Charles University in Prague

Faculty of Social Sciences
Institute of Economic Studies

MASTER'S THESIS

The Economic Value of Crop Diversity in the Czech Republic

Author: **Bc. Nicholas Tyack**

Supervisor: **Mgr Milan Ščasný PhD.**

Academic Year: **2015/2016**

Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature, and the thesis has not been used to obtain a different or the same degree.

The author grants to Charles University permission to reproduce and to distribute copies of this thesis document in whole or in part.

Prague, July 28, 2016

Signature

Acknowledgments

Many thanks go to Mgr Milan Ščasný Ph.D., the supervisor of the thesis, for being the best advisor imaginable, as well as Dr. Ing. Vojtěch Holubec, CSc. and Ing. Ludmila Papoušková, Ph.D. for their assistance during the process of conducting research and writing this thesis. Thanks are also due to Mgr Martin Kryl for his assistance programming my survey instrument, to those who helped with the pre-survey and translation of the questionnaire, and also to my parents.

This thesis was financially supported by research grant No. 910788 awarded by the Grant Agency of Charles University. The research leading to these results has received funding from the People Programme (Marie Curie Actions) of the European Union's Seventh Framework Programme FP7/2007-2013/ under REA grant agreement number 609642 (ECOCEP).

The responsibility for all errors is mine.

Abstract

We estimate the willingness-to-pay for conserving crop diversity in the Czech Republic. Discrete choice experiments are used to elicit preferences for the conservation of wine, hop, and fruit tree varieties, while a double-bounded dichotomous choice approach is used to elicit preferences for the conservation of unspecified, "general" crop diversity. The WTP values are derived for both of these contingent products from a sample representative of the general Czech population (n=731) and a sample of respondents living in the South Moravian region that is characterized by agriculture and wine production (n=418). We demonstrate a strong preference for conserving fruit trees over hops and wine varieties, and derive positive mean WTP of the general Czech population (ages 18-69) of 56 Kč ($2.26). Mean WTP for the conservation of general crop diversity is 167 Kč ($6.80). On average, residents of South Moravia have a greater WTP for "general" crop as well as fruit tree conservation. In total, the Czech adult population (ages 18-69) has an aggregate WTP of ~1.25 billion Kč ($50.5 million) for the conservation of general crop diversity, and ~410 million Kč ($16.8 million) for the conservation of fruit trees, revealing the previously unmeasured social welfare benefits of these activities. The estimated benefits of crop diversity conservation based on the stated preference method present the first welfare estimate of its kind for Czech crop diversity, and are an important contribution to the valuation of a resource that has the potential to help adapt agriculture to climate change.

JEL Classification	Q18, Q51, Q57
Keywords	Crop diversity, plant genetic resources for food and agriculture (PGRFA), stated preferences, discrete choice experiments, double-bounded dichotomous choice, multinomial logit, willingness to pay, consumer preferences

Author's e-mail	Ntyack@gmail.com
Supervisor's e-mail	Milan.Scasny@czp.cuni.cz

Abstrakt

Odhadujeme ochotu platit (WTP) za zachování rozmanitosti plodin v České Republice. Využíváme metodu výběrového experimentu s cílem zjistit preference lidí pro zachování odrůd vína, chmele a ovocných stromů, zatímco přístup diskrétní volby (*„double-bounded dichotomous choice“*) je použitý ke zjištění preferencí pro zachování nespecifikované, všeobecné rozmanitosti odrůd. Hodnota WTP je odhadnutá pro obě tyto podmíněné produkty pro vzorek respondentů reprezentativní pro obecnou populaci ČR (n=731), tak pro vzorek reprezentativní pro region Jižní Moravy, který charakterizuje zemědělská výroba a produkce vína (n=418). Prokazujeme silnou preferenci respondentů pro zachování odrůd ovocných stromů před odrůdami chmele a vinné révy, a odhadujeme pozitivní průměrnou hodnotu WTP pro obecnou populaci ve výši 56 Kč ($2.26). Průměrná hodnota WTP pro zachování nespecifikované diverzity plodin činí 167 Kč ($6.80). Respondenti z Jižní Moravy mají větší WTP jak pro balík "nespecifikovaných" odrůd , tak pro zachování odrůd ovocných stromů. Celkové přínosy dospělé populace ČR pro zachování balíku „nespecifikované“ diverzity odrůd činí přibližně 1.25 miliard Kč po dobu 10 rok (50.5 milionů $), zatímco přínosy ze zachování odrůd ovocných stromů dosahují přibližně 410 milionů Kč po dobu 10 rok (16.8 milionů $), které obě dokládají ekonomický význam zachovávání diverzity odrůd. Odhad přínosů ze zachování rozmanitosti odrůd metodou stanovených preferencí je první svého druhu a představuje významný příspěvek k oceňování produktů, které mají potenciál napomoct ekonomikám se lépe adaptovat na změny klimatu.

Klasifikace Q18, Q51, Q57

Klíčová slova preference spotřebitelů, ochota platit, stanovené preference, výběrový experiment, výběrová data, multinomial logit

E-mail autora Ntyack@gmail.com

E-mail vedoucího práce Milan.Scasny@czp.cuni.cz

Table of Contents

List of Tables

List of Figures

Acronyms

DBDC	Double-bounded dichotomous choice
PGR	Plant genetic resources
PGRFA	Plant genetic resources for food and agriculture
SBDC	Single-bounded dichotomous choice
WTA	Willingness to accept
WTP	Willingness to pay

Master's Thesis Proposal

Institute of Economic Studies
Faculