7.5)
Bean landraces***	Number of bean landraces	0.39 (0.82)	0.99 (1.2)	1.1 (1.3)
Maize landraces*	Number of maize landraces	0.03 (0.17)	0.06 (0.23)	0.1 (0.3)
Large livestock**	Number of large animals (cattle, pig, sheep, horse, donkey)	10.7 (59.2)	2.3 (3)	4.4 (23.9)
Small animals**	Number of small animals (poultry, rabbit, pigeon, bee)	26 (34)	21.5 (27.8)	36.7 (30.7)
			Percentage	
Landrace cultivation***	Household cultivates a landrace of bean or maize	27	52	52
Agro-diversity (all animals)	Household keeps animals in the home garden	74	77	86.4
Agro-diversity (large livestock)	Household keeps large livestock in the home garden	51	62	55
Organic Production *	Household does not use any chemicals in the home garden (including fertilisers, pesticides, insecticides, herbicides, fungicides and soil disinfectants)	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.

In addition to these inter and intra species richness, genetic diversity, soil microorganism diversity and agro-diversity components of agricultural biodiversity, scientific analyses of the agricultural biodiversity found on home gardens were also conducted. The Institute for Agrobotany collected samples of bean and maize landraces from the home gardens of the households in the survey sample. The results of the preliminary molecular biological analysis conducted on the landraces reveal 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). Some are thought to be appropriate for niche markets as they carry quality traits that are of cultural importance and that embody nutritional superiority for which consumers may be willing to pay.

Furthermore, home garden soil samples were also collected from the home gardens of the farm households in the sample to analyse their soil nutrient contents. This analysis, also being conducted by the agronomists at the Institute for Agrobotany, reveals that nutrient contents of home garden soils are far superior to those of the fields in each ESA. Home gardens with the highesst soil nutrient content are found in Dévaványa and lowest in Őrség-Vend (Csizmadia, 2004).

These crude measures of agricultural biodiversity, as reported in Table 2.5, along with the preliminary results of the scientific analyses point out to significant levels of agricultural biodiversity values that are being maintained in Hungarian home gardens across the three study sites. These results indicate that home gardens are 'repositories of agricultural biodiversity' that also produce other public goods, including conservation of Hungarian cultural heritage in the traditional varieties they contain and traditional methods employed to tend them.

2.4. Summary

Overall the results of the descriptive analysis reveal that the ESAs studied in this thesis are distinct, in terms of characteristics of the regions, communities, farm families, home gardens as well as the agricultural biodiversity values found in the home gardens. Traditional home garden management still continues in these ESAs, however at different levels of intensity. The following chapters investigate the relationships between the variables presented in Tables 2.2., 2.3. and 2.4. and the resultant agricultural biodiversity levels reported in Table 2.5, by using economic and econometric methodologies adapted from environmental economics and agricultural economics literatures.

APPENDIX TO CHAPTER 2

Table 2.A.1. Top ten vegetable species in Dévaványa ESA, N=104

Vegetable	No. of households	Frequency
Tomato	83	0.7410
Carrots	78	0.6964
Apiaceous	73	0.6517
Red onion	66	0.5892
Potato	66	0.5892
Peas	61	0.5446
Cucumber	58	0.5178
Pepper	46	0.4107
Garlic	45	0.4017
Lettuce	33	0.2946

Source: Gyovai et al. (2004); Hungarian Home Garden Diversity Household Survey, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002.

Table 2.A.2. Top ten vegetable species in Őrség-Vend, N=109

Vegetable	No. of households	Frequency
Tomato	109	1.0000
Pepper	106	0.9636
Apiaceous	101	0.9181
Potato	101	0.9181
Carrot	99	0.9000
Cucumber	88	0.8000
Red onion	72	0.6545
Cabbage	71	0.6454
Lettuce	71	0.6454
Peas	67	0.6090

Source: Gyovai et al. (2004); Hungarian Home Garden Diversity Household Survey, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002

Table 2.A.3. Top ten vegetable species in Szatmár-Bereg, N=110

Vegetable	No. of households	Frequency
Potato	95	0.8636
Tomato	91	0.8272
Carrot	87	0.7909
Pepper	84	0.7636
Kohlrabi	82	0.7454
Apiaceous	81	0.7363
Cabbage	69	0.6272
Red onion	62	0.5636
Cucumber	61	0.5545
Pumpkin	43	0.3909

Source: Gyovai et al. (2004); Hungarian Home Garden Diversity Household Survey, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002

Table 2.A.4. Top ten fruit species in Dévaványa ESA, N=104

Fruit	No. of households	Frequency
Plum	77	0.6875
Grapes	77	0.6875
Sour cherry	61	0.5446
Pear	52	0.4643
Apple	43	0.3839
Cherry	41	0.3661
Appricot	41	0.3661
Peach	39	0.3482
Nuts	38	0.3393
Strawberry	34	0.3036

Source: Gyovai et al. (2004); Hungarian Home Garden Diversity Household Survey, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002

Table 2.A.5. Top ten fruit species in Őrség-Vend ESA, N=109

Fruit	No. households	Frequency
Apple	98	0.8909
Plum	81	0.7363
Grapes	69	0.6272
Strawberry	62	0.5636
Nuts	58	0.5272
Pear	56	0.5090
Cherry	47	0.4272
Peach	38	0.3454
Raspberry	35	0.3181
Sour cherry	32	0.2909

Source: Gyovai et al. (2004); Hungarian Home Garden Diversity Household Survey, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002

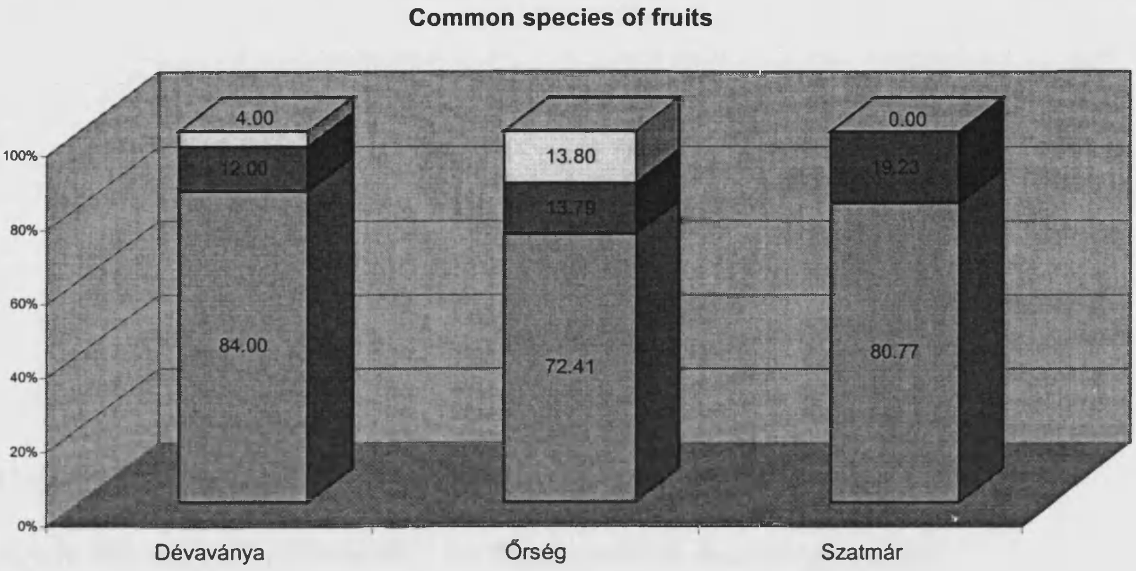
Table 2.A.6. Top ten fruit species in Szatmár-Bereg ESA, N=110

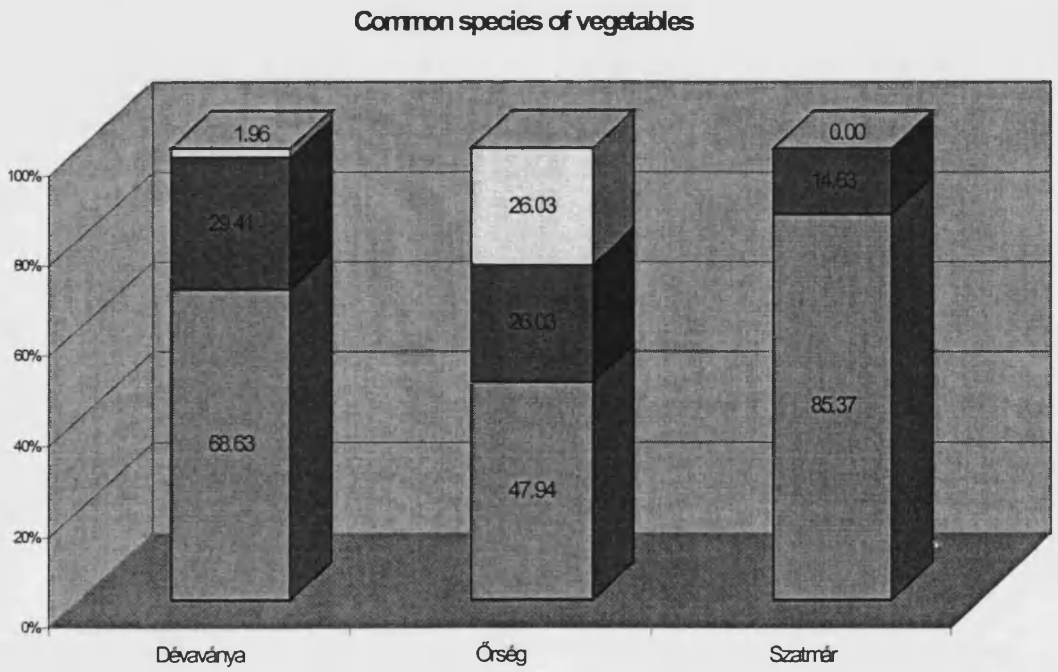
Fruit	No. of households	Frequency
Plum	83	0.7545
Apple	69	0.6272
Grapes	59	0.5363
Sour cherry	56	0.5090
Nuts	46	0.4181
Pear	41	0.3727
Peach	30	0.2727
Cherry	22	0.2000
Raspberry	22	0.2000
Strawberry	19	0.1727

Source: Gyovai et al. (2004); Hungarian Home Garden Diversity Household Survey, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002

Figure 2.A.1. Specificity of vegetable and fruit species to ESAs

Yellow indicates percentage of species that can be found only in that ESA, red indicates the percentage of species that can be found in two of the ESAs and blue indicates species common to all three ESAs. Source: Gyovai et al. (2004); Hungarian Home Garden Diversity Household Survey, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002





Chapter 3

Using a choice experiment to measure the value of agricultural biodiversity in Hungarian home gardens

3.1. Introduction

As explained in chapter 1, most of the outputs, functions and services that home gardens generate are not traded in the markets. In order to determine the values of the multiple benefits home gardens generate, including agricultural biodiversity values, environmental or non-market valuation methods must be employed. This chapter employs one such method, namely the choice experiment method, which can measure the values that farm families attach to multiple benefits of home gardens. It is the farm families' valuation of these home gardens and their multiple benefits that is of interest in this study, since most of the benefits of home gardens accrue to farm families that manage them. That is, it is the preferences of home garden farmers, who are both producers and consumers, that determine the implicit values these farm families attach to home gardens and the agricultural biodiversity therein (Scarpa *et al.*, 2003a).

The aim of this chapter is to use the choice experiment method to estimate the private values rural farm families assign to their home gardens and to components of agricultural biodiversity therein, in the three ESAs of Hungary. This chapter characterises those regions and farm families that value agricultural biodiversity the most, and hence would require the least amounts of economic incentives to continue management of agricultural biodiversity rich home gardens. In other words the aim of this chapter is to use farm families' stated preferences to identify the "least cost" regions and farm families, who should be ranked the highest amongst the candidates for conservation (Meng, 1997; Brown, 1991; Smale *et al.* forthcoming).

The total economic value of agricultural biodiversity is discussed in the next section. Section 3.3 presents the theoretical underpinnings of the choice experiment method and presents some examples of studies that employed this method. The survey design is presented in section 3.4. Section 3.5 explains the econometric models used to estimate the data and reports the findings. Conclusions are drawn in the final section.

3.2. Total economic value of agricultural biodiversity

As mentioned in chapter 1, agricultural biodiversity is eroding and resources available for conservation are limited, implying economic valuation (especially estimation of total economic value) can play an important role in ensuring an appropriate focus for conservation efforts (UNEP, 1995; Drucker *et al.*, 2001). As Swanson *et al.* (1994) state, in order to design policies and programmes that both encourage maintenance of agricultural biodiversity on farm and ensure that economic and agricultural development and growth occur, it is necessary to establish the value of what it is that needs to be conserved.

The economic value of a non-marketed, environmental, public good is called its total economic value and it encompass a broader definition of value compared to the economic value of a private good, which only include direct use value. The total economic value of agricultural biodiversity comprises of both use and non-use values, which individuals may drive benefits from. Use values is comprised of direct use value, indirect use value and option value. The *direct use value* of agricultural biodiversity includes values such as the quality and quantity of food agricultural biodiversity produces, the cash income it generates for the farmers, the productivity gains form crop genetic improvement and amenity values associated with agricultural landscapes (Brown, 1991; Primack, 1993; Swanson *et al.*, 1994; Evenson *et al.*, 1998).

For most private goods value is almost entirely derived from their direct use, however many environmental/public goods, such as agricultural biodiversity perform an array of functions that benefit the individuals indirectly. *Indirect use values* of agricultural biodiversity include production effects such as resistance to biotic and abiotic stress, functions such as ecosystem productivity, soil and water cycle quality, and habitat protection and provision for other components of biodiversity. When the cultivation of a broader set of crop varieties stabilises yields or farmers' incomes, agricultural biodiversity may also have a *portfolio value* (Swanson *et al.*, 1994). In addition to the direct and indirect use values and portfolio value, an important extension of use value of agricultural biodiversity is option value. The *option value* of agricultural biodiversity includes its potential to provide economic benefits to human society in the future, such as being inputs to improvement of many varieties and breeds. There are two components to option value. The first is *insurance value*, which represents the value of the option of using agricultural biodiversity in the future to combat as yet unknown, adverse conditions. And the second is *exploration value* denoting the value of exploiting undiscovered sources of information (Brown, 1991; Primack, 1993; Swanson *et al.*, 1994; Swanson, 1996a; Evenson *et al.*, 1998).

Non-use values of agricultural biodiversity are those derived from neither direct nor indirect use and consist of *bequest value, altruistic value, existence value* and *cultural value*. Some individuals may value the fact that the future generations will have the opportunity to enjoy an environmental asset, such a picturesque landscape. This value is known as *bequest value*. Others may be concerned that the good is available for others in this generation, whether or not they use it themselves. This value is called *altruistic value*. Individuals may value the simple fact that an environmental asset exists, whether or not it is used by these individuals. This value is called *existence value*. In addition to these non-use values of environmental goods, agricultural biodiversity may also generate *cultural value* through the traditional or indigenous knowledge associated with certain crop varieties, seed or breed management or farming techniques (Krutilla, 1967; Brown, 1991; Primack, 1993; Swanson *et al.*, 1994; Evenson *et al.*, 1998).

This definition of total economic value of agricultural biodiversity reveals that policies and programmes concerning them are not easy to assess with cost benefit analysis (Pearce, 1993). Firstly because agricultural biodiversity has a high public good content and hence many of its components do not have readily available monetary values attached to them. Secondly because such agricultural biodiversity is complex in the multiple types of values (use and non-use) it generates, which are also intergenerational, as well as intragenerational (e.g. local, national and global).

Environmental or non-market valuation methods have been developed to measure the total economic values of environmental/public goods. Capturing of this total economic value can guide resource allocation not only between agricultural biodiversity conservation and other socially valuable endeavours, but also between various types of agricultural biodiversity conservation. In addition, the information on the total economic value and to whom it accrues and to what extent, can also assist in the design of economic incentives and institutional arrangements for those who are managing and maintaining the remaining riches of agricultural biodiversity (Artuso, 1996; Drucker *et al.* 2001).

3.3. Choice experiment method

3.3.1. Theoretical underpinnings and the basic model

Among the environmental valuation methods[20], the choice experiment method is considered to be the most appropriate one for valuing the multiple benefits of home gardens. This is because the choice experiment method allows for estimation not only of the value of the environmental good as a whole, but also of the implicit values of its attributes (Hanley *et al.*, 1998a; Bateman *et al.*, 2003). This approach has a theoretical grounding in Lancaster's attribute theory of consumer choice (Lancaster,

[20] The most commonly employed environmental valuation method is the contingent valuation method (CVM). Apart from its ability to measure the value of an environmental good and its attributes, the choice experiment method has several other advantages over CVM. These include i) The respondents are more familiar with the choice approach compared to the payment approach used in CVM. ii) Choice experiment method can solve for a few of the biases that are present in the CVM. These include a) The strategic bias, that is stating an extremely high/low value to get a point across, is minimised in choice experiment method since the prices of the goods are already defined in the choice sets. b)Yea-saying bias is eliminated as in a choice experiment respondents have to choose between sets, hence they can not state that they value a good even if they do not. c) Insensitivity to scope is eliminated, since the choice sets that are offered to the respondents are complete and carefully designed, respondents might not mistake the scale of the good or its attributes for something else that it could be embedded in. iii) Willingness to accept (WTA) questions can be asked in choice experiments without the risk of facing huge discrepancies between WTA and willingness to accept (WTP) values as found in CVM (Kahneman, Knetsch and Thaler, 1990). It has been found that in CVM studies individuals seem to attach much more value to losses than they do to gains hence WTA values exceed WTP values considerably (Georgiou *et al.*, 1997). This phenomenon is avoided in choice experiments in which the WTA values are already reasonable and predetermined. Despite its advantages over CVM, it is too early to make a fair comparison between CVM and choice experiment method as the

1966), and an econometric basis in models of random utility (Luce, 1959; McFadden, 1974).

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

$$U_{ij} = U(Z_{ij}, S_i) \tag{3.1}$$

where for any farm family *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 of the home garden, Z_{ij}, and the social and economic characteristics of the farm family, S_i, since different families may receive different levels of utility from these attributes.

The random utility model is the theoretical basis for integrating choice behaviour with economic valuation in the choice experiment method. In this model, the utility of a choice is comprised of a systematic (explainable or deterministic) component, V_{ij}, and an error (unexplainable or random) component, e_{ij}, which is independent of the deterministic part and follows a predetermined distribution.

$$U_{ij} = V_{ij} + e_{ij} \tag{3.2}$$

latter has only been being employed very recently, though the number of studies that employ this method is increasing (Smith, 1997).

The systematic component can be explained as a function of characteristics of the home garden and of the social and economic characteristics of the farm family as explained above, in (3.1). That is

$$U_{ij} = V(Z_{ij}, S_i) + e_i \qquad (3.3)$$

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 alternative home gardens will be a function of the probability that the utility associated with a particular home garden option (j) is higher than that for other alternative home gardens. That is to say, the probability that farm family i will choose home garden j over all other options h is given by

$$P_{ij} = \Pr ob\{V_{ij} + e_{ij} > V_{ih} + e_{ih}; \forall j \neq h, \forall h \in C\} \qquad (3.4)$$

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 identically and independently distributed with a Weibull distribution (Greene, 1997). These assumptions ensure that the probability of any particular alternative j being chosen can be expressed in terms of logistic distribution. This specification is known as the conditional logit model (McFadden, 1974; Greene, 1997 pp. 913-914; Maddala, 1999, pp. 42), and it takes the general form

$$P_{ij} = \frac{e^{V_{ij}}}{\sum_{h \in C} e^{V_{ih}}} \qquad (3.5)$$

The conditional indirect utility function generally estimated is

$$V_{ij} = \beta + \beta_1 Z_1 + \beta_2 Z_2 + ... + \beta_n Z_n + \beta_a S_1 + \beta_b S_2 + ... + \beta_m S_k \quad (3.6)$$

where β is the alternative specific constant (ASC), that captures the effects in utility from any attributes not included in choice specific attributes. The number of home garden attributes considered is n and the number of social and economic characteristics of the farm family employed to explain the choice of the home garden 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 farm family, they can only enter as interaction terms with the home garden attributes.

The choice experiment method is consistent with utility maximisation 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:

$$CS = \frac{\ln \sum_i \exp(V_{i1}) - \ln \sum_i \exp(V_{i0})}{\alpha} \quad (3.7)$$

where CS is the compensating surplus welfare measure, α is the marginal utility of income (generally represented by the coefficient of the monetary 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 (3.7) to

$$W = -1\left(\frac{\beta_{attribute}}{\beta_{monetary\ variable}}\right) \tag{3.8}$$

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

The assumptions about the distributions of error terms implicit in the use of the conditional logit model impose a particular condition known as the independence of irrelevant alternatives (IIA) property. This property states that the relative probabilities of two options being chosen are unaffected by introduction or removal of other alternatives. In other words, the probability of a particular alternative being chosen is independent of other alternatives. Whether or not IIA property holds can be tested by dropping an alternative from the choice set and comparing parameter vectors for significant differences. If it is found that the IIA property is violated then conditional logit results would be biased hence a discrete choice model that does not require IIA property, such as random parameter logit model, should be used. Furthermore, inclusion of social and economic characteristics is also beneficial in avoiding IIA violations, since social and economic characteristics relevant to preferences of the respondents can increase the systematic component of utility while decreasing the random one (Rolfe *et al.*, 2000; Bateman *et al.*, 2003).

3.3.2. Previous applications

The choice experiment method was initially developed by Louviere and Hensher (1982) and Louviere and Woodworth (1983) in marketing economics literature, but has only been used in environmental economics literature for valuation of non-marketed environmental goods within the last decade. Although a relatively new addition to the portfolio of environmental valuation methods, there is already a noteworthy and ever-increasing number of applications of choice experiments.

The earliest applications in the literature are those of Adamowicz *et al.* (1994), on alternative flow scenarios for rivers in Canada, and Boxall *et al.* (1996) on recreational moose hunting. Bergland (1997) uses a variant of the choice experiment method to value changes in agricultural landscapes in Norway. Hanley *et al.* (1998b) employ the choice experiment method to value the attributes of public woodlands in the UK. Layton *et al.* (1999) use the choice experiment method to value multiple programmes to improve fish population. Rolfe *et al.* (2000) investigates the preferences of Australian public for various tropical rainforest conservation strategies with a choice experiment. Layton and Brown (2000) employ this method to investigate the preference of the public for policies that aim to mitigate the impacts of climate change.

There are a few choice experiment studies, such as Hanley *et al.* (1998c) and Paterson *et al.* (2001), which employ the choice experiment method to aid design of agri-environmental programmes that yield the highest benefit to the society. Hanley *et al.* (1998c) value the components of Scottish agri-environmental scheme, which offers payments to farmers in return for adoption of conservation practices, where Paterson *et al.* (2001) value the attributes of countryside in various states of the United States in an attempt to reveal importance of multifunctionality of agriculture. Few other choice experiment examples provide insights into the potential suitability of this method for valuing components of agricultural biodiversity or agricultural production methods that have impacts on agricultural biodiversity. Scarpa *et al.* (2003a) estimate the value of animal genetic resources (AnGR) to farm families, who produce and consume them, by comparing the value of attributes of creole pigs to those of more productive but less well adapted exotic breeds in Yucatan, Mexico. Scarpa *et al.* (2003b) value attributes of cattle to cattle producers in Kenya. Kontoleon *et al.* (2002) and Kontoleon (2003) investigate consumers' perceptions of genetically modified (GM) food and find that consumers across the EU are willing to pay considerable sums to have information on the GM content in their food supplies. And recently, Lusk *et al.* (2003) employ the choice experiment method to investigate consumers' preferences for beef produced with hormones in the United States.

These latter examples reveal that information on consumer and producer preferences on components of agricultural biodiversity and agricultural production methods obtained from choice experiments could potentially assist in designing policies and programmes for conservation of agricultural biodiversity. The choice experiment method can be used, for example, to assist efficient targeting of niche markets for traditional varieties produced with less input intensive methods. Choice experiment can also aid design of payment schemes to farmers for maintaining agricultural biodiversity in targeted 'hot spots' that are species rich or exhibit high levels of genetic variation.

3.4. Choice experiment design and administration

3.4.1. Preliminary research

A choice experiment is a highly 'structured method of data generation' (Hanley *et al.*, 1998a), 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, which are in turn presented to the respondents, who are asked to state their preferences[21].

The first step in choice experiment design is to define the good to be valued in terms of its attributes and levels these attributes take. In the choice experiment study reported in this thesis, the most important home garden attributes and their levels were identified with NAEP experts and agricultural scientists, drawing on the results of informal and focus group interviews conducted with farmers in each ESA, during October-November 2001 and May 2002. In addition to determination of the home garden attributes and attributes levels to be used in the choice experiment, the purposes of this groundwork were also to acquire an understanding of the home garden as an institution and to develop the method for implementing the choice experiment. The chosen home garden attributes and their levels are reported in Table 3.1 below.

Table 3.1. 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. Specialised crop production
Organic Production	Whether or not industrially produced and marketed chemical inputs are applied in home garden 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%

Each of the first four attributes represents a different component of agricultural biodiversity, including crop species diversity, agro-diversity in integrated management of livestock and crops, crop genetic diversity, as well as inter-species diversity in landrace cultivation and soil microorganism diversity in organic production as explained in greater detail chapter 2. In terms of total economic value of home gardens, the first four attributes make up the use values of agricultural biodiversity as they accrue to the farm families that tend these home gardens. The agricultural biodiversity found in the home gardens, especially the crop genetic resource rich landrace attribute has option values of exploration and insurance as explained in section 3.2. In addition to these values, all the attributes represent non-use values of agricultural biodiversity in terms of cultural values of traditional

[21] For a detailed explanation of choice experiment design techniques, please see Louviere *et al.* (2000) and Bennett and Blamey, (2001) and Bateman *et al.*, 2003).

Hungarian home gardens. There are also cultural values embedded in traditional varieties, i.e. landraces, with which traditional Hungarian dishes are cooked.

These five attributes also represent multifunctional agriculture values that Hungarian NAEP is aiming to promote. These include the values of the agricultural biodiversity maintained on home gardens, as well as the cultural heritage values of the traditional home gardens, landraces and the indigenous knowledge that comes with these. The last attribute, i.e. the level of household food self sufficiency the home garden supplies, represents the importance of home gardens for food security of Hungary's rural population, and all home garden produce represent food safety and quality, especially in landraces and in organic production.

The self-sufficiency attribute is a proxy monetary attribute necessary for estimating welfare changes. This proxy monetary attribute represents willingness to accept (WTA) compensation, i.e. benefit rather than a cost measured by willingness to pay (WTP), since the property rights of the home gardens and of their outputs and functions reside with the home garden farmers (Freeman, 2002). This indirect measure is preferred over a direct monetary variable in Hungarian Forints (HUF) because most (if not all) of the outputs and functions of home gardens are not traded in the markets, but consumed by the home garden producer farm families themselves. Therefore the farm families might not be familiar with a direct monetary attribute when it comes to valuing the attributes of the home gardens. Hence this proxy was chosen, which can also be converted into monetary units with the use of secondary data on the amount of HUF spent on household food consumption[22].

[22] Valuation methods have been applied in many settings in which there are no well functioning, developed markets (e.g. in developing countries). For example the contingent valuation study by Kramer *et al.* (1994) uses rice as a proxy for money to estimate the WTA compensation of people who

3.4.2. Choice experiment design

The number of attributes and attribute levels selected for this choice experiment reflect a balance between efficiency, resemblance to reality and enhancement of variability of each attribute (Kontoleon, 2003). Of the five attributes that were selected, two of them took four levels and the remaining three were binary. A large number of unique home garden descriptions (combinations of attributes) could be constructed from this number or attributes and levels[23] however, in this design orthogonalisation procedure was used to recover only the main effects, yielding 32 pair wise comparisons of home garden profiles[24].

The optimal number[25] of choice sets presented to each individual varies according to the difficulty of the choice tasks, the conditions under which the experiment is conducted and the incentives provided to the respondents. Any number of choice sets between 4 and 16 is generally considered to be efficient (Louviere *et al.*, 2000). Given that this choice experiment succeeded a rather lengthy household survey and that many respondents, who are the home garden decision-makers, are elderly, fewer choice sets were considered preferable to avoid respondent burden and fatigue. The 32 pairwise home garden comparisons were randomly blocked to six different versions, two with six choice sets and the remaining four with five choice sets. As a result, each farm family was presented with five or six choice sets, each with two home garden profiles (home garden A and home garden B) and an option to select neither garden.

The 'neither home garden' option was included in the design to increase the realism of the exercise, enhance the theoretical validity of the welfare estimates and improve

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live adjacent to the forests in Madagascar to abandon the forest products and services to which they have traditional use rights.

[23] Number of home gardens that can be constructed from 5 attributes, 2 with 4 levels and the remaining 3 with 2 levels is $4^2*2^3=128$

[24] Although exclusion of interaction effects may introduce bias into main effects estimations, it has been shown that main effects usually account for more than 80% of the explained variance in a model (Louviere, 1988; Louviere *et al.*, 2000).

the statistical efficiency of the estimated choice parameters (Adamowicz and Boxall, 2001; Banzhaf *et al.*, 2001; Kontoleon, 2003). In cases where demand behaviour is studied, inclusion of such an 'opt-out' option in the choice set is necessary if the estimated welfare measures are to be consistent with demand theory[26] (Bennett and Blamey, 2001; Bateman *et al.*, 2003; Kontoleon, 2003). Furthermore, the option of 'neither home garden' is also believed to be valuable in cases when participation levels are in themselves of policy interest. One of the aims of this research is to investigate the sustainability of this mode of agricultural production, or agroecosystem management. Therefore information on whether or not some farm families would prefer not to cultivate home gardens given the option to opt-out is important.

Pre-tests of the choice experiment were conducted at the Centre for Social and Economic Research on the Global Environment (CSERGE) of University College London (UCL) on nine of the staff. The choice experiment survey was translated to Hungarian, and then translated back to English to check consistency. After a final translation to Hungarian another pre-test was conducted with six of the staff from the Institute of Environmental and Landscape Management (IELM) of Szent István University. The survey approach and design were further modified following the pre-tests. An example of a choice set is presented in Figure 3.1. below and all of the 32 choice sets used in the choice experiment are reported in Table 3.A.1. in the appendix to this chapter.

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[25] Optimal number means the number of choice sets the respondent can answer without getting tired or bored (Bateman *et al.*, 2003).

[26] Similar reasons for inclusion of a 'neither' alternative are also valid for cases dealing with state of the world choices or choice experiments that offer respondents alternative policy options. The neither alternative may be considered as a status quo or baseline alternative. It is essential to include a status-quo option in the choice set to achieve welfare measures that are consistent with demand theory. If a status-quo alternative is not included in the choice set, respondents are being forced to choose one of the profiles presented, even if they do not prefer it at all (Bateman *et al.*, 2003).

Figure 3.1. Sample choice set

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

Home Garden Characteristics	Home Garden A	Home Garden B	
Total number of crop species grown in the home garden	25	20	Neither home garden A nor home garden B: I will NOT cultivate a home garden
Home garden production is combined with livestock production	Yes	Yes	
Home garden crops produced entirely with organic methods	No	No	
Home garden has a landrace	No	Yes	
Expected proportion (in %) of annual household food consumption met through food production in the home garden	45	75	

I prefer to cultivate Home garden A..... Home garden B.... Neither home garden ......
(please check (√) one option)

3.4.3. Administration of the choice experiment

The survey was conducted during August 2002, with face-to-face interviews following the farm household survey, whose descriptive statistics are presented in chapter 2 and data are analysed in chapter 5 and 6. The sample population in each community was randomly divided into six, each sub-sample receiving one of the six versions of the choice experiment.

Even though all the respondents are home garden farmers and hence are all familiar with the good that is being valued in the choice experiment, it was crucial that respondents had a uniform understanding of each of the attributes, as defined above.

Consequently, an introductory section explained to respondents the context in which choices were to be made, described each attribute and fixed the size of the hypothetical garden to 500m^2 [27] (please refer to Figure 3.A.1. in the appendix for the Introduction to the choice experiment). Further the respondents were also explained that the key attributes of home gardens had been selected as a result of prior research and combined artificially in the choice sets. Respondents were informed that completion of the exercise would help agricultural policy makers. And finally, the respondents were reminded that there were no right or wrong answers and that we were only interested in their opinions.

The sample design for the choice experiment and farm household survey is already presented in chapter 2. Of the 104, 109 and 110 households that were interviewed for the farm household survey in Dévaványa, Őrség-Vend and Szatmár-Bereg regions respectively, 96%, 76% and 86% agreed to take part in the choice experiment, which amounts to 100 farm families in Dévaványa, 83 in Őrség-Vend and 94 in Szatmár-Bereg. There was not any item non-response, in other words all the choice sets were answered due to the advantage of the in person interviewing. A total of 1487 choices were elicited from a total of 277 farm families.

3.5. Model specification and econometric results

3.5.1. Data preparation

The data were coded according to the levels of the attributes. Attributes with two levels entered the utility function as binary variables that were effects coded (Louviere *et al.*, 2000). For agro-diversity variable, mixed livestock and crop production was entered as 1 and specialised crop production was entered as –1. For organic production attribute, organically produced home gardens were entered as 1

[27] The size of the hypothetical home garden was chosen before the average home garden sizes in each region were established from the results of the farm household survey, as reported in chapter 2, Table 2.4. This home garden size was chosen as the Agricultural Census conducted in 2000 found the

and those home gardens that were not produced organically were entered as –1. For landrace attribute, those home gardens that contained a landrace were entered as 1 and those without were effects coded as –1. The levels used for crop species diversity and self-sufficiency in food consumption attributes were entered in a cardinal-linear form. Consequently the crop species diversity attribute took levels 6, 13, 20 and 25.

The 'percentage of annual household food consumption that is expected the home garden will supply' attribute was converted into HUF values by use of secondary data on the annual expenditure of the average Hungarian household on food consumption (HCSO, 2002). The secondary data reported the average Hungarian family to have 2.7 members and the average annual expenditure on food to be 303 450 HUF. As a result, it was calculated that home gardens that provide 15%, 40%, 60% and 75% of farm families' annual food consumption would provide 45 525 HUF, 136 575 HUF, 182 100 HUF and 227 624 HUF worth of benefits, respectively.

The attributes for the 'neither home garden' option were coded with zero values for all attributes. The alternative specific constants (ASC) were equalled to 1 when either home garden A or B was chosen and to 0 when 'neither home garden' alternative was chosen. In other words, in this model ASC is specified to account for the proportion of choice of participation in home garden production. Choice data were converted from wide to long format with a programme coded in LIMDEP 7.0 NLOGIT 2.0. This data conversion step was necessary to estimate models with multiple responses from each respondent, a format similar to panel data.

3.5.2. Conditional logit model estimations for the pool

The choice experiment was designed with the assumption that the observable utility function would follow a strictly additive form. The model was specified so that the probability of selecting a particular home garden was a function of attributes of that

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average home garden size in Hungary to be 591m^2 (HCSO, 2000). The size of 500m^2 was also recommended to be a realistic size by the lead agronomist of the project István Már.

home garden and of the alternative specific constant. Using the complete data set from all three regions, conditional logit models (as explained in section 3.3.1. above) with logarithmic and linear specifications for the attributes with four levels were compared. The highest value of the log-likelihood function was found for the specification with the crop species diversity attribute in logarithmic form, indicating that the marginal willingness to accept compensation for this attribute is diminishing[28]. For the population represented by the sample, indirect utility from home garden attributes takes the form

$$V_{ij} = \beta + \beta_1 \ln(Z_{diversity}) + \beta_2 (Z_{agro-diversity}) + \beta_3 (Z_{organic}) + \beta_4 (Z_{landrace}) + \beta_5 (Z_{selfsufficiency}) \tag{3.9}$$

where β refers to the alternative specific constant and β_{1-5} refer to the vector of coefficients associated with the vector of attributes describing home garden attributes. The results of the conditional logit estimates for the entire sample of 277 farm families is reported in Table 3.2.

[28] This specification is also found to be the most suitable one for ESA level conditional logit estimations.

Table 3.2. Conditional logit estimates for home garden attributes for the pool of three ESAs

Attribute	Coefficient. (s.e.)
Constant	-0.679** (0.247)
Crop Species Diversity	0.180** (0.074)
Agro-Diversity	0.398*** (0.042)
Organic Production	0.189*** (0.042)
Landrace	0.161*** (0.039)
Self sufficiency	0.708×10^{-5}*** (0.652×10^{-6})
Sample size	1487
ρ^2	0.126
Log likelihood	-1415.85

Source: Hungarian Home Garden Choice Experiment, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002.
*** 1% significance level, ** 5% significance level and *10% significance level with two-tailed tests

All of the home garden attributes are significant factors in the choice of home gardens, and any single attribute increases the probability that a home garden is selected, other attributes remaining equal. When the self-sufficiency attribute is used as the normalising variable, the most important home garden attribute for farm families is agro-diversity (integrated crop and livestock production). This is followed by organic farming methods and crop (inter- and intra-specific) diversity variables, all of which are similar and about half as important as the agro-diversity variable[29]. The negative sign on the ASC coefficient implies that respondents are highly responsive to changes in choice set quality and they make decisions that are closer both to rational choice theory and the behaviour observed in reality (Kontoleon, 2003). The overall fit of the model as measured by McFadden's ρ^2 is reasonable by conventional

[29] Note that the coefficients and standard errors for crop species diversity and self sufficiency appear lower than the other coefficients because actual values (6, 13, 20, 25) and (45 525 HUF, 136 575 HUF, 182 100 HUF and 227 624 HUF) were used respectively.

standards used to describe probabilistic discrete choice models[30] (Ben-Akiva and Lerman, 1985).

The IIA property of this model is tested using a procedure suggested by Hausman and McFadden (1984). This test involves constructing a likelihood ratio test around different versions of the model where choice alternatives are excluded. If IIA holds then the model estimated on all choices (the full choice set) should be the same as that estimated for a sub-set of alternatives (Bateman *et al.*, 2003). Whether or not the property of IIA is violated in this model is tested by following the Hausman procedure contained within LIMDEP 7.0 NLOGIT 2.0. The test results are reported in Table 3.3 for a version of the pooled model without the constant[31].

Table 3.3. IIA test for the pool of three ESAs

Alternative dropped	χ^2	D.o.f.	Probability
Home Garden A	11.76	5	0.0038
Home Garden B	4.73	5	0.4494
Neither Home Garden	14.93	5	0.0106

The IIA conditions are not violated when 'Neither home garden' or 'Home garden A' are dropped, however the violations are significant when 'Home garden B' is dropped from the choice sets. Therefore, the IIA tests performed indicate that the model does not fully conform to the underlying IIA conditions. Since the IIA property is violated, the model needs to be augmented either by including social and economic characteristics as interaction terms, or by employing the random parameter logit model or both (Morey and Rossmann, 2003).

[30] The ρ^2 value in multinomial logit models is similar to R^2 in conventional analysis, except that significance occurs at lower levels. Hensher and Johnson (1981) comment that values of ρ^2 between 0.2 and 0.4 are considered to be extremely good fits.

[31] The intercept had to be dropped from the model to avoid singularity problems. Because the ratios of model parameters should remain consistent the Hausman test is still valid under these conditions (Rolfe *et al.*, 2000)

3.5.3. Comparison of preferences across ESAs

As a result of the market, economic and agro-ecological differences across regions, as reported in chapter 2, it is hypothesised farm families in different ESAs may face different trade-offs in production of home gardens and consumption of home garden outputs. Identification of these differences, should they exist, may have relevant consequences for designing cost-efficient and effective home garden and agricultural biodiversity conservation policies and programmes.

Since it is likely that farm families in each of the three ESAs are to value home garden attributes differently, whether or not the set of parameter estimates of the pooled model is shared across the three distinct regions must be tested. To test this separate conditional logit models are estimated for each ESA, whose results are reported in Table 3.4. The following test is carried out to investigate whether or not preferences differ across ESAs,

$$H_0 : \beta_{pool} = \beta_{Dev} = \beta_{Orseg} = \beta_{Sz-B}$$

where β_x are the conditional logit model parameter vectors of the indirect utility function in equation (3.9) above. Rejection of the null-hypothesis would imply that farmers in different regions have different demand models for home gardens and their attributes. This test can be conducted with a Swait-Louviere log likelihood ratio test. The test statistic is asymptotically distributed as χ^2 and is expressed as

$$\chi^2 = -2(LL_1 - LL_2)$$

where LL_x refers to the log likelihood statistics of the different conditional logit models.

Table 3.4. Conditional logit estimates for home garden attributes by ESA

Attribute	Dévaványa	Őrség-Vend	Szatmár-Bereg
	Coeff. (s.e.)		
Constant	-0.050	-1.475***	-0.691
	(0.399)	(0.450)	(0.448)
Crop Species Diversity	-0.031	0.284**	0.301**
	(0.123)	(0.135)	(0.131)
Agro-diversity	0.504***	0.256***	0.411***
	(0.070)	(0.077)	(0.073)
Organic Production	0.293***	0.116	0.148**
	(0.072)	(0.077)	(0.073)
Landrace	0.085	0.241***	0.168***
	(0.065)	(0.071)	(0.067)
Self-sufficiency	0.466×10^{-5}***	0.954×10^{-5}***	0.768×10^{-5}***
	(0.106×10^{-5})	(0.124×10^{-5})	(0.115×10^{-5})
Sample size	533	455	499
ρ^2	0.109	0.125	0.181
Log likelihood	-521.65	-430.49	-443.80

Source: Hungarian Home Garden Choice Experiment, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002.
*** 1% significance level, ** 5% significance level and *10% significance level with two-tailed tests

Swait-Louviere log likelihood ratio test rejects the null hypothesis that the regression parameters are equal at 0.5% significance level[32]. Hence, farm families in each of the three regions have distinct preferences for home gardens and their attributes. When the same test is carried out to make pairwise comparisons, it is revealed that each of the three regions' parameters are different from each other, again at 0.5% significance level[33]. The largest differences between regional preferences are those between the two isolated regions of Szatmár-Bereg and Őrség-Vend and the industrialised and commercialised region of Dévaványa.

In Dévaványa ESA, where food markets and road infrastructure are fully developed, farmers' demand for either crop species diversity or landraces is insignificant, and in

[32] LR= -2[-1415.85-(-520.65+-430.49+-443.80)]=39.82, which is larger than 18.55, the critical value of chi square distribution at 6 degrees of freedom at 0.5% significance.

[33] Comparison of conditional logit estimates for Dévaványa vs. Őrség-Vend is LR= -2[-521.65+430.49]=182.32, Dévaványa vs. Szatmár-Bereg is LR= -2[-521.65+448.80]=155.7 and for Szatmár-Bereg vs. Őrség-Vend is LR= -2[-443.80+430.49]=26.62 all larger than 18.55, the critical value of chi square distribution at 6 degrees of freedom at 0.5% significance.

the case of crop species diversity it is in fact negative. The demand for agro-diversity variable is positive, significant and large in magnitude owing to the complementarity between crop production in the field and animal husbandry in the home garden. There is a significant and relatively large demand for organic production method in Dévaványa. In the isolated region of Őrség-Vend, where community level food markets are absent and distance to the nearest markets are up to 32.2 km far, demand for crop species diversity and landraces are each significant and nearly as large in magnitude as the demand for agro-diversity. No significant demand for organic production method is evident in Őrség-Vend ESA, reflecting poor soil quality in this region. In the other isolated ESA, Szatmár-Bereg, where market and road infrastructures are both poor, home garden farmers demand crop species diversity and landraces positively and significantly. Farm families in this region also place great importance on agro-diversity, perhaps in part because unemployment rates are high and labour intensive animal husbandry practices are less costly in terms of opportunity cost of time.

3.5.4. WTA values for each home garden attribute by ESA

The WTA compensation values for each of the home garden attributes are computed by finding the part-worth as described in equation (3.8) above. The results are reported in Table 3.5.

Table 3.5. WTA values for each home garden attribute by 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.
* -- indicates that the demand for the attribute is insignificant at 5% significance level.
** Figures in € are converted from Hungarian Forints (HUF) (1 € = 267.52 HUF, June 2003)

Farm families in Őrség-Vend and Szatmár-Bereg regions attach the highest private values to crop species diversity, crop genetic diversity as well as substantial values to agro-diversity. These regions are the ones in which high levels of agricultural biodiversity in terms of levels of crop species diversity, crop genetic diversity as well as agro-diversity have already been found as explained in chapter 2 Table 2.5. These results suggest that public investments to conserve especially crop biodiversity in home gardens would cost the least and be most effective in these regions compared to Dévaványa ESA.

3.5.5. Accounting for preference heterogeneity

Basic conditional logit model assumes homogeneous preferences across farm families in each ESA. However, preferences across families are in fact heterogeneous and 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, 1997). Furthermore, accounting for heterogeneity enables prescription of policies that take equity concerns into account. An understanding of who will be affected by a policy change in addition to understanding the aggregate economic value associated with such changes is necessary (Adamowicz and Boxall, 2001). Determination of individual 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 (segments) and by estimating the demand function for each group separately. Estimating the conditional logit model for each ESA does this above, and as expected -since each group (ESA) is distinct in its characteristics- each region's valuation of home gardens and their attributes varies. A second way of accounting for preference heterogeneity is by using household and decision-maker level characteristics directly as interaction terms. Interaction of individual-specific social and economic characteristics with choice specific attributes or with ASC of the indirect utility function is a common solution to dealing with the heterogeneity problem as well as with violations of the IIA (see for example Rolfe *et al.*, 2001). The main problem with this method is multicollinearity, which occurs when too many interactions are included in the estimation, hence the model needs to be tested down, using the higher log-likelihood criteria (Breffle and Morey, 2000).

An alternative method to accounting for preference heterogeneity is the use of random parameter logit model. Next section explains this model in greater detail and reports the random parameter logit estimates for the pooled sample and for each ESA. Section 3.4.7 investigates the effects of household and decision-maker level characteristics on farm families' demand for home garden attributes in each ESA.

3.5.6. Random parameter logit model

Even though segment analysis and use of social and economic characteristics help to recognise conditional heterogeneity, these methods do not detect for unobserved heterogeneity. It has been demonstrated that heterogeneity can be present in significant residual form even when conditional heterogeneity is accounted for (Garrod *et al.*, 2002). Unobserved heterogeneity in preferences across respondents can be accounted for by use of the random parameter logit model, which, unlike conditional logit is not based on the IIA assumption.

The random utility function in the random parameter logit model is given by

$$U_{ij} = V_{ij} + \varepsilon_{ij} \equiv Z_j(\beta + \eta_i) + e_{ij} \qquad (3.10)$$

where respondent i receives utility U from choosing alternative j from choice set C. Similarly to conditional logit model, utility is decomposed into a non-random component (V) and a stochastic term (e). Indirect utility is assumed to be a function of the choice attributes Z (as well as of social and economic characteristics S, if included in the model) with parameters β, which due to preference heterogeneity may vary across respondents by a random component η_i. By specifying the distribution of the error terms e and η, the probability of choosing j in each of the choice sets can be derived (Revelt and Train, 1998). With accounting for unobserved heterogeneity, Equation (3.5) in Section 3.3.1. above now becomes

$$P_{ij} = \frac{e^{Z_{ij}(\beta+\eta_i)}}{\sum_{h\in C} e^{Z_{ih}(\beta+\eta_i)}} \tag{3.11}$$

Since this model does not require IIA assumption, the stochastic part of utility may be correlated among alternatives and across the sequence of choices via the common influence of η_i. Treating preference parameters as random variables requires estimation by simulated maximum likelihood. Procedurally, the maximum likelihood algorithm searches for a solution by simulating m draws from distributions with given means and standard deviations. Probabilities are calculated by integrating the joint simulated distribution.

Recent applications of random parameter logit model have shown that this model is superior to conditional logit model in terms of overall fit and welfare estimates (Breffle and Morey, 2000; Layton and Brown, 2000; Kontoleon, 2003; Lusk *et al.*, 2003; Morey and Rossmann, 2003). However, it should also be noted that even if unobserved heterogeneity can be accounted for with the use of the random parameter logit model, the model fails to explain the sources of heterogeneity (Boxall and Adamowicz, 1999). One solution to detecting the sources of heterogeneity while accounting for unobserved heterogeneity would be by inclusion of respondent characteristics in the utility function as interaction terms. This would enable random parameter logit model to pick up preference variation in terms of both unconditional taste heterogeneity (random heterogeneity) and individual characteristics (conditional heterogeneity), and hence improve model fit (see for example Morey and Rossmann, 2003).

In this chapter the random parameter logit model was estimated using LIMDEP 7.0 NLOGIT 2.0. All the parameters were specified to be independently normally distributed and distribution simulations were based on 500 draws. The results of the random parameter logit estimations for the pool are reported in Table 3.6 below[34].

Table 3.6. Random parameter logit estimates for the pool of three ESAs

Attributes		Coeff. (s.e.)
Constant	Mean coefficient	-0.679***
		(0.233)
	St. Dev. of coefficient	0.002
		(0.070)
Crop Species Diversity	Mean coefficient	0.180**
		(0.071)
	St. Dev. of coefficient	0.0009
		(0.025)
Agro-Diversity	Mean coefficient	0.398***
		(0.041)
	St. Dev. of coefficient	0.001
		(0.041)
Organic Production	Mean coefficient	0.189***
		(0.042)
	St. Dev. of coefficient	0.003
		(0.040)
Landrace	Mean coefficient	0.162***
		(0.039)
	St. Dev. of coefficient	0.0006
		(0.039)
Self sufficiency	Mean coefficient	$0.708\text{x}10^{-5}$***
		($637\text{x}10^{-6}$)
	St. Dev. of coefficient	$0.203\text{x}10^{-7}$
		($371\text{x}10^{-6}$)
Sample size	4422	
ρ^2	0.127	
Log likelihood	-1415.84	
Replications for simulated probability	500	

Source: Hungarian Home Garden Choice Experiment, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002.
*** 1% significance level, ** 5% significance level and *10% significance level with two-tailed tests

[34] Regional subsamples were also estimated using random parameter logit model. The results are included in the appendix, Tables 3.A.2 through 3.A.4.

Random parameter logit model estimates of the pool of all three ESAs resulted in insignificant derived standard deviations indicating that data does not support any choice specific unconditional unobserved heterogeneity. Moreover, the log likelihoods are almost the same for the pool of all three ESAs with conditional logit model and with random parameter logit model. Therefore the Swait Louviere Log Likelihood ratio test results of the test cannot reject the null hypothesis that the random parameter logit model and conditional logit model estimates are equal[35]. Hence no improvement in the model fit can be achieved with the use of a random parameter logit model. On the basis of this test it can be concluded that the conditional logit model is sufficient for analysis of the data set presented in this thesis.

A summary of all the econometric models used in this chapter with their definitions, why they were applied to the data and their suitability to the data at hand are reported in Table 3.7 below.

[35] This result is true also for the ESA level random parameter logit model estimations. The log likelihood ratio for each ESA both for conditional logit and random parameter logit model models are equal. Therefore, the ESA level random parameter logit model estimations do not provide any improvements in model fit over ESA level conditional logit estimates.

Table 3.7. Summary of econometric models employed in this chapter

Econometric Model	Definition	Results
Conditional Logit	The choice of a home garden is a function of the attributes of the home garden and of the characteristics or the respondent. Since the errors terms are assumed to have a Weibull distribution and hence the model is estimated with a logit model (McFadden, 1974; Greene, 1997; Maddala, 1999)	Conditional logit model are reported in Tables 3.2 and 3.4. The model however violate the underlying IIA conditions, as reported in Table 3.2. Hence the model needs to be augmented either by including social and economic characteristics as interaction terms or by employing the random parameter logit model (Morey and Rossmann, 2003).
Random Parameter Logit Model	Mixed logit model which can account for unobserved heterogeneity and is not based on not require IIA assumptions (Revelt and Train, 1998).	Random parameter logit model estimates, as reported in Table 3.6, result in insignificant derived standard deviations indicating that data does not support any choice specific unconditional unobserved heterogeneity. Therefore conditional logit model with interactions is used.
Conditional Logit with Interactions	Interactions with social and economic characteristics of the farm families are included in order to deal with the heterogeneity problem and with violations of the IIA (Rolfe *et al.*, 2001)	This model presents an improvement over the conditional logit model and enables determining of observed preference heterogeneity as reported in Tables 3.8 to 3.10 below.

3.5.7. Conditional logit model accounting for preference heterogeneity

To account for heterogeneity of preferences across farm families the effects of farm family and home garden decision-maker level characteristics on farm families' demand for home gardens and home garden attributes must be investigated. As already mentioned above, in random utility models the effects of social and economic characteristics on choice cannot be examined in isolation but as interaction terms with choice attributes. Due to possible multicollinearity problems, it is not possible to include all the interactions between the household and decision-maker characteristics collected in our survey (as reported in chapter 2) and the five home garden attributes when estimating the conditional logit models (Breffle and Morey, 2000).

To address this limitation, independent variables were eliminated based on Variance Inflation Factors (VIF), which were calculated by running "artificial" ordinary least squares regressions between each independent variable (i.e. the farm family and decision-maker characteristics) as the "dependent" variable and the remaining independent variables[36]. Those independent variables for which $VIF_j > 5$ indicate clear evidence that the estimation of the characteristic is being affected by multicollinearity (Maddala, 2000). Five independent variables remained:

1) number of family members with off farm employment (denoted as *no. off farm*)
2) experience of the home garden decision maker(s) in years (denoted as *experience*)
3) percentage of household income spent on food (denoted as *foodexp.*)
4) number of family members that participate in home garden cultivation (denoted as *participation*), and
5) whether or not the family also cultivates a farm field (denoted as *field*).

The indirect utility function in equation (3.9) was then extended to include the 25 interactions between the five home garden attributes and the five household and decision-maker characteristics. The final conditional logit function that was estimated is:

$$
\begin{aligned}
V_{ij} &= \beta + \beta_1 \ln(Z_{diversity}) + \beta_2(Z_{agro-diversity}) + \beta_3(Z_{organic}) + \beta_4(Z_{landrace}) + \beta_5(Z_{selfsufficiency}) \\
&+ \delta_1(Z_{diversity} \times S_{noofffarm}) + \delta_2(Z_{agro-diversity} \times S_{noofffarm}) + \ldots + \delta_5(Z_{selfsufficiency} \times S_{noofffarm}) \\
&+ \delta_6(Z_{diversity} \times S_{experience}) + \ldots + \delta_{10}(Z_{selfsufficiency} \times S_{experience}) + \ldots \\
&+ \delta_{21}(Z_{diversity} \times S_{field}) + \ldots + \delta_{25}(Z_{selfsufficiency} \times S_{field})
\end{aligned}
\qquad (3.9')
$$

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

The effects of household and home garden decision-maker characteristics on farm families' demand for home garden attributes are reported for each ESA in Tables 3.8 through 3.10. Only those interactions that are significant at 10% level with one-tailed tests 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 garden attributes (Table 3.8). The demand for crop species diversity decreases with the number of household members employed off farm. Households cultivating at least one farm field in addition to home gardens also prefer lower levels of crop species diversity in the home 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 crop species diverse home gardens in Dévaványa. Demand for a landrace in the home garden also increases with food expenditure. These latter results reveal that in this ESA, even if perfectly functioning food markets exist, poorer farm families are dependent on the yield and diversity of their own home garden produce to supply their family's food.

The interaction between the demand for organically produced home gardens and the number of family members who are employed off farm is positive. Organic production can be a costly method of home garden management since chemical inputs that are certified as 'organic' cost more than regular fertilisers and farm families with off farm income may have more means to purchase such organic fertilisers. At the same time, organic methods might not produce the yield that is required to meet farm families' food consumption. Farm families with off farm income can insure themselves against crop failure that might arise as a result of production without chemical, since they can supplement their output with items purchased at the local markets found in Dévaványa.

Table 3.8. Effects of household and decision-maker characteristics on demand for home garden attributes in Dévaványa ESA

Attributes and interactions	Coefficient (s.e)
Constant	0.920 (0.522)
Crop Species Diversity	-0.624** (0.266)
Agro-diversity	0.512*** (0.072)
Organic Production	0.139 (0.099)
Landraces	-0.182 (0.177)
Self sufficiency	0.873×10^{-6} (0.232×10^{-5})
Crop species diversity * no. off farm	-0.015** (0.007)
Crop species diversity * field	-0.032** (0.013)
Crop species diversity * foodexp	0.002*** (0.0004)
Organic production * no. off farm	0.182*** (0.071)
Landraces * foodexp	0.007* (0.004)
Self sufficiency * foodexp	0.791×10^{-7}* (0.484×10^{-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.
*** 1% significance level, ** 5% significance level and *10% significance level with two-tailed tests

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 (Table 3.9). The demand for crop species diversity increases with the number of household members employed off farm. Thus in this region with missing community level markets, őrségi farm families, even those with off farm employment opportunities, might still not have easy access to food markets and hence would prefer diversity in their home gardens to provide for diversity in their diets. Another, complementary explanation could be that in this isolated, rural region these households see home garden cultivation as a recreational activity and get utility from cultivating diverse and labour intensive home gardens in their free time. Farm families' demand for a landrace in the home garden is however negatively associated with the number of household members employed off farm. This can be explained by the high opportunity cost of time these kinds of farm families face in engaging in production of ancestral crop varieties, which require more labour intensive methods compared to the varieties whose seeds can be purchased from the shops.

In Őrség-Vend ESA, 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 in this ESA that is isolated from all markets, including input markets, less wealthy families lack the funds to acquire and the access to 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 expenditure, indicating that poorer households rely more on home garden production for food.

Table 3.9. Effects of household and decision-maker characteristics on demand for home garden attributes in Őrség-Vend ESA

Attributes and interactions	Coefficient (s.e.)
Constant	-1.828*** (0.511)
Crop Species Diversity	0.274 (0.172)
Agro-diversity	0.264*** (0.083)
Organic Production	0.303 (0.250)
Landraces	0.410*** (0.107)
Self sufficiency	0.716×10^{-5}*** (0.209×10^{-5})
Crop species diversity * no. off farm	0.012** (0.006)
Organic Production * foodexp	0.011** (0.005)
Organic Production * experience	-0.149*** (0.05)
Landrace * no.off farm	-0.135** (0.067)
Self sufficiency * foodexp	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.
*** 1% significance level, ** 5% significance level and *10% significance level with two-tailed tests

In Szatmár-Bereg ESA, 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 (Table 3.10). Households cultivating a field also demand agro-diversity in the home garden revealing the complementarity between feed production in the field and livestock production in the home garden. Demand for agro-diversity decreases with the number of household members employed off farm because animal husbandry is a labour intensive home garden activity with high opportunity costs. Preferences of field cultivating farm families for home gardens without a landrace may reflect the effect of government subsidies for purchasing the seed of modern varieties in Szatmár-Bereg on agricultural biodiversity maintained in home gardens in this ESA[37].

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[38]. The greater the number of participants in home garden production, the lower the level of self-sufficiency they demand that it provide. This might be because household income increase with the number of home garden participants (who are usually adults), and households with higher incomes need to rely less on the home garden output for their livelihoods.

[37] This finding is similar to those of Meng (1997) and Meng, Taylor and Brush (1998), who also identify agricultural policies to be one of the determinants of loss of wheat diversity on Turkish farms. Their findings show that government's fixed prices for wheat, that paid no premiums for special varieties, discouraged production of traditional varieties.

[38] 16% of all the home garden decision-makers are 70 years of age and above. 11.3% of these respondents chose the 'neither home garden' option in all the choice sets presented to them. When asked why they chose this option all of them without an exception stated that they were too old to engage in such labour intensive task and they would prefer not to keep a home garden if they knew they could have access to food otherwise.

Table 3.10. Effects of household and decision-maker characteristics on demand for home garden attributes in Szatmár-Bereg ESA

Attributes and interactions	Coefficient (s.e.)
Constant	-0.671 (0.481)
Crop Species Diversity	0.275* (0.141)
Agro-diversity	0.410*** (0.125)
Organic Production	0.086 (0.079)
Landrace	0.263*** (0.096)
Self sufficiency	$0.151\text{x}10^{-4}$*** ($0.317\text{x}10^{-5}$)
Agro-diversity * no. off farm	-0.137* (0.079)
Agro-diversity * field	0.255* (0.147)
Landrace * field	-0.247* (0.143)
Self sufficiency * experience	$-0.855\text{x}10^{-7}$* ($0.455\text{x}10^{-7}$)
Self sufficiency * participation	$-0.156\text{x}10^{-5}$** ($0.674\text{x}10^{-6}$)
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.
*** 1% significance level, ** 5% significance level and *10% significance level with two-tailed tests

3.5.8. WTA values for selected farm family profiles per ESA

The results of the conditional demand functions with interactions reported in Tables 3.8-3.10 can be used to calculate the value assigned by the farm families to home garden attributes (Scarpa, *et al.*, 2003a), by modifying Equation (3.8) to

$$W = -1\left(\frac{\hat{\beta}_{attribute} + \delta_{atribute} \times S_1 ... + \delta_{attribute} \times S_5}{\hat{\beta}_{monetaryattribute} + \delta_{monetaryatribute} \times S_1 + ... + \delta_{monetaryattribute} \times S_5}\right) \qquad (3.8')$$

where 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 garden attributes are shown in Table 3.11, according to three social and economic "profiles", which are chosen to represents stereotypical farm families in rural Hungary.

Profile 1 represents a family with three members, relatively high income, two of its members working off farm, and three members participating in home garden production. This family does not engage in field cultivation and spends 30% of its income on food. The primary decision-maker in the home garden has 20 years of experience. Profile 2 pertains to a small family of an elderly couple, both of which participate in home garden production and their average years of experience in home garden cultivation is 50 years. They have no employment outside of the farm and no farm fields. This family spends 50% of its income on food. 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% of its income on food. The experience of the primary decision-maker in the home garden is 30 years. The results of the derivation of WTA estimates conditional on the social and economic variables of these family profiles are reported in Table 3.11.

Table 3.11. WTA values by family 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.

The derived WTA values -with the exception of the value of crop species diversity for dévaványai families- are negative. These negative signs on the WTA derivations conditional on social and economic characteristics of the farm families can be seen as a test for theoretical validity. Since the signs on the estimated coefficients on the interacted variables are consistent with theoretical expectations of negative WTA values, it can be concluded that the test is passed favourably.

WTA value estimates for the three household profiles in the three regions disclose four main results. First, crop species diversity has negative use value in Dévaványa, the ESA with fully functioning food markets. This result shows that farm families in this ESA are rather WTP to obtain one more specie than to produce it themselves. Crop species diversity is valued highly by all types of households in the other two regions where there are no food markets in settlements and transactions costs of participating in the nearest food markets are high.

Second, the agro-diversity attribute is valued most highly in Dévaványa as a result of complementarity between animal husbandry and intensive feed production in the fields. Though this traditional Hungarian method of integrated livestock and crop production is especially important for older households, it is also valued highly by szatmári farm family that is younger and farm-based[39].

Third, the demand for organically produced home gardens represent bipolarity of preferences for this attribute. 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 labour-intensive, input-extensive production methods[40]. Younger home gardeners that have off farm occupations, and hence higher levels of income and education also prefer organic production methods, possibly with organically certified inputs, compared to no inputs at all[41]. 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 employing chemical inputs that was shaped during the chemical input-intensive period of collectivised agriculture.

Fourth, in all three regions, the elderly farm family with longest years of experience in gardening values landraces the most. This demonstrates unequivocally that the extent to which Hungarian cultural heritage is expressed in landraces, that heritage is now being valued most highly and also most probably conserved by the remaining elderly home gardens.

[39] Descriptive statistics reported in chapter 2, Table 2.4. reveal that statistically higher percentages of dévaványai and szatmári farm families reported that they supply some of their feed for the livestock they keep in their home gardens from their fields, compared to the farm families in Őrség-Vend ESA

[40] Many of the oldest home garden decision-makers interviewed are the remaining *parasztс*s, who still practice their labour input intensive and chemical input free traditional production methods of before 1955. *Paraszt* is a Hungarian term used to refer to subsistence-farmers, i.e. those farmers and farm households that were completely self-sufficient and dependent on their land for their livelihood and existed before the collectivisation era (Gyovai, personal communication, 2003).

[41] This result can also be explained by the open-mindedness of these younger and mobile households in adapting to environmentally friendly production techniques. Few of the őrségi households interviewed stated that they worked in the neighbouring Austrian towns, where organic production method is widely used and encouraged. Also several Austrians settle in the őrségi villages that border Austria,

3.6. Conclusions

The aim of this study was to estimate the private values associated with traditional Hungarian home gardens and their multiple attributes. Data was collected in personal interviews from home garden cultivating farm families in three purposively selected, environmentally sensitive areas (ESAs) of Hungary that are included in the National Agri-Environment Programme (NAEP) and in which the Institute for Agrobotany had identified some important landraces. The choice experiment method was applied to investigate farm families' demand for home gardens and their attributes conditional on the characteristics of the regions, households and main decision-makers in the home gardens.

In general, the findings of the choice experiment support the a priori assumption that home gardens and their multiple attributes contribute positively and significantly to the utility of farm families in ESAs of Hungary. To the extent that the findings are representative of other ESAs in the country, they confirm that home gardens continue to be a vital institution for that nation since the benefits to home garden cultivation are overall positive and high. The value estimates reported in this chapter represent lower bounds since only the private, use values of home gardens were estimated[42].

To investigate if the multiple values that are generated by home gardens are shared across regions, whether or not the values farm families attach to home gardens differ according to the region in which the farm families are located is examined. Where

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and these families are known to bring with them environmentally friendly agricultural production methods, such as organic production.

[42] If the social (regional, national or global) use and non-use values that accrue to the public were also taken into account, these value estimates would be expected to be higher. The Eurobarometer that was released in January 2003 investigated the public opinion on agricultural policies in the candidate countries to the EU. The results of this public opinion poll reveal that the public in these countries supports the multifunctional agriculture promoted by the reformed CAP of the EU. Over 80% of the respondents state that the aim of the EU's agricultural policy should be to ensure that agricultural products are healthy and safe; to favour methods of organic production; to protect medium or small sized farm; to promote respect for the environment; to encourage diversification of agricultural products and activities as well as to favour and improve life in the countryside. The public in these countries therefore does attach values to agricultural production that yields multifunctional benefits. Hence, it should be expected that the total economic value of Hungarian home gardens would most likely be higher than the private (use) value estimates presented in this chapter.

"location" or regions represent a combination of factors related to market infrastructure, farming system, soils and landscape, and cultural references, as explained in chapter 2. The results reveal that differences between regions, in terms of market integration, infrastructure quality and agro-ecological condition, affect home gardeners' private valuation. Our results indicate that in isolated regions that lack food markets, such as Őrség-Vend and Szatmár-Bereg, home gardens that are rich in intra- and inter-species crop diversity are highly valued. In Őrség-Vend, the region with poor soil quality, organic production methods are not so important. Finally, agro-diversity is the most highly valued home garden attribute in Dévaványa, the ESA that supports intensive agricultural production in fields as well as gardens. The effects of regional and community level social and economic factors on farm families' demand for home gardens and agricultural biodiversity therein are investigated in greater detail in the next chapter.

The results of the choice experiment analyses accounting for preference heterogeneity of households disclose that in all three ESAs elderly, experienced and retired home garden production decision-makers attach the highest values to cultivation of landraces, otherwise known as 'ancestral,' 'heirloom,' or 'heritage' crop varieties. Organic production is valued most highly by younger, more educated, higher-income households, as well as by those that are older and lower-income, and less so by middle-aged, middle-income households. Demand for agro-diversity varies by ESA, but those home gardeners who are integrated with field production attach very high values to agro-diversity. Also elderly households which are devoted to traditional method of integrated crop and livestock production placed high values on agro-diversity in all three ESAs.

The choice experiment study discloses the farm family and regional characteristics that are important to consider in designing programmes or policies to conserve or enhance the agricultural biodiversity and other attributes of Hungarian home gardens. Economic theory predicts that those farm families who now attach the highest values to their home gardens would need the least additional public funds as incentives to continue their management (Meng, 1997; Smale *et al.* forthcoming). These "least cost" sites should be ranked the highest as candidate sites and farm families for conservation (Brown, 1991).

APPENDIX TO CHAPTER 3

Table 3.A.1. Description of the 32 choice sets of the choice experiment

			Home garden A					Home garden B				
Q	V	CS	Diversity	Animal	Organic	Landrace	Food %	Diversity	Animal	Organic	Landrace	Food %
1	1	Q1	25	YES	NO	NO	45	20	YES	NO	YES	75
2	1	Q2	13	YES	YES	YES	75	20	YES	NO	YES	60
3	1	Q3	25	NO	YES	NO	15	6	NO	YES	NO	60
4	1	Q4	25	YES	YES	NO	60	6	YES	NO	NO	75
5	1	Q5	6	YES	YES	YES	60	25	YES	NO	YES	60
6	1	Q6	20	YES	NO	YES	75	6	NO	YES	YES	15
7	2	Q1	13	NO	NO	YES	60	6	NO	YES	NO	75
8	2	Q2	20	NO	YES	YES	60	20	YES	NO	NO	45
9	2	Q3	20	NO	YES	NO	45	13	NO	YES	NO	60
10	2	Q4	13	YES	YES	NO	15	13	NO	NO	YES	45
11	2	Q5	20	YES	YES	NO	75	25	YES	YES	NO	15
12	2	Q6	13	NO	YES	NO	60	13	YES	YES	YES	15
13	3	Q1	25	NO	NO	NO	75	20	NO	YES	YES	45
14	3	Q2	13	NO	YES	YES	45	20	NO	YES	YES	15
15	3	Q3	6	YES	YES	NO	45	6	NO	YES	YES	45
16	3	Q4	6	NO	NO	YES	15	20	YES	NO	NO	15
17	3	Q5	20	NO	NO	YES	45	6	YES	NO	YES	60
18	4	Q1	6	YES	NO	YES	45	13	YES	YES	NO	45
19	4	Q2	13	NO	NO	NO	45	25	YES	YES	NO	15
20	4	Q3	25	NO	NO	YES	15	13	YES	YES	YES	60
21	4	Q4	20	NO	NO	NO	60	25	NO	NO	YES	45
22	4	Q5	20	YES	YES	YES	15	20	NO	YES	NO	75
23	5	Q1	6	YES	NO	NO	60	20	NO	YES	NO	60
24	5	Q2	13	YES	NO	NO	75	25	NO	NO	NO	60
25	5	Q3	6	NO	YES	YES	15	25	NO	NO	YES	15
26	5	Q4	6	NO	NO	YES	75	13	NO	NO	NO	75
27	5	Q5	13	YES	NO	YES	15	6	NO	NO	NO	45
28	6	Q3	6	NO	YES	NO	75	6	YES	NO	YES	75
29	6	Q4	20	YES	NO	NO	15	13	YES	YES	YES	75
30	6	Q5	25	YES	NO	NO	60	13	NO	NO	YES	15
31	6	Q1	25	NO	YES	YES	75	25	YES	YES	NO	45
32	6	Q2	25	YES	YES	YES	45	25	NO	NO	NO	75

Q: Question number, V: Number of the version of the choice experiment, CS: Choice set number

Figure 3.A.1. Introduction to the choice experiment

Choice Experiment on Hungarian Home Gardens: Introduction Sheet

Szent István University of Gödöllő and University of London are carrying out a survey that might have impacts on the Government's agricultural policy. We are interested in your opinions. There are no right or wrong answers and your answers will be treated in strictest confidence.

In this survey we would like to find out what the important characteristics of home gardens are to the home garden producers. Therefore, with the help of several home garden producers and agricultural scientists we have identified 5 home garden characteristics and generated several home gardens using differing levels of these characteristics. Home garden characteristics and their levels include

1. *Crop species diversity in the home garden.* This is measured by the "Total number of crop species that are grown in the home garden" characteristic. For example a garden with one tomato variety, one bean varieties, one maize variety, one squash variety, one paprika variety and one onion variety has in total 6 different crops. We will present you with 4 levels of crop diversity: 6, 13, 20 or 25 varieities.

2. *Livestock production.* The "Home garden production is combined with livestock production" characteristic, indicates whether you would prefer a home garden without livestock production to one that is combined with livestock production. In other words, would you prefer an integrated crop and livestock production system over a system that is specialised in crops.

3. *Organic production.* The "Home garden crops are produced entirely with organic production methods" characteristic indicates whether or not a home garden is produced with organic methods of production.. For example, when a farmer sells home garden crops that are produced entirely with organic methods, these products are certified as organic. These are the practices to which we are referring when we use the term "organic production." Specifically, by organic production methods we mean application of no chemicals or application of those chemicals that are certified as 'can be used for biological production'. Consider your imaginary garden. Decide whether or not you prefer a garden in which you produce crops with entirely organic methods.

4. *Landrace.* "Home garden has a landrace" characteristic indicates whether or not you prefer to have a garden in which a landrace is grown as opposed to none. A landrace is defined as a crop variety that was grown by farmers, such as you or your ancestors, before the agricultural modernisation programs took place during the 1960s.

5. *Economic importance of home gardens.* "Expected proportion (in %) of annual household food consumption met through food production in the home garden" indicates the importance of the contribution of the home garden production to your household budget. For example, if the expected proportion of annual household food consumption met through food production in the home garden is 60%, that means the remaining 40% of your household food consumption must be supplied from other sources (such as markets, supermarkets, exchange with neighbours). The percentage specified for each garden represents the extent to which you expect that garden to provide your household with its present annual food requirements, considering that production can vary with weather conditions. The percentages that will be presented to you include 15%, 45%, 60% and 75%.

We have put the generated home gardens in pairs on a series of cards, and we would like you to indicate out of the pair, which home garden you prefer in each card.

Now, please imagine you will cultivate a hypothetical home garden. The following 5 *(or 6)* questions will each present you with two different home gardens: home garden A and home garden B, each garden is **500m^2** in area in each case. Could you please compare each garden in the following cards I will be presenting to you and tell me which one you prefer in each case? Home garden A or home garden B or neither home garden A nor home garden B, in which case you will not be cultivating a home garden?

Table 3.A.2. Random parameter logit model estimates for Dévaványa ESA

Attributes		Coeff. (s.e.)
Constant	Mean coefficient	0.050 (0.384)
	St. dev. of coefficient	0.002 (0.110)
Diversity	Mean coefficient	-0.031 (0.117)
	St. dev. of coefficient	0.0003 (0.040)
Agro-diversity	Mean coefficient	0.504*** (0.070)
	St. dev. of coefficient	0.0006 (0.068)
Organic production	Mean coefficient	0.293*** (0.070)
	St. dev. of coefficient	0.0005 (0.067)
Landrace	Mean coefficient	0.085 (0.066)
	St. dev. of coefficient	0.002 (0.064)
Self sufficiency	Mean coefficient	0.466×10^{-5}*** (0.105×10^{-5})
	St. dev. of coefficient	0.845×10^{-8} (0.598×10^{-6})
Sample size	1599	
ρ^2	0.109	
Log likelihood	-521.65	
Replications for simulated probability	500	

Source: Hungarian Home Garden Choice Experiment, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002.
*** 1% significance level, ** 5% significance level and *10% significance level with two-tailed tests

Table 3.A.3. Random parameter logit model estimates for Őrség-Vend ESA

Attributes		Coeff. (s.e.)
Constant	Mean coefficient	-1.475***
		(0.433)
	St. dev. of coefficient	0.007
		(0.122)
Diversity	Mean coefficient	0.284**
		(0.131)
	St. dev. of coefficient	0.001
		(0.044)
Agro-diversity	Mean coefficient	0.256***
		(0.077)
	St. dev. of coefficient	0.002
		(0.074)
Organic production	Mean coefficient	0.116
		(0.077)
	St. dev. of coefficient	0.003
		(0.073)
Landrace	Mean coefficient	0.241***
		(0.072)
	St. dev. of coefficient	0.002
		(0.070)
Self sufficiency	Mean coefficient	$0.954\text{x}10^{-5}$***
		($0.123\text{x}10^{-5}$)
	St. dev. of coefficient	$0.918\text{x}10^{-8}$
		$0.661\text{x}10^{-6}$
Sample size	1344	
ρ^2	0.125	
Log likelihood	-430.49	
Replications for simulated probability	500	

Source: Hungarian Home Garden Choice Experiment, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002.
*** 1% significance level, ** 5% significance level and *10% significance level with two-tailed tests

Table 3.A.4. Random parameter logit model estimates for Szatmár-Bereg ESA

Attributes		Coeff. (s.e.)
Constant	Mean coefficient	-0.691
		(0.409)
	St. dev. of coefficient	0.008
		(0.140)
Diversity	Mean coefficient	0.301**
		(0.123)
	St. dev. of coefficient	0.001
		(0.049)
Agro-diversity	Mean coefficient	0.411***
		(0.072)
	St. dev. of coefficient	0.001
		(0.070)
Organic production	Mean coefficient	0.148**
		(0.073)
	St. dev. of coefficient	0.005
		(0.070)
Landrace	Mean coefficient	0.168**
		(0.069)
	St. dev. of coefficient	0.513
		(0.067)
Self sufficiency	Mean coefficient	0.768×10^{-5}***
		(0.109×10^{-5})
	St. dev. of coefficient	0.332×10^{-7}
		(0.693×10^{-6})
Sample size	1479	
ρ^2	0.181	
Log likelihood	443.80	
Replications for simulated probability	500	

Source: Hungarian Home Garden Choice Experiment, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002.
*** 1% significance level, ** 5% significance level and *10% significance level with two-tailed tests

Chapter 4

Economic transition, development and farmers' demand for agricultural biodiversity in Hungarian home gardens

4.1. Introduction

The loss of agricultural biodiversity and associated knowledge has been identified as a serious potential cost of economic development (Myers, 1987; Oldfield and Acorn, 1987; Brush, Taylor and Bellon, 1992). In order to investigate if this statement holds for the case study presented in this thesis, this chapter relates economic development and transition in Hungary to farm families' demand for agricultural biodiversity on their home gardens. In this chapter it is hypothesised that farm families' demand for home gardens and the agricultural biodiversity therein will decrease as Hungary's economic transition proceeds and local, regional and national markets become integrated with European Union accession. This hypothesis is tested with the choice experiment introduced in the previous chapter conducted across 22 communities in 3 regions with varying levels of economic development and market integration owing to the stratified sample design explained in chapter 2.

The next section explains briefly the economic transition, development and growth taking place in the country and restates the role of home gardens in the livelihoods of farm families in rural Hungary. Section 4.3 gives a brief overview of previous studies that investigated the relationship between economic development and farm families' demand for agricultural biodiversity on farms. Section 4.4 reports the results of the econometric analyses and the final section draws the conclusions.

4.2. Economic transition and development in Hungary and the role of home gardens

In 1989 political and economic institutions began transforming the socialist, centrally planned system in Hungary that had been in place for over 40 years into a democratic, free market system (Feick et al., 1993). Since the transition has began, the economic growth in the country has been 'impressive', being named 'the Hungarian miracle' (Halpern and Wyplosz, 1998; OECD, 2002). The successful structural reforms in the country enabled Hungary to narrow its living standards gap separating it from more advanced economies, moving from 47% in 1996 to 52% of the OECD average per capita GDP in 2002 (OECD, 2002; World Bank, 2003). The registered unemployment rate has been low and even decreasing, with full employment rates in Western Hungary and Budapest area. The labour participation, however, is low and labour bottlenecks are thought to impede further economic growth in the country. High growth rates necessary for a rapid catch-up to average European Union (EU) income levels will require both high trend productivity growth and increased labour force participation (OECD, 2002).

Economic and political transition, however, came at a cost of increasing income inequality and a high inflation rate, especially for domestic goods (Wyzan 1996; OECD, 2002). Activity rates have been persistently low in low-skilled segments of the working age population and especially older workers have been finding it increasingly difficult to re-enter the labour market, and hence are withdrawing from the labour force[43] (Wyzan, 1996; OECD, 2002). A country with a labour force participation rate above that of OECD average and comparable to that of the Unites States ten years ago, Hungary now supports the lowest activity rate among OECD countries for low skilled individuals. These developments create a divide between incomes of those who are actually employed and whose productivity and wage increase rapidly and the inactive and those in sectors whose wages have fallen (e.g. agriculture) (Wyzan 1996; OECD, 2002).

Income inequality in Hungary is higher than when communism fell and is rising. Wyzan (1996) finds that the percentage of population characterised as 'poor' is higher in all transitional economies, including Hungary, than it was under communism. The social groups that tend to be the poorest are those that are unemployed and with low educational attainment. The percentage of elderly among the poor are more heavily represented compared to the Western economies, as pensions have fallen relative to

[43] Hungary has responded to rising unemployment associated with market-based restructuring by creating a comprehensive system of early-retirement, light disability and welfare benefits that reduced the labour force participation rate to well below the OECD average by the mid-1990s (OECD, 2002).

wages, and both pensions and wages were eroded by inflation, especially during the first years of transition (Wyzan, 1996).

Rural and peri-urban families' survival mechanisms in transitional economies have been likened to those employed in the third world, in that they rely on home produced agricultural products for households' food consumption (Wyzan, 1996; Seeth *et al.*, 1998; Szép, 2000). As explained in chapter 1, many farm families, as well as peri-urban households supply their families' food consumption from agricultural production in their home gardens, which have been important institutions in rural Hungary since –and even before- the socialist period (Szelényi, 1998; Kovách, 1999; Meurs, 2001; Swain, 2000; Szép, 2000). Home gardens have insured families against consumption risks since community level food markets were few and not fully developed during the socialist era, with variable and uncertain food quality and quantity. After fifteen years since Hungary has started its transition to market economy, community level food markets are still lacking in Hungary, even after the economic transition. This is a result of a combination of historical discouragement of food market formation, high transaction costs and the increasing number of super and hypermarkets in the country that is causing the disappearance of existing few local shops and markets[44] (WHO, 2000). Therefore, during the transition to market economy, home gardens have been insuring the poorer households against consumption risks, as well as food price risks, which came about as a result of high and increasing inflation rates.

Increasing availability and accessibility of markets and price stability are expected to materialise with EU accession, which would lead to reductions in the high consumption risks, transaction costs and low wages that bring about dependency on home-grown food. EU accession is also expected to lead to improved rural infrastructure through SAPARD, along with rural development and the growth of employment opportunities in rural areas outside the agricultural sector (Weingarten et

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[44] The number of hypermarkets has increased from 5 in 1996 to 63 in 2003 (HCSO, 2003).

al., 2004). On the other hand, EU membership can cause higher prices and increasing number of super and hypermarkets, which can lead to further marginalisation of the already marginalised households. If farm families' need for home produced agricultural goods diminishes, as a result of EU accession and completion of transition to market economy, then so would the agricultural biodiversity levels managed on home gardens, which are reported in chapter 2 Table 2.5.

4.3. Economic development and agricultural biodiversity

Three strands of applied economics literature motivate this study. The first analyses the relationship between market development and farmers' choice of production technology, which in turn influences agricultural biodiversity managed on farms (Fafchamps, 1992; Goeschl and Swanson, 1999). Thin markets generate price, income and consumption risks for semi-commercial farmers. If, in addition, farmers have no market insurance mechanisms to enable them to cope with risk *ex post*, they manage risk *ex ante.* Risk is managed *ex ante* through choosing more diverse crop and livestock combinations or producing more than would be optimal in the absence of risk (Roumasset, Boussard and Singh, 1979; Sadoulet and de Janvry, 1995; Moschini and Hennessy, 2000).

Fafchamps (1992) demonstrates that when markets are thin and isolated and/or farmers cannot participate in markets due to high transaction costs, food prices become stochastic, especially for smaller farmers a large covariance between price and income exists. Smaller farmers, who are more risk averse as they lack alternative insurance mechanisms, choose to be self-sufficient in food production in order to insure themselves against price, income and consumption risks. Thus farmers allocate farm resources (e.g. land or household time endowment) to production of a range of food crops and varieties rather than specialising in one or a few cash crops. Fafchamps further demonstrates that as markets get integrated price risks decline, agricultural productivity increases and transaction costs fall. Consequently, the need to become self-sufficient in food production diminishes, freeing farm resources to be used in production of cash crops.

Goeschl and Swanson (1999) demonstrate theoretically that as markets develop and become integrated, farmers' demand for agricultural biodiversity on farm, both as a production input and a provider of consumption goods, subsides. In their model, the integration of output and input markets within farmers' communities, and across broader areas with more heterogeneous natural environments, is the fundamental force driving this change in farmers' demand. When markets are absent, thin, or non-integrated, agricultural biodiversity on farms is often the only instrument available for farm families to manage risks in price and income and hence in consumption. Goeschl and Swanson show that market access supplies farmers with tools to cope more effectively with risk, reducing demand for agricultural biodiversity on farms for purposes of risk management.

As market-induced risks decline with development, any remaining agricultural diversification reflects agro-ecological heterogeneity and production sources of uncertainty (Bellon and Taylor, 1993). It has been found that diversity in crops helps reduce the risk of crop failure due to fluctuating weather conditions (see e.g. Abalu, 1973; Walker *et al.*, 1983; Mcintire, 1983; Singh, 1981). Agricultural biodiversity is also found to reduce pest pressure either through allelopathic effects of crops or through the impact on pest densities of a mixed stand of crops as pests are more likely to spread when crops have the same genetic basis (Gleissman, 1986; Altieri and Lieberman, 1986; Brush, 2000). In Hungary, though production sources of risk such as rainfall variability are believed to be moderate, there is considerable agroecological heterogeneity in the study sites (Juhász, 2000; Gyovai, 2002; Csizmadia, 2004).

The second strand of economic literature investigates the effects of another aspect of economic development, namely population density, on farmers' choice of agricultural production methods, which has consequences for management of agricultural biodiversity on farms. Boserup (1965) and Hayami and Ruttan (1985) find that the ratio of labour to land to be one of the main factors in explaining the transition from low yield, land extensive cultivation (such as traditional farming systems that result in agricultural biodiversity) to land intensive, modern agricultural production systems. They argue that agricultural production becomes intensified (implying reduced levels of agricultural biodiversity managed on farms) in areas that have high population density. Pingali (1997) finds that adaptation of modern varieties of crops has been most complete in densely populated areas where traditional mechanisms for enhancing yields have been exhausted. He adds that intensification occurs in less densely populated areas only if soil conditions are suitable and markets are accessible.

The third strand of literature relates economic development indicators, such as farmers' access to market infrastructure to crop biodiversity levels measured on farms (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; Winters *et al.*, 2004). Brush, Taylor and Bellon (1992) find that one of the driving forces behind continued cultivation of traditional varieties of potatoes on Andean farms in Peru is to compensate for market imperfections and satisfy household demand for diversity in consumption. They find that market access, along with access to insurance and financial resources, is necessary for farmers to adopt modern production technologies, such as modern varieties of potatoes. Adoption, in turn, is associated with cultivation of fewer traditional varieties of potatoes on farms. Meng (1997) and Meng, Taylor and Brush (1998) find the level of market integration, as well as risk attitudes, to be determinants of whether Turkish farmers grow landraces or not. They conclude that isolation from market centres affect positively and significantly the probability of keeping an agricultural biodiversity rich traditional farming system based upon traditional varieties.

Imperfect markets have been found to result in higher levels of within and between species diversity on farms in the *milpa* systems of Puebla, Mexico (Van Dusen 2000; Van Dusen and Taylor, 2003). Smale, Bellon and Aguirre Gómez (2001) observed a negative relationship between infrastructure development in a community (transportation, communication and education) and maize landrace diversity managed on farms in Guanajuato, Mexico. The diversity of rice varieties cultivated on Nepalese farms is found to increase with the distance of the farm households to the nearest market (Gauchan 2004). Recently, Winters *et al.* (2004) found potato diversity in Cajamarca, Peru to be significantly and positively associated with distance to the nearest potato market, indicating that more remote households tend to manage greater potato diversity on farms.

4.4. Econometric analysis

These empirical studies introduced above investigated the relationship of economic development indicators, such as market and infrastructure development and population density, to agricultural biodiversity on farms with revealed preferences observed in survey data from farm households. This study applies a choice experiment, a stated preference method instead, as explained in the previous chapter.

4.4.1. Conditional logit model accounting for community level heterogeneity

As explained in chapter 3, the conditional logit model that fitted the data the best was found to be the specification with the crop species diversity variable in logarithmic form. For the population represented by the sample, indirect utility from home garden attributes takes the form

$$V_{ij} = \beta + \beta_1 \ln(Z_{diversity}) + \beta_2 (Z_{agro-diversity}) + \beta_3 (Z_{organic}) + \beta_4 (Z_{landrace}) + \beta_5 (Z_{selfsuffidency}) \tag{4.1}$$

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, as before.

Farm families' demand for home gardens and their attributes depends on the social and economic characteristics of the households and home garden decision-makers who manage them, as explained and investigated in great detail in the previous chapter. Demand for attributes of home gardens also depend on the social and economic characteristics of the communities in which the farm families are located. The analysis in this chapter holds characteristics of the farm families constant, and focuses on the effects of community level economic development and market integration indicators on farm families' demand for home garden produce and agricultural biodiversity in their home gardens.

The community level social and economic characteristics employed in this chapter are defined and their descriptive statistics are reported in chapter 2, Table 2.2. To investigate the effect of community level characteristics on farm families' demand for home garden attributes, the following conditional logit model with interaction terms was estimated separately for each community level characteristic,

$$
\begin{aligned}
V_{ij} &= \beta + \beta_1 \ln(Z_{diversity}) + \beta_2(Z_{agro-diversity}) + \beta_3(Z_{organic}) + \beta_4(Z_{landrace}) + \beta_5(Z_{selfsuffidency}) \\
&\delta_1(Z_{diversity} \times E_{commchr}) + \delta_2(Z_{agro-diversity} \times E_{commchr}) + \delta_3(Z_{organicproduction} \times E_{commchr}) \\
&+ \delta_4(Z_{landrace} \times E_{commchr}) + \delta_5(Z_{selfsufficiency} \times E_{commchr})
\end{aligned} \tag{4.2}
$$

where E denotes the social and economic characteristics of the community (environment) in which the farm family is located. Table 4.1 reports the coefficients of these interaction terms between home garden attributes and each community level characteristic. As economic theory suggests and previous empirical studies have demonstrated, higher levels of market development and integration are negatively related to farmers' demand for agricultural biodiversity on farms. The effects of shops and enterprises on the demand for crop species diversity are negative and significant. Other community characteristics that proxy for economic development (e.g. number of schools and population density), also have negative effects on farm families' demand for crop species diversity. Demand for crop species diversity, however, is found to increase in farmers' distance to the nearest food market.

The more densely populated the community, the greater the number of schools, enterprises and shops, the less farmers demand landraces in their home gardens. Existence of train station and food market in the community is also negatively correlated with farmers' demand for landraces in the home gardens. Distance from the nearest market positively affects the demand for landraces, consistent with other evidence that these are more likely to be found among more isolated communities.

The unemployment rate in the community is positively related with the farm families' demand for agro-diversity and organic production. Both of these components of home gardens are highly labour intensive and would more likely be undertaken where opportunity costs for employment are low. On the other hand, demand for organic production increases with population density and food markets, reflecting the luxury good nature of organically produced food, since with market availability farm families' can insure food consumption *ex post* by purchasing food in the markets in case the home garden output fails.

The demand for self-sufficiency in food consumption is greater the more distant the communities are from the nearest market town, reflecting transactions costs that induce farmers to depend on home-produced goods. Conversely, the more urbanised the communities are and the higher the numbers of shops, markets and train stations, the less produce farm families demand from the home gardens. Demand for self-sufficiency in food consumption also increases in the unemployment rate of the community, reflecting poorer farmers' dependence on self-produced food.

Table 4.1. Effects of community level characteristics on farm families' demand for home garden attributes.

Community level characteristics	Crop Species Diversity	Animal husbandry	Organic Production	Landrace	Self sufficiency	ρ^2	Log likelihood
Area	-0.87×10^{-6}**	0.59×10^{-5}*	0.41×10^{-5}	-0.63×10^{-5}**	-0.83×10^{-10}**	0.134	-1407.4
Population	-0.19×10^{-5}**	0.11×10^{-4}*	0.66×10^{-5}	-0.14×10^{-4}**	-0.18×10^{-9}**	0.135	-1406.5
Population density	-0.064**	0.52*	0.84**	-0.68*	-0.88×10^{-5}**	0.135	-1405.9
Primary Schools	-0.01***	-0.0047	-0.0087	-0.082**	-0.55×10^{-6}	0.133	-1409.2
Secondary Schools	-0.018***	0.042	-0.0041	-0.11**	-0.12×10^{-5}*	0.135	-1407.2
Food markets	-0.01	0.19**	0.18**	-0.1*	-0.18×10^{-5}**	0.134	-1407.9
Enterprises	-0.44×10^{-4}***	0.69×10^{-4}	-0.36×10^{-4}	-0.23×10^{-3}*	-0.29×10^{-8}**	0.136	-1405.0
Shops	-0.15×10^{-3}**	0.46×10^{-3}	0.56×10^{-4}	-0.84×10^{-3}*	-0.10×10^{-7}**	0.135	-1406.7
Train Station	-0.0058	0.13*	0.1	-0.1*	-0.18**	0.132	-1412.0
Distance (km)	0.5×10^{-3}*	-0.0046	-0.0044	0.0054*	0.78×10^{-7}**	0.132	-1405.0
Distance (min)	0.47×10^{-3}	-0.004	-0.0047	0.0061**	0.67×10^{-7}*	0.131	-1412.7
Unemployment rate	-0.51×10^{-3}	0.055***	0.031**	0.01	0.24×10^{-6}*	0.134	-1407.9

Source: Hungarian Home Garden Choice Experiment, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002; Hungarian Central Statistical Office Census (2001), Statistical Yearbooks for counties of Békés, Jász-Nagykun-Szolnok, Vas and Szabolcs-Szatmár-Bereg (2001)

*Statistically significant at 10% level; ** at 5% level; *** at 1% level with one-tailed test; Sample size= 1487

4.4.2. Community development index

It is not possible to include all the interactions of the community level characteristics with five home garden attributes in one conditional multinomial logit estimate due to possible multicollinearity problems (Breffle and Morey, 2000), as explained in chapter 3. Therefore, four indices were constructed from the set of community level characteristics introduced in Table 2.2. in chapter 2.

The first index is a community development index (CDI) that is similar to the human development index (HDI) developed by the United Nations (UNDP, 2003). First an index was created for each community level characteristic, assigning a score of 100 to the highest achieving community and ranking other communities proportionately in descending order. The CDI was then calculated for each community by averaging over the indices of the characteristics. The resulting rating of 22 communities according to CDI is reported in Table 4.A.1 in the appendix to this chapter. According to CDI Gyomaendrőd community in Dévaványa ESA is the most developed community, while Kerkáskápolna community in Őrség-Vend region is the least.

The results of the conditional logit regression with interactions of CDI and home garden attributes are reported in Table 4.2. The significant interactions are those between farm families' demand for crop species diversity and CDI, for landrace and CDI, for self-sufficiency in food consumption the home garden supplies and CDI. All coefficients have negative signs, confirming that demand for crop species diversity and landrace components of agricultural biodiversity, as well as reliance on home gardens to supply household food consumption decrease with economic development and market integration.

Table 4.2. Effects of CDI on farm families' demand for home garden attributes

Attributes and interactions	Coeff. (s.e.)
Constant	-0.811*** (0.256)
Crop Species Diversity	0.304*** (0.093)
Agro-diversity	0.343*** (0.064)
Organic Production	0.147** (0.064)
Landrace	0.229*** (0.058)
Self sufficiency	0.806×10^{-5}*** (0.832×10^{-6})
Crop species diversity *SDI	-0.315×10^{-3}** (0.142×10^{-3})
Agro-diversity *SDI	0.166×10^{-2} (0.145×10^{-2})
Organic Production * SDI	0.142×10^{-2} (0.148×10^{-2})
Landrace *SDI	-0.209×10^{-2}* (0.135×10^{-2})
Self sufficiency *SDI	-0.306×10^{-7}** (0.154×10^{-7})
Sample size	1487
ρ^2	0.135
Log likelihood	-1407.09

Source: Hungarian Home Garden Choice Experiment, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002; Hungarian Central Statistical Office Census (2001), Statistical Yearbooks for counties of Békés, Jász-Nagykun-Szolnok, Vas and Szabolcs-Szatmár-Bereg (2001)
*** 1% significance level, ** 5% significance level and *10% significance level with one-tailed tests

4.4.3. Factor analysis and urbanisation, food market and population density indices

The other three indices, namely urbanisation index (URI), food market index (FMI) and population density index (PDI) were each calculated using factor analysis. The factor analytic techniques are used to *reduce* the number of variables and to *detect structure* in the relationships between variables, in other words to *classify variables* (Statsoft, 2002). Therefore, in this chapter factor analysis is applied to reduce the number of community level characteristics while detecting the structures among them. This method is commonly used in social sciences and has been used only recently to assess heterogeneity in stated preference methods[45].

The factor analysis in this study was undertaken using the principal factor extraction method in STATA 6.0. Factors with an eigenvalue above one were retained. Varimax rotation suggested the existence of three factors (results are presented in Table 4.A.2 in the appendix to this chapter). The factors were named on the basis of the variables that 'factored' together as well as the relative magnitude of the factor loadings.[46] The first factor consisted of number of secondary schools in the community, area and population of the community as well as the number of shops and enterprises in the community, indicating "urbanisation", and so was this index named. The second factor consisted of distance to nearest market and presence of food market in the communities hence this factor was named "food market". The final factor consisted of the population density and train station variables, which was called "population density". 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 6.0. The three indices that came out of the factor analysis are reported in Table 4.A.3, and the rankings of communities according to each index, URI, FMI and PDI are reported in Tables 4.A.4 through 4.A.6. in the appendix to this chapter.

The indices that are created through factor analysis are used as independent variables and are interacted with farm families' demand for home garden attributes. The results of the interactions between the indices that were created by the factor analysis, namely URI, FMI and PDI, and the farm families' demand for home garden attributes are reported in Tables 4.3 through 4.5 below, respectively.

Table 4.3. reports the results of the conditional logit regression with interactions with URI. The significant interactions are those between the urbanisation index and

[45] Some of the recent applications of factor analysis in stated preference studies can be found in Boxall and Adamowicz (1999), Nunes and Schokkaert (2002) and Kontoleon (2003).

demand for crop species diversity, demand for landraces and the level of self-sufficiency demanded from home garden. Similar to the CDI above, higher URI, i.e. the more urbanised a community is, results in farmers choosing to be less dependent on home garden output for their food consumption, and also in farmers preferring home garden with the less crop species and crop genetic diversity.

Table 4.3. Effects of URI on farm families' demand for home garden attributes

Attributes and interactions	Coeff. (s.e)
Constant	-0.766*** (0.252)
Crop Species Diversity	0.272*** (0.084)
Agro-diversity	0.356*** (0.054)
Organic Production	0.168*** (0.054)
Landrace	0.215*** (0.050)
Self sufficiency	0.777×10^{-5}*** (0.749×10^{-9})
Crop species diversity *URI	-0.259×10^{-5}*** (0.112×10^{-5})
Agro-diversity *URI	0.138×10^{-4} (0.113×10^{-4})
Organic Production * URI	0.847×10^{-5} (0.116×10^{-4})
Landrace *URI	-0.177×10^{-4}** (0.105×10^{-4})
Self sufficiency *URI	-0.234×10^{-9}** (0.120×10^{-9})
Sample size	1487
ρ^2	0.135
Log likelihood	-1406.43

Source: Hungarian Home Garden Choice Experiment, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002; Hungarian Central Statistical Office Census (2001), Statistical Yearbooks for counties of Békés, Jász-Nagykun-Szolnok, Vas and Szabolcs-Szatmár-Bereg (2001)
*** 1% significance level, ** 5% significance level and *10% significance level with one-tailed tests

[46] 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 above 1 and the factor loadings are also high, providing assurance that these can be considered as legitimate factors (Kontoleon, 2003).

The results of the interactions between FMI and the demand for home garden attributes are reported in Table 4.4 below. The significant interactions between FMI and home garden attributes include the ones with demand for crop species diversity, landraces and self-sufficiency. These results disclose that the more integrated into markets a community is, the less the farm families in that community depend on their home gardens to supply their household food consumption and the less crop species and crop genetic diversity the farmers demand in their home gardens.

Table 4.4. Effects of FMI on farm families' demand for home garden attributes

Attributes and interactions	Coeff. (s.e.)
Constant	-0.562** (0.260)
Crop Species Diversity	0.103 (0.095)
Agro-diversity	0.454*** (0.063)
Organic Production	0.249*** (0.064)
Landrace	0.104* (0.058)
Self sufficiency	0.627×10^{-5}*** (0.829×10^{-6})
Crop species diversity *FMI	-0.986×10^{-3}* (0.783×10^{-3})
Agro-diversity *FMI	0.957×10^{-2} (0.806x10-2)
Organic Production * FMI	0.926×10^{-2} (0.818×10^{-2})
Landrace *FMI	-0.011* (0.747×10^{-2})
Self sufficiency *FMI	-0.151×10^{-6}** (0.858×10^{-7})
Sample size	1487
ρ^2	0.132
Log likelihood	-1411.95

Source: Hungarian Home Garden Choice Experiment, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002; Hungarian Central Statistical Office Census (2001), Statistical Yearbooks for counties of Békés, Jász-Nagykun-Szolnok, Vas and Szabolcs-Szatmár-Bereg (2001)
*** 1% significance level, ** 5% significance level and *10% significance level with one-tailed tests

Finally, the interactions between the farm families' demand for home garden attributes and the final index, PDI, are presented in the last column of Table 4.5. The results indicate that reliance on home gardens for household food consumption as well as farmers' demand for landraces decrease with this index. However, the interactions between agro-diversity and PDI, and organic production and PDI are positive, reflecting the intensive labour input required for these modes of home garden production, as well as the luxury good nature of organically produced goods.

Table 4.5. Effects of PDI on farm families' demand for home garden attributes

Variable	Coeff. (s.e.)
Constant	-0.746***
	(0.259)
Crop Species Diversity	0.242**
	(0.099)
Agro-diversity	0.307***
	(0.070)
Organic Production	0.115*
	(0.070)
Landrace	0.237***
	(0.064)
Self sufficiency	$0.832\text{x}10^{-5}$***
	($0.893\text{x}10^{-6}$)
Crop species diversity *PDI	-0.015
	(0.015)
Agro-diversity *PDI	0.252*
	(0.156)
Organic Production * PDI	0.225*
	(0.158)
Landrace *PDI	-0.210*
	(0.144)
Self sufficiency *PDI	$-0.348\text{x}10^{-5}$**
	($0.167\text{x}10^{-5}$)
Sample size	1487
ρ^2	0.133
Log likelihood	-1410.40

Source: Hungarian Home Garden Choice Experiment, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002; Hungarian Central Statistical Office Census (2001), Statistical Yearbooks for counties of Békés, Jász-Nagykun-Szolnok, Vas and Szabolcs-Szatmár-Bereg (2001)
*** 1% significance level, ** 5% significance level and *10% significance level with one-tailed tests

4. 5. Conclusions

The application of a stated preference method, namely a choice experiment 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 farm families reside develop and are integrated in physical market infrastructure, farm families rely less on their home-produced goods for food and the overall agricultural biodiversity they demand diminishes.

The findings of the analyses of choice experiment data interacted with community level data reveal that farmers attach the highest values to home garden production and agricultural biodiversity, especially crop biodiversity, therein in the most isolated and economically marginalised communities of the country. The opportunity costs for these farmers of maintaining home gardens, and hence their demand for home gardens and agricultural biodiversity therein may change with economic development, rising incomes and the market integration that is expected to occur in Hungary as a result of economic transition and EU membership (Fischler, 2003). Market infrastructure in Hungary has expanded rapidly since transition to the market economy began in 1990 (WHO, 2000; HCSO, 2003). Infrastructure development and new employment opportunities as proposed in SAPARD (Weingarten et al., 2004) are expected to increase farmers' access to markets.

The results of the analyses presented above forecast that these changes are bound to reduce farmers' dependency on home gardens for household food consumption as well as their demand for agricultural biodiversity in their home gardens. Therefore, a commitment must now be made to conserve the present levels of agricultural biodiversity that are found in the home gardens of economically and geographically marginalised communities. On the other hand, these already marginalised communities may become increasingly so with further economic transition, development and growth as it has been the case so far in some regions (e.g. Szatmár-Bereg). In this case action must be taken to tackle equity issues to compensate the poorest farm families in the country for being stewards of the country's agricultural biodiversity riches and cultural heritage.

APPENDIX TO CHAPTER 4

Table 4.A.1. Construction of the community development index (CDI)

ESA	Community Name	Community No	Train Station	Distance to market	Population Density	Unemployment	Shops	Enterprises	Primary Schools	Secondary Schools	Food Markets	CDI
Dévaványa	Gyomaendrőd	2	100	100	100	38.7	100	100	100	100	100	93.19
Dévaványa	Szeghalom	4	100	100	92.00	3.99	92.69	59.85	50	50	100	72.06
Dévaványa	Túrkeve	5	100	100	82.00	3.42	63.01	51.78	75	50	100	69.47
Dévaványa	Dévaványa	1	100	100	80.00	5.04	41.55	28.72	50	50	100	61.70
Dévaványa	Körösladány	3	100	100	80.00	5.37	24.20	17.09	25	0	100	50.18
Őrség-Vend	Őriszentpéter	20	100	4.7	76.00	6.53	8.68	10.38	25	0	0	25.70
Őrség-Vend	Apátistvánfalva	12	0	8.5	61.00	100.00	1.83	1.47	25	0	0	21.98
Őrség-Vend	Bajánsenye	13	100	3.9	49.00	7.57	2.28	3.56	25	0	0	21.26
Őrség-Vend	Orfalu	19	0	7.6	15.4	100	0	0.21	0	0	0	13.69
Szatmár-Bereg	Beregsurány	8	0	5.1	69.00	6.40	7.31	2.41	25	0	0	12.80
Szatmár-Bereg	Beregdaróc	7	0	4.5	69.00	2.13	3.65	3.46	25	0	0	11.97
Szatmár-Bereg	Gelénes	10	0	5.9	59.00	5.24	4.11	1.36	25	0	0	11.18
Őrség-Vend	Felsőszölnök	14	0	7.8	57.00	6.56	1.83	1.78	25	0	0	11.11
Szatmár-Bereg	Csaroda	9	0	5.8	53.00	2.68	3.65	2.83	25	0	0	10.33
Szatmár-Bereg	Barabás	6	0	4.9	43.00	8.63	5.02	3.35	25	0	0	9.99
Őrség-Vend	Magyarszombatfa	18	0	3.8	37.00	24.83	2.28	3.25	0	0	0	7.91
Őrség-Vend	Kétvölgy	17	0	6.6	43.00	17.50	0.46	1.05	0	0	0	7.62
Őrség-Vend	Velemér	22	0	4.4	22.00	26.50	0.91	0.63	0	0	0	6.05
Szatmár-Bereg	Márokpapi	11	0	5.6	41.00	2.47	2.74	0.94	0	0	0	5.86
Őrség-Vend	Kercaszomor	15	0	3.1	35.00	2.65	0.91	1.15	0	0	0	4.76
Őrség-Vend	Szalafő	21	0	7	18.00	5.41	1.37	1.26	0	0	0	3.67
Őrség-Vend	Kerkáskápolna	16	0	4.3	22.00	3.61	0.46	0.10	0	0	0	3.39

Table 4.A.2. Results of the factor analysis

Community characteristics	Rotated Factor Loadings		
	Factor 1 Urbanisation	Factor 2 Food Market	Factor 3 Population Density
Train station	0.34	-0.48	0.54
Distance to the nearest market	-0.44	0.75	-0.29
Secondary School	0.88	-0.38	0.22
Food Market	0.47	-0.81	0.34
Area	0.72	-0.61	0.31
Population	0.77	-0.54	0.33
Population Density	0.45	-0.37	0.77
Shops	0.81	-0.40	0.35
Enterprises	0.89	-0.29	0.33
Eigenvalues	4.08	1.56	1.31

Table 4.A.3. Urbanisation, food market and population density indices calculated from factor scores

ESA	Community name	Community No	Train Station	Distance to market	Secondary School	Food market	Population	Area	Population Density	Shops	Enterprises	URI	FMI	PDI
Dévaványa	Dévaványa	1	1	0	1	1	8888	21673	0.41	91	274	6734.25	0.49	0.65
Dévaványa	Gyomaendrőd	2	1	0	2	1	15381	30398	0.51	219	954	11735.36	0.49	0.69
Dévaványa	Körösladány	3	1	0	0	1	5129	12387	0.41	53	163	3886.50	0.49	0.65
Dévaványa	Szeghalom	4	1	0	1	1	10198	21713	0.47	203	571	7775.82	0.49	0.67
Dévaványa	Túrkeve	5	0	0	1	1	10047	23652	0.42	138	494	7662.72	0.49	0.19
Szatmár-Bereg	Barabás	6	0	20.4	0	0	828	3819	0.22	11	32	647.79	-9.98	0.10
Szatmár-Bereg	Beregdaróc	7	0	22.1	0	0	845	2382	0.35	8	33	645.78	-10.81	0.16
Szatmár-Bereg	Beregsurány	8	0	19.8	0	0	563	1600	0.35	16	23	430.53	-9.68	0.16
Szatmár-Bereg	Csaroda	9	0	12.9	0	0	655	2468	0.27	8	27	507.35	-6.31	0.12
Szatmár-Bereg	Gelénes	10	0	16.9	0	0	608	2055	0.30	9	13	464.61	-8.27	0.14
Szatmár-Bereg	Márokpapi	11	0	18	0	0	455	2118	0.21	6	9	353.39	-8.80	0.10
Őrség-Vend	Apátistvánfalva	12	0	11.8	0	0	404	1286	0.31	4	14	309.68	-5.77	0.14
Őrség-Vend	Bajánsenye	13	1	25.8	0	0	545	2185	0.25	5	34	427.25	-12.62	0.57
Őrség-Vend	Felsőszölnök	14	0	12.8	0	0	682	2356	0.29	4	17	522.57	-6.26	0.13
Őrség-Vend	Kercaszomor	15	0	32.2	0	0	233	1287	0.18	2	11	185.12	-15.75	0.08
Őrség-Vend	Kerkáskápolna	16	0	23.1	0	0	101	920	0.11	1	1	82.72	-11.30	0.05
Őrség-Vend	Kétvölgy	17	0	15.1	0	0	140	628	0.22	1	10	110.85	-7.38	0.10
Őrség-Vend	Magyarszombatfa	18	0	26.2	0	0	298	1594	0.19	5	31	241.66	-12.81	0.09
Őrség-Vend	Orfalu	19	0	13.2	0	0	55	694	0.08	0	2	47.50	-6.46	0.04
Őrség-Vend	Őriszentpéter	20	1	21.2	0	0	1305	3356	0.39	19	99	1009.46	-10.37	0.64
Őrség-Vend	Szalafő	21	0	14.2	0	0	238	2737	0.09	3	12	203.85	-6.94	0.04
Őrség-Vend	Velemér	22	0	22.7	0	0	106	955	0.11	2	6	88.29	-11.10	0.05

Table 4.A.4. Ranking of communities according to URI

ESA	Community name	Community No	URI
Dévaványa	Gyomaendrőd	2	11735.36
Dévaványa	Szeghalom	4	7775.821
Dévaványa	Túrkeve	5	7662.716
Dévaványa	Dévaványa	1	6734.25
Dévaványa	Körösladány	3	3886.499
Őrség-Vend	Őriszentpéter	20	1009.455
Szatmár-Bereg	Barabás	6	647.7868
Szatmár-Bereg	Beregdaróc	7	645.7836
Őrség-Vendvidék	Felsőszölnök	14	522.5667
Szatmár-Bereg	Csaroda	9	507.3511
Szatmár-Bereg	Gelénes	10	464.6075
Szatmár-Bereg	Beregsurány	8	430.5347
Őrség-Vend	Bajánsenye	13	427.2498
Szatmár-Bereg	Márokpapi	11	353.3922
Őrség-Vend	Apátistvánfalva	12	309.6777
Őrség-Vend	Magyarszombatfa	18	241.6645
Őrség-Vend	Szalafő	21	203.8456
Őrség-Vend	Kercaszomor	15	185.1208
Őrség-Vend	Kétvölgy	17	110.848
Őrség-Vend	Velemér	22	88.29295
Őrség-Vend	Kerkáskápolna	16	82.72156
Őrség-Vend	Orfalu	19	47.49758

Table 4.A.5. Ranking of communities according to FMI

ESA	Community name	Community No	FMI
Dévaványa	Gyomaendrőd	2	0.48906
Dévaványa	Szeghalom	4	0.48906
Dévaványa	Túrkeve	5	0.48906
Dévaványa	Dévaványa	1	0.48906
Dévaványa	Körösladány	3	0.48906
Őrség-Vend	Apátistvánfalva	12	-5.77091
Őrség-Vend	Felsőszölnök	14	-6.25997
Szatmár-Bereg	Csaroda	9	-6.30887
Őrség-Vend	Orfalu	19	-6.45559
Őrség-Vend	Szalafő	21	-6.94465
Őrség-Vend	Kétvölgy	17	-7.38481
Szatmár-Bereg	Gelénes	10	-8.26511
Szatmár-Bereg	Márokpapi	11	-8.80308
Szatmár-Bereg	Beregsurány	8	-9.68339
Szatmár-Bereg	Barabás	6	-9.97682
Őrség-Vend	Őriszentpéter	20	-10.3681
Szatmár-Bereg	Beregdaróc	7	-10.8082
Őrség-Vend	Velemér	22	-11.1017
Őrség-Vend	Kerkáskápolna	16	-11.2973
Őrség-Vend	Bajánsenye	13	-12.6177
Őrség-Vend	Magyarszombatfa	18	-12.8134
Őrség-Vend	Kercaszomor	15	-15.7477

Table 4.A.6. Ranking of communities according to PDI

ESA	Community name	Community No	PDI
Dévaványa	Gyomaendrőd	2	0.689546
Dévaványa	Szeghalom	4	0.672919
Dévaványa	Körösladány	3	0.647457
Dévaványa	Dévaványa	1	0.64564
Őrség-Vend	Őriszentpéter	20	0.635915
Őrség-Vend	Bajánsenye	13	0.572076
Dévaványa	Túrkeve	5	0.194496
Szatmár-Bereg	Beregdaróc	7	0.162427
Szatmár-Bereg	Beregsurány	8	0.161113
Őrség-Vend	Apátistvánfalva	12	0.143841
Szatmár-Bereg	Gelénes	10	0.135467
Őrség-Vend	Felsőszölnök	14	0.132541
Szatmár-Bereg	Csaroda	9	0.121517
Őrség-Vend	Kétvölgy	17	0.102073
Szatmár-Bereg	Barabás	6	0.099271
Szatmár-Bereg	Márokpapi	11	0.098362
Őrség-Vend	Magyarszombatfa	18	0.085599
Őrség-Vend	Kercaszomor	15	0.082893
Őrség-Vend	Velemér	22	0.050821
Őrség-Vend	Kerkáskápolna	16	0.050266
Őrség-Vend	Szalafő	21	0.039815
Őrség-Vend	Orfalu	19	0.036287

Chapter 5

Managing agricultural biodiversity in Hungarian home gardens: A farm household level analysis

5.1 Introduction

Chapters 3 and 4 examined the stated preferences of farm families in rural Hungary for four components of agricultural biodiversity found on their home gardens with a choice experiment. The historical role and policy significance of these 'repositories of agricultural biodiversity' was explained in chapter 1. The agricultural biodiversity levels found on home gardens as well as the characteristics of the home garden farming families and of the communities and ESAs in which they are located were reported in chapter 2.

In this chapter, the farm household survey data[47] is analysed to explain the variation in observed levels of the four components of agricultural biodiversity, as reported in Table 2.5 in chapter 2. These observed diversity outcomes reflect the optimal production and consumption choices of farm families living in communities with imperfect markets for production inputs and home garden outputs. Predictions are made based on the econometric models, which enable profiling of the farm families that are most likely to sustain current levels of agricultural biodiversity components. Profiles of such households can assist in designing targeted strategies for on farm conservation programmes that are cost-effective, efficient and equitable.

Next section presents a literature review of the case studies on conservation of agricultural biodiversity on farm, conducted in several developing countries. Section 5.3 presents the underlying conceptual approach, i.e. the theoretical model that motivates the econometric models and some comparative statics. Next, hypotheses and operational variables are defined. Section 5.5 introduces the econometric models employed in this chapter. The results of the econometric analyses of the factors that explain variation in levels of four different components of agricultural biodiversity found on Hungarian home gardens are reported in section 5.6. Section 5.7 pulls out the predictions of the econometric analyses to profile the households and home

[47] Please refer to the appendix to this chapter for the Hungarian Home Garden Diversity Survey in English.

gardens that are most likely to sustain these components. Conclusions are drawn in the final section.

5.2. Review of the literature on conservation of agricultural biodiversity on farm

This line of literature came out as a result of the recognised importance of agricultural biodiversity combined with its erosion at an unprecedented rate over the past century, as explained in chapter 1. Seeking for means to halt this erosion and to conserve remainder of this resource *in situ* on farms at least cost, without hindering economic and agricultural development and growth, economists and conservationists turned their attention to farm families that are continuing to employ agricultural biodiversity rich traditional farming methods.

Neoclassical economic theory predicts that specialisation in one kind of variety or technology is the profit maximising solution for a farmer and that it is costly to maintain a diverse portfolio of species, varieties and management systems due to several reasons. These reasons include time and management intensity of diversity maintenance and high opportunity costs associated with not specialising in particular varieties or species with the highest current economic return (Brush, Taylor and Bellon, 1992; Smale, Bellon and Aguirre Gómez, 2001; Gauchan and Smale, 2003). But in reality, it has been observed that contrary to economic theory, farmers often prefer to maintain a diverse portfolio of varieties and to continue employing traditional agricultural technologies, even when modern technologies and high yielding varieties (HYVs) are available to them. Economic studies so far have tried to explain this behaviour by developing several theories, which in turn are tested for their validity using farm and household level survey data.

Several explanations have been found for persistence of management of agricultural biodiversity on farms. These include farmers' attitudes towards risk (in yield, income, price and consumption) and their need to compensate for market imperfections in satisfying household demands for diversity in consumption. Many farmers manage high levels of agricultural biodiversity on farms to keep options open for possible future benefits of diversity, such as being sources of new varieties (i.e. option value of agricultural biodiversity, as discussed in chapter 3). Many farm families use agricultural biodiversity as a way of spreading out labour needs to ensure that limited labour supplies are used more efficiently. There are also cultural benefits (e.g. cuisine, ritual, prestige, payment, gift, social ties) to agricultural biodiversity, and agricultural biodiversity is also found to have positive impacts on overall productivity and soil quality. The number of economic studies that attempted to explain the reasons for on farm conservation and the means by which this method of conservation can be strengthened, are however small compared to the magnitude of the problem of loss agricultural biodiversity in farmers' fields throughout the world[48].

Brush, Taylor and Bellon (1992) investigate the effects of adoption of modern varieties of potato on the diversity of potato varieties on Andean farms. They find adoption of modern varieties to be one of the principal causes of agricultural biodiversity loss. Their findings reveal that farmers only partially adopt to modern varieties of potato and they continue to employ traditional technologies and to maintain crop diversity on farm. Brush, Taylor and Bellon model diversity in potatoes simultaneously with the area planted to modern varieties as a function of household and production characteristics. They identify agro-ecological heterogeneity, in terms of fragmentation of land, to affect the diversity levels maintained on farms positively. They find off farm income availability and access to the markets to have negative and significant impacts on the potato diversity managed on Andean farms. They also find that in the study site that is isolated from market infrastructure, both rich and poor farmers manage higher levels of diversity compared to farm families with medium wealth.

Meng (1997) and Meng, Taylor and Brush (1998) investigate the diversity of traditional varieties of wheat on Turkish farms. They consider the impacts of a

[48] These studies were briefly introduced in the previous chapter. In the context of that chapter, these studies' findings on the effects of market integration and economic development on farm families' demand for agricultural biodiversity on farms were highlighted.

combination of factors, including missing markets, farmer's attitudes towards risk and environmental constraints, on farmers' choices of which varieties to produce, and hence on wheat diversity outcomes on Turkish farms. They find that regional effects signifying environmental constraints, off farm income determining attitudes towards risk, and market integration, measured as transaction costs and distance from markets, all significantly explain diversity of traditional varieties of wheat on Turkish farms. They also investigate the impacts of institutional constraints on diversity and find that the government's fixed prices for wheat, which paid no premiums for traditional varieties, discouraged their production. The study identifies the characteristics of the households that are most likely to maintain traditional varieties of wheat. Those households would be the least-cost and most efficient targets for potential on farm conservation of wheat diversity policies or programmes in the wheat diversity areas of Turkey.

Almost all of the studies on *in situ* conservation of agricultural biodiversity on farm concentrate on diversity within a single crop. An exception to this is Van Dusen (2000) and Van Dusen and Taylor (2003), who investigate within and between species diversity of crops in Mexican *milpa* systems. These studies consider the impacts of agro-ecological conditions, extent of market integration and several household and village level characteristics on agricultural biodiversity outcomes on Mexican farms and find that all these exogenous factors do affect the level of agricultural biodiversity farm families choose to maintain on farm. Their findings disclose that imperfect markets and diverse agro-ecological conditions result in higher, and access to migration result in lower within and between species diversity maintained in the *milpa* systems on Mexican farms.

Smale, Bellon and Aguirre Gómez (2001) study the demand of farmers for traditional varieties of maize in a region of Mexico where cultivation of modern varieties of the crop is negligible. They find that farmers continue cultivation of traditional varieties of maize since they receive private benefits from their several attributes, in line with Lancaster's attribute theory of consumer choice (1966). The maize landrace attributes from which farm families derive utility include their suitability for market sales, consumption of the staple food, food for special occasions, security to avoid disastrous harvests and quality for feed/forage for livestock. The findings of Smale, Bellon and Aguirre Gomez show that the group of variables on the relative provision of these attributes explains the diversity in maize most significantly and differences in varieties in the provision of attributes that farmers identify as important explain the demand for different landraces. Furthermore, their findings suggest that improvements in infrastructure, such as transportation, communication and education, might diminish maize diversity managed on farms as the farmers gain access to markets. However, they also find that the productivity potential of certain landraces, which is a result of agro-ecological conditions, counteracts the effects of infrastructure development, resulting in higher levels of diversity.

Benin *et al.* (2003) study the determinants of inter and intra-species cereal diversity on farms and in communities in Ethiopian highlands. Their findings disclose that agro-ecological, market, household and community level characteristics all effect agricultural biodiversity managed on farms and in communities. They state that policies that shape the access of communities and individual farm families to production assets such as land, labour, oxen and livestock have significant implications for both the inter- and infra-species diversity among cereals. Benin *et al.* find introduction of modern varieties to have little effect on agricultural biodiversity managed on farms mainly because of their limited adaptability to local environments and because of the economic constraints faced by the farm families. Of the household level characteristics they find education, especially that of women to affect diversity managed on farms positively.

Gauchan (2004) investigates the factors that give rise to diversity of rice varieties on Nepalese farms. He finds the rice diversity managed on farms to increase in the size of the household labour stock, age of the main decision-maker, education of the male decision-maker and agro-ecological heterogeneity. He also finds education of the female decision-maker to have a negative effect on rice diversity managed on farms.

As mentioned in chapter 4, Gauchan finds that rice diversity maintained on farms increases in the distance of the farm families to the nearest market.

And most recently, Winters *et al*., (2004) study potato diversity managed on farms in Cajamara, Peru. Their findings disclose that diversity of potato varieties managed on farms increase in the size of the land owned (though at a diminishing rate), number of different plots cultivated, indicating agro-ecological heterogeneity, distance to the nearest market and wealth indicators. They also find that those households that have off farm incomes and that produce high market value agricultural products (i.e. milk) manage fewer potato varieties on their farms.

5.3. Conceptual approach

5.3.1 Theoretical model of the farm household with missing markets

The behavioural model employed to explain the farm households' production and consumption decisions is based on the semi-subsistence model of the farm household with missing markets (Singh, Squire and Strauss, 1986; de Janvry, Fafchamps and Sadoulet, 1991; Taylor and Adelman, 2003).

Though motivated by the situation of developing country farmers, the model is appropriate for analysing the case of home garden production in Hungary. As explained in chapter 1, due to a combination of historical, institutional and geographical factors, home gardens are managed by the farm families to supply families' food needs. Though farm families occasionally participate in market sales of home garden produce in some locations, profit maximisation does not guide their production decisions (Swain, 2000). Even where local markets are more plentiful, as in Dévaványa ESA, heterogeneity of produce quality often induces families to find a "corner" solution where they produce and consume their own output[49] (Singh, Squire and Strauss, 1986; Van Dusen and Taylor, 2003).

The Hungarian case study, therefore, is similar to those in which the markets are missing for outputs (e.g. agricultural products) and/or for inputs (e.g. chemicals, labour). A market is said to be missing, if the cost of participating in the market, namely transaction costs, are so high that self-sufficiency is the household's optimal strategy. Transaction costs[50] subtract from the producer's sales price, and add to the consumer's purchasing price, thereby creating a 'wedge' or a price band between high consumer prices and low producer prices. If the household's shadow price, that is households' valuation of the good in the absence of markets, fall in this price band, the household's optimal response would be to not to participate in the market and to be self-sufficient (de Janvry, Fafchamps and Sadoulet, 1991).

The model depicts a farm family that maximises its utility over consumption of market purchased goods, C_m, leisure, C_l, and home garden outputs, C_k, subscripted k for *kert*, Hungarian for home garden (5.1). The utility is maximised subject to budget, time, and production technology constraints, (5.2), (5.3) and (5.4) respectively. Household utility is influenced by Ω_{HH}, denoting a vector of household characteristics of the farm family that condition consumption preferences. In this simple model the utility function is assumed to be quasi-concave with positive partial derivatives. The prices of all market purchased goods, inputs and wages are exogenous, and production is assumed to be riskless.

[49] During the formal and informal interviews many farm families and home garden decision-makers stated that they prefer the quality of their own produce to what they could purchase in the shops or in the food markets. This is the case in many other transitional economies with strong home garden traditions, such as Bulgaria (Elmeades, personal communication, 2004).
[50] These costs include the costs of transportation to and from the market; mark-ups by merchants; the opportunity cost of time involved in selling (search costs); the opportunity cost of time involved in buying (recruitment and supervision costs); risks associated with uncertain prices and availabilities that determine perceived certainty equivalent prices that are lower than farm-gate prices for items sold and higher for items bought, and a variety of other transaction costs that are household specific (de Janvry, Fafchamps and Sadoulet, 1991).

$$U = U(C_k, C_m, C_l; \Omega_{HH}) \quad (5.1)$$

$$Y = wT + E - wH - p_V V \quad (5.2)$$

$$G(Q, H, V; \Omega_K) = 0 \quad (5.3)$$

$$H + L_o + C_l \equiv T \quad (5.4)$$

where (5.2), full income is composed of value of stock of total time owned by the household (*T*), exogenous income (*E*), which includes non-wage, non-household production income such as direct assistance or pensions, less the values of household management input used in the home garden production (H), and other variable inputs required for production of home garden outputs, such as chemicals, seeds, feed for livestock (V)[51]. For management of home gardens, household management input (*H*) is a necessary and also sufficient input, since these small farms are typically managed by family labour alone, as explained in chapter 1.

The household faces a production constraint for production technology in the home garden (5.3), depicting the relationship between farm inputs (H, V) and all outputs (Q) by an implicit production function (G,) that is quasi-convex, increasing in outputs and decreasing in inputs. The vector Ω_K represents the fixed agro-ecological features of the home garden, such as soil quality. The household also faces a time constraint (5.4), and cannot allocate more time to home garden cultivation (H), off home garden employment (L_O, including employment either in other forms of agricultural production, such as field production or in off farm employment) and leisure (C_l), than the total time available to the household, *T*.

The farm household is driven toward the goal of self-sufficiency in home garden production because of thin, unreliable or missing markets and the consumption and

[51] Note that many of the households that cultivate a home garden also engage in field production, as reported in Table 2.4. in chapter 2. This simple model treats field production decisions as predetermined or exogenous to home garden decisions, affecting them through *E* in full income. Time allocated to field crop production is included in the 'off home garden employment' variable, treating

price risks they face, as explained in chapter 4. This phenomenon brings about an additional constraint that induces the household to equate home garden output demand and supply, resulting in an endogenous, shadow price for home garden outputs. Thus, consumption and production decisions cannot be separated.

$$Q_k = C_k(\Omega_M) \tag{5.5}$$

Q_k and C_k denote the quantity demanded and supplied of home garden produce, and Ω_M is a vector of exogenous characteristics related to availability and access to markets.

The household maximises utility (5.1) subject to the constraints (5.2), (5.3), (5.4) and (5.5). This maximisation results in the following Lagrangian.

$$\mathcal{L} = U(C_k, C_m, C_l; \Omega_{HH}) + \lambda(wT + E - wC_l - p_m C_m - wH - p_v V) + \rho[Q_k - C_k(\Omega_M)] \\ + \mu G(Q, H, V; \Omega_K) \tag{5.6}$$

Assuming interior solutions exist, the optimal set of output and consumption levels and endogenous prices for the home garden products are given by the solutions to the first order conditions. The first order conditions for all inputs and consumption goods for which the markets exist, are:

$$\partial \mathcal{L} / \partial C_m = \partial U / \partial C_m - \lambda p_m = 0$$

$$\partial \mathcal{L} / \partial C_l = \partial U / \partial C_l - \lambda p_l = 0$$

$$\partial \mathcal{L} / \partial \lambda = w(T - H - C_l) + E - p_v V - p_m C_m = 0$$

$$\partial \mathcal{L} / \partial H = -\lambda w + \mu G_h = 0$$

$$\partial \mathcal{L} / \partial V = -\lambda p_v + \mu G_v = 0$$

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wages as exogenous and fixed for both field employment and off farm employment. All variables are

$$\partial \mathcal{L} / \partial \mu = G(Q, H, V; \Omega_K) = 0 \tag{5.7}$$

where the first two equations imply the optimal demand for market purchased goods and leisure respectively. These equations show that the marginal utility the household receives from each commodity equals to Lagrange multiplier, λ, times its market price, p_m and w respectively. The third first order condition is the full income constraint, which insures that the net full income received is expended. Following two equations represent the optimal amount of each input required in the home garden, determined by the equality between the Lagrange multiplier, λ, times the price of the input and its marginal product. The last equation insures being on the transformation function. The optimal demand for the home garden output is

$$\partial \mathcal{L} / \partial C_k = \partial U / \partial C_k - \rho = 0 \tag{5.8}$$

which implies that the marginal utility obtained from consuming home garden products equals to its shadow price, ρ. The supply of the home garden output is

$$\partial \mathcal{L} / \partial Q_k = \rho - \mu G_k = 0 \tag{5.9}$$

which implies that the marginal cost of producing home garden products equals to its shadow price. Substituting for the shadow price ρ in (5.8) and (5.9), it can be shown that the marginal utility of home garden outputs equals to the marginal cost of home garden outputs and to the shadow price.

$$\frac{\partial U}{\partial C_k} = \mu G_k = \rho \tag{5.10}$$

The endogenous shadow price is household-specific, depending on the household characteristics that affect access to markets and consumption demand, such as wealth,

measured for the season preceding the survey.

education, age, household composition. Agro-ecological features of the home garden such as soil quality or irrigation enter the equation through their affect on supply. Fixed factors related to market transactions costs and observed market prices also influence the shadow prices of home garden outputs. The shadow price, ρ, can therefore be expressed as a function of all exogenous prices and household, agro-ecological and market characteristics:

$$\rho = \rho^*(p_m, p_v, w; \Omega_{HH}, \Omega_K, \Omega_M) \tag{5.11}$$

The solution to the household maximisation with missing markets for home garden outputs can be written as:

$$Q_k = Q_k^*(\rho, p_v, w; \Omega_K) \tag{5.12}$$

$$H = H^*(\rho, p_v w; \Omega_K) \tag{5.13}$$

$$V = V^*(\rho, p_v, w; \Omega_K) \tag{5.14}$$

$$C_i = C_i^*(\rho, p_m, w, Y; \Omega_{HH}) \qquad i = k, m, l \tag{5.15}$$

Equation (5.12) is the optimal supply of home garden outputs; (5.13) is the optimal demand of household labour in home garden production; (5.14) is the optimal demand for all other inputs in home garden production; and (5.15) is the optimal demand for market purchased goods, household produced goods and leisure.

Substituting the solution for the shadow price (5.11) into home garden output production and consumption solutions (5.12 to 5.15), optimal production of home garden outputs is seen to be a function of all exogenous variables:

$$Q_k = Q_k^*(p_m, p_v, w; \Omega_{HH}, \Omega_K, \Omega_M) \tag{5.16}$$

Following Van Dusen and Taylor (2003) the level of agricultural biodiversity maintained on the home gardens, which is a direct outcome of the production and consumption choices of the farm household, is a function of all prices, and characteristics of the households, markets, and of the home garden plots

$$ABD = ABD(Q_K^*(p_m, p_v, w; \Omega_{HH}, \Omega_K, \Omega_M)) \tag{5.17}$$

5.3.2. Comparative statics

To investigate the effects of exogenous changes –whether policy or market induced, such as changes in wages, prices of outputs or inputs, exogenous income on farm household behaviour - comparative statics need to be investigated. The overall impact of an exogenous shock of an increase in wages, which might materialise with EU accession, further economic transition and market integration, is investigated with the comparative statics presented in equation (5.18).

Keeping demand for leisure and the shadow price of home garden produce constant, direct effect of an increase in wages is investigated with the first two terms on right hand side of (5.18). An increase in wages results in an increase in the value of time endowment component of total income. Since home garden outputs are normal goods, demand for home garden outputs and hence their production and hence the agricultural biodiversity in the home garden would increase as a result of the increase in total income. On the other hand, an increase in wages results in a decrease in the home garden profit component of household income through increasing costs of home garden production, as a result of increasing price of the input *H*. This fall in the household income through decreasing profits would result in decrease in household demand for home garden outputs. Whether it is the positive impact of the time endowment effect (first term on the right hand side of equation (5.18)) or the negative impact of the profit effect (second term on the right hand side of equation (5.18)) that takes over is undetermined. In short, the overall direct effect of increasing wages on the agricultural biodiversity maintained in the home garden is ambiguous.

The indirect effect of this change on the demand for home garden outputs can be seen from the third and fourth terms on the right hand side of (5.18). The first term shows that an increase in wages results in an increase in the income level and hence in an increase in the demand for home garden outputs. This increases the shadow price of the home garden output. This results in a decrease in home garden output demand, since these goods are normal goods. The household thereby decreases its home garden output production and hence the agricultural biodiversity maintained on the home garden. This impact of increasing wage on home garden output production is thus negative. On the other hand, as it can be seen from the fourth term on the right hand side, an increase in wages results in a decrease in the home garden profits, and hence in income, which results in a decrease in the demand for home garden outputs. The shadow prices for home garden outputs decrease, leading to an increase in the demand for home garden outputs. The overall sign of the indirect effect is ambiguous and so is the overall sign of the indirect and direct effects.

$$\frac{\partial C_k}{\partial w} = \left[\frac{\partial C_k}{\partial (T-H-C_l)} \frac{\partial (T-H-C_l)}{\partial w} + \frac{\partial C_k}{\partial \Pi} \frac{\partial \Pi}{\partial w} \right]\Bigg|_{\overline{\rho},\overline{C_l}} + \left[\frac{\partial \rho}{\partial C_k} \frac{\partial Q}{\partial \rho} \right] \left[\frac{\partial C_k}{\partial (T-H-C_l)} \frac{\partial (T-H-C_l)}{\partial w} + \frac{\partial C_k}{\partial \Pi} \frac{\partial \Pi}{\partial w} \right]\Bigg|_{\overline{C_l}} \qquad (5.18)$$

An increase in exogenous income, such as direct payments, would increase the demand for home garden output, since they are normal goods, holding income and shadow price of home garden outputs constant (5.19). The second term on the left hand side, the income effect, would also undoubtedly be positive, since increase in income would cause an increase in demand for all consumption goods, including home garden outputs. The indirect effect on the other hand, as represented by the third term on the right had side of (5.19), would be an increase in the shadow price of the home garden products as the increased demand causes a perceived scarcity of home garden outputs. The farm household would therefore increase the production of the home garden output in order to equate its supply and demand, and this might amount to strengthening the conservation of agricultural biodiversity on the home gardens.

$$\frac{\partial C_k}{\partial E} = \left.\frac{\partial C_k}{\partial E}\right|_{\bar{\rho}\bar{Y}} + \left.\frac{\partial C_k}{\partial Y}\frac{\partial Y}{\partial E}\right|_{\bar{\rho}} + \left[\frac{\partial C_k}{\partial \rho}\frac{\partial \rho}{\partial E}\right]\left[\frac{\partial Q}{\partial \rho}\frac{\partial \rho}{\partial E}\right] \tag{5.19}$$

The conclusion that can be drawn from the comparative statics analysis is that if interdependence between production and consumption in a farm family is not taken into consideration, the results that can be inferred from only consumption or only production models can consist of large biases (Taylor and Adelman, 2002).

5.4. Dependent and Explanatory Variables

The dependent variables include the components of agricultural biodiversity as reported in Table 2.5 in chapter 2. The four components of agricultural biodiversity investigated in this chapter include crop species diversity, landrace cultivation, which results in genetic diversity, agro-diversity as a result of management of large livestock alongside crops and organic production, which results in soil microorganism diversity. Crop species diversity is a count, represented as a species richness index. The other components are dummy variables representing participation in agricultural biodiversity yielding activities.

Explanatory variables used in the analysis of the survey data are divided into three sets according to the vectors denoted in the theoretical model presented above: household, farm, and market characteristics. The descriptive statistics for these three sets of variables for the three ESAs are reported in Tables 2.3 and 2.4 chapter 2. Variable definitions and hypothesised effects are shown in Table 5.1.

Table 5.1. Definition of explanatory variables and their hypothesised effects on components of agricultural biodiversity

Characteristics	Definition	Crop species diversity	Landrace cultivation	Agro-diversity	Organic Production
Household characteristics					
AGE	the age of the main home garden decision maker	+	+	+	+
AGE2	AGE squared	-	-	-	-
HGPAR	number of family members that participate in home garden production	+, -	+, -	+, -	+,-
TOTFOC	total area of cultivated fields that are also owned by the household (in m^2)	+,-	+,-	+,-	+,-
CAR	household owns a car =1, 0 else	-	-	-	+,-
Farm characteristics					
HGAREA	size of the home garden (in m^2)	+,-	+,-	+,-	-
IRRPER	percentage of the home garden area irrigated	+,-	+,-	-	+,-
GOODSOIL	home garden soil is of good quality=1, 0 else	+,-	+,-	-	+,-
Market characteristics					
SALEM2	value of the sales of the home garden crop output (in HUF) in preceding period, per square meter of the home garden	+,-	-	-	-
DISTKM	distance of the community in which the household is located to the nearest food market (in km^2)	+	+	+	+,-

Age in this model proxies also for experience and education level because of the strong statistical correlations observed among these variables in this data set. Age of the home garden decision-maker is positively correlated with their experience, and negatively correlated with their education. It is hypothesised that age is positively related to crop biological diversity (Brush, Taylor and Bellon, 1992; Meng, 1997; Van Dusen, 2000), especially in Hungary, where older farmers who were raised on family farms before the period of collectivisation are known to be those that cultivate ancestral seed varieties and employ traditional practices. Age probably also relates positively to traditional methods of integrated crop and livestock management without the use of chemical inputs. The quadratic term for age is included since older farmers may prefer not to maintain labour intensive agricultural biodiversity rich home gardens.

The number of household members that participate in home garden production represents the relevant family labour stock, and its effect is hypothesised to be positive for crop (Benin *et al.*, 2003; Gauchan, 2004) and agro-diversity. As Brush, Taylor and Bellon (1992) state 'Sorting, identification and storage of diverse varieties [that are present in the home gardens] is inherently a time and management-intensive activity'. However, home garden participation is highly correlated with the number of children in the family, as well as with the number of family members with off farm employment and hence with exogenous income. Therefore, the effect of this variable on agricultural biodiversity managed on farms might also be negative, as child rearing and off farm employment compete with labour intensive agricultural biodiversity yielding home garden activities. The effect of this variable is ambiguous for soil microorganism diversity as larger families might prefer to use chemicals to ensure sufficient output, but they might also have the exogenous income required for access to and participation in food markets.

The total area of owned, cultivated fields and car ownership account for the wealth and social status of the family. Total area of owned, cultivated fields indicates the extent to which the household is dedicated to agriculture. More 'agricultural' households may have less or more agricultural biodiversity on farms, depending on the complementarity or substitutability of inputs, such as household labour time and chemicals, and outputs (e.g. field output being feed for livestock) between home garden and field production. Car ownership also indicates increased market access, which could be negatively correlated with the need to maintain agricultural biodiversity in home gardens. The effect of car ownership on choice of organic production methods is however ambiguous, given the luxury good nature of organically produced goods in some regions as found from investigation of the stated preference data in chapters 2 and 3.

Wealth indicators are also thought to influence attitudes toward output variability or market uncertainty. Risk aversion, and hence agricultural biodiversity found on farms, is hypothesised to decrease in wealth (Meng, 1997; Van Dusen, 2000). Though farm production is inherently uncertain because of the time lag between input choices and harvest, there is little reason to expect high degrees of output variability in home garden production in Hungary. Market sources of risk are substantial, however, as explained in the previous chapter and in chapter 1.

Farm physical characteristics and micro-ecologies clearly affect the numbers and types of crops and varieties grown on farms (Brush, Bellon and Taylor, 1992; Meng, 1997; Meng, Taylor and Brush, 1998; Van Dusen, 2000; Van Dusen and Taylor, 2003; Gauchan, 2004). Agricultural biodiversity found on home gardens can decrease in the size of the home garden due to increasing scope for specialisation in fewer activities by taking advantage of economies of scale. However agricultural biodiversity on the home gardens can also increase in size as the farm families would have more space, as well as production niches to undertake several agricultural biodiversity-yielding activities. It is hypothesised that farmers with large home gardens would not chose organic production methods since the cost of this method increase in the size of the home garden.

Favourable agricultural production conditions in terms of more irrigation and good soil quality might affect agricultural biodiversity positively, by increasing the productivity of labour input, or negatively, by inducing specialisation in production of less species, especially in larger home gardens for possible market sales. Farmers might also choose to engage in agricultural biodiversity rich production to increase the productivity of an agroecosystem that is not very productive otherwise[52], as discussed in Van Dusen (2000) and Di Falco and Perrings (2002). Many landraces, for example, are bred to adapt to marginal soil conditions and non-irrigated lands. Hence it can be expected that adverse agro-ecological conditions on the home garden might result in landraces being cultivated there, since these varieties, by definition are suitable for cultivation in plots where other varieties might not be cultivated easily. The effect of irrigation and good quality soil on agro-diversity is however hypothesised to be negative, since farmers with good crop production conditions might not choose to tend livestock.

Market characteristics indicate the extent to which the farm families are integrated into markets as sellers (the household specific value of home garden crop output sales variable), and the transaction costs the farm households face in market participation (the community specific distance to the nearest food market variable). Previous studies demonstrate that the more integrated into markets the farm families are, the less agricultural biodiversity they will maintain on farm (Brush, Taylor and Bellon, 1992; Meng, 1997; Van Dusen, 2000; Smale, Bellon and Aguirre Gómez, 2001; Gauchan, 2004; Winters *et al.,* 2004). This result was also found in the previous chapter, with analyses of the choice experiment data. It is hypothesised that households that are integrated into markets as sellers would prefer less agricultural

[52] Diversity of species, varieties and production systems in an agroecosystem might bring about production complementarities, affecting the demand for total system diversity (Van Dusen, 2000). Di Falco and Perrings (2002) find that varietal diversity in agroecosystems reduces yield variability and increases the overall productivity of the entire system. There are several explanations for the phenomenon of diversity increasing productivity of agricultural systems including crops being able to segment the use of resources either spatially or temporally to reduce competition, and reduction in pest pressures. Enrichment of the soil through increased biomass production and protection from soil erosion as a result of having the soil covered for longer periods of the cropping cycle are also some of the reasons why agricultural biodiversity might increase productivity of agroecosystems (Altieri and Merrick, 1988; Traxler and Byerlee, 1993; Van Dusen, 2000).

biodiversity on their home gardens, since they would be specialising in production of a fewer species. It is also hypothesised that farm families' demand for agro-diversity and crop diversity increases in distance to the nearest market, but ambiguous for organic production, since families might prefer to ensure home garden output level by using chemicals when food markets are far away.

5.5. Estimation and econometric issues

5.5.1. Random utility model applied to management of agricultural biodiversity in home gardens

Participation in home garden activities that result in agricultural biodiversity is modelled following the random utility framework proposed by McFadden (1974) and as employed in other conservation of agricultural biodiversity on farm studies (e.g. Meng, 1997, 1998; Van Dusen, 2000; Van Dusen and Taylor, 2003; Gauchan, 2004). The reduced form of the model for the home garden producer household with missing markets for home garden outputs describes the overall welfare of the farm family to be a function of it's household and home garden characteristics and the extent to which the household is integrated into food markets. That is

$$U(\Omega_{HH}, \Omega_K, \Omega_M) \tag{5.20}$$

let $U_i^*(\Omega)$ denote the maximum utility level the household can achieve given its constraints, if the household participates in the home garden activity *i,* which results in some level of agricultural biodiversity. Let $U_{-i}^*(\Omega)$ denote maximum constrained utility otherwise. Both of these utility levels assume optimal choices of production and consumption.

In the random utility model, as explained in chapter 3, the utility the farm family derives from undertaking a home garden activity consists of two parts, an observable part and an unobservable one (Luce, 1959; McFadden, 1974). The utility levels the farm family derives from participating in a home garden activity and otherwise are respectively:

$$U_i^*(\Omega) = \overline{U}_i^*(\Omega) + \varepsilon_i$$

and

$$U_{-i}^*(\Omega) = \overline{U}_{-i}^*(\Omega) + \varepsilon_{-i} \qquad (5.21)$$

The household chooses to participate in the home garden activity i if and only if the utility the household derives from participating in the home garden activity is higher than that of not participating in it. That is,

$$\overline{U}_i^*(\Omega) + \varepsilon_i \succ \overline{U}_{-i}^*(\Omega) + \varepsilon_{-i}$$

or

$$\overline{U}_i^*(\Omega) - \overline{U}_{-i}^*(\Omega) \succ \varepsilon_{-i} - \varepsilon_i$$

$$(5.22)$$

The level of utility derived from each activity is not observable, however the household's actual choice is. For the dichotomous choice case the farm family's choice of activity can be characterised by a variable I_i, such that

$$I_i = \begin{array}{l} 1 \text{ if } U_i^*(\Omega) \succ U_{-i}^*(\Omega) \\ 0 \text{ if } U_i^*(\Omega) \le U_{-i}^*(\Omega) \end{array} \qquad (5.23)$$

The farm family takes several such decisions on whether or not to participate in a home garden activity while managing its home garden. The solution to this set of I participation decisions yields a set of optimal participation choices I^*, where the probability of observing a household's participation in activity i is given by

$$\Pr(i) = \Pr(I_i^* = 1) = \Pr(U_i^*(\Omega) \succ U_{-i}^*(\Omega)) = M(\overline{U}_i^*(\Omega) - \overline{U}_{-i}^*(\Omega) \succ \varepsilon_{-i} - \varepsilon_i) \tag{5.24}$$

where it is commonly assumed that both error terms are normally distributed with mean zero and constant variance, and where M is their cumulative distribution function that is assumed to have a standard normal distribution.

5.5.2. Model specification for landrace cultivation, agro-diversity and organic production

The agricultural biodiversity yielding home garden production decisions of whether or not to engage in integrated crop and livestock management, to cultivate landraces and to employ only organic production methods, all implicate dichotomous, binary choices. (5.24) can be estimated with a univariate Probit model for a binary outcome of taking part in each agricultural biodiversity yielding home garden management activity.

For this model a goodness of fit measure based on the formula developed by Zavoina and McKelvey (1975) is tested (Greene, 1998). The pseudo R^2 (ρ^2) measure is calculated by

$$\rho^2 = N\left(\frac{Var(yf)}{(1+Var(yf))}\right) \tag{5.25}$$

where

$$yf = \beta' x + IMR = E[y^* / y] \qquad (5.26)$$

and IMR is the Inverse Mill's ratio and N is the number of observations.

5.5.3. Model specification for crop species diversity

The Poisson model for count data is the suitable model for estimation of the farm family's decision on how many crop species to cultivate in the home garden, which is a discrete variable (Greene, 1997). Figures 5.A.1. to 5.A.3. in the appendix to this chapter present the histograms for crop species diversity for the pool for all three ESAs and for each ESA, each demonstrating a Poisson distribution.

The probability of choosing k activities given n independent trials is represented by the binomial distribution

$$P(Y = k) = \binom{n}{k} p^k (1-p)^{n-k} \qquad (5.27)$$

where $\binom{n}{k} = \frac{n!}{k!(n-k)!}$ and p is the probability of choosing k.

Statistical theory states that a repetition of a series of binomial choices, from the random utility formulation, asymptotically converges to a Poisson distribution as n becomes large and p becomes small.

$$\lim_{n\to\infty}\binom{n}{k}p^k(1-p)^{n-k}=\frac{e^{-\lambda}\mu^k}{k!} \tag{5.28}$$

where $p=\mu/n$ and μ is the mean of distribution, such as the mean number of crop species cultivated in the home garden per household. This formulation allows modelling of the probability that a household chooses a number of crop species k given a parameter μ, the sample mean.

The statistical theory outlined above can be modelled into a series of discrete farmer decisions that sums across an aggregation of choices to a Poisson distribution. In other words, each farm family makes a series of discrete choice decisions on whether or not to cultivate a specie in their home garden, resulting in several species in the home garden and cumulatively contributing to the overall crop species diversity in the home garden. The summation of a series of discrete choices can be approximated by a Poisson regression for a count of the total number of crop species in the home garden (Hellerstein and Mendelsohn, 1993; Greene, 1997; Van Dusen, 2000; Wale, 2003). Accordingly Poisson specification is used to model the increase in household utility from one additional crop specie produced. The Poisson regression model is the development of the Poisson distribution presented in (5.28) to a non-linear regression model of the effect of independent variables x_i on a scalar dependent variable y_i. The density function for the Poisson regression is

$$f(y_i/x_i)=\frac{e^{-\mu_i}\mu_i^{y_i}}{y_i!} \tag{5.29}$$

where the mean parameter is the function of the regressors x and a parameter vector β is given by

$$E(y_i / x_i) = \mu_i = \exp(x_i^{'}\beta) \qquad and \qquad y = 0,1,2,..... \tag{5.30}$$

where

$$\exp(x_i^{'}\beta) = \exp(\beta_0) + \exp(\beta_1 x_{1i}) + \exp(\beta_2 x_{2i}) .... + \exp(\beta_k x_{ki}) \tag{5.31}$$

Also note that

$$\beta_j = \frac{\partial E[y_i / x_i] / \partial x_{ji}}{E[y_i / x_i]} = \frac{\partial \log E[y_i / x_i]}{\partial x_{ji}\, \partial x_{ji}} \tag{5.32}$$

That is the coefficients of the marginal effects of the Poisson model can be interpreted as the proportionate change in the conditional mean if the j^{th} regressor changes by one unit.

Finally the Poisson model sets the variance to equal to the mean. That is

$$V(y_i / x_i) = \mu_i(x_i, \beta) = \exp(x_i^{'}\beta) \tag{5.33}$$

This restriction of the equality of the mean and variance in the Poisson distribution is often not realistic as it has been found that the conditional variance tends to exceed the mean resulting in over-dispersion problem (Cameron and Trivedi, 1986; Grogger and Carson, 1991; Winkelmann, 2000). If over-dispersion problem does exist, the conditional mean estimated with a Poisson model is still consistent though the standard errors of β are biased downwards (Grogger and Carson, 1991). A more generalised model to account for the over-dispersion problem is based on the negative binomial probability distribution expressed as

$$f(y_i / \mu,\alpha) = \frac{\Gamma(y+\alpha^{-1})}{\Gamma(y+1)\Gamma(\alpha^{-1})}\left(\frac{\alpha^{-1}}{\alpha^{-1}+\mu}\right)^{\alpha^{-1}}\left(\frac{\mu}{\alpha^{-1}+\mu}\right)^{y} \qquad (5.34)$$

where

$$\mu_i = \exp(x_i^{'}\beta) \qquad y = 0,1,2.... \qquad (5.35)$$

and $\alpha \geq 0$ characterises the degree of over-dispersion, or the degree to which the variance differs from the mean. That is, in the case of the Negative Binomial model employed here

$$V(y_i / x_i) = \mu_i + \alpha\mu_i^2 \qquad (5.36)$$

Cameron and Trivedi (1990) have proposed a regression-based test for over dispersion, which tests for the significance of the α parameter as compared to the Poisson model (Greene, 1998). The test is based on the hypothesis that the Poisson model, $(y - E[y])^2 - E[y]$ has mean zero and that under both the null and the alternative hypotheses the Poisson model gives consistent estimates of $E[y_i] = \mu_i$. The test is based on the hypotheses

$$H_0 : Var[y_i] = \mu_i$$

vs.

$$H_1 : Var[y_i] = \mu_i + \alpha g(\mu_i) \qquad (5.37)$$

The test is carried out with simple least squares regressions by testing the significance of the single coefficient in OLS regression of

$$z_i = [(y_i - \mu_i)^2 - y_i]/(\sqrt{2}\mu_i)$$

on

$$w = g(\mu_i)/(\sqrt{2}\mu_i) \tag{5.38}$$

This is a simple t-test that is carried with two additional regressions

$$g(\mu_i) = \mu_i$$

and

$$g(\mu_i) = \mu_i^2 \tag{5.39}$$

5.5.4. Likelihood ratio tests

Likelihood ratio test introduced in chapter 3 is employed again in this chapter in order to investigate whether or not the parameters of the estimated Probit and Poisson models for each one of the components of agricultural biodiversity is shared across the three ESAs in our sample. It is expected that each ESA, having distinct agro-ecological, social, cultural, economic, as well as market characteristics has different determinants of agricultural biodiversity in home gardens.

In addition to the testing of the separability of the sample into regions, separability of household decisions on home garden production choice is also tested according to the household model. If the household's decisions on home garden output production and consumption choices are found to be separable, then the farm household model introduced above is recursive, and hence the agricultural biodiversity outcomes on the home gardens should only be determined by the production characteristics of the home garden. The separability of home garden production can be tested by checking if the household, home garden production and market characteristics are significant in explaining households' decision, as proposed by Lopez (1986) and tested in crop species diversity context by Van Dusen (2000) and Van Dusen and Taylor (2003). For this test a general, unrestricted model is estimated with all three sets of variables, which is then compared to a restricted model that is estimated only with the home garden production characteristics. The likelihood ratio test statistics is given by

$$LR = -2\left[\ln L(\beta_{restricted}) - \ln L(\beta_{unrestricted})\right] \tag{5.40}$$

which is equal to the critical value at the χ^2 distribution with the degrees of freedom equal to the number of variables omitted in the restricted model.

Table 5.2 below summarises all the econometric models used to analyse the data, their characteristics and suitability to the data for each agricultural biodiversity attribute of the home gardens.

Table 5.2. Summary of the econometric models used in analysis of the revealed choice agricultural biodiversity data

Agricultural biodiversity attribute	Econometric Model	Definition
Crop species diversity	Poisson Model	Suitable model for estimation of count data, based on Poisson distribution but restricted by the assumption that the sample mean equals sample distribution
	Negative Binomial Model	Suitable model for estimation of count data, based on Poisson distribution, however unlike the Poisson model it is not based on the assumption that the sample mean equals sample distribution
Landrace cultivation, livestock production and organic production	Probit Model	Suitable model for binary choice of whether or not to engage in agricultural biodiversity yielding home garden activity. The Probit Model is based on the normal distribution.

Finally, Table 5.3 summarises all the tests conducted in this chapter.

Table 5.3. Summary of all the tests employed in this chapter

Model	Test	Aim of the test
Poisson	Regression based test for over-dispersion Cameron and Trivedi (1990)	To investigate whether or not the distribution of the sample mean differ from distribution of the variance, if the test fails than Negative Binomial model should be employed.
Probit	McKelvey and Zavoina (1975) goodness of fit measure	To investigate the goodness of fit of a Probit regression.
All models	Likelihood ratio test for separability of exogenous factors that affect agricultural biodiversity in home gardens (Lopez, 1986)	To investigate whether or not all three groups of exogenous factors (household, home garden and market) affect households' choice of agricultural biodiversity together or separately. If the model is separable then it is recursive (Singh, Squire and Strauss, 1986)
All models	Likelihood ratio test for separability of ESAs	To investigate whether or not the factors that affect agricultural biodiversity management in home gardens are the same across the three ESAs

5.6. Econometric results

The following subsections present the results of the econometric analyses that investigate the effects of each of household, home garden and market level characteristics on farm families' probability of undertaking home garden management activities that result in the four components of agricultural biodiversity riches in the home gardens.

5.6.1. Crop species diversity in Hungarian home gardens

The regression explaining crop species diversity in home gardens is estimated with a Poisson regression since the dependent variable is a non-negative integer as explained above (Hellerstein and Mendelsohn, 1993). Statistical tests for both pooled and separate regressions for the three study sites revealed over-dispersion[53] (Cameron and Trivedi, 1990). Consequently, the regressions were estimated with a Negative Binomial model, an extension of the Poisson regression model, which allows the distribution of the variance to differ from the distribution of the sample mean as explained above (Greene, 1997).

The results of the Negative Binomial model for crop species diversity are reported in Table 5.4. The hypothesis that parameters are constant across regions was rejected with a log likelihood ratio test at 0.5% significance level, and hence separate regressions were estimated for each ESA[54]. Results of the log likelihood ratio tests on separability of home garden production and consumption decisions are consistent with the maintained hypothesis that production and consumption decisions cannot be separated for home garden production for the pool of three ESAs. Greater variation in factors across sites may explain why more of them are statistically significant in the pooled regression, as reported in the first column of Table 5.4., than in the separate regressions. Statistical tests of individual parameters confirm that older decision-makers maintain more crop species, but less so as they age. The stock of family participants in home garden production also contributes positively and significantly to crop species diversity managed on home gardens. The larger the size of the home garden, the higher is the number of crop species grown. Farm families with greater expanses of owned fields alongside home gardens have lower crop species diversity, perhaps because their labour resources are relatively stretched. The most statistically significant variable whose effect also has the largest magnitude is the farm families' distance to the nearest food market. High transactions costs to market participation in most isolated communities induce farmers to depend on the diversity of their home garden output to supply them with foodstuffs.

[53] The results of the Poisson regressions for the pool of all three ESAs and for each ESA are reported in Table 5.A.1 in the appendix to this chapter. The Poisson regression model yields significant results for most of the variables that are thought to effect households' decisions on cultivating a crop species. This model, however, is not suited to the data. The regression based over-dispersion tests show that Poisson model for the pool and for each ESA contain highly significant over-dispersion parameters, α, as represented by the highly significant WI1 and WI2 parameters of the test.

[54] LR= -2[-1050.38-(-327.46+-348.78+-344.46)]=59.36, which is larger than 25.19, the critical value of chi square distribution at 10 degrees of freedom at 0.5% significance.

Results of the log likelihood ratio tests on separability of home garden production and consumption decisions for each ESA reveal that production and consumption decisions cannot be separated for home garden production in any ESA, except Dévaványa. In that region with greater market development and urbanisation, only farm characteristics influence crop species diversity. Specifically, the percent of area that is irrigated positively affects crop species diversity. In each other region and all regions taken together, the level of crop species diversity, a metric calculated over optimal product choices (that in turn imply planting decisions) is affected jointly by household and market characteristics, as well as farm characteristics.

Differences emerge among tests of individual hypotheses in the more isolated regions, Őrség-Vend and Szatmár-Bereg. In Őrség-Vend car ownership is positively associated with the family's decision to cultivate more crop species in their garden. In other words, őrségi households that are better off cultivate more species than their poorer counterparts[55]. Good soil quality also has a favourable effect on crop species richness. Marginal effects of these two significant factors are similar in magnitude. In Szatmár-Bereg, the sign of the most significant (and largest) factor, distance to the nearest food market, is negative. Home gardens in the more distant villages of Szatmár-Bereg are larger in size. Families cultivating these small farms tend to specialise in fewer species, such as fruit trees, for sales to the fruit juice industry, as explained in chapter 2. Similarly, the coefficient on the value of sales of home garden output is negative, though not statistically significant. The size of the total farm area that is cultivated and owned also affects crop species counts negatively and significantly. Families who farm larger fields and sell their produce are more likely to have access to food markets and hence to substitutes for home garden outputs. Cultivated area owned is also wealth indicator, revealing that in Szatmár-Bereg ESA,

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[55] A reason for this finding could be an extension to that found by Szép (2000), which investigates time allocation patterns of Hungarian home garden producer households and finds a rational labour supply behaviour. That is as wages of the main home garden decision-makers increase, they choose to engage in off home garden employment less. It can be argued that these home gardeners might prefer to use that time for leisure activities, such as for cultivation of a species rich home garden.

households that are wealthier are more likely to cultivate fewer species of crops in their home gardens, consistent with the risk aversion hypothesis. Finally, irrigation in the home garden contributes positively to crop species richness in szatmári home gardens.

Table 5.4. Determinants of crop species diversity in Hungarian home gardens

Variables	Pool Coeff. (s.e)	Pool Marginal effects	Dévaványa Coeff. (s.e)	Dévaványa Marginal effects	Őrség-Vend Coeff. (s.e)	Őrség-Vend Marginal effects	Szatmár-Bereg Coeff. (s.e)	Szatmár-Bereg Marginal effects
Constant	1.9***	30.3	1.8**	25	2.2***	43.7	2.9***	43.5
	(0.36)		(1)		(0.6)		0.63	
AGE	0.023*	0.4	0.03	0.35	0.02	0.3	0.02	0.3
	(0.013)		(0.03)		(0.02)		(0.03)	
AGE2	-0.0002*	-0.003	-0.0002	-0.003	-0.00008	-0.002	-0.0002	-0.003
	(0.00011)		(0.0003)		(0.0002)		(0.0002)	
HGPAR	0.03*	0.5	0.01	0.14	0.03	0.6	0.002	0.3
	(0.02)		(0.045)		(0.03)		(0.05)	
TOTFOC	$-0.23*10^{-6}$	-0.00004	$-0.2*10^{-6}$	-0.000002	$0.12*10^{-6}$	0.000002	$-0.11*10^{-5}$*	-0.00002
	$(0.45*10^{-6})$		$(0.8*10^{-6})$		$(0.2*10^{-5})$		$(0.7*10^{-6})$	
CAR	-0.0004	-0.007	-0.0004	-0.006	0.2***	4.4	-0.17	-2.5
	(0.02)		(0.06)		(0.07)		(0.12)	
HGAREA	0.00002*	0.0003	0.00003	0.0004	$0.7*10^{-5}$	0.0001	0.00001	0.0002
	(0.00001)		(0.00009)		(0.1×10^{-4})		(0.00001)	
IRRPER	0.002***	0.03	0.002**	0.03	-0.0008	-0.02	0.003*	0.05
	(0.0006)		(0.001)		(0.0009)		(0.002)	
GOODSOIL	-0.0005	-0.0008	-0.000005	-0.00006	0.21*	4.2	0.0001	0.002
	(0.0005)		(0.0008)		(0.15)		(0.09)	
SALEM2	-0.0004	-0.006	-0.0021	-0.03	0.00024	0.005	-0.0003	-0.005
	(0.0006)		(0.0032)		(0.0009)		(0.001)	
DISTKM	0.01***	0.2	-	-	0.00023	0.05	-0.04***	-0.6
	(0.002)				(0.0048)		(0.01)	
Sample size	323		104		109		110	
Iterations completed	17		15		16		17	
Log likelihood	-1050.38		-327.46		-348.78		-344.46	
Chi squared	166.1		55.74		22.79		24.32	
D.o.f	1		1		1		1	
Significance level	0.00		0.00		0.0000018		0.00	
α	0.092***		0.11***		0.041***		0.062***	
	(0.012)		(0.025)		(0.014)		(0.17)	
Separability test $\Omega_{HH} = \Omega_M = 0$ (D.o.f = 7 for all except Dévaványa D.o.f. = 6)								
Likelihood ratio test	32.3***		5.9		15.9**		16.5**	
Probability	0.999		0.884		0.999		0.999	

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

* significant at less than 10%, ** significant at less than 5%, *** significant at less than 1% with one-tailed or two-tailed tests as shown in Table 5.1; regression is Negative Binomial; marginal effects are computed at mean values.

5.6.2. Crop genetic diversity in Hungarian home gardens

Univariate Probit regressions for landrace cultivation in the home garden, which results in crop genetic diversity are reported in Table 5.5. As explained in chapter 2, in this project only bean and maize landraces were investigated. Therefore landrace cultivation refers to cultivation of either bean or maize landraces. Log-likelihood ratio tests again confirm the non-separability of consumption and production decisions in each region and for the pool of three ESAs, as reported in Table 5.5. Log likelihood ratio tests also confirm the dependence of parameters on region[56], both at 0.5% significance level. Each one of the models performs well by assigning over 65% of predictions into the correct category. The ρ^2 goodness of fit measure, however, is not high for the pool and for Szatmár-Bereg ESA but performs well for the other two ESAs.

For the pool of three ESAs household characteristics (age, labour supply, wealth) and distances to the nearest market play an overwhelming role in the decision to plant landraces in the home garden. Stocks of family labour have both large and statistically significant effects. The importance of age and experience is particularly pronounced in Dévaványa, where it is the only significant variable. Clearly, in this more urbanised and economically developed region, the older farmers who were raised as children on home gardens with landraces before the collectivisation period are those who retain them.

Őrségi families who are more agriculturally based, with larger fields and with more family labour engaged on the home garden are more likely to cultivate landraces. In this less favourable agro-ecology, the irrigated share of the home garden relates negatively to the prospects that a landrace is grown. Coupled with the negative sign on the soil quality variable, these findings imply landraces in this region are found in less favoured environmental niches. Poorer families in Szatmár-Bereg, without cars and the market access they provide, are more likely to cultivate landraces. In this ESA larger home garden areas increase the likelihood that landraces are grown alongside.

[56] LR= -2[-202.60-(-49.71+-63.65+-64.70)]=49.08, which is larger than 25.19, the critical value of chi square distribution at 10 degrees of freedom at 0.5% significance, hence the parameters cannot be pooled for the three ESAs.

Table 5.5. Determinants of landrace cultivation in Hungarian home gardens

	Pool		Dévaványa		Őrség-Vend		Szatmár-Bereg	
Variables	Coeff. (s.e)	Marginal effects	Coeff. (s.e)	Marginal effects	Coeff. (s.e)	Marginal effects	Coeff. (s.e)	Marginal effects
Constant	-4.5***	-1.8	-12.43	-0.07	-3	-0.15	-3	-0.3
	(1.2)		(4.2)		(2.7)		(2)	
AGE	0.12***	0.05	0.42***	0.0024	0.1	0.005	0.03	0.003
	(0.04)		(0.14)		(0.1)		(0.07)	
AGE2	-0.0009**	-0.4×10^{-3}	-0.0035***	-0.00002	-0.0007	-0.00004	-0.0001	-0.1×10^{-4}
	(0.00036)		(0.0012)		(0.0008)		(0.0006)	
HGPAR	0.14***	0.8×10^{-3}	-0.23	-0.001	0.2**	0.01	0.43***	0.04
	(0.068)		(0.19)		(0.1)		(0.14)	
TOTFOC	-0.6×10^{-6}	-0.12×10^{-6}	$-0.6*10^{-5}$	$-0.3*10^{-7}$	0.00002**	$0.1*10^{-5}$	0.13×10^{-6}	0.1×10^{-7}
	(0.1×10^{-5})		$(0.6*10^{-5})$		(0.00001)		(0.3×10^{-5})	
CAR	0.002	0.8×10^{-3}	0.2	0.2	-0.24	-0.01	-0.97***	-0.1
	(0.006)		(0.34)		(0.3)		(0.35)	
HGAREA	0.4×10^{-5}	0.2×10^{-5}	-0.0001	$-0.5*10^{-6}$	-0.00005	$-0.3*10^{-5}$	0.6×10^{-4}*	0.6×10^{-5}
	(0.3×10^{-4})		(0.0003)		(0.00005)		(0.4×10^{-4})	
IRRPER	-0.002	-0.8×10^{-3}	-0.001	$-0.8*10^{-5}$	-0.0052*	-0.0003	0.0046	0.5×10^{-3}
	(0.002)		(0.0035)		(0.0036)		(0.005)	
GOODSOIL	-0.0008	-0.3×10^{-3}	-0.0007	$-0.4*10^{-5}$	-0.23	-0.01	-0.18	-0.018
	(0.0007)		(0.001)		(0.5)		(0.3)	
SALEM2	0.0014	0.5×10^{-3}	0.01	$0.6*10^{-4}$	0.3	0.02	0.2×10^{-3}	0.1×10^{-4}
	(0.001)		(0.01)		(0.3)		(0.0014)	
DISTKM	0.03***	0.01	-	-	-0.014	-0.0007	0.049	0.005
	(0.0075)				(0.02)		(0.045)	
Sample size	323		104		109		110	
Log likelihood	-202.60		-49.71		-63.65		-64.70	
Chi squared	38.32		21.74		23.57		22.78	
D.o.f	10		9		10		10	
Significance level	0.00003		0.0097		0.0088		0.01	
Correct predictions	65%		73%		85%		71%	
ρ^2	0.44		0.74		0.996		0.49	
Separability test $\Omega_{HH} = \Omega_M = 0$ (D.o.f = 7 for all except Dévaványa D.o.f. = 6)								
Likelihood ratio test	19.9***		20.45***		20.94***		19.4***	
Probability	0.999		0.999		0.999		0.999	

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

* significant at less than 10%, ** significant at less than 5%, *** significant at less than 1% with one-tailed or two-tailed tests as shown in Table 5.1; regression is Probit; marginal effects are computed at mean values.

5.6.3. Agro-diversity in Hungarian Home Gardens

The dichotomous choices of whether or not to manage livestock alongside crops in the home garden is modelled with a univariate Probit model, the results of which are reported in Table 5.6. Only management of large animals (i.e. pig, cattle, horse and donkey, among which pig is the most common across ESAs) is taken into account when defining agro-diversity. This is because small animals do not require as much inputs (e.g. labour time, land area and feed) compared to the larger ones. Log likelihood ratio tests suggest that production decisions are not separable from consumption decisions in any of the regions (including Dévaványa) and regression parameters depend on region[57], both at 0.5% significance levels. Each one of the models performs well by assigning 65% and more of the predictions into the correct category. The ρ^2 goodness of fit measure is reasonable for all ESAs.

For all regions taken together, household characteristics as a set are highly significant determinants of the decision to integrate crops and livestock, distance to market has a weaker effect, and farm characteristics are of no importance. Older, and hence more experienced and traditional decision-makers are more likely to undertake both crop and livestock production in their home gardens. The effect of age declines with this labour-intensive mode of production, offset by the positive effect of the number of family members involved. The labour requirements of livestock production are reflected in the prominent magnitudes of the coefficients on the number of family members involved in home garden production. Larger field areas cultivated and owned are also associated with higher prospects of integrating crops and livestock in the home garden since field output contributes feed and fodder to livestock production. Distance to the nearest food market has a less significant effect, but reflects farm family demand for self-sufficiency in consumption of pork and salami, crucial in the Hungarian diet.

In Dévaványa, where markets are prevalent, distance to the nearest market is of no consequence in the decision for integrated crop and livestock production in the home garden, though age again plays a major role. Denser settlements mean that home garden sizes are significant in the decision to raise livestock in addition to crops. In Őrség-Vend, the age of the decision-maker and stocks of family labour working in the home garden are also important, though garden and field areas are not in its less populated, more dispersed communities in *szer* forms. Owning a car, which provides access to shops in town and indicates wealth, has a large negative effect on the probability that a household raises livestock in the home garden. Distance to market is significant but somewhat less important. In Szatmár-Bereg larger home garden areas are negatively associated with livestock production because szatmári households with larger home gardens tend to specialise in crop (especially fruit trees, as explained above) production for market sales. The negative effect of value of home garden output sales reinforces this finding, though the coefficient is not statistically significant.

[57] LR= -2[-193.38-(-47.04+-58.06+-61.04)]=54.48, which is larger than 25.19, the critical value of chi square distribution at 10 degrees of freedom at 0.5% significance, thereby indicating that the regions cannot be pooled.

Table 5.6. Determinants of agro-diversity in Hungarian home gardens

	Pool		Dévaványa		Őrség-Vend		Szatmár-Bereg	
Variables	Coeff. (s.e)	Marginal effects	Coeff. (s.e)	Marginal effects	Coeff. (s.e)	Marginal effects	Coeff. (s.e)	Marginal effects
Constant	-3.3***	-1.3	-7.7**	-0.005	-4.7*	-1.7	-0.74	-0.7x10^{-3}
	(1.15)		(3.25)		(2.5)		(1.97)	
AGE	0.12***	0.05	0.31***	0.2x10^{-3}	0.14*	0.05	0.045	0.4x10^{-4}
	(0.04)		(0.12)		(0.085)		(0.07)	
AGE2	-0.001***	-0.5x10^{-3}	-0.003***	-0.2x10^{-5}	-0.0014*	-0.5x10^{-3}	-0.0006	-0.6x10^{-6}
	(0.0004)		(0.0011)		(0.0007)		(0.0006)	
HGPAR	0.22***	0.09	-0.09	-0.5x10^{-4}	0.43***	0.16	0.28**	0.3x10^{-3}
	(0.07)		(0.18)		(0.13)		(0.14)	
TOTFOC	0.5x10^{-5}**	0.2x10^{-5}	0.0001	0.7x10^{-7}	0.7x10^{-5}	0.27x10^{-5}	0.6x10^{-5}*	0.56x10^{-8}
	(2*10^{-5})		(0.9X10^{-4})		(0.6x10^{-5})		(0.35x10^{-5})	
CAR	0.0025	0.1x10^{-2}	0.003	0.2x10^{-5}	-0.79**	-0.3	-1***	-0.9x10^{-3}
	(0.005)		(0.01)		(0.34)		(0.38)	
HGAREA	-0.4x10^{-4}	-0.1x10^{-3}	0.0006**	0.4x10^{-6}	0.5x10^{-4}	0.2x10^{-4}	-0.0002***	-0.2x10^{-6}
	(0.3*10^{-4})		(0.0003)		(0.5x10^{-4})		(0.7x10^{-4})	
IRRPER	-0.0002	-0.7x10^{-4}	0.0017	0.1x10^{-5}	0.0033	0.001	-0.0007	-0.6x10^{-3}
	(0.002)		(0.0036)		(0.0037)		(0.0055)	
GOODSOIL	-0.0008	-0.3x10^{-3}	-0.005	-0.3x10^{-5}	-0.37	-0.14	0.4	0.410^{-3}
	(0.0007)		(0.038)		(0.54)		(0.3)	
SALEM2	-0.0001	-0.4x10^{-4}	0.01	0.6x10^{-5}	-0.0086	-0.003	-0.0013	-0.1x10^{-5}
	(0.0008)		(0.01)		(0.01)		(0.046)	
DISTKM	0.013*	0.05	-	-	0.046*	0.017	0.027	0.3x10^{-4}
	(0.008)				(0.024)		(0.046)	
Sample size	323		104		109		110	
Log likelihood	-193.38		-47.04		-58.06		-61.04	
Chi squared	56.3		50.05		28.22		29.49	
D.o.f	10		9		10		10	
Significance level	0.00		0.00		0.0017		0.001	
Correct predictions	65%		78%		74%		72%	
ρ^2	0.55		0.998		0.56		0.56	
Separability test $\Omega_{HH} = \Omega_M = 0$ (D.o.f = 7 for all except Dévaványa D.o.f. = 6)								
Likelihood ratio test	52.5***		39.9***		21.7***		21.5***	
Probability	0.999		0.999		0.999		0.999	

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

* significant at less than 10%, ** significant at less than 5%, *** significant at less than 1%* with one-tailed or two-tailed tests as shown in Table 5.1; regression is Probit; The marginal effects are computed at mean values.

5.6.4. Soil microorganism diversity in Hungarian home gardens

The univariate Probit regressions for estimating the determinants of the decision to use organic production methods are statistically significant only for the pooled regression, and the log likelihood ratio test for separability of ESAs cannot reject the hypothesis that ESAs can be pooled[58]. The results for the pooled regression are reported in the first column of Table 5.7. The log likelihood ratio tests for separability of ESAs reveal that the pool of three ESAs cannot be separated. The Probit model for the pool performs very well by assigning over 86% of the predictions into the correct category, and the ρ^2 goodness of fit measure is reasonable at 0.58. Econometric results for ESA level regressions are also reported in the same table, however these regressions are statistically weak because of the smaller percentages of farmers engaged in organic production relative to other components of agrobiodiversity, as reported in Table 2.5 in chapter 2.

In contrast with the other components of agricultural biodiversity, higher numbers of family participants in home garden production imply that the household is less likely to employ organic methods. Since the stock of home garden labour is highly correlated with family size, this finding suggests that larger families may be reluctant to expose themselves to the yield risks associated with avoiding chemical inputs. Since organic techniques also require labour to substitute for chemicals in pest and disease control, larger home garden areas reduce the likelihood that they are used. Though the effects are statistically weak, good soil quality is positively associated with organic farming since it substitutes for fertilisers.

[58] LR= -2[-117.71-(-43.68+-41.74+-24.46)]=15.66, which is larger than 12.55, the critical value of chi square distribution at 10 degrees of freedom at 25% significance.

Table 5.7. Determinants of organic production in Hungarian home gardens

Variables	Pool		Dévaványa		Őrség-Vend		Szatmár-Bereg	
	Coeff. (s.e)	Marginal effects	Coeff. (s.e)	Marginal effects	Coeff. (s.e)	Marginal effects	Coeff. (s.e)	Marginal effects
Constant	-1.31	-0.13	1.4	0.31	-9.7*	-1.7	-0.2	-0.01
	(1.5)		(2.3)		(5.7)		(3)	
AGE	-0.03	0.0024	-0.07	-0.015	0.3*	0.05	-0.05	-0.003
	(0.05)		(0.08)		(1.8)		(0.1)	
AGE2	-0.00014	-0.00001	-0.0006	0.00014	-0.0024*	-0.0004	0.0004	0.00003
	(-0.0004)		(0.0007)		(0.0015)		(0.0009)	
HGPAR	-0.3***	-0.024	-0.09	-0.02	-0.27**	-0.05	-0.4*	-0.02
	(0.1)		(0.18)		(0.16)		(0.27)	
TOTFOC	$-0.2*10^{-6}$	$-0.2*10^{-7}$	$-0.25*10^{-6}$	$-0.5*10^{-7}$	$0.9*10^{-5}$	$0.2*10^{-5}$	$-0.2*10^{-5}$	$-0.1*10^{-6}$
	$(0.8*10^{-6})$		$(0.1*10^{-5})$		$(0.6*10^{-5})$		(0.00001)	
CAR	0.003	0.0002	0.002	0.0005	-0.13	-0.02	-0.3	-0.02
	(0.015)		(0.014)		(0.37)		(0.65)	
HGAREA	-0.0002**	-0.00002	-0.0003	-0.00006	-0.00013	-0.0002	-0.0003*	-0.00002
	(0.0001)		(0.0003)		(0.00013)		(0.0002)	
IRRPER	-0.002	-0.0002	-0.0036	-0.0008	-0.002	-0.0004	-0.0014	-0.00008
	(0.002)		(0.0037)		(0.004)		(0.009)	
GOODSOIL	0.03	0.003	0.003	0.0006	0.64*	0.11	0.007	0.0004
	(0.25)		(0.013)		(0.5)		(0.5)	
SALEM2	0.00008	$0.8*10^{-5}$	0.0005	0.0001	-0.002	-0.0004	0.0008	0.00005
	(0.001)		(0.0019)		(-0.004)		(0.0018)	
DISTKM	0.01	0.0009	-	-	0.016	0.003	0.07	0.004
	(0.009)				(0.025)		(0.084)	
Sample size	323		104		109		110	
Log likelihood	-117.71		-43.68		-41.74		-24.46	
Chi squared	25.40		5.29		17.38		13.38	
D.o.f	10		9		10		10	
Significance level	0.0046		0.81		0.066		0.2	
Correct predictions	86%		84%		84%		92%	
ρ^2	0.58		0.56		0.57		0.59	
Separability test $\Omega_{HH} = \Omega_M = 0$ (D.o.f = 7 for all except Dévaványa D.o.f. = 6)								
Likelihood ratio test	11.12*		1.96		12.72*		10.81*	
Probability	0.989		0.419		0.998		0.987	

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

* significant at less than 10%, ** significant at less than 5%, *** significant at less than 1%* with one-tailed or two-tailed tests as shown in Table 5.1; regression is Probit; The marginal effects are computed at mean values.

5.7. Designing conservation programmes

The predictions from the models estimated above enable identification of the profiles of families that are most likely to sustain the four key components of agricultural biodiversity on traditional Hungarian home gardens. These profiles can be used to design targeted, least-cost incentive mechanisms to support conservation. Revealed choices farm families reported in the farm household survey indicate the value farmers assign to these components, given the constraints they face.

Farm families that are most likely to manage crop species diversity rich home gardens in each ESA are reported in Table 5.8 and compared to the other farm families in the sample. In Dévaványa, farm families with high probabilities of maintaining crop species diversity levels above the regional average have older home garden decision-makers and fewer children, as reflected in the dependency ratio. These families cultivate smaller total areas of fields but larger home gardens than other households. They are less likely to own cars and home gardens with good quality soil, and both groups have nearby markets.

In Őrség-Vend, the opposite is true, as families with high probabilities of maintaining crop species diversity levels above the regional average own and cultivate larger fields than others. The soils in the home gardens of these farm families are three times more likely to be of good quality, and they have less irrigation in the home garden. These farm families also have lower dependency ratio, fewer family members working off farm and consequently lower incomes and lower food expenditures. They are only slightly farther away from the nearest markets, and sell considerably less home garden produce per unit area. In Szatmár-Bereg, families with high probabilities of maintaining crop species diversity levels above regional average own much smaller total areas of fields and are half as likely to own cars, but they are slightly closer to markets. These households have more irrigation and are likely to have better quality soil in their home gardens.

Table 5.8. Comparison of households with above- and below-average predicted levels of crop species diversity [1]

Characteristics	Dévaványa N=104		Őrség-Vend N=109		Szatmár-Bereg N=110	
	Above Mean	Below Mean	Above Mean	Below Mean	Above Mean	Below Mean
No. of predictions	28	76	46	63	38	72
Age	63.4***	56.7	59.2	56.9	54.7*	57.4
Education	9.95	10.05	9.9	9.94	9	9.6
Home garden participation	1.9	2.1	2.6	2.5	2.5	2.4
Dependency ratio	0.035***	0.075	0.08*	0.12	0.11	0.09
No. off farm employment	0.79	0.84	0.96	1.09	0.57*	0.72
Income	74407.8	75169.4	86581.2*	95941.6	69476.8	72961.5
Food expenditure (HUF)	30142	29507.9	30996***	38854.4	23003.6	22775.6
Field owned and cultivated (m^2)	2586.2**	44758.7	14219.3**	7118.1	7740***	25011
Car	33.3%§§§	40.7%	67.4%	60.3%	28.9%	50%
Home garden area (m^2)	683.1***	529.9	1905.7	1419.4	2551	2701
Irrigation	49.7**	31.1	39.3**	50.9	27***	11.6
Good quality soil	3.7%§§§	21.6%	15.2%§§§	4.8%	39.5%§§§	26.8%
Sales per m^2 home garden in HUF	7.4	4.7	0.4**	11.1	18**	40.9
Distance to the nearest food market	0	0	21.7*	20.2	16.7***	19.2

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

[1] Predicted with probability above 5%; Regional means of crop species diversity for Dévaványa, Őrség-Vend and Szatmár-Bereg are shown in Table 2.5 in chapter 2. Pairwise t-tests show significant differences at less than ***1% significance level, **5% significance level and *10% significance level; Pearson Chi square tests show significant differences at less than §§§ 0.5% significant level, and §§ 1% significant level

Farm families that are most likely to cultivate landraces are predicted and their profiles are reported in Table 5.9. In Dévaványa ESA only one farm family had a high predicted probability (over 75%) of growing landraces, reflecting that landrace cultivation in this ESA is not a sustainable home garden activity. In Őrség-Vend those with high probabilities of growing landraces have older and less educated home garden decision-makers, smaller dependency ratios and less exogenous income compared to those farm families that are not likely to cultivate landraces. These farm families have much larger owned and cultivated field areas than other families, and sell more home garden produce per m^2 of home garden.

In both regions, farm families that are predicted to cultivate landraces are located farther from markets. In Őrség-Vend they have smaller home gardens than other households, while the opposite is true in Szatmár-Bereg. Szatmári farm households that have high predicted probabilities of growing landraces have more family members participating in home garden production, and are less likely to own cars and home gardens with good quality soil compared to other households in that region.

Table 5.9. Comparison of households with high predicted probability of growing landraces and all other households[1]

	Őrség-Vend N=109		Szatmár-Bereg N=110	
	High Probability	Others	High Probability	Others
No. of predictions	20	89	23	87
Age	63.8***	56.5	56.6	56.5
Education	8.7***	10.2	9	9.5
Home garden participation	2.8	2.5	3.4***	2.2
Dependency ratio	0.04***	0.12	0.1	0.09
No. off farm employment	1	1.04	0.87	0.6
Income	84161.8*	93750.8	82084.8	69027.6
Food expenditure (HUF)	35956.9	35517.8	25533.7	22168.1
Field owned and cultivated (m^2)	37374.1***	3989.3	21912.3	18286.8
Car	65%	63%	21.7%§§§	48.3%
Home garden area (m^2)	896.5**	1788.3	3684.5**	2375.5
Irrigation	48.4	45.5	12.4	18.2
Good quality soil	5%§	10.1%	21.7%§§§	33.7%
Sales per m^2 home garden in HUF	35.7***	0.01	34.6	32.6
Distance to the nearest food market	23.1**	20.2	19.4**	18.1

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

[1] High probability is 75% or more; Pairwise t-tests show significant differences at less than ***1% significance level, **5% significance level and *10%significantce level; Pearson Chi square tests show significant differences at less than §§§ 0.5% significant level, §§ 1% significant level; § 5% significance level.

Farm families that are most likely to manage livestock in their home gardens are reported in Table 5.10. Across regions, larger farm households are more likely to undertake mixed crop and livestock production. In Dévaványa and Szatmár-Bereg regions, those that own and cultivate larger fields are more likely to manage livestock alongside crops, reflecting the complementarity between feed production in the field and livestock production in the home garden. Dévaványai farm families with high predicted probabilities of agro-diversity are also more likely to own cars, have home gardens with good quality soil and be more integrated into markets as sellers of home garden produce.

In Őrség-Vend and Szatmár-Bereg regions, younger home garden decision-makers are predicted to be managers of both crops and livestock. In Őrség-Vend and Dévaványa, farm families with larger home gardens are more likely to raise animals in their home gardens, contrary to Szatmár-Bereg, where orchards are cultivated in larger home gardens. Both őrségi and szatmári farm families that are more likely to engage in livestock production have higher dependency ratios and number of household members that are employed off farm. Őrségi households that are predicted to manage agro-diversity in their home gardens are located further away from the markets, and hence are more dependent on their own production of livestock for the families' meat consumption.

Table 5.10. Comparison of households with high predicted probability of engaging in integrated management of livestock and crops and all other households[1]

	Dévaványa N=104		Őrség-Vend N=109		Szatmár-Bereg N=110	
	High Probability	Others	High Probability	Others	High Probability	Others
No. of predictions	24	80	39	70	32	78
Age	55.8	59.3	54***	60	46.8***	60.5
Education	11*	9.7	9.6	10.1	10.1*	9.06
Home garden participation	2.5***	1.9	3.7***	1.9	3.3***	2
Dependency ratio	0.04	0.07	0.19***	0.05	0.15**	0.08
No. off farm employment	1.06	0.75	1.6***	0.74	0.97**	0.55
Income	76362.5	74544.9	100916.3*	87018.8	81110.9	67920.5
Food expenditure (HUF)	26900.9	30522.1	40623	32894.9	26020.5	21520.3
Field owned and cultivated (m^2)	142127.4***	787.7	13735	8098.1	39414.2***	10688.2
Car	66.7%§§§	30.4%	61.5%	64.3%	46.9%	41%
Home garden area (m^2)	974.3***	450.2	2249.7**	1276.4	1609.7***	3075.7
Irrigation	36.9	35.8	45.2	46.5	18.4	16.4
Good quality soil	20.8%§§	15.6%	12.8%§§	7.1%	37.5%	28.6%
Sales per m^2 home garden in HUF	16.3***	2.2	0.6	9.9	15.4	40.2
Distance to the nearest food market	0	0	22.1*	20	18.7	18.2

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

[1]High probability is 75% or more; Pairwise t-tests show significant differences at less than ***1% significance level, **5% significance level and *10%significance level

Pearson Chi square tests show significant differences at less than §§§ 0.5% significance level, and §§ 1% significance level

5.8. Conclusions

This chapter employed the farm household survey data collected from 323 households in three ESAs of Hungary to investigate the revealed preferences of farm families for four components of agricultural biodiversity maintained in home gardens, given the household, agro-ecological and market participation constraints they face.

Across regions, one of the most significant determinants of revealed preferences for maintaining agricultural biodiversity on Hungarian home gardens is age of the home garden decision-maker. Since outmigration of younger generation is a common phenomenon in the more isolated regions, this finding implies that crop species and genetic diversity levels, though relatively rich in these locations, are in jeopardy. Number of family members that participate in home garden production, i.e. the family labour stock is an important determinant of agricultural biodiversity managed on home gardens. Larger families choose to manage home gardens that are richer in terms of crop biodiversity (inter and intra-species diversity) as well as agro-diversity, however farm families' preference for organic production method decrease as families' size become larger. Finally distance to the nearest food market is a significant determinant of agricultural biodiversity farm families choose to manage on home gardens, with agricultural biodiversity levels increasing in the distance to the nearest food market.

One of the main results of the analysis is uniqueness of each region studied in terms of levels of agricultural biodiversity found in the home gardens of farm families, as well as the factors that explain their variation. In each statistical analysis conducted, the hypotheses that population parameters of interest are constant across regions is rejected. Therefore determinants of the agricultural biodiversity farm families choose to manage in each ESA are examined, reported and explained for each region separately. The impacts of household, agro-ecological and market factors on the agricultural biodiversity farm families choose to manage on their home gardens differ (both in magnitude and in direction) across regions. These results imply that any policy or programme that aims to support the management of current levels of agricultural biodiversity in rural Hungary needs to recognise the diversity of traditional home gardens and their context.

Findings are also consistent with the maintained hypothesis that for all regions, the choices of farm families concerning the goods they produce in home gardens, as reflected in the components of agricultural biodiversity measured here, cannot be separated from their consumption decisions. According to the model of the agricultural household that motivates the approach taken in this chapter, market imperfections in Hungary's transitional economy continue to induce farmers to produce for their own food requirements. Furthermore, any policy or programme that affects the wealth, education or labour participation of family members, as well as the formation of food markets within settlements, will influence the choices and observed levels of crop species richness, landrace cultivation, and integrated crop and livestock production through the households' internal equilibria.

Finally, this chapter employed predictions from the empirical model to identify the profiles of those households that would be most likely to sustain management of agricultural biodiversity rich home gardens. These farm families would be the least cost options for any policy or programme that would aim conservation of traditional Hungarian home gardens and the agricultural biodiversity riches they provide.

APPENDIX TO CHAPTER 5

HOME GARDEN DIVERSITY SURVEY

Number: ☐ ☐ ☐

Enumerator code: ☐ ☐ ☐

Settlement name: ....

Date: 2002. ☐ ☐ month ☐ ☐ day   Start: ☐ ☐ hour ☐ ☐ minute

End: ☐ ☐ hour ☐ ☐ minute

Dear Madam/Sir,

My name is... I am a student of University of Szent István. Institute of Agrobotany of Tápiószele and Institute of Environmental Management of University of Szent István of Gödöllő are conducting a research that aims to identify the traditional varieties of crops in Hungary and to investigate the cultivation methods that come with these traditional varieties. As a part of this study, we are carrying out this survey, in which we would like you to take part. Participation in this survey is voluntary and you have the right to not to answer the questions that you do not feel comfortable with. The survey is anonymous and your answers will be treated in the strictest confidence. By participating in this survey you are contributing immensely to the successful development of our research. The survey should not last longer than 40 minutes.

Thank you in advance for your cooperation.

A. FARM AND HOME GARDEN CHARACTERISTICS

Firstly, we would like to find out about your home garden, field(s) and other plot(s) and the methods you use to cultivate them. The questions that are to follow are directed not only at you, but also at your entire household, which is defined as the group of people who live under the same roof and share the same budget.

1. Could you please tell us which one(s) of the following land type(s)/plots you own, rent out and/or rent it?

Land Type	*Home Garden*	*Field*	*Grassland*	*Orchard*	*Forest*	*Vineyard*	*Fishing Lake*	*Not in Use*
Owned								
Rented out								
Rented in								

2. Could you please tell us the following characteristics for each plot you have stated above?

Plot No.	*Home Garden, field, orchard, grassland location (with the appropriate name of the location of the plot)*	*Land Type*		*Area (ha/nöl/m^2)*	*Soil fertlity (good, medium, bad) and/or AK value*	*% area irrigated*	*Owned/ Rented in/ Rented out*
		Home Garden/Field/ Orchard/ Grassland	*Inside or outside the village*				
1.		H	I / O		*Good/Medium/Bad ......AK*		O / RI / RO
2.		F/O/G	I / O		*Good/Medium/Bad ......AK*		O / RI / RO
3.		F/O/G	I / O		*Good/Medium/Bad ......AK*		O / RI / RO
4.		F/O/G	I / O		*Good/Medium/Bad ......AK*		O / RI / RO
5.		F/O/G	I / O		*Good/Medium/Bad ......AK*		O / RI / RO
6.		F/O/G	I / O		*Good/Medium/Bad ......AK*		O / RI / RO

3. Could you please tell us all the crops you have cultivated in your <u>home garden</u> (e.g. vegetables, fruit trees etc.) this year (from January 2002 to August 2002) and the total amount of manure, fertiliser and chemicals you have used during the period of September 2001 to August 2002?

Crop	*Variety name or Local name*	*Area (m^2)*	*Yield (kg)*	*Intercropped (e.g. beans and maize)*	*Fertiliser (F) (kg), Soil Disinfectant(D)/ Compost(C)/ Manure(M) (Number of applications)*	*Herbicide(H)/ Insecticide(I)/ Fungicide(U) (Number of applications)*

4. Could you please state all the crops you have cultivated in your owned and/or rented in field(s) and/or orchard(s) (e.g. cereals, fodder plants, fruit trees etc.) this year (from January 2002 to August 2002) and the total amount and type (if known) of manure, fertiliser and chemicals you have used in each plot, including the grassland, during the period of September 2001 to August 2002 ?

Plot No.	*Crop*	*Variety name or Local name*	*Area (ha, m^2, nöl)*	*Average Yield (kg/ha) or Total Output in the given plot*	*Intercropped (e.g. squash and maize)*	*Fertiliser (F) (kg) and type, Soil Disinfectant(D)/ Compost(C)/ Manure(M)/ (Number of applications)*	*Herbicide(H)/ Insecticide(I)/ Fungicide(U) (Name and the number of applications)*

5. Could you please tell us more about the maize and bean varieties you grow?

	Variety 1.	*Variety 2.*
Maize variety name		
Years grown		
Frequency of seed replacement		
Source of seed	Acquaintance or relative/ market/ shop/further off; distance ......km	Acquaintance or relative/ market/ shop/ further off, distance......km

	Variety 3.	*Variety 4.*
Maize variety name		
Years grown		
Frequency of seed replacement		
Source of seed	Acquaintance or relative/ market/ shop/further off; distance......km	Acquaintance or relative/market/ shop/further off; distance......km

	Variety 1.	*Variety 2.*
Bean variety name		
Years grown		
Frequency of seed replacement		
Source of seed	Acquaintance or relative/ market/ shop/ further off; distance ......km	Acquaintance or relative/ market/ shop/further off; distance......km

	Variety 3.	*Variety 4.*
Bean variety name		
Years grown		
Frequency of seed replacement		
Source of seed	Acquaintance or relative/ market/ shop/ further off; ,distance......km	Acquaintance or relative/ market/ shop/ further off, distance ......km

	Variety	*Variety ....*
...... variety name		
Years grown		
Frequency of seed replacement		
Source of seed	Acquaintance or relative/market/ shop/ further off, distance ......km	Acquaintance or relative/ market/ shop/ further off, distance......km

6. Do you engage in livestock production?

1 Yes

2 No

7. If yes, could you please tell us the type(s) of livestock you produce, number of heads of each type and the percentage distribution of source of feed?

Livestock Type	*Number of head*	*Source of feed (%)*		
		Home Garden	*Field/ Grassland*	*Purchased*
Cattle				
Pig				
Sheep				
Poultry				
Other				

8. Could you please try to estimate your total cash expenditures on your home garden and other plots you cultivate for the following categories of expenditure for the period of September 2001 to August 2002?

The machinery category includes the rental costs of the machinery and labour and the cost of the chemicals used, whereas the manual labour category is the cost of the rental of labour, without the complementary inputs, e.g. rental of labour for collection of apples.

Expenditure Category	*Home Garden*	*Field/Orchard/Grassland*	*Total*
Seed			
Fertiliser, manure, compost			
Electricity and heat			
Petrol and gas oil			
Herbicide, fungicide, insecticide			
Manual labour			
Machinery (rented labour with machinery)			
Building maintenance and supplies			
Other			

9. What is the distribution of labour (in percentage) used for cultivation of crops in the field(s), orchard(s) and grassland(s), for the following type of activities between the following labour categories, again for the period of September 2001 to August 2002?

Type of activity	*Family Labour*	*Outside help not paid in cash*	*Outside help paid in cash*
Soil preparation			
Plant protection			
Harvest			

B.CONSUMPTION AND SALES

The following questions are related to the consumption and sales of the crops you cultivate.

10. Of the crops you cultivate in your home garden, what percentage of each crop category below do you sell, consume, give as gifts or save as seed? Please also state the most important crop in terms of sales in each category.

Crop Category	*Own consumption (food and feed)*	*Sales*	*How often do you sell?**	*To whom do you sell?* **	*Where do you sell?****	*Gifts*	*Seed*
Vegetables (except maize, beans, squash and potato)							
Fruits (fresh, dry, conserved)							
Fodder plants (alfalfa, mangle etc.)							
Dry seeds (poppy seeds, split peas, lentils etc.)							
Maize							
Beans							
Squash							
Potato							

* I sell 1. ...times a week 2. once a week; 3. once a fortnight; 4. once a month; 5. rarely, less than once a month; 6. once a year; 7. none

** I sell to 1. a wholesaler; 2. retailer; 3. other farmers; 4. private individuals for home consumption (strangers, not close acquaintances); 5. private individuals for home consumption (friends, close acquaintances, relatives)

*** I sell 1. inside the village (<10km); 2. outside the village (10km -30km); 3. Outside the village (30km<)

11. Of the crops you cultivate in your <u>field(s) and/or orchard(s),</u> what percentage of each crop category below do you sell, consume, give as gifts or save as seed? Please also state the most important crop in terms of sales in each category.

Crop Category	*Own consumption (food and feed)*	*Sales*	*How often do you sell?**	*To whom do you sell?* **	*Where do you sell?****	*Gifts*	*Seed*
Vegetables (except maize, beans, squash and potato)							
Fruits (fresh, dry, conserved)							
Fodder plants (alfalfa, mangle etc.)							
Cereals (wheat, rye, barley, oat etc.)							
Root crops (sunflower, tobacco etc.)							
Dry seeds (poppy seeds, split peas, lentils etc.)							
Maize							
Beans							
Squash							
Potato							

* I sell 1. …times a week 2. once a week; 3. once a fortnight; 4. once a month; 5. rarely, less than once a month; 6. once a year; 7. none

** I sell to 1. a wholesaler; 2. retailer; 3. other farmers; 4. private individuals for home consumption (strangers, not close acquaintances); 5. private individuals for home consumption (friends, close acquaintances, relatives)

*** I sell 1. inside the village (<10km); 2. outside the village (10km -30km); 3. Outside the village (30km<)

C. HOUSEHOLD CHARACTERISTICS

And finally, we would like to find out more about the characteristics of your household.

12. Could you please state with whom you live together and the involvement of each household member in the cultivation of home garden and/or field(s)?

A household is defined as a group of people who live under the same roof and share the same budget.

Family Status	*Age*	*Education level**	*Occupation***	*Home garden cultivation participation*	*Field cultivation participation*	*Home Garden decision maker*	*Field decision maker*	*Farming Experience of the decision makers in years*
1. Husband/ Male Partner								
2. Wife/ Female Partner								
3. Daughter 1.								
4. Daughter 2.								
5. Son 1.								
6. Son 2.								
7. Grandfather								
8. Grandmother								
9. Grandson								
10. Granddaughter								
11. Greatgrandmother								
12. Greatgrandfather								
13. Other								

* 1. Less than 8 years; 2. 8 years; 3. Technical or trade school; 4. High school; 5. College or university.

** 1. Full-time job; 2. One part-time job; 3. More than one part-time jobs; 4. One full-time and one or more part-time jobs; 5. Unemployed; 6. Housewife; 7. On maternity; 8. benefit; 8. Pensioner; 9. Student; 10. Other

13. Which one of the statements below is true for your household? Please choose only one.

1 We can hardly make ends meet.
2 We can only afford the necessities.
3 We do not have any financial problems, however we do not live in luxury either.
4 We have enough money to live a life of ease.
5 We live a comfortable life, sometimes we can afford luxury goods.
6 We live in luxury.

14. Which one(s) of the statements below are true for your household?

1 We have a car. It is less than 5 years old.
2 We have a car. It is more than 5 years old.
3 We have a colour television.
4 We have a computer. It is less than one year old.
5 In the past two years we spent at least one holiday abroad.
6 In the past two years we spent at least one holiday of more than 5 days in Hungary.
7 We have another flat.
8 We have a microwave oven.
9 We do not have any of the items on this list.

15. Could you please tell the average monthly net income (excluding farm income) of your household?.

We are not interested in your income but in the income of your household, please include in your statement not only the wages the members of your household receive, but also the pensions and any other cash incomes, e.g. maternity and unemployment benefits, etc. Please do not include the income from the farm output sales.

..........................Ft

In which one of the following categories of income brackets does your household average monthly net income lie?

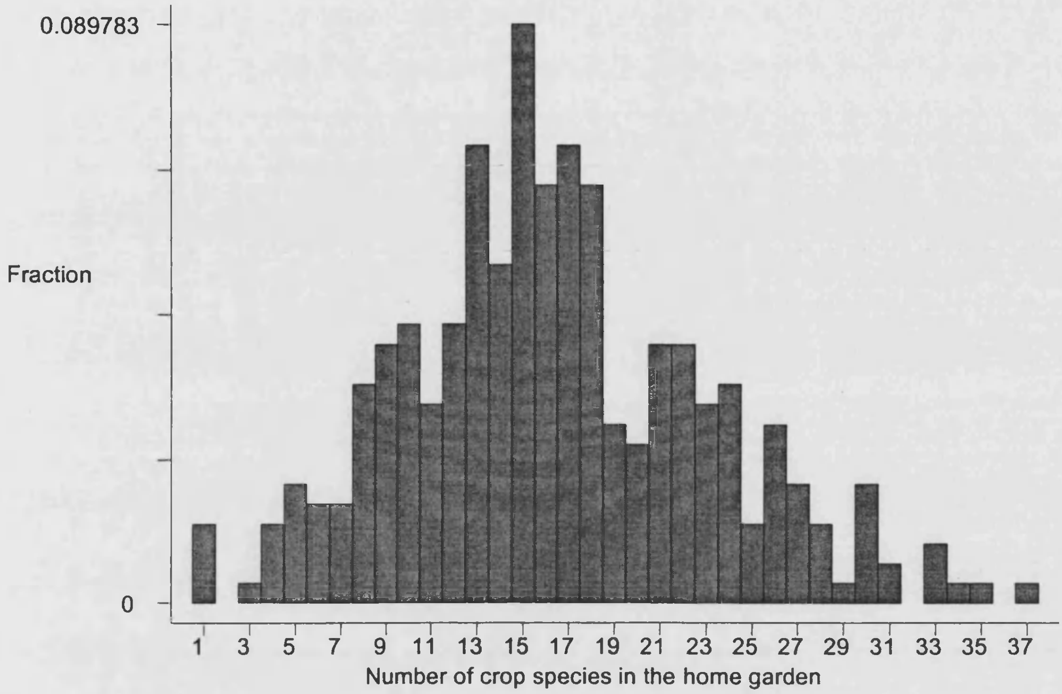
1	0 – 37.000 Ft
2	37.000 – 50.000 Ft
3	50.000 – 60.000 Ft
4	60.000 – 70.000 Ft
5	70.000 – 80.000 Ft
6	80.000 – 100.000 Ft
7	100.000 – 150.000 Ft
8	150.000 – 200.000 Ft
9	200.000 Ft and more

16. Could you please state the percentage of your household income your household spends on food consumption?

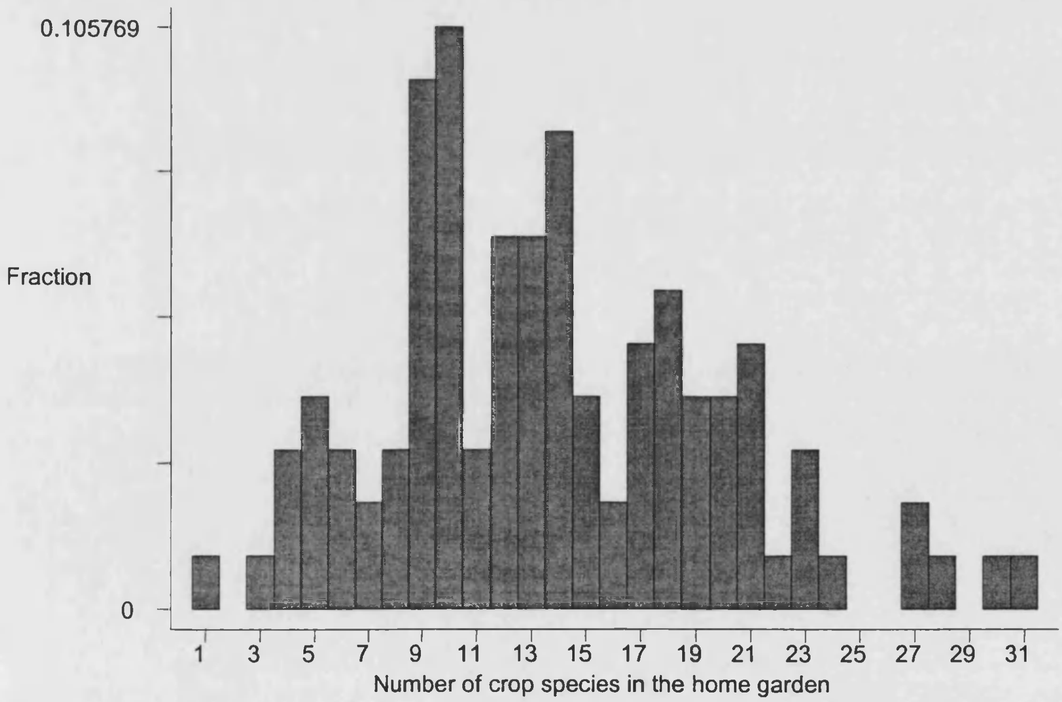
...............................%

Thank you for your cooperation and patience.

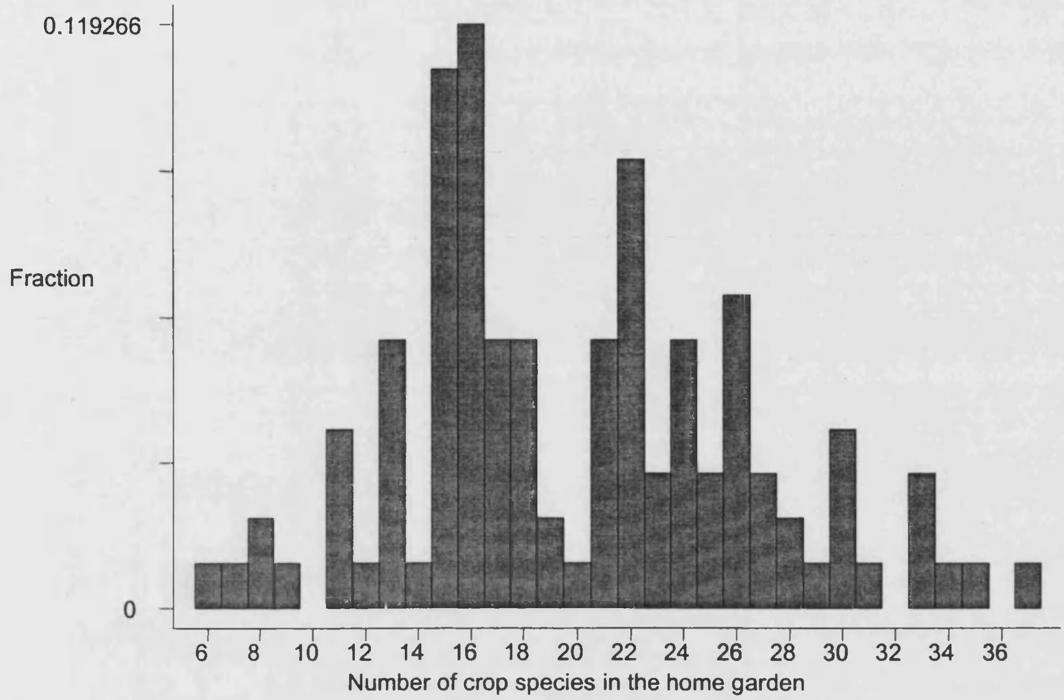
Figure 5.A.1. Histograms for crop species diversity
Histogram for crop species diversity for the pool of three ESAs



Histogram for crop species diversity in Dévaványa ESA



Histogram for crop species diversity in Őrség-Vend ESA



Histogram for crop species diversity in Szatmár-Bereg ESA

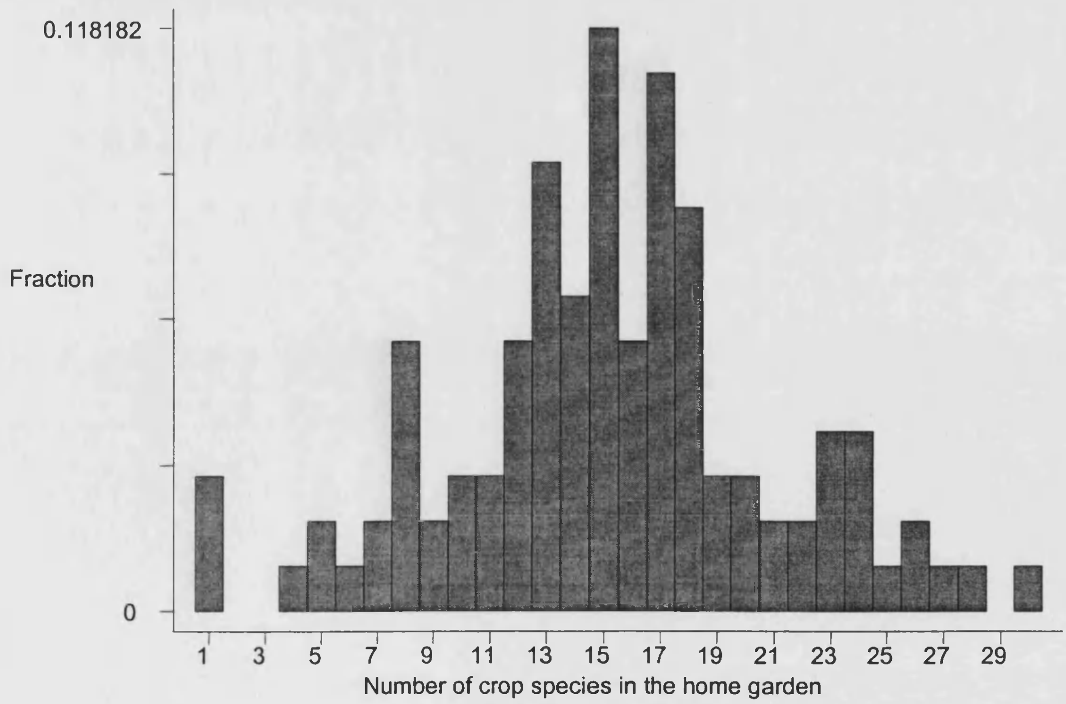


Table 5.A.1.Determinants of crop species diversity in Hungarian home gardens

Variables	Pool	Dévaványa	Őrség-Vend	Szatmár-Bereg
	Coeff. (s.e.)			
Constant	1.9***	1.9***	2.2***	2.8***
	(0.22)	(0.45)	(0.41)	(0.35)
GE	0.023***	0.24*	0.015	0.022*
	(0.008)	(0.15)	(0.014)	(0.013)
AGE2	-0.0002***	-0.00022*	-0.00008	-0.0002*
	(0.00007)	(0.00013)	(0.00012)	(0.00014)
HGPAR	0.029**	0.0079	0.028	0.017
	(0.012)	(0.03)	(0.018)	(0.025)
TOTFOC	$-0.25*10^{-6}$*	$-0.17\text{x}10^{-6}$	$0.14\text{x}10^{-6}$	$-0.1\text{x}10^{-5}$
	$(0.14*10^{-6})$	$(0.14*10^{-6})$	$(0.85\text{x}10^{-6})$	$(0.61\text{x}10^{-6})$
CAR	-0.0004**	-0.00042**	0.23***	-0.16**
	0.00021	(0.00022)	(0.054)	(0.06)
HGAREA	0.000015***	0.00003	$0.6\text{x}10^{-5}$	0.000012
	$(0.5\text{x}10^{-5})$	(0.00004)	$(0.8\text{x}10^{-5})$	$(0.8*10^{-5})$
IRRPER	0.002***	0.0022***	-0.00082	0.0031***
	(0.00035)	(0.00063)	(0.0006)	(0.001)
GOODSOIL	0.000056	$0.9\text{x}10^{-6}$	0.22***	0.00009
	(0.00014)	(0.00018)	(0.077)	(0.00026)
SALEM2	-0.00036**	0.002***	0.00025	-0.00031
	(0.00016)	(0.0007)	(0.00044)	(0.00027)
DISTKM	0.01***	-	-0.00035	-0.037***
	(0.0014)		(0.0035)	(0.0085)
Sample size	323	104	109	110
Log likelihood	-1133.43	-355.32	-360.18	-356.63
Chi squared	129.82	34.22	37.39	43.93
D.o.f	10	9	10	10
Significance level	0.00	0.00008	0.00005	0.000003
Deviance	0.14	0.12	0.16	0.17
WI1	1***	1***	0.79***	1***
	(0.001)	(0.0013)	(0.22)	(0.002)
WI2	0.99***	1***	0.038***	0.99***
	(0.0044)	(0.0045)	(0.011)	(0.01)

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

* significant at less than 10%, ** significant at less than 5%, *** significant at less than 1% with one-tailed or two-tailed tests as shown in Table 5.1; regression is Poisson

Chapter 6

Sustainable use and management of crop genetic resources: Landraces in Hungarian home gardens

6.1. Introduction

The focus of this chapter is on the crop genetic resources maintained in Hungarian home gardens in the form of landraces or traditional varieties of bean and maize. This study is driven by the recent findings of the Institute for Agrobotany, which reassure the genetic importance of bean and maize landraces found in the home gardens. The aim of this chapter is to identify the factors that cause farm families to cultivate landraces in their home gardens and the determinants of crop genetic resource richness found on home gardens.

The following section discusses the importance and role of landraces in Hungary. Section 6.3 provides a statistical description of the farm families who maintain landraces in their home gardens and compares them to the other households in the sample that do not cultivate landraces. Section 6.4 presents the econometric approach and section 6.5. reports the findings of econometric analyses. The final section concludes the chapter.

6.2. Crop genetic resources in Hungary

Landraces are crop genetic resources that have evolved continuously under continuous natural and farmer selection practices in the fields of farmers, and are the progenitors of the modern crop varieties developed and diffused among farmers around the world (Harlan, 1972). Unique and rare alleles found in landraces and recombined through crossing have historically contributed to the increased productivity, resistance and resilience of modern crop varieties, providing improved returns to farming industry while benefiting consumers with lower food prices, food safety and security (Kloppenburg, 1988; Fowler, 1994; Evenson and Lemarié, 1998; Evenson and Gollin, 2003; Swanson and Goeschl, 2000).

Hungary is home to a great diversity of potentially valuable plant and animal landraces whose conservation is of national value. The cultivated plants found in Hungary originated primarily in ancient times (Bronze Age, Roman), with a minor number introduced from the "New World" (Bela *et al.*, 2003). Most species may be considered indigenous and many varieties "hungaricum" given their longevity as part of Hungary's cultural flora (Ángyán, 2000). Several local varieties of wheat, rye, fruits, vegetables and grapes are present, and Hungary is also rich in landraces of domesticated animals (e.g. chicken, cattle, pig) (Bela *et al.*, 2003).

In the modern, intensive agricultural system that dominates most of Hungary's landscape today, crop landraces have been replaced by modern and high yielding varieties of crops in large and middle scale farms (Már, 2002; Bela *et al.*, 2003). Landraces continue to survive in the areas that are marginal to intensive agricultural production, mainly in the home gardens, where they are adapted to specific conditions and cultivated with traditional methods. Continued management and use of this local crop genetic resource stock is believed to be crucial to future plant breeding activities in Hungary as well as to sustaining rural households' livelihoods, eco-system health and services (Már, 2002). Continued management and use of these landraces is also crucial for conservation of Hungarian cultural heritage, as well as for keeping options open for possible income generating, niche market production opportunities (Már, 2002).

The Institute of Agrobotany collected landrace samples (as well as soil samples) from the home gardens of farm families who were interviewed for the farm household survey and the choice experiment. Preliminary molecular biological research conducted on these landraces reveals that they are genetically heterogeneous, and many contain rare and adaptive traits (Már personal communication, 2004). Some are found to carry quality traits that are of cultural importance and nutritional value and for which consumers may be willing to pay. This scientific approval of the importance of landraces calls for further investigation of the characteristics of the farm families that choose to conserve them and that maintain crop genetic richness.

6.3. Landrace cultivating farm families

Of the 323 farm families interviewed for the farm household survey introduced in the previous chapter, 142 of them stated that they cultivated landraces of beans or maize. By region, 26.9%, 52.3% and 52.7% of all households in Dévaványa, Őrség-Vend and Szatmár-Bereg regions respectively have at least one landrace of maize or bean in their small farms.

Table 6.1 reports the differences in these characteristics between households who cultivate at least one landrace of either maize or bean and those who do not cultivate either of these landraces across regions.

Table 6.1. Descriptive statistics for farm families with and without landraces for the pool of three ESAs

	Pool N=323	
	With landrace	Without landrace
No. farm families	142	181
Decision maker characteristics		
Age	59.3**	56.2
	(12.1)	(14.4)
Education	9.2**	10.2
	(2.6)	(3)
Household characteristics		
Home garden participation	2.5	2.3
	(1.3)	(1.2)
Household nonfarm income (HUF)	77794.4	81049.1
	(37050.2)	(39160.8)
Car	44%	52%
Food expenditure share of income	38	36.5
	(15.7)	(14.1)
Total field owned and cultivated area	13662.1	26141
	(35683.5)	(161874.3)
Distance to the nearest market	16**	11.1
	(9.2)	(10.3)
Home garden characteristics		
Home garden area	1797.6	1506.3
	(2803.9)	(2431)
Home garden output sales in HUF/m^2	20.2	11.4
	(79)	(61.9)
No. of crop species	18.4***	14.8
	(6.3)	(6.6)
Good quality soil in home garden (0,1)	18%	20%
Organic production in home garden (0,1)	11%	16%
Livestock in home garden (0,1)	88%§§§	72%
Irrigated land (%)	31.2	34.3
	(37.9)	(42)
No. of landraces	2	0
	(1)	
No. bean landraces	1	0
	(0.2)	(0)
No. maize landraces	0.14	0
	(0.4)	(0)

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

Pairwise t-tests between households that cultivate landraces and those who do not within each region show significant differences at ***1% significance level, **5% significance level and *10%significantce level. Pearson Chi-square tests between households that cultivate landraces and those who do not within each region show significant differences at §§§ 1% significance level.

Across the three ESAs, those farm families that cultivate at least one landrace are located in more isolated communities, have older and less educated decision-makers compared to those farm families that do not cultivate a landrace. Farm families that choose to cultivate a landrace also have home gardens that are richer in terms of inter-species crop diversity and agro-diversity, as revealed by the significant differences in crop species diversity and integrated livestock and crop management between the two groups of farm families.

Given the differences between the three ESAs in terms of demographics, agro-ecological conditions and market characteristics, descriptive statistics for the households who produce a landrace and those who do not are also reported per ESA, in Table 6.2[59]. In Dévaványa, landrace-cultivating households have smaller home gardens and spend a greater percentage of their income on food. Hence landraces reside with less wealthy farm families in this region. In addition, households who manage landraces tend home gardens that are relatively rich in terms of crop species diversity.

In Őrség-Vend, farm families that cultivate landraces have less educated decision-makers, farm more extensive fields, and spend larger proportions of their budget on food. They are also poorer, as well as more agriculturally-based. Őrségi households who manage landraces are more likely to have livestock and richer crop species diversity in their home gardens compared to those that do not. In Szatmár-Bereg families that manage landraces have older and less educated farm decision-makers,

[59] Descriptive statistics and also the econometric analyses presented below were also carried out for bean maize landraces separately. However, the results for the pooled landraces are not statistically different from the results for individual landraces. Comparison of the the Poisson Hurdle model (as will be explained in Sections 6.4. and 6.5.) for the pool of ESAs and for both landraces to Poisson Hurdle model for the pool of ESAs for each landrace with a reveal that likelihood ratio test L=-2[-421.78-(-66.10+-170.51+-200.66)]=10.99 exceeds the chi square statistic of 9.34 at 10 degrees of freedom at 50% significance level. Therefore the model for pooled landraces are not different from the models for individual landraces. The descriptive statistics for bean and maize landraces and the results of the econometric analyses for landraces of each crop are reported separately in Tables 6.A.1 through 6.A.8 in the appendix to this chapter.

and are located in more isolated communities of this region. A smaller percentage of households who cultivate a landrace also own a car compared to those who do not. Szatmári farmers who choose to cultivate a landrace in their home gardens also manage home gardens with more crop species diversity and livestock.

When landrace cultivating farm families are compared across three regions, it is disclosed that szatmári decision-makers are the least educated landrace conservers across the three sites. Dévaványai households that manage crop genetic resources in home gardens have fewer members who participate in home garden production compared to the other two regions. Income levels of the landrace-cultivating households differ across regions significantly. Szatmári households that manage more landraces on their small farms not only have the lowest incomes across the three regions, but also spend the lowest percentages of their income on food. A higher percentage of őrségi landrace growers own cars compared to the other two regions, and they are the most isolated across the three regions.

Home garden area differs significantly across regions between those who cultivate landraces, with landrace growers in Dévaványa tending the smallest areas and those in Szatmári farming the largest. Szatmári home gardens that contain landraces have the lowest irrigated area percentages compared to the home gardens in the other two sites, signalling Szatmári landraces might be suitable to arid soil conditions compared to other two ESA's landraces. However, the percentage with good quality soils in their home gardens is the highest in Szatmár-Bereg compared to the other two sites. Dévaványai small farms have the lower landrace count on average than those in the other two areas.

Table 6.2. Descriptive statistics for farm families with and without landraces by ESA

	Dévaványa N=104		Őrség-Vend N=109		Szatmár-Bereg N=110	
	With landrace	Without landrace	With landrace	Without landrace	With landrace	Without landrace
No. households	28	76	57	52	57	53
Decision maker characteristics						
Age	60.4	57.8	59.1	56.4	59.1*	53.7*
	(8.6)	(14.4)	(11.8)	(13)	(13.9)	(15.6)
Education [aa]	10.1	10	9.4**	10.5**	8.6***	10.1***
	(2.5)	(2.9)	(2)	(3)	(3.1)	(3.7)
Household characteristics						
Home garden participation[aaa]	1.9	2.1	2.7	2.4	2.5	2.3
	(0.7)	(1.1)	(1.4)	(1.2)	(1.3)	(1.3)
Household nOn Farm income (HUF) [aaa]	77182.8	74147.1	89534	94685	66355.4	77567.7
	(25303.5)	(24913.8)	(43372.9)	(43224)	(31507.9)	(48093.3)
Car (0,1) [aaa]	39.3%	39%	61.4%	65.4%	30%[§§§]	56.6%[§§§]
Food expenditure share of income. [aaa]	43.4*	37.5*	42*	37.1*	31.3	34.6
	(14.3)	(14.8)	(17.9)	(14.9)	(11.1)	(12.3)
Distance to nearest food market (km)[aaa]	0	0	21	20.4	18.9**	17.8**
	(0)	(0)	(6.5)	(6.8)	(2.8)	(3.2)
Home garden characteristics						
Home garden area [aaa]	570.9*	571.3*	1353.6	1921.8	2844.2	2439.5
	(445)	(760.5)	(2657.5)	(3089)	(3251.1)	(2815.4)
Total field owned and cultivated area[aaa]	4596.2	44018.2	15059.3**	4695.2**	16718.4	21546.9
	(12256.2)	(245818.9)	(33824.9)	(8660.8)	(44010)	(50272.8)
Home garden sales in HUF/m^2	14.1	2.2	12.5	0.04	30.8	35.3
	(53.3)	(11.2)	(68.5)	(0.2)	(97.4)	(110.3)
No. of crop species [aaa]	16.4***	12.8***	21.4***	18.5***	16.4***	14***
	(7)	(5.6)	(6.4)	(6.5)	(4.5)	(6.6)
Good quality soil (0,1)%	11	19	8.8	9.6	30.4	32
Organic production in home garden (0,1)%	7	20	16	19	9	8
Livestock production in home garden (0,1)%	75	74	90	65	93	79
Irrigated land in home garden (%)	53.9	36.2	42.9	49.4	17.3	16.6
	(40.1)	(45.7)	(39.4)	(41.6)	(27.3)	(29.2)
No. of landraces [aaa]	1.6	0	2	0	2.3	0
	(0.9)	(0)	(1)	(0)	(1.1)	(0)
No. bean landraces	1.5	0	1.9	0	2.1	0
	(1)	(0)	(1)	(0)	(1.1)	(0)
No. maize landraces	0.11	0	0.11	0	0.2	0
	(0.3)	(0)	(0.3)	(0)	(0.4)	(0)

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

Pairwise t-tests between households that cultivate landraces and those who do not within each region show significant differences at ***1% significance level, **5% significance level and *10%significantce level. Pearson Chi-square tests between households that cultivate landraces and those who do not within each region show significant differences at [§§§] 1% significance level. Pairwise t-tests between households that cultivate landraces across regions show significant differences at [aaa]1% significance level, [aa]5% significance level.

6.4. Estimation and econometric issues

The reduced form equation (5.17) is the basis of the econometric estimation using a count model. The dependent variable, landrace richness, is an integer greater than or equal to zero. The histograms for landrace count are reported in Figures 6.A.1. through 6.A.4. in the appendix to this chapter. Four count models were considered, including the Poisson, Poisson Selection, Poisson Hurdle and Zero Inflated Poisson models. Zeros are observed for farm families who did not grow a landrace in the survey season, representing over half of the sample. The descriptive statistics presented above and histograms of the dependent variables suggested the need to correct for selection bias. However, the coefficient on the estimated inverse Mills ratio had no statistically significant effect on landrace richness and the null hypothesis of no selection bias could not be rejected. The Zero Inflated Poisson (ZIP) model was estimated to account for stated non-participation in landrace cultivation only in the year in which the survey is conducted (Greene, 1998), however this model failed to converge.

Finally, the Poisson Hurdle model and Poisson models were estimated. Log-likelihood ratio tests conducted at the 0.5% significance level confirmed that the Poisson Hurdle compared favourably with the Poisson model for the pool of three ESAs and for two of the three regions (Őrség-Vend and Szatmár-Bereg)[60]. While the Poisson model assumes that the same underlying process generates the data recording the decision to grow a landrace and the number of landraces to grow, the Poisson Hurdle model allows for independent processes, incorporating a selection effect

[60] Comparison of the Poisson and Poisson Hurdle model for the pool of three ESAs reveal that L=-2[-431.78-(-203.92+-184.5)]=86.81, which exceeds the chi square statistic of 25.19 at 10 degrees of freedom at 0.5% significance level. Therefore for the pool of three ESAs Poisson Hurdle outperforms normal Poisson. Comparison of the Poisson and Poisson Hurdle model for the Dévaványa ESA reveal that L=-2[-76.02-(-50.64+-22.06)]=6.64, which exceeds the chi square statistic of 5.90 at 9 degrees of freedom at 75% significance level. Therefore for the Dévaványa ESA of normal Poisson performs better. Comparison of the Poisson and Poisson Hurdle model for Őrség-Vend ESA reveal that L=-2[-148.04-(-63.54+-70.79)]=27.42 which exceeds the chi square statistic of 25.19 at 10 degrees of freedom at 0.5% significance level. Therefore for the pool of Őrség-Vend ESA Poisson Hurdle outperforms normal Poisson. And finally Comparison of the Poisson and Poisson Hurdle model for Szatmár-Bereg EAS reveal that L=-2[-162.50-(--65.9+-78.79)]=35.28, which exceeds the chi square

through the estimation of separate regressions. In Dévaványa region, where far fewer farmers choose to cultivate landraces, the null hypothesis that two independent processes generated the data was rejected and the Poisson model was used instead[61].

The two-step Poisson Hurdle model for selectivity is formerly generalised by Mullahy (1986), discussed in the context of two-part decision-making by Pohlmeier and Ulrich (1995), and applied to farmer decision-making process by Van Dusen (2000). The first stage of the model is a binary (0,1) choice to grow a landrace or not. The second stage of the model is a truncated Poisson model (*LR* >0), which considers the number of landraces cultivated or their richness. The likelihood function is specified as a combination of two independent processes over two different domains. That is

$$L = \prod_{i=1}^{N1} P(y_i = 0 | x_i^{'}\beta_1)^{d_i} (1 - P(y_i = 0 | x_i^{'}\beta_1))^{1-d_i} \times \prod_{i=1}^{N2} \frac{P(y_i | x_i^{'}\beta_2)}{P(y_i \geq 1 | x_i^{'}\beta_2)} \tag{6.1}$$

where N1 represents the full sample of the households and N2 is the restricted sample of only those households who choose to cultivate at least one landrace. The variable *d* represents the binary variable of the first stage discrete choice. Given that the two processes are independent, the log likelihood functions are additive and the two equations can be estimated separately. The two separate parameter vectors β_1 and β_2 can be viewed individually for their effects on the crop landraces managed in Hungarian home gardens.

Table 6.3 below reports a summary of all the econometric models used for analysis of the count data on landrace diversity.

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statistic of 25.19 at 10 degrees of freedom at 0.5% significance level. Revealing that for Szatmár-Bereg ESA Poisson Hurdle outperforms normal Poisson.

[61] Over-dispersion parameter for negative binomial model, α, is found to be insignificant in all regressions, therefore, there is not evident over-dispersion. Consequently, the Poisson models are efficient.

Table 6.3. Summary of the econometric models used for analysis of landrace diversity

Econometric Model	Definition	Results
Poisson Selection Model	This model corrects for sample selection, which if not accounted for, would bias the estimates (Greene, 1998).	No significant selection bias is found.
Zero Inflated Poisson	This model accounts for correction of 0s (i.e. stated non-participation) in landrace cultivation, which occur only in the year in which the survey is conducted and might be a positive number any other period (Greene, 1998).	This model fails to converge with the data set at hand.
Poisson Model	The generic model for estimation of count data, as explained in greater detail in chapter 5.	This model was estimated for the pool and for each ESA. Whether or not the Poisson Hurdle Model is an improvement over the Poisson Model is tested with a likelihood ratio test.
Poisson Hurdle Model	Two step model for selectivity, in the first step the binary Poisson for the choice of whether or not to take part in the activity is estimated and in the second step a truncated Poisson for the count data is estimated (Mullahy, 1986).	Comparison of Poisson and Poisson hurdle models reveals that for the pool and for Őrség-Vend and Szatmár-Bereg ESAs Poisson Hurdle Model is the suitable model. However, for Dévaványa, where landrace richness is lower, Poisson is the most suitable model. These results are reported in Table 6.4 and 6.5.

6.5. Econometric results

Explanatory variables have already been defined in the previous chapter. The results from the estimation of the Hurdle model for the pool of all three ESAs are reported in Table 6.4. The binary Poisson model is reported in the first column. This regression reveals the factors that influence the farm families' decision on whether or not to cultivate a landrace in the home garden. The age of the main home garden decision-maker is positive and significant determinant of whether or not the household chooses to engage in landrace cultivation. As it was found in other studies (e.g. Meng, 1997 and Van Dusen, 2000), it is the older generation of farmers, who are by implication more likely to farm in a traditional manner (Meng, 1997), that choose to conserve genetic diversity by cultivating these traditional varieties. The fact that younger generation does not continue this practice reveal that long-term sustainability of on farm conservation is in jeopardy (Van Dusen, 2000) unless specific measures are taken to ensure the continued cultivation of these landraces. The quadratic age variable is significant and negative, revealing that oldest farmers are less likely to undertake landrace cultivation as their ability to work in labour intensive home garden production decreases at an advanced age.

Number of household members that participate in home garden cultivation is positive and significant disclosing that the more household members participate in home garden cultivation, the more likely it is that the household will engage in cultivation of a traditional crop variety. This is because landrace cultivation is generally a labour intensive activity since the selection of seeds, tending and harvesting of these varieties require labour input rather than mechanical or market purchased inputs (Brush, Taylor and Bellon, 1992). This result may also reflect the observation that landraces tend to be conserved by more traditional of Hungarian families. Traditional Hungarian families are extended families of three cohabiting generations (Már, 2002, personal communication).

Of the agro-ecological characteristics of the home gardens the only significant characteristic of the home garden that effects the likelihood that the household chooses to cultivate a landrace in the home garden is the quality of the soil. Good quality soil dummy is negative signifying that the better the quality of the soil the less likely that the household will choose to engage in landrace cultivation in the home garden. This result -coupled with the negative though only weakly significant affect of irrigation on the probability of cultivating landraces- point out to the fact that for the pool of all three ESAs, landraces are more suited to those home gardens with unfavourable agro-ecological conditions.

Both of the market related variables are significant and positive. The positive and significant coefficient on the sales from home garden produce variable discloses that the more integrated into the markets a household is as a seller of home garden produce, the more likely that it will be engaged in landrace cultivation. This finding suggests niche market potential. The coefficient on distance to the nearest market is also positive and highly significant implying that the more isolated the household is from the centres of ESAs, the more likely that they will cultivate landraces in their home gardens. This result is in line with those of previous studies and also with the findings of chapter 4, which investigated this point with the use of a stated preference methodology, namely choice experiment.

The second regression reported in Table 6.4 is a truncated Poisson regression for the richness of landraces cultivated in the home gardens of the households who choose to cultivate a landrace. This analysis helps to explain whether the discrete choice of landrace cultivation, as reported above, is affected by a different set of household, agro-ecological and market characteristics than that is affecting the level of crop genetic diversity in the home gardens. The significant determinants of the number of landraces the households choose to cultivate in their home gardens are number of home garden participants and distance to the nearest market. Landrace richness managed on home gardens increases in these variables. Thus, higher levels of Hungarian genetic diversity are being conserved by those farm households that are in the most isolated communities and in those home gardens that are produced with more intensive labour input.

Table 6.4. Determinants of choice of landrace cultivation and richness for the pool of three ESAs

	Poisson Hurdle			
	Binary Choice (0-1)		Count (>0)	
	Coeff. (s.e.)	Marginal effects	Coeff. (s.e.)	Marginal effects
Constant	-5.56*** (1.60)	-1.66	-0.8 (1.56)	-0.98
AGE	0.14** (0.06)	0.04	-0.02 (0.05)	0.02
AGE2	-0.001** (0.0005)	-0.0003	$-0.9\text{x}10^{-4}$ (0.0005)	-0.0001
HGPAR	0.15** (0.08)	0.044	0.11** (0.07)	0.14
TOTFOC	$-0.7\text{x}10^{-6}$ ($0.2\text{x}10^{-5}$)	$-0.2\text{x}10^{-6}$	$-0.14\text{x}10^{-5}$ ($0.3\text{x}10^{-5}$)	$-0.2\text{x}10^{-5}$
CAR	0.003 (0.01)	0.001	0.04 (0.19)	0.05
HGAREA	$0.8\text{x}10^{-5}$ ($0.4\text{x}10^{-4}$)	$0.24\text{x}10^{-5}$	$-0.14\text{x}10^{-4}$ ($0.34\text{x}10^{-4}$)	$-0.2\text{x}10^{-4}$
IRRPER	-0.002 (0.002)	-0.0007	-0.002 (0.002)	-0.0022
GOODSOIL	-0.001* (0.0008)	-0.0003	-0.0003 (0.0007)	-0.0004
SALEM2	0.0014* (0.001)	0.00043	$-0.7\text{x}10^{-5}$ (0.001)	$-0.8\text{x}10^{-5}$
DISTKM	0.031*** (0.009)	0.009	0.022** (0.01)	-0.03
Sample size	323		142	
Log likelihood	-203.92		-184.5	
Chi squared	109.56		60.63	
D.o.f	10		10	
Significance level	0.00		0.00	

Source: Hungarian Home Garden Diversity Household Survey, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002.
* significant at less than 10%, ** significant at less than 5%, *** significant at less than 1%

As investigated in the previous chapters, the three ESAs studied in this thesis are distinct. Likelihood ratio tests disclose that the three regions do differ and hence cannot be pooled at 0.5% significance level[62]. Therefore, Poisson Hurdle model is

[62] The binary Poisson cannot be pooled for the three ESAs as the Log Likelihood ratio L=-2[-203.92-(-50.64+-63.54+-65.9)]=47.68 exceeds the chi square statistic of 25.19 at 10 degrees of freedom at 0.5% significance level. The Hurdle Poisson cannot be pooled for the three ESAs either as the likelihood ratio L=-2[-184.5-(-22.06+-70.79+-78.96)]-25.38 exceeds the chi square statistic of 25.19 of at 10 degrees of freedom at 0.5% significance level.

estimated for each region separately and the results of these regressions are reported in Table 6.5. For Dévaványa the Poisson model is estimated, as explained above. In this ESA it is the older farmers that conserve landraces. The quadratic age variable is significant and negative, revealing that oldest farmers are less likely to undertake landrace cultivation as their ability to work in labour intensive home garden production decreases at an advanced age. Dévaványai landraces appear to be more suitable to poor soil conditions, i.e. to the marginal agro-ecological niches in this region with relatively favourable agricultural conditions. The relationship between the value of sales of the home garden produce and the number of landraces that the home gardeners produce is positive and significant. This result reveals that the households that conserve landraces in Dévaványa are mainly those that are engaged in relatively intensive and market oriented small-scale farming in their home gardens, rather than those that are engaged in home garden cultivation just for household consumption.

In Őrség-Vend region, the higher the number of family members participating in home garden production and the lower the proportion of garden land that is irrigated, the more likely that the household will choose to cultivate at least one landrace in its home garden. Őrségi landraces are therefore suited to arid production niches. The truncated Poisson regression reveals that for those households who choose to cultivate a landrace, the only significant determinant of landrace richness is the number of home garden participants. Again, this results points out that landrace cultivation is generally a labour intensive activity.

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

In none of the site-specific regressions is the distance to the nearest food market a significant factor explaining the choice to grow landraces or landrace richness. One reason may be that the variation in this factor is partitioned more between sites than within them, an artefact of the sample design, as explained in chapter 2.

Table 6.5. Determinants of choice of landrace cultivation and richness, by ESA

	Dévaványa		Őrség-Vend				Szatmár-Bereg			
	Poisson		Poisson Hurdle				Poisson Hurdle			
			Binary Choice (0-1)		Count (>0)		Binary Choice (0-1)		Count (>0)	
Variable	Coeff. (s.e.)	Marginal effects	Coeff. (s.e.)	Marginal effects	Coeff. (s.e.)	Marginal effects	Coeff. (s.e.)	Marginal effects	Coeff. (s.e.)	Marginal effects
Constant	-21.14***	-8.57	-3.65	-1.08	-1.4	-1.68	-4.18*	-1.28	0.01	0.016
	(6.37)		(3.51)		(3.25)		(2.32)		(2.02)	
AGE	0.68***	0.27	0.10	0.031	0.035	0.04	0.051	0.015	0.028	0.043
	(0.21)		(0.12)		(0.11)		(0.078)		(0.065)	
AGE2	-0.005***	-0.002	-0.0007	-0.0002	-0.0002	-0.0003	-0.0003	-0.9×10^{-4}	-0.0002	-0.0004
	(0.002)		(0.001)		(0.001)		(0.0007)		(0.0006)	
HGPAR	-0.11	-0.044	0.26***	0.078	0.13*	0.15	0.42***	0.13	0.024	0.037
	(0.22)		(0.13)		(0.09)		(0.14)		(0.13)	
TOTFOC	-0.9×10^{-5}	-0.4×10^{-5}	0.2×10^{-4}	0.61×10^{-5}	-0.7×10^{-6}	-0.9×10^{-6}	0.8×10^{-6}	0.3×10^{-6}	-0.2×10^{-5}	-0.3×10^{-5}
	(0.9×10^{-5})		(0.9×10^{-5})		0.5×10^{-5}		(0.4×10^{-5})		(0.4×10^{-5})	
CAR	0.1	0.04	-0.3	-0.087	0.13	0.15	-1.21***	-0.37	0.14	0.22
	(0.37)		(0.36)		(0.34)		(0.4)		(0.33)	
HGAREA	-0.6×10^{-4}	-0.2×10^{-4}	-0.7×10^{-4}	-0.2×10^{-4}	-0.5×10^{-4}	-0.6×10^{-4}	0.5×10^{-4}	0.15×10^{-4}	-0.4×10^{-4}	-0.6×10^{-4}
	(0.0003)		(0.7×10^{-4})		(0.7×10^{-4})		(0.5×10^{-4})		(0.5×10^{-4})	
IRRPER	-0.0033	-0.001	-0.006*	-0.0017	0.7×10^{-4}	-0.9×10^{-4}	0.004	0.0013	-0.0006	-0.001
	(0.0038)		(0.004)		(0.004)		(0.006)		(0.005)	
GOODSOIL	-0.0014**	-0.0006	-0.25	-0.073	0.43	0.51	-0.06	-0.019	0.5*	0.74
	(0.0008)		(0.61)		(0.39)		(0.3)		(0.26)	
SALEM2	0.0064***	0.003	0.33	0.098	-0.0019	-0.0023	0.0003	0.0001	-0.0012	-0.0019
	(0.002)		(0.31)		(0.0035)		(0.0015)		(0.0016)	
DISTKM	-	-	-0.024	-0.007	0.009	0.01	0.07	0.021	-0.013	-0.02
			(0.025)		(0.023)		(0.05)		(0.04)	
Sample size	104		109		57		110		57	
Log likelihood	-76.02		-63.54		-70.79		-65.9		78.96	
Chi squared	39.85		60.82		27.54		57.15		21.53	
D.o.f	9		10		10		10		10	
Sig. Level	0.000008		0.00		0.002		0.00		0.018	

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

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

6.6. Cultural values of landraces and Conclusions

Analysis of survey data reveals information about the farmers and locations where crop landrace richness is most likely to be found in rural Hungary. The results reveal that those farmers who maintain landraces are older, and the families that manage them are larger, having a higher number of home garden production participants. They do sell their produce, but are more distant from food markets than other farm families. In Dévaványa, the densely populated region with high productivity potential, crop landraces are found on the poorer soils. In the two isolated regions with low productivity potential, landraces are found in home gardens with better soils in Szatmár-Bereg region and on home gardens with less irrigation in Őrség-Vend.

The results of both the revealed preference studies in this chapter and in chapter 5, as well as those of the stated preference studies in chapters 3 and 4 disclose that farmers reveal and state higher levels of demand for traditional varieties in the isolated regions, compared to Dévaványa. These findings echo that of Hebbert *et al.* (2002), who state that many of the rural traditions that are extinct in the rest of the country (such as architecture, settlement forms, traditional dishes) can be found only in the isolated regions. In addition to the farm household, market level and agro-ecological reasons that have explained why this might be so in the previous chapters, there are also cultural and biological reasons that can explain why traditional varieties of crops are continued to be cultivated in the isolated ESAs.

These isolated regions are on the borders of the country, with Őrség-Vend bordering Austria and Slovenia and Szatmár-Bereg bordering Ukraine. Therefore a considerable amount of geneflow is expected to take place compared to the Dévaványa ESA, which is located near the centre of the country (Már, 2004, personal communication). In addition, cultural backgrounds of the border regions are more diverse compared to Dévaványa. In Szatmár-Bereg mixed marriages between Hungarians and Ukranians are common, which results in Ukranians brining with them different culinary traditions and traditional varieties to Szatmár-Bereg[63]. In Őrség-Vend, as mentioned in chapter 3, there is continuous exchange of labour and knowledge between neighbouring Austrian communities. This diversity of culture reflects to the diversity of traditions (of cooking and farming) that result in the diversity and richness of traditional varieties that are found in the home gardens of these regions (Már and Gyovai, 2004, personal communication).

During the informal and focus group interviews that were conducted with landrace growing farm families in October-November 2001 and May 2002, farm families were asked about why they cultivated landraces and the attributes and uses of their landraces. Many home garden decision-makers have stated the main reasons for their continued management of landraces of bean and maize to be conservation of their cultural identity and of their family inheritance. Several home garden decision-makers have also identified various uses and benefits of landraces to be the reasons for their continued cultivation. The uses and benefits of landraces as stated by the farm families that cultivate them include special local dishes that can be cooked with landraces[64]; superior taste of landraces[65]; their higher nutritional value (as also certified by the molecular biological analysis conducted by the Institute for Agrobotany); their better cooking and storage quality compared to those varieties one can purchase in the shops; preference of livestock for certain maize landraces; their resistance to local pests and diseases; their suitability to certain production niches;

[63] Marriages between different communities and nations have been identified by ethnobotanists to be one of the causes of crop biodiversity, as in several cultures brides and/or grooms bring with them seeds of crops to cultivate on the farms and home gardens of their new families (Eyzaguirre, personal communication, 2004).

[64] Some local dishes that are cooked with landraces include *tésztás bableves* (bean soup), *káposztás paszuly* (bean with cabbage) in Szatmár-Bereg, and *tejfölös bableves* (bean soup) in Őrség-Vendvidék and *főzelék* (vegetable dish) in both ESAs.

[65] Some farmers likened the taste of some bean landraces to 'chesnut' or 'chicken'.

their uses for traditional method of intercropping[66] and specific cultural uses of some landraces[67].

In short, the qualitative data on farmers' preferences as they stated in informal interviews and focus group discussions reveal that maize and bean landraces generate several private benefits to farm families who cultivate them in the isolated regions of Hungary. Smale, Bellon and Aguirre Gomez (2001) note that 'In addition to the private value they [landraces] generate for the farmers who grow them, landraces have social value because plant breeders use them as sources of novel alleles (gene types) or gene combinations to improve the crops that produce the food, feed and fibre on which societies depend.' The scientific research conducted at the Institute of Agrobotany found the landraces to have important potential and actual public values as they are genetically heterogeneous, and contain rare and adaptive traits (Már, personal communication, 2004). Therefore the landraces found on home gardens can be potentially important for improvement of crops, as well as for possible niche market as a result of their nutritional and cultural values.

[66] The traditional method of intercropping of beans, maize and squash (similar to Mexican *milpa* (Van Dusen, 2000)), which is still common in the isolated regions as observed by the agronomists during the fieldtrips. This intercropping technique requires landrace varieties of runner beans *Phaseolus coccineus, as* modern varieties of beans that are found in Hungary today are not of runner variety.

[67] One farmer in Gelénes community of Szatmár-Bereg stated that he continued cultivation of a red maize landrace as its red kernels are appropriate for the game *malom*, which is a Hungarian version of the board game nine men's morris (Gyovai, personal communication, 2004)

APPENDIX TO CHAPTER 6

Table 6.A.1. Descriptive statistics for farm families with and without bean landraces for the pool

	Pool N=323	
	With bean landrace	Without bean landrace
No. of households	136	187
Decision maker characteristics		
Age	59.8**	56
	(12)	(14.3)
Education	9.2**	10.2
	(2.7)	(3)
Household characteristics		
Home garden participation	2.4	2.3
	(1.3)	(1.2)
Household nonfarm Income (HUF)	78361.1	80532.5
	(36971)	(39181.3)
Car (0,1)	45%	51%
Food expenditure share of income	37.6	36.9
	(15)	(14.7)
Total field owned and cultivated area	14155.1	25382.1
	(36379.4)	(159298.3)
Distance to nearest market	16.3**	11
	(9.2)	(10.2)
Home garden characteristics		
Home garden area	1841.6	1483.7
	(2852)	(2399.5)
Home garden sale in HUF/m^2	21.1	11
	(80.7)	(60.9)
No. of crop species	18.6***	14.7
	(6.3)	(6.5)
Good quality soil in home garden (0,1)	19%	19.5%
Organic production in home garden (0,1)	12%	15.5%
Livestock in home garden (0,1)	88%§§§	73%
Irrigated land (%)	31.2	34.2
	(38)	(41.8)
No. landraces	2.1	0.03
	(1)	(0.2)
No. bean landraces	2	0
	(1)	
No. maize landraces	0.1	0.03
	(0.3)	(0.2)

Source: Hungarian Home Garden Diversity Household Survey, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002.
Pairwise t-tests between households that cultivate landraces and those who do not within each region show significant differences at ***1% significance level, **5% significance level and *10%significantce level. Pearson Chi-square tests between households that cultivate landraces and those who do not within each region show significant differences at §§§ 1% significance level.

Table 6.A.2. Descriptive statistics for farm families with and without bean landraces, by ESA

	Dévaványa N=104		Őrség-Vend N=109		Szatmár-Bereg N=110	
	With bean landrace	Without bean landrace	With bean landrace	Without bean landrace	With bean landrace	Without bean landrace
No. of households	26	78	54	55	56	54
Decision maker characteristics						
Age	60.7	57.7	60.1*	55.6	59.1*	53.8
	(8.8)	(14.2)	(12.3)	(13.1)	(14)	(15.5)
Education [a]	10	10	9.4**	10.4	8.6**	10.1
	(2.5)	(2.9)	(2.1)	(2.9)	(3.1)	(3.2)
Household characteristics						
Home garden participation [a]	1.9	2.1	2.6	2.5	2.5	2.4
	(0.7)	(1.1)	(1.4)	(1.3)	(1.3)	(1.3)
Household nonfarm Income (HUF) [aa]	79446.9	73470.2	89230.3	94702.2	67376	76301.7
	(24807.4)	(24953.7)	(44234.1)	(42346.4)	(30826.7)	(48537.5)
Car (0,1)	42.3%	37.7%	61%	65.5%	30.4%[§§§]	56%
Food expenditure share of income	41.8	38.2	41.7	37.7	31.7	34.1
	(13.1)	(15.3)	(17.5)	(15.6)	(10.9)	(12.6)
Total field owned and cultivated area [a]	4949.7	42889.5	15619.4*	4710.6	17016.9	21147.9
	(12665.4)	(242706.5)	(34668)	(8471.9)	(44350)	(49882.5)
Distance to nearest market [a]	0	0	21.5	20	18.9*	17.8
	(0)	(0)	(6.4)	(6.8)	(2.8)	(3.2)
Home garden characteristics						
Home garden area [aa]	607.1	559.2	1357	1887.5	2882.1	2407.7
	(441.3)	(754.3)	(2723)	(3013.1)	(3267.7)	(2798.5)
Home garden sale in HUF/m^2	15.2	2.2	13.2	0.04	31.4	34.7
	(55.2)	(11)	(70.3)	(0.2)	(98.2)	(109.3)
No. of crop species [aaa]	16.6***	12.8	21.7*	18.3	15.5	13.9
	(7.3)	(5.5)	(6.4)	(6.4)	(4.4)	(6.6)
Good quality soil in home garden (0,1)	12%[§§§]	18.4%	9.3%	9%	31%	29.6%
Organic production in home garden (0,1)	7.7%	19.2%	16.7%	18.2%	8.9%	8%
Livestock in home garden (0,1)	73%	74%	89%[§§§]	65.5%	93%[§§§]	80%
Irrigated land (%)[a]	34.8	36.5	43.8	48.2	17.4	16.5
	(44.4)	(45.8)	(40)	(41.1)	(27.5)	(28.9)
No. bean landraces [a]	1.6	0	2	0	2.1	0
	(0.9)	(0)	(1)	(0)	(1)	(0)
No. maize landraces	0.04**	0.03	0.06	0.06	0.2***	0.02
	(0.2)	(0.16)	(0.2)	(0.2)	(0.4)	(0.1)

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

Pairwise t-tests between households that cultivate landraces and those who do not within each region show significant differences at ***1% significance level, **5% significance level and *10%significantce level. Pearson Chi-square tests between households that cultivate landraces and those who do not within each region show significant differences at [§§§] 1% significance level. Pairwise t-tests between households that cultivate landraces across regions show significant differences at [aaa]1% significance level, [aa]5% significance level, [a] 10% significance level

Table 6.A.3. Descriptive statistics for farm families with and without maize landraces for the pool

	Pool N=323	
	With maize landrace	Without maize landrace
No. of households	20	303
Decision maker characteristics		
Age	58.5	57.5
	(11.9)	(13.6)
Education	8.3***	9.9
	(2.5)	(2.9)
Household characteristics		
Home garden participation	2.8	2.3
	(1.4)	(1.2)
Household nonfarm income (HUF)	75000.9	79923
	(40308.9)	(38131.5)
Car (0,1)	30%	50%
Food expenditure share of income	34.2	37.4
	(18.7)	(14.5)
Total field area owned and cultivated	923***	21957.3
	(2469.2)	(127379.4)
Distance to nearest market	13.9	13.2
	(6.7)	(10.3)
Home garden characteristics		
Home garden area	1771.3	1625.3
	(2015)	(2637.9)
Home garden sales in HUF/m^2	0.7***	16.2
	(3.1)	(72.2)
No. of crop species	15.7	16.4
	(4.1)	(6.8)
Good quality soil in home garden (0,1)	30%	18%
Organic production in home garden (0,1)	5% [aaa]	14.5%
Livestock in home garden (0,1)	100% [aaa]	78%
Irrigated land in home garden (%)	19.8***	33.8
	(28.2)	(40.8)
No. landraces	2.5***	0.8
	(1.2)	(1.2)
No. bean landraces	1.5***	0.8
	(1.2)	(1.2)
No. maize landraces	1***	0
	(0)	(0)

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

Pairwise t-tests between households that cultivate landraces and those who do not within each region show significant differences at ***1% significance level, **5% significance level and *10%significantce level. Pearson Chi-square tests between households that cultivate landraces and those who do not within each region show significant differences at §§§ 1% significance level

Table 6.A.4.Descriptive statistics for farm families with and without maize landraces by ESA

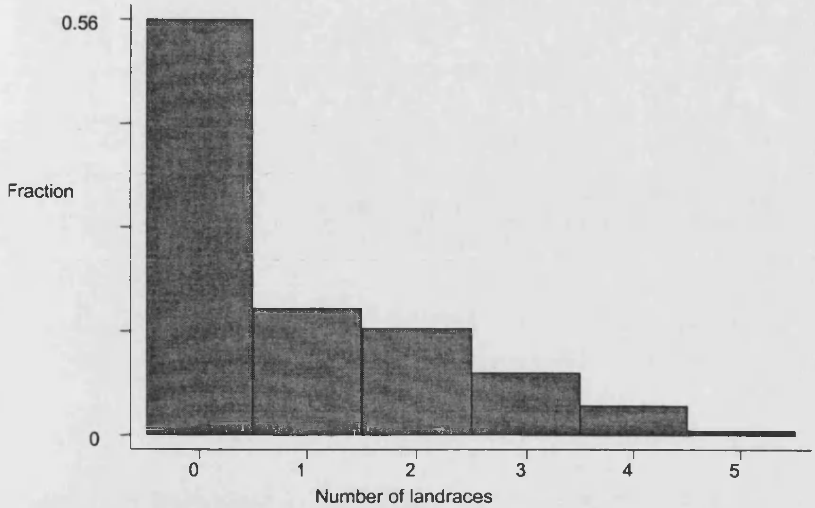
	Dévaványa N=104		Őrség-Vend N=109		Szatmár-Bereg N=110	
	With maize landrace	Without maize landrace	With maize landrace	Without maize landrace	With maize landrace	Without maize landrace
No. of households	3	101	6	103	11	99
Decision maker characteristics						
Age	59 (6.6)	58.5 (13.3)	52.3 (12.9)	58.2 (12.4)	61.7 (12)	55.9 (15.1)
Education[aaa]	10.7 (0.6)	10 (2.8)	8.7 (2)	10 (2.6)	7.5*** (2.6)	9.6 (3.2)
Household characteristics						
Home garden participation[aaa]	2** (0)	2.1 (1)	3 (1.6)	2.5 (1.3)	2.8 (1.5)	2.4 (1.3)
Household nonfarm income (HUF)	61833.3 (24760.5)	75354.4 (24953.9)	72250 (34919.6)	93141.3 (43474.3)	80092.6 (47642)	70831.6 (39869)
Car (0,1)	33.3%	39%	50%	64.1%	18.2%	45.5%
Food expenditure share of income	56.7** (12.6)	38.6 (14.5)	38.3 (24.2)	39.7 (16.2)	25.7*** (8.5)	33.7 (11.8)
Total field area owned & cultivated[a]	0 (0)	34396.8 (213645.2)	3051.7** (3923.8)	10526.4 (26276)	13.6*** (45.2)	21159.4 (49083.5)
Distance to nearest market[aaa]	0 (0)	0 (0)	14.6*** (3.4)	21.1 (6.6)	17.4 (2.6)	18.5 (3.1)
Home garden characteristics						
Home garden area	606.7 (877.6)	570.1 (686.9)	1050 (809.9)	1658.1 (2946.5)	2482.4 (2440.7)	2667.8 (3111.3)
Home garden sales in HUF/m^2	0*** (0)	5.6 (29.8)	0 (0)	7 (51.1)	1.4*** (4.2)	36.5 (108.4)
No. of crop species	14.7 (2.1)	13.7 (6.3)	18 (5.6)	20.1 (6.6)	14.7 (3.4)	15.3 (6)
Good quality soil in home garden (0,1)	33.3%	16.3%	0%	9.7%	45.5%	30%
Organic production in garden (0,1)[aaa]	0%	16.8%	0%	18.5%	9%	8.1%
Livestock in home garden (0,1)	100%	73.3%	100%	75.7%	100%	84.8%
Irrigated land in home garden (%)	33.3 (57.7)	36.2 (45.2)	25.2 (22.6)	47.2 (40.9)	13.2 (21.7)	17.4 (28.9)
Bean landraces	33.3%	24.8%	50%	49.5%	91%	46.5%
No. bean landraces	0.7 (1.2)	0.4 (0.8)	0.8 (1)	1 (1.2)	2 (1)	1 (1.3)
No. maize landraces	1 (0)	0 (0)	1 (0)	0 (0)	1 (0)	0 (0)

Source: Hungarian Home Garden Diversity Household Survey, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002. Total sample size=323

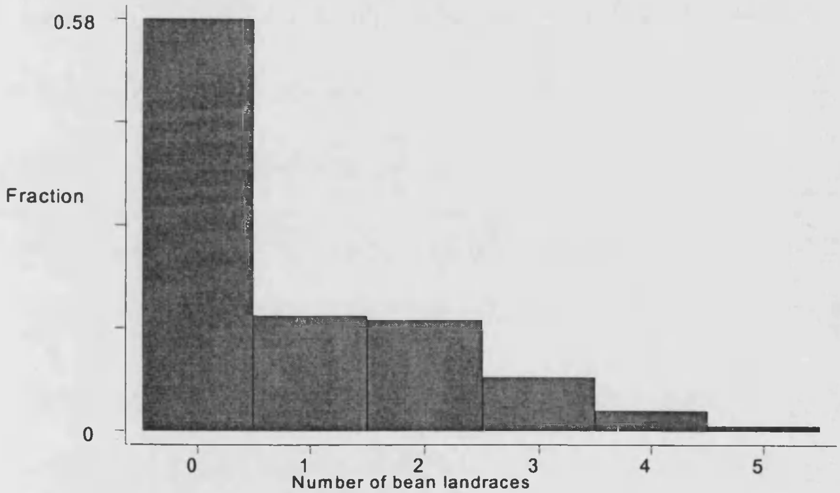
Pairwise t-tests between households that cultivate landraces and those who do not within each region show significant differences at ***1% significance level, **5% significance level and *10%significantce level. Pearson Chi-square tests between households that cultivate landraces and those who do not within each region show significant differences at §§§ 1% significance level. Pairwise t-tests between households that cultivate landraces across regions show significant differences at [aaa]1% significance level, [aa]5% significance level.

Figure 6.A.1. Histograms for landraces for the pool

Histogram for both maize and bean landraces



Histogram for bean landraces



Histogram for maize landraces

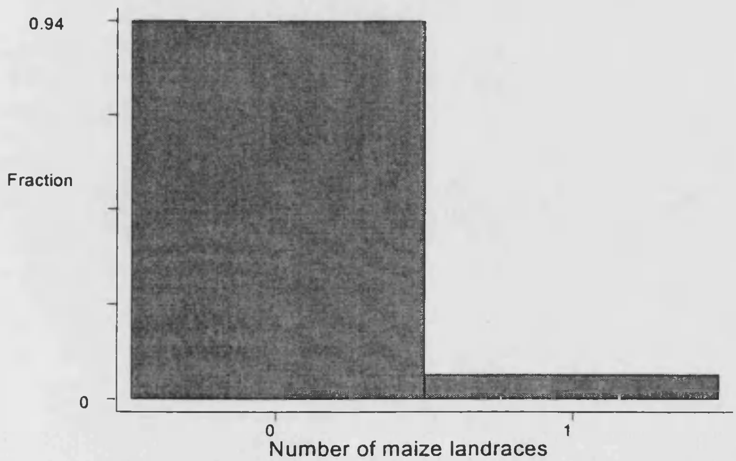
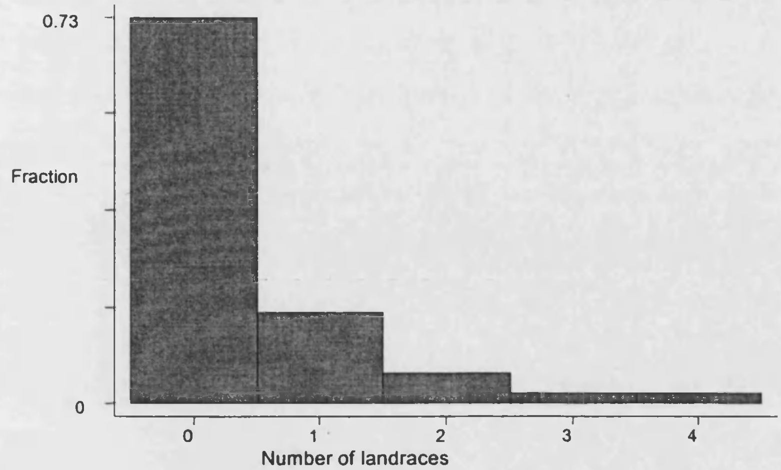
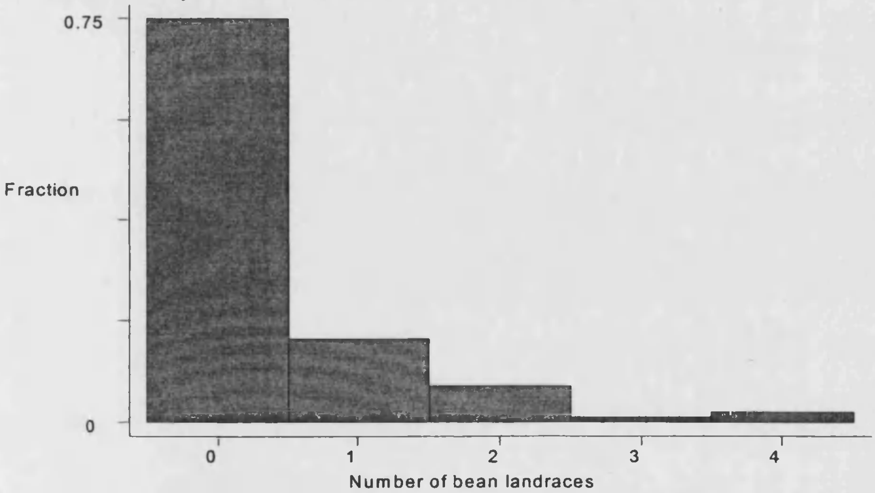


Figure 6.A.2. Histograms for landraces in Dévaványa ESA

Histogram for both maize and bean landraces in Dévaványa ESA



Histogram for bean landraces in Dévaványa ESA



Histogram for maize landraces in Dévaványa ESA

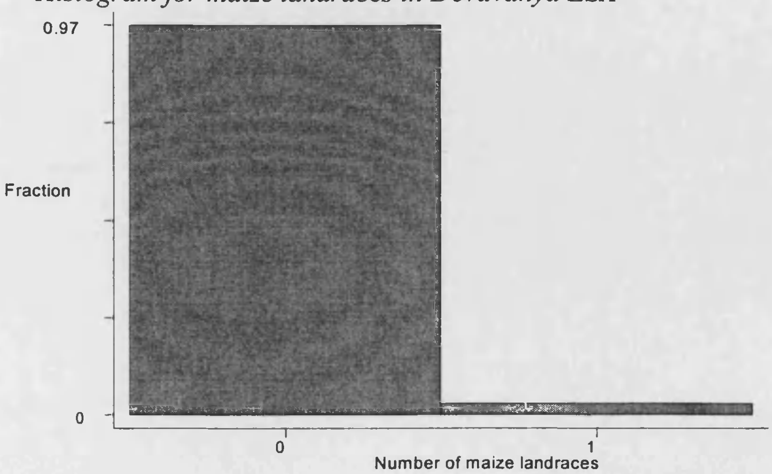
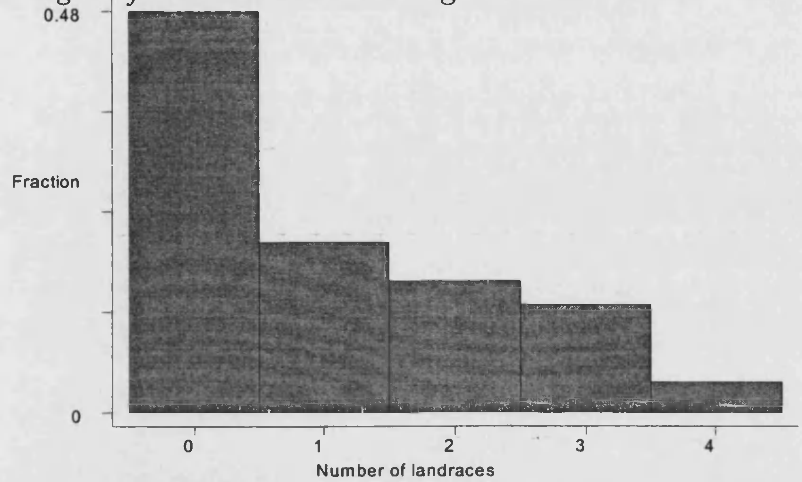
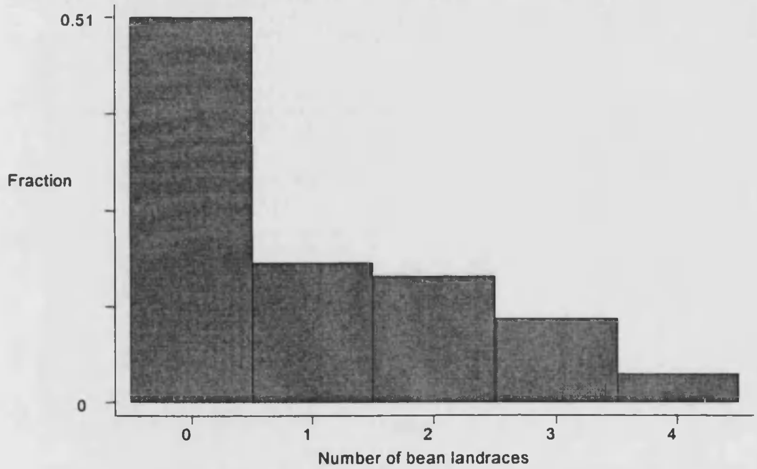


Figure 6.A.3. Histogram for landraces for Őrség-Vend ESA

Histogram for all landraces in Őrség-Vend ESA



Histogram for bean landraces in Őrség-Vend ESA



Number of maize landraces in Őrség-Vend ESA

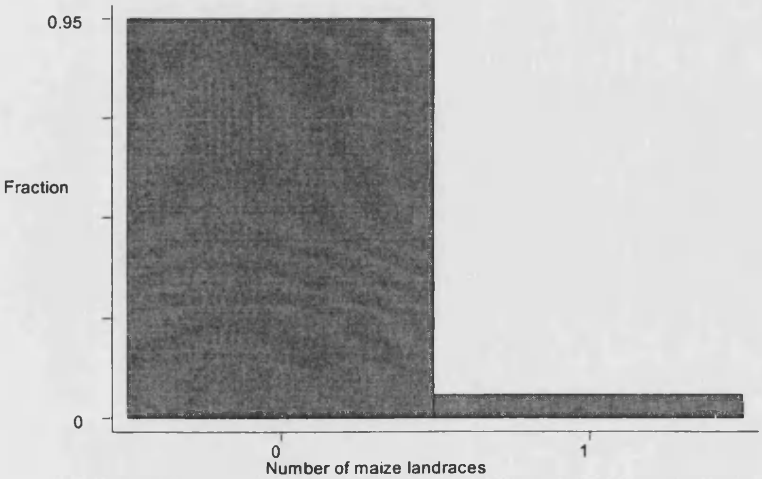
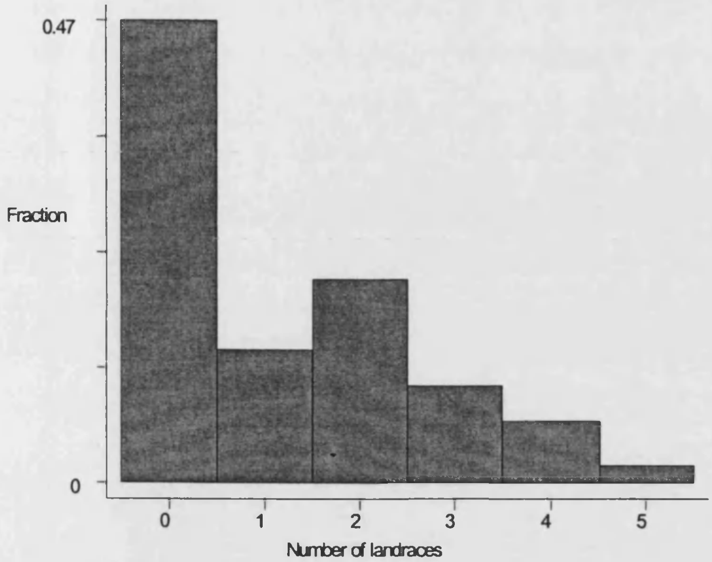
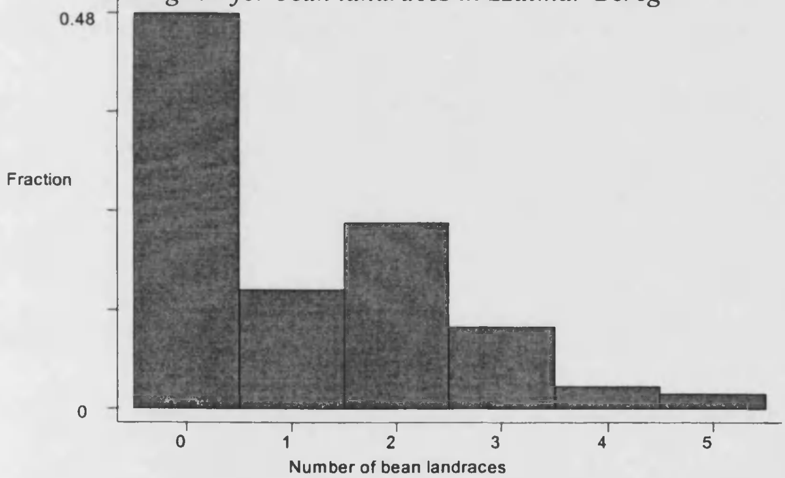


Figure 6.A.3. Histograms for landraces for Szatmár-Bereg ESA

Histograms for landraces in Szatmár-Bereg ESA



Histogram for bean landraces in Szatmár-Bereg



Histogram for maize landraces in Szatmár-Bereg ESA

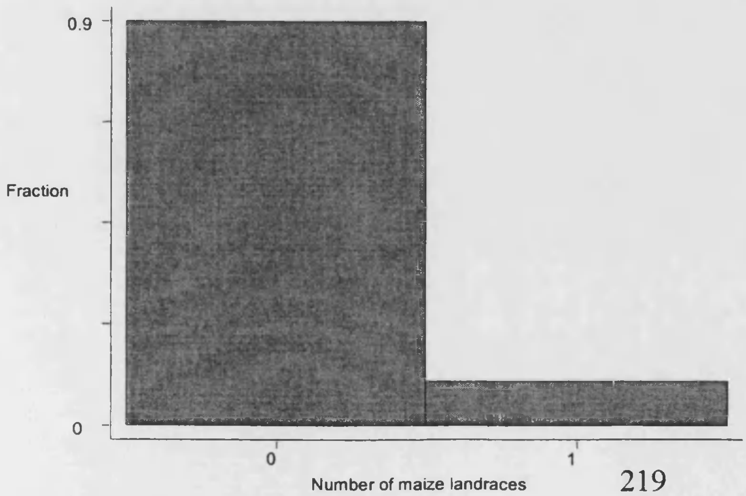


Table 6.A.5. Determinants of bean landrace cultivation choice and richness for the pool

	Poisson Hurdle			
	Binary Poisson (0-1)		Count (>0)	
	Coeff. (s.e.)	Marginal effects	Coeff. (s.e.)	Marginal effects
Constant	-5.91*** (1.67)	-1.71	-0.27 (1.58)	-0.31
AGE	0.14** (0.06)	0.041	0.0015 (0.054)	0.0018
AGE2	-0.001** (0.0005)	-0.0003	$0.4x10^{-5}$ (0.0005)	$0.4x10^{-5}$
HGPAR	0.12* (0.08)	0.04	0.12** (0.07)	0.14
TOTFOC	$-0.5x10^{-6}$ ($0.14x10^{-5}$)	$-0.13x10^{-6}$	$-0.1x10^{-5}$ ($0.3x10^{-5}$)	$-0.13x10^{-5}$
CAR	0.004 (0.011)	0.001	0.024 (0.2)	0.03
HGAREA	$0.2x10^{-4}$ ($0.4x10^{-5}$)	$0.5x10^{-5}$	$-0.3x10^{-4}$ ($0.4x10^{4}$)	$-0.3x10^{-4}$
IRRPER	-0.002 (0.002)	-0.0006	-0.001 (0.002)	-0.001
GOODSOIL	-0.001* (0.0008)	-0.0003	-0.0004 (0.0007)	-0.0004
SALEM2	0.0015* (0.001)	0.0004	0.0002 (0.001)	0.0002
DISTKM	0.034*** (0.009)	0.01	0.021** (0.01)	0.024
Sample size	323		136	
Log likelihood	-200.66		-170.51	
Chi squared	105.95		61.65	
D.o.f	10		10	
Significance level	0.00		0.00	

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

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

Table 6.A.6. Determinants of bean landrace cultivation choice and richness, by ESA

	Dévaványa		Őrség-Vend				Szatmár-Bereg			
	Poisson		Poisson Hurdle				Poisson Hurdle			
			Binary Choice (0-1)		Count (>0)		Binary Choice (0-1)		Count (>0)	
	Coeff. (s.e.)	Marginal effects	Coeff. (s.e.)	Marginal effects	Coeff. (s.e.)	Marginal effects	Coeff. (s.e.)	Marginal effects	Coeff. (s.e.)	Marginal effects
Constant	-21.42***	-7.87	-7.51*	-2.18	1.88	2.23	-3.67	1.36	-0.40	0.53
	(6.6)		(4.14)		(3.37)		(2.28)		(2.14)	
AGE	0.68***	0.25	0.22	0.063	-0.077	-0.09	0.03	0.02	0.027	0.04
	(0.21)		(0.14)		(0.0007)		(0.076)		(0.069)	
AGE2	-0.005***	-0.002	-0.0016	-0.0005	0.0007	0.0008	-0.0001	-0.0002	-0.00025	-0.0003
	(0.002)		(0.0012)		(0.001)		(0.0007)		(0.0006)	
HGPAR	-0.00016	-0.04	0.22*	0.064	0.16**	0.18	0.36***	0.11	-0.0046	-0.006
	(0.0003)		(0.14)		(0.09)		(0.14)		(0.14)	
TOTFOC	-0.00001	$-0.4x10^{-5}$	$0.2x10^{-4}$***	$0.6x10^{-5}$	$-0.2x10^{-5}$	$-0.2x10^{-5}$	$0.1x10^{-5}$	$0.3x10^{-6}$	$-0.9x10^{-6}$	$-0.1x10^{-5}$
	(0.00001)		$(0.9x10^{-5})$		$(0.5x10^{-5})$		$(0.4x10^{-4})$		$(0.4x10^{-5})$	
CAR	0.49	0.19	-0.28	-0.08	0.21	0.25	-0.33***	0.34	0.2	0.26
	(0.36)		(0.37)		(0.35)		(0.13)		(0.37)	
HGAREA	-0.00016	-0.00007	$-0.4x10^{-4}$	$-0.1x10^{-4}$	$-0.5x10^{-5}$	$-0.6x10^{-4}$	$0.17x10^{-4}$	$0.17x10^{-4}$	$-0.5x10^{-4}$	$-0.6x10^{-4}$
	(0.0003)		$(0.7x10^{-4})$		$(0.7x10^{-4})$		$(0.15x10^{-4})$		$(0.6x10^{-4})$	
IRRPER	-0.003	-0.001	-0.004	-0.0013	0.0005	0.0005	0.0014	0.0007	-0.00015	-0.0002
	(0.004)		(0.004)		(0.004)		(0.0018)		(0.005)	
GOODSOIL	-0.0022**	-0.0008	-0.08	-0.023	0.5	0.58	-0.0022	-0.002	0.42*	0.56
	(0.0009)		(0.61)		(0.4)		(0.1)		(0.28)	
SALEM2	-[a]		0.34	0.1	-0.0024	-0.0028	$0.9x10^{-4}$	$0.9x10^{-4}$	-0.0008	-0.001
			(0.32)		(0.004)		$(0.5x10^{-3})$		(0.0016)	
DISTKM	-	-	-0.014	-0.004	0.006	0.007	0.024	0.024	0.012	0.016
			(0.025)		(0.023)		(0.017)		(0.04)	
Sample size	104		109		54		110		56	
Log likelihood	76.31		-62.79		-65.86		-67.37		-73.64	
Chi squared	31.71		58.28		27.95		52.88		22.35	
D.o.f	9		10		10		10		10	
Sig. level	0.0002		0.00		0.0018		0.00		0.01	

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

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

[a] Sale of home garden output variable dropped out as the regressors were found collinear.

Table 6.A.7. Determinants of maize landrace cultivation choice for the pool

	Poisson	
	Coeff. (s.e.)	Marginal effects
Constant	-8.80** (4.48)	-0.55
AGE	0.18 (0.15)	0.01
AGE2	-0.0014 (0.0013)	$-0.9x10^{-4}$
HGPAR	0.38** (0.18)	0.024
TOTFOC	-0.00014** ($0.9x10^{-4}$)	$-0.9x10^{-5}$
CAR	0.0019 (0.017)	0.00012
HGAREA	$-0.2x10^{-4}$ (0.0001)	$-0.1x10^{-5}$
IRRPER	-0.01* (0.007)	-0.0006
GOODSOIL	0.82** (0.5)	0.05
SALEM2	-0.0014 (0.0022)	$-0.9x10^{-4}$
DISTKM	0.009 (0.025)	0.0006
Sample size	323	
Log likelihood	-66.10	
Chi squared	19.07	
D.o.f	10	
Significance level	0.04	

Source: Hungarian Home Garden Diversity Household Survey, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002.
* significant at less than 10%, ** significant at less than 5%, *** significant at less than 1%

Table 6.A.8. Determinants of maize landrace cultivation choice by ESA

	Dévaványa		Őrség-Vend		Szatmár-Bereg	
	Poisson		Poisson		Poisson	
	Coeff. (s.e.)	Marginal effects	Coeff. (s.e.)	Marginal effects	Coeff. (s.e.)	Marginal effects
Constant	-88.82 (78.06)	-2.59	5.37 (9)	0.3	-13.39* (7.22)	-1.34
AGE	2.82 (2.61)	0.083	-0.16 (0.32)	-0.009	0.32 (0.23)	0.032
AGE2	-0.024 (0.022)	-0.0007	0.0013 (0.003)	0.7×10^{-4}	-0.002 (0.0019)	-0.0002
HGPAR	0.81 (0.98)	0.024	0.21 (0.34)	0.012	1.06*** (0.41)	0.11
TOTFOC	-0.15 (220.66)	-0.004	-0.13×10^{-4} (0.5×10^{-4})	-0.8×10^{-6}	-0.0013 (0.0021)	-0.0001
CAR	0.005 (0.05)	0.00015	-0.11 (1.1)	-0.006	-1.54* (1.09)	-0.15
HGAREA	-0.0005 (0.001)	-0.13×10^{-4}	-0.0002 (0.00025)	-0.1×10^{-4}	0.5×10^{-4} (0.0012)	0.5×10^{-5}
IRRPER	-0.0022 (0.014)	-0.6×10^{-4}	-0.013 (0.014)	-0.0007	0.0053 (0.016)	0.0005
GOODSOIL	2.37* (1.71)	0.07	-35.46 (64642576)	-1.95	0.95* (0.7)	0.09
SALEM2	-27.39 (1574364.8)	-0.8	-192.48 (88616190)	-10.6	-0.11 (0.096)	-0.011
DISTKM	-	-	-0.19* (0.12)	-0.01	-0.097 (0.11)	-0.001
Sample size	104		109		110	
Log likelihood	-8.87		-17.47		-22.09	
Chi squared	9.54		11.85		28.47	
D.o.f	9		10		10	
Sig. level	0.39		0.3		0.0015	

Source: Hungarian Home Garden Diversity Household Survey, Hungarian On Farm Conservation of Agricultural Biodiversity Project, 2002.
* significant at less than 10%, ** significant at less than 5%, *** significant at less than 1%

Chapter 7

Conclusions, policy implications, contributions to literature and directions for future research

7.1. Introduction

This final chapter restates the major findings of the thesis and discusses their implications for design of policies and programmes that aim to conserve and promote sustainable use of Hungarian agricultural biodiversity riches. Contributions to the literature on the economics of conservation of agricultural biodiversity on farm are pointed out. Finally, directions for future research are presented.

7.2. Major findings and conclusions

Using stated and revealed preference methods, a choice experiment and farm household survey respectively, the private (use) values that farm families attach to traditional Hungarian home gardens and agricultural biodiversity riches therein are investigated in three agricultural biodiversity and biodiversity hotspot regions of Hungary.

The major findings of this thesis are

(i) *Home gardens are repositories of agricultural biodiversity and Hungarian cultural heritage.* In this thesis agricultural biodiversity is measured in its four main components, including crop species diversity, crop genetic diversity, agro-diversity and soil microorganism diversity. The results of the farm household survey, informal and focus group interviews, as well as those of the scientific analyses conducted at the Institute for Agrobotany disclose strong evidence of important agricultural biodiversity riches found in home gardens across the three sites, which also conserve Hungarian cultural heritage. It can be concluded that traditional Hungarian home gardens provide multifunctional agricultural values.

(ii) *Considerable heterogeneity is present across regions and communities.* The three sites studied in this thesis differ in terms of agro-ecological, market integration and economic development characteristics. One of the main results of the analyses of both revealed and stated preference data sets is uniqueness of each region studied in terms of levels of agricultural biodiversity found in the home gardens of farm families, as well as the factors that explain their variation. In each statistical analysis conducted in this thesis the hypothesis that population parameters of interest are constant across regions is rejected.

(iii) *Markets are missing for home garden outputs.* The results of the statistical analyses of the farm household survey reveal that in all regions, the production choices of farm families concerning the goods they produce in home gardens, as reflected in the components of agricultural biodiversity measured in this thesis, cannot be separated from their consumption decisions. Therefore market imperfections in Hungary's transitional economy continue to induce farmers to produce for their own food requirements. This statement holds even for the region that is most integrated into markets for specialised home garden produce such as landraces, organically produced food and livestock.

(iv) *Farm families and communities that attach the highest stated values to agricultural biodiversity in home gardens are profiled.* According to the results of the choice experiment, those farm families that are furthest away from the food markets attach the highest values to crop species diversity. Landraces are valued most highly by the elderly and poorer farm families. Those farm families that are larger and also cultivate fields alongside home gardens value agro-diversity the most, while organic production method is valued most highly by younger and better off farm families, as well as by poorer, elderly ones.

(v) *Farm families and communities that attach the highest revealed values to agricultural biodiversity in home gardens are profiled.* Predictions that result from the analyses of the farm household data reveal that those farm families that are most likely to manage home gardens with higher crop species diversity are larger, have home gardens with favourable agro-ecological conditions and greater distances to the nearest food markets. Landraces are most likely to be grown by those farm families that are larger, have older decision-makers, marginal production conditions in the home garden and reside in the most isolated communities in the country. And agro-diversity is the chosen method of home garden management by those farm families that are larger and cultivate expanses of fields.

(vi) *There are possible diversity-development trade offs.* Investigation of the relationship between farm families' demand for agricultural biodiversity and the economic development and market integration level of the communities in which the farm families are located reveals a negative relationship between the two. Hungary is a transitional economy with a high economic growth rate and will be joining the European Union (EU) in May 2004. Therefore the equilibria of farm families and communities that conserve agricultural biodiversity at the moment might not be stable, in which case the long-term sustainability required for on farm conservation might not be guaranteed.

7.3. Policy implications

7.3.1. Inclusion of home gardens in the National Agri-Environmental Programme

The major findings of this thesis reveal that farm families in the most economically, geographically and agro-ecologically marginalised communities and regions of the country conserve *de facto* the traditional Hungarian home gardens and the agricultural biodiversity and cultural values therein. As long as this is the case, the opportunity costs of maintaining agricultural biodiversity levels in these communities and regions are nil. However, there is insufficient assurance that Hungarian society can rely indefinitely on its marginalised farm families to conserve these 'repositories of agricultural biodiversity' and cultural heritage.

Beginning with membership of the EU, isolated regions are likely to be drawn into regional, national and EU level markets (Fischler, 2003) and the opportunity costs of the labour now used in home garden production is expected to rise. National and EU level policies and programmes, such as the National Agri-Environmental Programme (NAEP) and Special Accession Programme for Agriculture and Rural Development (SAPARD) are now in place to encourage economic activities, improve infrastructure and retain community populations in the countryside (Juhász, 2000; Weingarten *et al.*, 2004). Such rural development policies and programmes could cause the time allocated to home garden production and farm families' demand for their own home garden produce to decrease as they choose to undertake more remunerative activities and participate in markets that become increasingly available. Therefore, unless specific measures are taken, increasing economic development and market integration in the country could cause the demise of agricultural biodiversity rich traditional home gardens.

On the other hand, the marginalised communities may become increasingly marginalised with further economic transition. It has been found that the increasing number of hyper and supermarkets in Hungary caused disappearance of local shops and markets, making the access of the poor and vulnerable to food even more limited (WHO, 2000; HCSO, 2003). In addition, ever since economic transition began, the percentage of poor people and the inequality levels in the country, especially between those that are high skilled and employed and those that are low skilled, older and unemployed has increased (Wyzan, 1996; OECD, 2002). This further marginalisation and increasing poverty of farm families could cause them to depend on their own produce even more, resulting in maintenance of agricultural biodiversity rich home gardens.

Both concerns related to conservation of agricultural biodiversity on home gardens and those related to social equity, as well as Hungary's commitments as a signatory to international agreements[68] might be addressed through integrating agricultural biodiversity rich home garden management practices into publicly-financed, national programmes in selected communities, with selected farm families. The most proximate means to subsidise traditional home garden production and agricultural biodiversity conservation is the NAEP, which is structured around contract payments to those farmers that undertake sustainable, environmentally-friendly agricultural production methods that generate multifunctional agricultural values, as explained in chapter 1.

Once public decision-makers recognise the contribution of Hungarian home gardens to multifunctional agriculture, they would understand that the exclusion of home gardens from NAEP would only cause economic inefficiencies. The findings of this thesis can be a starting point for identifying locations and farmers to include in contracting schemes to support the sustainable management of agricultural biodiversity in home gardens. By analysing the revealed and stated preferences of 323 farm families across twenty two communities in three regions of Hungary, which are considered as agricultural biodiversity 'hotspots', this thesis has identified the characteristics of farm families, decision-makers and farming communities that attach the highest private values to home gardens and the agricultural biodiversity therein. These characteristics are important to consider in designing programmes or policies to conserve or enhance the agricultural biodiversity and other attributes of Hungarian home gardens. Economic theory predicts that those farm families who now attach the highest values to their home gardens would need the least additional public funds as incentives to continue their management (Meng, 1997; Smale *et al.* forthcoming).

[68] Hungary is a signatory to Convention on Biological Diversity (CBD), the International Treaty on Plant Generic Resources for Food and Agriculture (IT) and the Global Plan of Action for the Conservation and Sustainable Utilisation of Plant Genetic Resources for Food and Agriculture (GPA). All of these international agreements promote *in situ* conservation of agricultural biodiversity on farm and expect all of their signatories to implement measures to encourage conservation and sustainable use of agricultural biodiversity in their countries, as explained in chapter 1.

These "least cost" sites and farm families should be ranked the highest as candidate sites and farm families for conservation (Brown, 1991).

7.3.2. Development of niche markets for home garden produce

Market based incentives are generally less costly than publicly funded conservation programmes (Smale, 2001b). The high nutritional value and superior cooking qualities of home garden produce, especially of landraces and organically produced foodstuff, might serve as a basis for development of niche markets (Már, 2002; Már, 2004, personal communication). Farmers would have economic incentives to grow landraces and/or produce home garden products organically, if urban consumers in Hungary or elsewhere are willing to pay premium for their products because they have unique attributes.

Agricultural industry responds to the demand of the society (Cuffaro, 2002) and the post-industrial agricultural economy is characterised by growth in demand for an array of increasingly specialised goods and services (Antle, 1999). Several studies found that high income consumers are willing to pay higher prices for foodstuff with preferred eating and nutritional quality. Traditional varieties of many crops and breeds, as well as organically produced food is found to fetch premium prices in the markets (Unnevehr, 1986; Unnevehr *et al.*, 1992; Pingali *et al.*, 1997; Smale, 2000). In the EU, numerous recent studies point to the rising demand of high-income, EU consumers for goods produced with organic methods or heirloom varieties of crop and animal species (see for example Kontoleon, 2003).

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

The EU has already created such necessary market mechanisms for farmers' and communities to appropriate the benefits of high cultural and environmental value products they produce. In 1992, with Council Regulations EC No 2081/92 and EC No 2082/92, the European Union created labels (systems) known as PDO (Protected Designation of Origin), PGI (Protected Geographical Indication) and TSG (Traditional Speciality Guaranteed) to promote and protect agricultural products[69]. The EU acquired these systems with three main aims in mind (EU, Agriculture and Food web site, 2004): 1) encouraging diverse agricultural production in a rural development context; 2) protecting product names from misuse and imitation; 3) helping consumers by giving them product information. Consumer demand for such certified and labelled agricultural products has been found in the USA (Blend and van Ravenswaay, 1999) as well as in the EU (Kontoleon, 2003). Such prospects for niche markets or geographical denomination of origin might therefore be considered as part of the market integration that Hungary will experience with EU membership. The results of this thesis, once combined with the detailed findings of genetic analyses undertaken by the Institute for Agrobotany, can help identify the landraces, communities and farmers who are the most promising candidates to take part in such initiatives.

[69] A PDO (Protected Designation of Origin) covers the term used to describe foodstuffs which are produced, processed and prepared in a given geographical area using recognised know-how. In the case of the PGI (Protected Geographical Indication) the geographical link must occur in at least one of the stages of production, processing or preparation. Furthermore, the product can benefit from a good reputation. A TSG (Traditional Speciality Guaranteed) does not refer to the origin but highlights traditional character, either in the composition or means of productionhttp://europa.eu.int/comm/agriculture/foodqual/quali1_en.htm)

Generally, however, governments also need to invest in developing the infrastructure to support the formation of niche markets, and given the development status of some of the communities that might supply such produce, market based mechanisms may be costly. Furthermore, Franks (1999) warns that conservation goals are unlikely to be met by depending on revenues earned from marketing commercially valuable traits of rare breeds or landraces. In addition, such incentives might induce the farm families or communities to specialise in production of a few landraces or varieties, thereby reducing other agricultural biodiversity in the home gardens, such as agro-diversity or crop species diversity. Therefore, a mixture of subsidies and other market based incentives might be preferable to depending on market based incentives to create the necessary incentives for conservation of efficient levels of agricultural biodiversity.

7.3.3. Other conservation programmes, policies and initiatives

As target communities and farm families are identified, programmes, policies and initiatives to increase farmers' demand for agricultural biodiversity should also be considered, especially for landraces of crops and livestock, for which markets are incomplete. Policy or programme options that can increase farmers' awareness, demand and knowledge of landraces may include diversity fairs, educational campaigns and participatory plant breeding programmes (Smale, 2002).

In addition, one of the main results of the thesis is that the sustainability of *in situ* conservation of agricultural biodiversity, especially of landraces is in jeopardy because it is mainly elderly farmers that manage landraces. Therefore programmes must be developed to ensure transfer of knowledge and skills that reside with older farmers to future generation of home garden farmers. These initiatives may be incorporated into the rural development programmes of NAEP.

7.4. Contributions to the literature

Empirical studies investigating the economics of conserving agricultural biodiversity on farms have been few (Smale, 2002). A review of these studies is presented in chapter 5. They have, so far, been limited exclusively to developing countries, crop biodiversity component of agricultural biodiversity and to microeconomic theory of the farm household applied with econometric models to cross sectional data sets collected with household surveys (Smale, 2002).

Contributions of this thesis to the economics of conservation of agricultural biodiversity on farm literature include:

1. Employment of a choice experiment, adapted from environmental economics literature, to investigate the private values of attributes of home gardens that accrue to the farm families and that are not traded in the markets. The overall contribution of this choice experiment study conducted in this thesis to conservation of agricultural biodiversity on farm literature is that stated preference methods, such as the choice experiment method, can be a complementary approach to the farm household model.

2. Contributions of the choice experiment study to the choice experiment literature include:

    (i) Estimation of WTA values for home garden attributes[70]. The theoretical validity of these results, as explained in chapter 3, confirm that choice experiment method can be used to estimate WTA values as well as it can estimate WTP. This result has implications for stated preference methods, as previously estimated WTA values from other methods, such as from CVM, were not considered to be reliable (Kahneman, Knetsch and Thaler, 1990). Therefore, it can be stated that the choice experiment method has advantages over CVM at least when the property rights of the environmental good that is being valued reside with the respondent.

(ii) Implementation of a choice experiment in the context of a transitional economy, in which markets are just being developed. It can be claimed that the choice experiment method, which is based on marketing literature originally, can be used under these circumstances, when the monetary attribute is formatted in such a way that the respondent can understand and identify with it.

(iii) Estimation of the values for an agroecosystem. There have been a few choice experiment studies that looked at the specific components of agricultural biodiversity, such as animal genetic resources, however this is a first that attempted to estimate the values of multiple attributes of an agroecosystem. It can be stated that this method yields satisfactory outcomes when valuing environmental goods that entail multiple benefits, such as ecosystems.

3. Contribution of the analysis of the farm household data set contributes to the present literature on conservation of agricultural biodiversity on farm through:

(i) Investigation of the determinants of conservation of an entire agroecosystem, in all of its most important components in this context, rather than diversity within a single crop or a cluster of crops, as exemplified by previous studies on this topic.

(ii) Investigation of the motivations for on farm conservation of agricultural biodiversity in a developed country context. The farm

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[70] The only other choice experiment study that the author of this thesis is aware of that estimates WTA value is that of Horne and Petäjistö (2003), which investigates landowners' preferences for moose management in Finland.

household model that has so far been applied only to developing countries was employed in this context as the markets for home garden produce are imperfect in rural Hungary, as explained in chapters 1 and 4.

7.5. Future research directions

Possible directions for future research include

(i) *Fusion of stated and revealed preference data sources.* Since both choice experiment and farm household data analysis are based on random utility theory and the data are from the same farm families, they will be combined to get a richer data set and to take advantage of the relative strengths of different types of data. Both stated and revealed preference methods have advantages and drawbacks. Stated preference methods are criticised because of their hypothetical nature and the fact that actual behaviour is not observed, while revealed preference method might suffer from collinearity among attributes. Combination of these two data sets is expected to improve the efficiency of the estimates and reveal more robust results about the determinants of agricultural biodiversity that are found on Hungarian home gardens (Adamowicz, Louviere and Williams, 1994; Adamowicz *et al.*, 1997; Adamowicz, and Boxall, 2001)

(ii) *Incorporating genetic data.* In chapter 6, richness, that is count of landraces, is employed as a crude measure for crop genetic diversity on home gardens. Even though number of landraces is not synonymous with crop genetic diversity (Smale *et al.*, 2001b), it was thought to be a realistic assumption in this case study. This is because all landraces identified in the home gardens are potentially equally valuable in terms of genetic diversity and the cultural heritage values they contain. However, once the Institute for Agrobotany completes the molecular biological analyses it is conducting on the landraces found in farm families' home gardens, the methodology developed in chapters 5 and 6 will be reapplied by integrating the molecular measures of crop diversity to farm household data.

(iii) *Investigating multi-output production technology.* Many of the farm families in the sample cultivate fields alongside home gardens creating the dual structure of Hungarian agriculture as explained in chapter 1. It is hypothesised that agricultural production activity in type of plot will have impacts on the other, i.e. production is joint, as a result of possible input fixity. An analysis will be carried out based on the assumption that jointness in agricultural production is due to the fixity of total household time endowment, which needs to be allocated between the fields and the home gardens. This argument follows a well-established literature that is based on the notion that allocable fixed inputs necessitate joint production even if the production technologies are distinct (Schumway, Pope and Nash, 1984, 1988; Guyomard, 1988; Leathers, 1991). A thorough understanding of the jointness of production is expected to shed light on to the effects of policies on field production (such as increase in price of the field output) on production of home gardens and therefore on the maintenance of agricultural biodiversity therein.

(iv) *Spatial effects.* Hitherto the statistical analysis of most if not all stated preference data has proceeded on the assumption that the random error components of responses made by individuals located at different points on a plane surface are uncorrelated with one another. In reality individuals' responses will be determined in part by factors unobserved by the analyst but varying in abundance through space. In the present context this means that the response of different farm families located nearby to one another might be more similar than the response of otherwise identical farm families but geographically more distant to another. Greater efficiency (and even different

results) might be obtained by in some way incorporating geographical information into the analysis. Spatial effects will be considered in future analyses.

(v) *Incorporation of attitudes towards risk.* Stochasticity inherent in agricultural production as a result of time lags, biological and natural processes create uncertainty, and farm families' behaviour under uncertainty is expected to be affected by their risk preferences. Even if output price risk is reduced as a result of market integration, it is expected that the production risk will remain. Therefore farmers' individual risk attitudes will be derived from the farm household data and these will be incorporated into the choice experiment analysis as interaction effects to explain the impacts of farm families' attitudes towards risk on their demand for agricultural biodiversity in home garden. (Antle, 1987; Koundouri *et al.*, 2004)

(vi) *Investigation of public (non-use) values of traditional Hungarian home gardens.* A choice experiment will be carried out to investigate the public (non-use) values the Hungarian public might attach to this traditional method of agricultural production, as well as to the traditional varieties of crops and animal breeds and Hungarian cultural heritage, which are conserved in home gardens. Such a study would enable estimation of the total economic value of home gardens thereby leading to a possible cost benefit analysis of their conservation.

BIBLIOGRAPHY

Abalu, G. 1976. "A note on crop mixtures under indigenous conditions in northern Nigeria", *Journal of Development Studies*, Vol. 12, No. 3, pp. 212-220.

Adamowicz, V., J. Louviere and M. Williams. 1994. 'Combining Stated and Revealed Preference Methods for Valuing Environmental Amenities', *Journal of Environmental Economics and Management*. Vol. 26, pp. 271-292.

Adamowicz V., J. Swait, P. Boxall, J. Louviere and M. Williams. 1997. "Perceptions versus Objective Measures of Environmental Quality in Combined Revealed and Stated Preference Models of Environmental Valuation", *Journal of Environmental Economics and Management*, Vol. 32, No. 1, pp. 65-84.

Adamowicz, W.L., P.A. Kupris and M.M. Veeman. 1999. "Consumers Responses to the Potential Use of Bovine Somatotrophin in Canadian Dairy Production", *Canadian Journal of Agricultural Economics*, Vol. 47, pp. 151-163.

Adamowicz, W.L., P.C. Boxall, J.J. Louviere, Y. Swait and N. Williams. 2000. "Stated Preference Methods for Valuing Environmental Amenities", Chapter 13 in Bateman I.J. and K.G. Willis (Eds.) *Valuing environmental preferences: theory and practice of the contingent valuation method in the US, EU, and developing countries,* Oxford University Press, Oxford.

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

Altieri, M. and M. Liebman. 1986. "Insect, Weed, and Plant Disease Management in Multiple Cropping Systems", in Francis C. (Ed.) *Multiple Cropping Systems*, Macmillan, New York.

Altieri M. and L. Merrick. 1988. "Agroecology and *In situ* conservation of native crop diversity in the Third World", in Wilson E.O. (Ed.) *Biodiversity,* National Academy Press, Washington D.C.

Ángyán J. 2000. *Action Plan for Preservation of Biodiversity: Strategy for Hungarian Agricultural Sector*. MTA, Budapest

Antle, J. 1987. "Econometric Estimation of Producers' Risk Attitudes", *American Journal of Agricultural Economics*, Vol. 69, pp. 509-522.

Antle, J.M. 1999. "The new economics of agriculture", presidential address prepared for the Annual Meetings of American Agricultural Economists Association, Nashville, August, 1999.

Artuso, A. 1996. "Creating linkages between valuation, conservation and sustainable development of genetic resources", paper prepared for the Symposium on the Economics of Valuation and Conservation of Genetic Resources field output Agriculture, Centre for International Studies on Economic Growth, Tor Vergata University, May 13-15, 1996, Rome, Italy.

Banzhaf R.M., F.R. Johnson and K.E. Mathews. 2001. "Opt out Alternatives and Angles Preferences", in Bennett, J.J. and R.K. Blamey (Eds.) *The Choice Modelling Approach to Environmental Valuation*, Edward Elgar, London, pp. 133-156.

Bateman, I.J., Carson, R.T., Day, B., Hanemann, W.M., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., Ozdemiroglu, 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", Edward Elgar, Cheltenham.

Bateman, I.J. and K. G. Willis (Eds.). 2000. *Valuing environmental preferences: theory and practice of the contingent valuation method in the US, EU, and developing countries,* Oxford University Press, Oxford.

Bela, G., G. Pataki, M. Smale and M. Hajdú. 2003. "Conserving Genetic Resources on Smallholder Farms in Hungary: Institutional Analysis", paper presented at the BIOECON International Conference on 'Economic Analysis of Policies for Biodiversity Conservation', August 28-29, 2003, Venice, Italy.

Bellon, M.R., and E. Taylor. 1993. "Folk Soil Taxonomy and the Partial Adoption of New Seed Varieties" *Economic Development and Cultural Change,* Vol. 41, No. 4, pp. 763-786.

Bellon, M.R., Pham, J.L. and M.T. Jackson. 1997. "Genetic conservation: a role for rice farmers", in Maxted, N., B.V. Ford-Lloyd and J.G. Hawkes (Eds.) *Plant Genetic Conservation: The In situ Approach.* Chapman and Hall, London, pp. 263-289

Bellon, M.R. *et al.*, 1998. "Farmers' perceptions of varietal diversity: implications for on farm conservation of rice", in Smale, M (Eds). 1998. *Farmers, Gene Banks and Crop Breeding: Economic Analyses of Diversity in Wheat, Maize and Rice*, Kluwer Academic Press, Boston and CIMMYT, Mexico City, pp. 95-108.

Ben-Akiva, M. and S. R. Lerman. 1985. *Discrete Choice Analysis, Theory and Application to Travel Demand*, MIT Press, Cambridge Massachusetts.

Benin, S., M. Smale, B. Gebremedhin, J. Pender, and S. Ehui. 2003. "The determinants of cereal crop diversity on farms in the Ethiopian highlands", EPTD Discussion Paper No. 105, IFPRI, Washington, D.C.

Bennett, J.J. and R.K. Blamey. 2001. *The Choice of Modelling Approach to Environmental Valuation,* Edward Elgar Publishing Limited, Cheltenham.

Bergland, O. 1997. "Valuation of Landscape Elements Using a Contingent Choice Model", paper prepared for the 1997 EAERE Conference, June, 1997, Tilburg.

Blend J.R. and E.O. van Ravenswaay. 1999. "Measuring consumer demand for ecolabelled apples", *American Journal of Agricultural Economics,* Vol. 81 No.5, pp. 1072-1077.

Bockstael, N.E. and K.E. McConnell. 1983. "Welfare Measurement in the Household Production Framework", *The American Economic Review*, Vol. 73, Issue 4, pp. 806-814.

Boserup E. 1965. *The Conditions for Agricultural Growth*, Allen and Unwin, London.

Boxall, P.C., Adamowicz, W.L., Swait, J., Williams, M., and Louviere, J. 1996. "A comparison of stated preference methods for environmental valuation", *Ecological Economics,* Vol. 18, pp. 243-253.

Boxall, P.C. and W.L. Adamowicz. 1999. "Understanding Heterogeneous Preferences in Random Utility Models: The Use of Latent Class Analysis", Department of Rural Economy, University of Alberta Staff Paper 99-02

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*, Vol. 15, pp 1-20.

Bretting, D.K. and D.N. Duvick. 1997. "Dynamic conservation of plant genetic resources", *Advances in Agronomy*, Vol. 61, pp.1-51.

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

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

Brookfield, H., C. Padoch, H. Parsons, and M. Stocking. 2002. *Cultivating Biodiversity: Understanding, Analysing and Using Agricultural Diversity*, The United Nations University, ITDG Publishing, London

Brown, G.M. 1990. "Valuation of Genetic Resources". In Orians, G.H., G.M. Brown, W.E Kunin and J.E. Swierzbinski (Eds) *The Preservation and Valuation of Biological Resources*, University of Washington Press, Seattle, pp.203-228 .

Brush, S. 1986. "Genetic diversity and conservation in traditional farming systems", *Journal of Ethnobiology*, Vol. 6, pp. 151-167

Brush, S. 1989. "Rethinking crop genetic resource conservation", *Conservation Biology*, Vol. 3, pp. 19-29.

Brush, S. 1991. "A farmer-based approach to conserving crop germplasm", *Economic Botany*, Vol. 45, pp. 153-165.

Brush, S., E. Taylor, and M. Bellon. 1992. "Technology Adoption and Biological Diversity in Andean Potato Agriculture", *Journal of Development Economics,* Vol. 39, No. 2, pp. 365-387.

Brush, S.B. 1992. "Farmers' rights and genetic conservation in traditional farming Systems", *World Development*, Vol. 20, pp. 1617-1630.

Brush, S.B. and E. Meng. 1998. "Farmers' valuation and conservation of crop genetic resources", *Genetic Resources and Crop Evolution,* Vol. 45, pp. 139-150.

Brush, S.B. 2000. *Genes in the field: On farm conservation of crop diversity*, International Development Research Centre, International Plant Genetic Resources Institute and Lewis Publishers, Boca Raton.

Cameron, A. and P. Trivedi. 1986. "Econometrics Models Based on Count Data: Comparisons and Applications of Some Estimators", *Journal of Applied Econometrics*, Vol.1, pp. 1-46.

Cameron, A. and P. Trivedi. 1990. "Regression Based Tests for overdispersion in the Poisson Regression Model", *Journal of Econometrics*, Vol. 46, pp. 347-364.

Carson, R., R. Mitchell, M. Hanemann, R. Kopp, S. Presser and P. Ruud. 1992. *A Contingent Valuation Study of Lost Passive Use Values Resulting from the Exxon Valdez Oil Spill*, A Report to The Attorney General of the State of Alaska.

Casley, D.J. and D.A. Lury. 1982. *Data Collection in Developing Countries,* Oxford University Press, Oxford.

Chambers, R.G. and R.E. Just. 1989. "Estimating Multioutput Technologies", *American Journal of Agricultural Economics,* Vol. 71, pp. 980-95.

Chiang, A.C. 1984. *Fundamental Methods of Mathematical Economics*, Third Edition, McGraw Hill International Editions.

Clawson, D.L. 1985. "Harvest Security and Intraspecific Diversity in Small-Scale Tropical Agriculture", *Economic Botany* Vol. 39, pp 56-67.

Collar, N. J., M.J. Crosby and A.J. Stattersfield. 1994. *Birds to watch 2: the world list of threatened birds*, BirdLife Conservation Series No. 4, BirdLife International, Cambridge.

Commission of the European Communities. 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 Programme.*
http://www.biodiv.org/programmes/areas/agro

Cornes, R. and T. Sandler. 1996. *The Theory of Externalities, Public Goods and Club Goods*, Second Edition, Cambridge University Press, Cambridge.

Cooper, D., R. Vellve, and H. Hobbelink. 1992. *Growing Diversity: Genetic Resources and Local Food Security*. Intermediate Technology Publications, London.

Conway G. R. 1993. "Sustainable agriculture: the trade-offs with productivity, stability and equitability", in Barbier E. B. (Ed.) *Economics and Ecology: New Frontiers and Sustainable Development*, Chapman and Hall, London.

Cromwell, E. 1999. "Agriculture, biodiversity and livelihoods: issues and entry points", Final Report to Overseas Development Institute, ODI, UK.

Cropper M. and C. Griffith. 1994. "The Interaction of Population Growth and Environmental Quality", *Population Economics*, Vol. 84, No. 2, pp. 250- 254

Cuffaro N. 2002. "Population Growth and Agricultural Intensification in Less Developed Countries", in Swanson, T. (Ed.) *Biotechnology, Agriculture and the Developing World,* Kluwer Academic Publishers, pp 25-43.

Currier, K.M. 2000. *Comparative Statics Analysis in Economics*, World Scientific Publishing, Singapore.

Csizmadia, G. 2004. "Analysis of Small Farm Useful Soil Nutritive Matter from Dévaványa, Őrség-Vend and Szatmár-Bereg Regions of Hungary", Institute of Agrobotany Working Paper, Tápiószele, Hungary

Deaton, A. and J. Muellbauer. 1980. *Economics and Consumer Behaviour.* Cambridge University Press, Cambridge.

de Janvry, A., M. Fafchamps and E. Sadoulet. 1991. "The Peasant Household Behaviour with Missing Markets: Some Paradoxes Explained", *The Economic Journal*, Vol. 101, pp.1400-1417.

Di Falco, S. and C. Perrings. 2002. "Cooperative Production and Intraspecies Crop Genetic Diversity: The case of Durum Wheat in Southern Italy", paper presented at the first BIOECON Workshop on Property Right Mechanisms for Biodiversity Conservation. International Plant Genetic Resources Institute (IPGRI) 30-31 May, 2002, Rome, Italy.

Di Falco, S. 2003. *Crop Genetic Diversity, Agroecosystem Production and the Stability of Farm Income,* Ph.D. Thesis, University of York, UK.

Drucker A.G., V. Gomez and S. Anderson. 2001. "The economic valuation of farm animal genetic resources: a survey of available methods", *Ecological Economics*, Vol. 36, pp.1-18.

Engels, J. 2002. "Home gardens- a genetic resources perspective", in Watson, J.W. and P.B. Eyzaguirre (Eds.) *Proceedings of the Second International Home Gardens Workshop: Contribution of home gardens to in situ conservation of plant genetic resources in farming systems, 17-19 July 2001, Witzenhausen, Federal Republic of Germany,* International Plant Genetic Institute, Rome, pp. 3-9.

Evenson, R.E., D. Gollin and V. Santaniello (Eds.). 1998. *Agricultural Values of Plant Genetic Resources,* CAB International, Wallingford, pp 1-25.

Evenson, R.E. and S. Lemarié. 1998. "Crop Breeding Models and Implications for Valuing Genetic Resources", in Smale, M (Ed) *Farmers, Gene Banks and Crop Breeding: Economic Analyses of Diversity in Wheat, Maize and Rice.* Kluwer Academic Publishers, Boston and CIMMYT, Mexico City, pp. 79-92.

Evenson, R.E. and D. Gollin (Eds.). 2003. *Crop Variety Improvement and Its Effect on Productivity: The Impact of International Agricultural Research*, CAB International, Wallingford.

Eurobarometer. 2003. *Candidate Countries Eurobarometer: Public Opinion in the Countries Applying for the European Union on Agriculture*, CC-EB 2002.3 on Agriculture http://europa.eu.int/comm/agriculture/survey/cc/rep_en.pdf

Eyzaguirre, P.B. and J.W. Watson. 2002. "Home gardens agrobiodiversity: an overview across regions" in Watson, J.W. and P.B. Eyzaguirre (Eds.) *Proceedings of the Second International Home Gardens Workshop: Contribution of home gardens to in situ conservation of plant genetic* *resources in farming systems, 17-19 July 2001, Witzenhausen, Federal Republic of Germany*, International Plant Genetic Institute, Rome, pp.10-13.

Fafchamps, M. 1992. "Cash Crop Production, Food Price Volatility and Rural Market Integration in the Third World", *American Journal of Agricultural Economics,* Vol. 74, No.1, pp. 90-99, February 1992.

FAO. 1997. *Global Plan of Action* for the conservation and sustainable utilisation of plant genetic resources for food and agriculture, Food and Agriculture Organisation (FAO) of the United Nations

FAO. 1998. *The state of the world's plant genetic resources for food and agriculture*, Food and Agriculture Organisation (FAO) of the United Nations, Rome, Italy.

FAO. 1999. "Multifunctional Character of Agriculture and Land", Conference Background Paper No. 1, Maastricht.

FAO. 2001. "International convention on plant genetic resource for food and agriculture", Food and Agricultural Organisation (FAO) of the United Nations, Nov 3, 2001 FAO Press release 01/81 C5
http://www.fao.org/WAICENT/OIS/PRESS_NE/PRESSENG/2001

Feick, L.F., R.A. Higie and L.L. Price. 1993. "Consumer search and decision problems in a transitional economy: Hungary 1989-1992", Marketing Science Institute, Report No. 93-113, Massachusetts, USA
http://www.msi.org/msi/publication_summary.cfm?publication=355

Fernandes, E.C.M. and P.K.M. Nair. 1986. "An evaluation of the structure and function of tropical home gardens", *Agricultural Systems*, Vol. 21, pp. 279-310.

Fischler, F. 2003. "Opportunities in an enlarged Europe", paper presented at the 16th European Industry Strategy Symposium, 10 February, 2003, Villach.

Fowler, C, and P. Mooney. 1990a. *The Threatened Gene: Food, Policies and the Loss of Genetic Resources*, The Lutterworth Press, Cambridge.

Fowler, C and P. Mooney. 1990b. *Shattering: Food, Politics, and the Loss of Genetic Diversity*, University of Arizona Press, Arizona.

Fowler, C. 1994. *Unnatural Selection: Technology, Politics, and Plant Evolution*, International Studies in Global Change, No 6. Gordon & Breach, Langhorne.

Fowler, C., M. Smale, and S. Gaiji. 2001. "Unequal exchange? recent transfers of agricultural resources and their implications for developing countries", *Development Policy Review*, Vol.19, No.2, pp. 181-204.

Fowler, F.J. 2001. *Survey Research Methods*, Third Edition, Sage Publications.

Frankel, O.H. 1970. "Genetic dangers of the Green Revolution", *World Agriculture*, Vol. 19, pp. 9-14

Frankel, O., A. Brown, and J. Burdon. 1995. *The Conservation of Plant Biodiversity*, Cambridge University Press, Cambridge.

Franks, J. 1999. "In Situ Conservation of Plant Genetic Resources for Food and Agriculture: A UK Perspective", *Land Use Policy*, Vol. 16, Issue. 2, pp. 81-91

Franks, J. 1999. "The Conservation of Domesticated Animal Genetic Resources", *The Ecological Economic Bulletin*, Vol. 4, No. 1, pp.16-19.

Freeman, A.M. 2002. *The Measurement of Environmental and Resource Values: Theory and Methods*, Resources for the Future, Washington D.C.

Garrod, G. D., R. Scarpa and K. G. Willis. 2002. "Estimating the Benefits of Traffic Calming on Through Routes: A Choice Experiment Approach", *Journal of Transport Economics and Policy*, Vol. 36, No. 2, pp. 211-231.

Gauchan, D. 2003. "International Treaty on Plant Genetic Resource for Food and Agriculture", paper presented in the regional seminar on policies for the protection of farmer's rights in mountain regions "Evolving *sui generis* options for the Hindu Kush Himalayas", 24-26 March, 2003, Kathmandu. SAWTEE and ICIMOD, Nepal

Gauchan, D. and M. Smale. 2003. "Choosing the 'right' tools to assess the economics costs and benefits of growing landraces: an example from Bara District, Central Terai, Nepal", *Plant Genetic Resources Newsletter*, No. 134, pp. 41-44

Gauchan, D. 2004. *Conserving Crop Genetic Resources On-Farm: The Case of Rice in Nepal,* Ph.D. Thesis, University of Birmingham.

Georgiou, S., D. Whittington, D.W. Pearce and D. Moran. 1997. *Economic Values and the Environment in the Developing World,* Edward Elgar, Cheltenham.

Gleissman, S. 1986. "Plant Interactions in Multiple Cropping Systems", in Francis C. (Ed.) *Multiple Cropping Systems*, Macmillan, N.Y.

Goeschl, T. and T. Swanson. 1999. "Analysing the Relationship Between Development and Diversity: The Case of Crop Genetic Resources", Manuscript, Department of Land Economy, University of Cambridge.

Goeschl, T. and T. Swanson. 2001. "Lost Horizons: The Interaction between IPR Systems and Evolutionary Races in Pathogens", paper presented at the Annual American Economic Association Meeting, New Orleans.

Greene, W.H. 1997. *Econometric Analysis,* Third Edition, Prentice Hall.

Greene, W.H. 1998. LIMDEP Version 7.0 NLogit Version 2.0, Econometric Software, Inc, Plainview, N.Y.

Grogger, J.T. and R. Carson. 1991. "Models for truncated counts", *Journal of Applied Econometrics*, Vol. 6, pp. 225-238.

Guyomard, H. 1988. "Quasi-Fixed Factors and Production Theory: The Case of Self Employed Labour in French Agriculture", *Irish Journal of Agricultural Economics and Rural Sociology*, Vol.13, pp.21-33.

Gyovai, Á. 2002. "Site and sample selection for analysis of crop diversity on Hungarian small farms". In Smale, M., I. Már and D.I. Jarvis (Eds.) *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'*, International Plant Genetic Resources Institute, Rome.

Gyovai, Á., G. M. Csizmadia and L. Holly. 2004. "Cultivated plant diversity in Environmentally Sensitive Areas", poster presentation at the Hungarian Academy of Science, 18-19 February, 2004, Budapest.

Haab, T.C. and K.E. McConnell. 2002. *Valuing Environmental and Natural Resources: the Econometrics of Non-Market Valuation*, Edward Elgar, Cheltenham.

Halpern, L. and C. Wyplosz (Eds.). 1998. *Hungary: Towards a Market Economy*, Cambridge University Press, Cambridge.

Hanley, N., R.E. Wright and W.L. Adamowicz. 1998a. "Using Choice Experiments to Value the Environmental", *Environmental and Resource Economics*, Vol.11, No. 3-4, pp.413-428.

Hanley, N. 1998b. "Valuing the countryside: rural land use policy evaluation in the UK", *Hume Papers on Public Policy*, Vol. 6, No.3, pp.17-37.

Hanley, N., D. MacMillan, R.E. Wright, C. Bullock, I. Simpson, D. Parsisson and B. Crabtree. 1998c. "Contingent Valuation versus Choice Experiments: Estimating the Benefits of Environmentally Sensitive Areas in Scotland", *Journal of Agricultural Economics*, Vol. 49, pp. 1-15.

Harlan, J.R. 1972. "Genetics of disaster", *Journal of Environmental Quality*, Vol. 1, No.3, pp. 212-215

Harlan, J.R. 1975. *Crops and man,* American Society of Agronomy, Madison, Wisconsin.

Hausman J.A. and D. McFadden. 1984. "Specification Tests for the Multinomial Logit Model", *Econometrica*, Vol. 52, pp.1219-1240.

Hawkes, J. G. 1983. *The Diversity of Crop Plants*, Harvard University Press, Cambridge, MA.

Hayami Y. and V. Ruttan. 1985. *Agricultural Development: An International Perspective*, John Hopkins University Press, Baltimore.

Hebbert, C., N. Longley and D. Richardson. 2002. *The Rough Guide to Hungary,* Fifth Edition, The Rough Guides.

Hellerstein, D. and R. Mendelsohn. 1993. "A theoretical foundation for count data models", *American Journal of Agricultural Economics* Vol. 75, pp. 604-611.

Hensher D.A. and L.W. Johnson. 1981. *Applied Discrete Choice Modelling*. London. Croom-Helm/New York: John Wiley.

Hernandez, X.E. 1989. "Maize and the greater southwest", *Economic Botany,* Vol.39, pp. 416-430.

Hodgkin, T. 2002. "Home gardens and the maintenance of genetic diversity", in Watson, J.W. and P.B. Eyzaguirre (Eds.) *Proceedings of the Second International Home Gardens Workshop: Contribution of home gardens to in situ conservation of plant genetic resources in farming systems, 17-19 July 2001, Witzenhausen, Federal Republic of Germany,* International Plant Genetic Institute, Rome, pp 14-18.

Huffman, W. and M. Lange. 1982. "Farm Household Production: Demand for Wife's Labour, Capital Services and Capital-labour Ratio", Yale University Economic Growth Centre Discussion Paper no.408, New Haven, Connecticut.

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

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

Hungarian Central Statistical Office (HCSO). 2003. http://www.ksh.hu/pls/ksh/docs/index_eng.html

Horne P and L. Petäjistö. 2003. "Preferences for Alternative Moose Management Regimes among Finnish Landowners: A Choice Experiment Approach", *Land Economics,* Vol. 79, Issue 4, pp. 472-482.

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

Jackson, M.T. 1995. "Protecting the Heritage of Rice Biodiversity", *Geojournal*, Vol.35, pp. 267-74.

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.

Juma, C. 1989. *The Gene Hunters*, Zed Books, London

Just, E.R., Zilberman, D. and E. Hochman. 1983. "Estimation of Multiproduct production Functions", *American Journal of Agricultural Economics*, Vol. 65, pp. 770-780.

Kahneman, D., J. Knetsch and R. Thaler. 1990. "Experimental tests of the endowment effect and the Coase theorem", *Journal of Political Economy*, Vol. 98, No. 6, pp. 1325-1348.

Kloppenburg, J.R. 1988. *First the seed: the political economy of plant technology, 1492-2000*, Cambridge University Press, Cambridge.

Kollar, H.P. 1996. *Action Plan for the Great Bustard (Otis tarda) in Europe.* http://europa.eu.int/comm/environment/nature/directive/birdactionplan/otistarda.htm

Kontoleon, A., M. Yabe and E. Ryan. 2002. "Consumer Preferences and Attitudes for GM Foods: Estimating the Social Welfare of GM Labelling and Investigating the Importance of Preference Heterogeneity", Department of Economics and CSERGE Working Paper, University College London, London.

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

Koundouri, P., C. Nauges and V. Tzouvelekas. 2004. "Endogenous technology adoption under production risk: Theory and application to irrigation technology", Working paper, University of Toulouse

Kovách, I. 1999. "Hungary: Cooperative Farms and Household plots", in Meurs M. (Ed.) *Many Shades of Red: State Policy and Collective Agriculture,* Rowman and Littlefield, Boulder.

Kovács, K. 1998. "Restructuring post-socialist agriculture. Introduction to the selected articles on agricultural restructuring in East-Central Europe", *Replika,* Special Issue, pp.139-143.

Kramer, R.A., N. Sharma, P. Shyamsundar, and M. Munasinghe. 1994. "Cost and Compensation Issues in Protecting Tropical Rainforests: Case Study of Madagascar", Environment Working Paper No. 62, The World Bank, Washington, D.C.

Krutilla, J.V., 1967. "Conservation reconsidered", *American Economic Review, Vol.* 57, No.3, pp. 777-786.

Lancaster, K.1966. "A new approach to consumer theory", *Journal of Political Economy,* Vol. 84, pp.132-157.

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

Landauer, K and M. Brazil (Eds.). 1990. *Tropical Homegardens*, United Nations University, Tokyo.

Lankoski, J. (Ed.). 2000. *Multifunctional character of agriculture*, Agricultural Economics Research Institute, Research Report No. 241, Finland.

Layton, D.F., G.M. Brown and M.L. Plummer. 1999. "Valuing Multiple Programmes to Improve Fish Populations". Report to the Washington State Department of Ecology.

Layton, D.F and G.M. Brown. 2000. "Heterogeneous preferences regarding global climate change", *The Review of Economics and Statistics*, Vol. 82, No. 4, pp. 616-624.

Leathers, H.D. 1991. "Allocatable Fixed Inputs as a Cause of Joint Production: A Cost Function Approach", *American Journal of Agricultural Economics*, Vol. 73, pp.1083-90.

Lipton, M. 1968. "The theory of the optimising peasant", *Journal of Developing Areas*, Vol. 4, pp. 327-351.

Lopez, R. 1986. "Structural Models of the Farm Household that Allow for Interdependent Utility and Profit-Maximization Decisions", in Singh I., L. Squire and J. Strauss (Eds.) *Agricultural Household Models*, The Johns Hopkins University Press, Baltimore.

Louviere, J.J. and D.A. Hensher. 1982. "On the Design and Analysis of Simulated Choice or Allocation Experiments in Travel Choice Modelling", *Transportation Research Record*, Vol. 890, pp. 11-17.

Louviere, J.J. and G. Woodworth. 1983. "Design and Analysis of Stimulated Consumer Choice Experiments or Allocation Experiments: An Approach

Based on Aggregate Data", *Journal of Marketing Research*, Vol. 20, pp. 350-367.

Louviere, J.J. 1988. *Analyzing Decision Making: Metric Conjoint Analysis*, Sage Publications, Inc, Newbury Park, CA.

Louviere, J. J., D.A. Hensher, J.D. Swait and W.L. Adamowicz. 2000. *Stated Choice Methods: Analysis and Applications*, Cambridge University Press, Cambridge.

Luce, D. 1959. *Individual Choice Behaviour,* John Wiley, New York, NY.

Lupwayi, N., W. Rick and G. Clayton. 1997. "Zillions of Lives Underground", APGC Newsletter, http://www.pulse.ab.ca/newsletter/97fall/zillion.html

Lusk J.L., J. Roosen and J.A. Fox. 2003. "Demand for beef from cattle administered growth hormones or fed genetically modified corn: a comparison of consumers in France, Germany, the United Kingdom and the United States", *American Journal of Agricultural Economics. Vol.* 85, No.1, pp.16-29.

Lynne, G.D. 1988. "Allocable Fixed Inputs and Jointness in Agricultural Production: Implications for Modelling: Comment", *American Journal of Agricultural Economics,* Vol.70, No.4, pp. 948-949.

Maddala, G.S. 1999. *Limited Dependent and Qualitative Variables in Econometrics,* Cambridge University Press, Cambridge.

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

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

Már, I. 2002. "Safeguarding agricultural biodiversity on-farms in Hungary" in Smale, M. I. Már and D.I. Jarvis (Eds) *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', International Plant Genetic Resources Institute, Rome, pp. 41-43.

Maxted, N., B.V. Ford-Lloyd and J.G. Hawkes. 1997. "Complementary conservation strategies", *Plant Genetic Conservation: The In situ Approach*, Chapman and Hall, London.

McFadden, D. 1974. "Conditional Logit Analysis of qualitative choice behaviour", in Zarembka P. (Ed.) *Frontiers in Econometrics*, Academic Press, N.Y.

McIntire, J. 1983. "Two Aspects of farming in SAT Upper Volta: animal traction and mixed cropping", West Africa Economic Program Progress Report 7, International Crops Research Institute for the Semi Arid Tropics, Ougadougou, Upper Volta.

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, Davis.

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 Smale, M (Ed.) *Farmers, Gene Banks and Crop Breeding: Economic Analyses of Diversity in Wheat, Maize and Rice,* Kluwer Academic Press, Boston and CIMMYT, Mexico City, pp. 127-142.

Meurs, M. 1999. *Many Shades of Red: State Policy and Collective Agriculture*, Rowman and Littlefield, Boulder.

Meurs, M. 2001. *The Evolution of Agrarian Institutions: A Comparative Study of Post-Socialist Hungary and Bulgaria*, University of Michigan Press, Ann Arbor.

Morey, E.R., and K.G. Rossmann. 2003. "Using Stated-Preference Questions to Investigate Variations in Willingness to Pay for Preserving Marble Monuments: Classic Heterogeneity, Random Parameters, and Mixture Models" *Journal of Cultural Economics,* Vol. 27, No. 4, pp.-229.

Moschini, G. and D.A. Hennessy. 2000. "Uncertainty, Risk Aversion and Risk Management for Agricultural Producers". In Gardner B. and G. Rausser, (Eds.) *Handbook for Agricultural Economics*, Elsevier Science Publishers, Amsterdam.

Mullahy, J. 1986. "Specification and Testing of Some Modified Count Data Models", *Journal of Econometrics,* Vol. 33, No. 3, pp. 341-65.

Myers, N. 1987. "The extinction spasm impending: synergisms at work", *Conservation Biology,* No. 1, pp.14-21.

Naeem, S., L.J. Thompson, S.P. Lawler, J.H. Lawton and R.M.Woodfin. 1995. "Empirical evidence that declining species diversity may alter the performance of terrestrial ecosystems", Philosophical Transactions of the Royal Society of London, Series B 347, pp. 249-262.

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 Labour Centre. 2000. Budapest, Hungary. http://www.ikm.iif.hu/english/economy/labour.htm.

Nunes, P. and E. Schokkaert. 2003. "Warm glow and embedding in contingent valuation", *Journal of Environmental Economics and Management,* Volume: 45, Issue: 2, pp. 231-245.

Oldfield, M.L. and Alcorn, J.B. 1987. "Conservation of traditional agroecosystems", *Bioscience,* Vol. 37, pp.199-208.

OECD. 2002. *Economic Surveys: Hungary*, Organisation of Economic Cooperation and Development, Paris.

Paterson R.W., K.J. Boyle, M. Ahearn, A. Alberini, J. Bergstrom, L. Libby, and P. Welsh. 2001. *Improved Information in Support of a National Strategy for Open Land Policies: Summary of Focus Group Findings Summer, 2000,* REP 495, Staff Paper Maine Agricultural and Forest Experiment Station, University of Maine.

Pearce, D.W., and R.K. Turner. 1989. *Economics of Natural Resources and the Environment*, Harvester Wheatsheaf, London.

Pearce D.W. 1993. *Cost-Benefit Analysis*, Macmillan.

Pearce D.W. 1998. "Cost-benefit analysis and environmental policy", *Oxford Review of Environmental Policy*, Vol.14, No. 4, pp. 17-25.

Pearce D.W. and D. Moran. 2001. "Handbook on the applied valuation of biological diversity", Report prepared for Environment Directorate, OECD, Paris.

Pemberton, M. and N. Rau. 2001. *Mathematics for Economists: An introductory textbook*, Manchester University Press, Manchester.

Petrick, M. and E. Tyran. 2001. " Development Perspectives of Subsistence Farms in South-Eastern Poland: Social Buffer Stock or Commercial Agriculture?" Paper presented at the 76th EAAE Seminar "Subsistence Agriculture in Central and Eastern Europe: How to Break the Vicious Circle?", May 6-8, 2001, Halle (Saale).

Perales R.H., S.B. Brush, and C.O. Qualset. 1998. "Agronomic and economic competitiveness of maize landraces and in situ conservation in Mexico", in Smale, M. (Ed.), *Farmers, Gene Banks and Crop Breeding: Economic Analyses of Diversity in Wheat, Maize, and Rice*, Kluwer Academic Press, Boston and CIMMYT, Mexico City, pp. 109-126.

Pingali, P.L., M. Hossain and R.V. Gerpacio. 1997. "Asian Rice Market: Demand and Supply Prospects", in Pingali, P., M. Hossain and R.V. Gerpacio *Asian Rice Bowls: The Returning Crises?* CAB International and IRRI.

Pingali, P.L. 1997. "From Subsistence to Commercial Production Systems: The Transformation of Asian Agriculture", *American Journal of Agricultural Economics*, Vol. 79, pp. 628-634

Pohlmeier, W and V. Ulrich. 1995. "An Econometric Model of the Two Part Decisionmaking Process in the Demand for Health Care", *Journal of Human Resources* Vol.30, No. 2, pp. 339-61.

Posey, D. and G. Dutfield. 1996. *Beyond Intellectual Property*, International Development Research Centre, Ottawa, Ontario.

Pretty, J.N. 1995. *Regenerating Agriculture: Policies and Practice for Sustainability and Self-Reliance*, Joseph Henry Press, Washington, D.C.

Primack, R. 1993. *Essential of conservation biology*, Sinauer Sinauer Associates, Inc. Publishers: Sunderland, MA..

Renkow, M. 1990. "Household Inventories and Marketed Surplus in Semi-subsistence Agriculture", *American Journal of Agricultural Economics*, Vol. 72, pp. 664-75.

Revelt, D. and K. Train. 1998. "Mixed logit with repeated choices: Households' choice of appliance efficiency level", *Review of Economics and Statistics,* Vol. 53, pp. 647-657.

Rhoades, R.E., and V.D. Nazarea. 1999. "Local management of biodiversity in traditional agroecosystems", in Collins, W.W. and C.Q. Qualset (Eds.) *Biodiversity in Agroecosystems*, CRC Press.

Rolfe, J., J.J. Bennett and J. Louviere. 2000. "Choice Modelling and Its Potential Application to Tropical Rainforest Preservation", *Ecological Economics*, Vol. 35, No. 2, pp. 289-302.

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

Roumasset, J.A., J-M. Boussard and I. Singh (Eds.). 1979. *Risk Uncertainty and Agricultural Development*, Agricultural Development Council, New York.

Sadoulet, E. and A. de Janvry. 1995. *Quantitative Development Policy Analysis*, The Johns Hopkins University Press, Baltimore.

Scarpa, R., A. Drucker, S. Anderson, N. Ferraes-Ehuan, V. Gomez, C. R. Risopatron and O. Rubio-Leonel. 2003a. "Valuing Animal Genetic Resources in Peasant Economies: The Case of the Box Keken Creole Pig in Yucatan", *Ecological Economics,* Vol. 45, No.3, pp. 427-443

Scarpa R., E.S.K. Ruto, P. Kristjanson, M. Radeny, A.G. Drucker and J.E.O. Rege. 2003b. "Valuing indigenous cattle breeds in Kenya: An empirical comparison of stated and revealed preference value estimates". *Ecological Economics,* Vol. 45, Issue. 3, pp. pp. 409-426

Schumway, C.R., R. Pope and E. Nash. 1984. "Allocatable Fixed Inputs and Jointness in Agricultural Production: Implications for Modelling", *American Journal of Agricultural Economics*, Vol.66, pp.72-78.

Schumway, C.R., R. Pope and E. Nash. 1988. "Allocatable Fixed Inputs and Jointness in Agricultural Production: Implications for Modelling: Reply", *American Journal of Agricultural Economics,* Vol. 70, pp. 95-952.

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.

Shiva, V. 1991. *The Violence of the Green Revolution*, Zed Books, London.

Shively, G.E. 2001. "Poverty, consumption risk and soil conservation", *Journal of Development Economics*, Vol. 65, pp. 267-290.

Shrestha, R.K., A.F. Seidl, and A.S. Moraes. 2002. "Value of recreational fishing in the Brazilian Pantanal: a travel cost analysis using count data models", *Ecological Economics,* Vol. 42, pp. 289-299.

Silberberg, E. 1978. *The Structure of Economics: A Mathematical Analysis*, McGraw-Hill, New York.

Simon, Á. 2001. *Agricultural Background For the On Farm Project,* Institute for Agrobotany, Tápiószele, Hungary.

Singh, R.P. 1981. *Crop failure and intercropping in the semi arid tropics of India*, Economic Program Progress Report No. 21, ICRISAT, Patancheru, India.

Singh, I., L. Squire and J. Strauss. 1986. *Agricultural Household Models,* The Johns Hopkins University Press, Baltimore.

Smale, M., R.E. Just and H.D. Leathers. 1994. "Land Allocation in HYV Adoption Models: An Investigation of Alternative Explanations", *American Journal of Agricultural Economics,* Vol. 76, pp. 535-546.

Smale, M. 1996. "Understanding Global Trends in the Use of Wheat Diversity and International Flows of Wheat Genetic Resources", Economics Working Paper 96-02, CIMMYT, Mexico City.

Smale, M. and T. McBride. 1996. *World Wheat Facts and Trends 1995/96,* CIMMYT, Mexico City.

Smale, M. 1997. "The Green Revolution and Wheat Genetic Diversity: Some Unfounded Assumptions", *World Development,* Vol. 25, pp. 1257-69.

Smale, M. (Ed.). 1998. *Farmers, Gene Banks and Crop Breeding: Economic Analyses of Diversity in Wheat, Maize and Rice,* Kluwer Academic Press, Boston and CIMMYT, Mexico City.

Smale, M., M. Bellon and P. Pingali, 1998. "Farmers, gene banks and crop breeding: Introduction and overview", in Smale M. (Ed.) *Farmers, gene banks and crop breeding: Economic analyses of diversity in wheat, maize, and ric*e, Kluwer Academic Press, Boston and CIMMYT, Mexico City.

Smale, M. 2000. "Economic Incentives for Conserving Crop Genetic Diversity on Farms: Issues and Evidence", Plenary Paper prepared for the XXIV Conference of Agricultural Economists, 13-18 August, 2000, Berlin.

Smale, M., R.M. Bellon and J.A. Aguirre Gomez. 2001a. "Maize Diversity, Variety Attributes, and Farmers' Choices in Southeastern Guanajuato, Mexico", *Economic Development and Cultural Change*, Vol. 50, No 1, pp. 201-225.

Smale, M. 2001b. "Economic incentives for conserving crop genetic diversity on farms: issues and evidence", in Peters G.H. and P. Pingali (Eds.) *Tomorrow's Agriculture: Incentives, Institutions, Infrastructure and Innovations*, Proceedings of the 24th International Conference of Agricultural Economists, Ashgate, Oxford.

Smale, M. I. Már and D.I. Jarvis (Eds.). 2002. *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'*, International Plant Genetic Resources Institute, Rome.

Smale, M. 2002. "The conceptual framework for economics research in IPGRI's Global *In Situ* Conservation On-farm Project." in Smale, M. I. Már and D.I. Jarvis (Eds.) *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'*, International Plant Genetic Resources Institute, Rome.

Smale, M. and D. Jarvis. 2002. "Definitions and context", in Smale, M. I. Már and D.I. Jarvis (Eds.) *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'*, International Plant Genetic Resources Institute, Rome.

Smale, M., E. Meng, J.P. Brennan and R. Hungary. 2003. "Determinants of spatial diversity in modern wheat: examples from Australia and China", *Agricultural Economics*, Vol. 28, No.1, pp.13-26.

Smale, M., M. R. Bellon, D. Jarvis, and B. Sthapit. *Forthcoming*. Economic concepts for designing policies to conserve crop genetic resources on farms. Forthcoming in *Genetic Resources and Crop Evolution.*

Smith, K.V. 1997. "Pricing what is priceless: a status report on non-market valuation of environmental resources", in Folmer H. and T. Tietenberg (Eds.) *The International Yearbook of Environmental and Resource Economics 1997/1998: A Survey of Current Issues*, UL and Lyme USA: Edwar Elgar.

Statistical Yearbook 2001, Békés county, HCSO, Management of Békés county, Béksécsaba, 2002.

Statistical Yearbook 2001, Jász-Nagykun-Szolnok county, HCSO, Management of Jász-Nagykun-Szolnok county, 2002.

Statistical Yearbook 2001, Vas county, HCSO, Management of Vas county, Szombathely, 2002.

Statistical Yearbook 2001, Szabolcs-Szatmár-Bereg county, HCSO, Management of Szabolcs-Szatmár-Bereg county, Nyíregyháza, 2002.

StatSoft, Inc. 2002. *Electronic Statistics Textbook,* StatSoft. Tulsa, OK, http://www.statsoft.com/textbook/stathome.html

Strauss, J. 1986. "The theory and comparative statics of agricultural household models: a general approach" in Singh, I., L. Squire and J. Strauss *Agricultural Household Models,* The Johns Hopkins University Press, Baltimore.

Sutlive, V.H. 1978. The *Iban of Sarawak*, AHM Publishing Corporation, Arlington Heights, VA.

Swain, N. 1999. "Agricultural Restitution and Co-operative Transformation in the Czech Republic, Hungary and Slovakia", *Europe-Asia Studies*, Vol. 51, No. 7, pp. 1199-1219.

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, 29 June – 1 July 2000, The Arkleton Centre for Rural Development Research, King's College, University of Aberdeen, Scotland.

Swaminathan, M.S. 2002. "The past, present and future contribution of farmers to the conservation and development of genetic diversity", in: Engels, J.M.M., v.r. Rao, A.H.D. Brown and M.T. Jackson (Eds.) *Managing Plant Genetic Diversity*, International Food Policy research Institute, Rome.

Swanson, T. 1993. *The International Regulation of Extinction,* Macmillan, London and New York University Press, New York.

Swanson T., D.W. Pearce and R. Cervigni. 1994. "The appropriation of the benefits of plant genetic resources for agriculture: an economic analysis of the alternative mechanisms for biodiversity conservation", Background Study Paper No.1 for First Extraordinary Session of the FAO Commission on Plant Genetic Resources, Food and Agriculture Organisation (FAO) of the United Nations, Rome.

Swanson, T. (Ed.). 1995. *Intellectual Property Rights and Biodiversity Conservation*, Cambridge University Press, Cambridge.

Swanson T. 1996a. "Global values of biological diversity: the public interest in the conservation of plant genetic resources for agriculture", *Plant Genetic Resources Newsletter*, No. 105, pp. 1-7.

Swanson T. 1996b. "The reliance of northern economies on biodiversity: biodiversity as information", *Ecological Economics* Vol. 17, pp. 1-8.

Swanson, T. 1997. *Global Action for Biodiversity*, EarthScan, London.

Swanson T. and S. Johnston.1999. *Global Environmental Problems and International Environmental Agreements: The Economics of International Institution Building,* Edward Elgar, Cheltenham.

Swanson, T. and T. Goeschl. 2000. "Property Rights issues involving plant genetic resources: implications of ownership for economic efficiency", *Ecological Economics* Vol. 32, pp. 75-92.

Swanson, T. and T. Goeschl. 2002. "The Social Value of Biodiversity for R&D", *Environmental and Resource Economics,* Vol. 22, pp. 477-504.

Swanson, T. (Ed.). 2002a. *Biotechnology, Agriculture and the Developing World,* Kluwer Academic Publishers, Boston.

Swanson, T. (Ed.). 2002b. *The Economics of Managing Biotechnologies*, Edward Elgar, Cheltenham

Swanson T. and T. Goeschl. 2003. "Pests, Pathogens and Patent Holders: Implications of Biotechnologies for Patent Policies", paper prepared for presentation at Duke University's Conference on "International Public Goods, the Transfer of Technology after TRIPs".

Szelényi, I (Ed.). 1998. *Privatising the Land:* Rural Political Economy in Post-communist Societies, 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*, Vol. 22, No. 4, pp. 95-106.

Taylor, E. and I. Adelman. 2003. "Agricultural Household Models: Genesis, Evolution and Extensions", *Review of the Economics of the Household.* Vol 1, No. 1, pp. 33-58.

Teisl, M.F., B. Roe and A.S. Levy. 1999. "Ecocertification: Why it might not be a "field of dreams", *American Journal of Agricultural Economic*s, Vol. 81 No.5, pp. 1088-1071.

The Guardian. 2004. "Farm policy puts birds in new EU states at risk of being wiped out", By Andrew Osborn in Brussels, Friday January 23, 2004

Tilman, D. and J.A. Downing, 1994. "Biodiversity and stability in grasslands", *Nature,* Vol. 367, pp. 363-365.

Torquebiau, E. 1992. "Are tropical agroforestry home gardens sustainable?", *Agriculture, Ecosystems and Environment,* Vol. 41, pp.189-207.

Toquero Z., B. Duff, T. Ander-Lacsina and Y. Hayami. 1975. "Marketed Surplus Functions for a Subsistence Crop: Rice in the Philippines", *American Journal of Agricultural Economics,* Vol. 57, pp. 705-9.

Traxler, G. and D. Byerlee. 1993. "A Joint-Product Analysis of the Adoption of Modern Cereal Varieties in Developing Countries", *American Journal of Agricultural Economics,* Vol. 75, No.4, pp. 981-989.

UNDP. 2003. Human Development Report 2003 *Millennium Development Goals: A compact among nations to end human poverty* http://hdr.undp.org/reports/global/2003/

UNEP. 1995. *Global Biodiversity Assessment.* United Nation Environment Program (UNEP): Cambridge University Press, Cambridge.

Unnevehr, L.J. 1986. "Consumer Demand for Rice Grain Quality and Returns to Research for Quality Improvement in Southeast Asia", *American Journal of Agricultural Economics,* Vol. 68, No. 3, 1986, pp. 634-41.

Unnevehr, L., B. Duff and B.O. Juliano. 1992. *Consumer Demand for Rice Grain Quality*, Terminal Report of IDRC Projects, National Grain Quality (Asia) and International Grain Quality Economics (Asia), IDRC, Ottowa and IRRI, los Banos, Laguna, Philippines

Vajda. L. 2003. *The view from Central and Eastern Europe*, Agricultural outlook forum 2003, USDA, Washington, D.C.

http://www.usda.gov/oce/waob/oc2003/speeches/vajda.pdf.

Van Dusen, M.E. 2000. *In situ Conservation of Crop Genetic Resources in the Mexican Milpa System,* Ph.D. Dissertation, University of California, Davis.

Van Dusen, E. M. Lee, E. Dennis, J. Ilyasov and S. Treshkin, 2003, "The Conservation of Agricultural biodiversity in Uzbekistan: The Impacts of Land Reform Process", paper Presented to the CAPRI Workshop, "Property Rights, Collective Action and Local Conservation of Genetic Resources", 29 September, 2003, Rome, Italy.

Van Dusen, E. and J.E. Taylor. 2003. "Missing markets and crop genetic resources: evidence from Mexico", Manuscript, University of California, Berkeley, USA.

Varian, H.R. 1992. *Microeconomic Analysis,* Third Edition, W.W. Norton & Company, New York.

Wale, E., J. Mburu and D. Virchow. 2003. "Incentives, opportunity costs and contract design for on-farm conservation in Ethiopia", paper presented at the third BIOECON Workshop on 'Contract Mechanisms for Biodiversity Conservation', 22-25 May, 2003, Montpellier, France.

Walker T.S., R.P. Singh, N.S. Jodha. 1983. *Dimensions of farm level diversification in the semi arid tropics of rural south India*, Economic Program Progress Report No. 51, ICRISAT, Patancheru, India.

Watson, J.W. and P.B. Eyzaguirre (Eds.). 2002. *Proceedings of the Second International Home Gardens Workshop: Contribution of home gardens to in situ conservation of plant genetic resources in farming systems, 17-19 July 2001, Witzenhausen, Federal Republic of Germany*, International Plant Genetic Resources Institute, Rome.

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

Weitzman, M. 1993. 'On Diversity', *Quarterly Journal of Economics*, Vol. 107, pp. 363-406.

Wessels, C.R., R.J. Johnston and H. Donath. 1999. "Assessing consumer preferences for ecolabelled seafood: The influence of species, certifier and household attributes", *American Journal of Agricultural Economics,* Vol.81, No.5, pp. 1084-1089.

WHO. 2000. "The Impact of Food and Nutrition on Public Health: The case for a Food and Nutrition Policy and an Action Plan for the European Region of WHO, 2000-2005 http://www.hospitalitywales.demon.co.uk/nyfaweb/fap4fnp/fap_26.htm, and the Draft Urban Food and Nutrition Action Plan http://www.hospitalitywales.demon.co.uk/nyfaweb/urban/urb_02.htm

Wilding, C. 2002. "DEFRA Review of Policy on Genetic Resources for Food and Agriculture", UK Department of Environment, Food and Rural Affairs.

Winkelmann, R. 2000. *Econometric Analysis of Count Data*, Springer, Heidelberg.

Winters, P., L.H. Hintze and O.Ortiz. 2004. "Factors influencing potato diversity in Cajamarca, Peru", Paper presented at the IPGRI – IFPRI Workshop on 'Valuing the Biological Diversity of Crops in a Development Context' with the support of BIOECON and FAO, 29-30 March, 2004, Rome, Italy.

World Bank. 2003. "Hungary at a glance", http://www.worldbank.org/data/countrydata/aag/hun_aag.pdf

Wyzan, M. 1996. "Increased inequality, poverty accompany economic transition", *Transition*, Vol. 2, No. 20. http://archive.tol.cz/Publications/Transition/Features/Feature.V02N20-Wyzan.html

Zavoina, R. and W. McElvey. 1975. " A Statistical Model for the Analysis of Ordinal Level Dependent Variables", *Journal of Mathematical Sociology*, Summer, pp. 103-120.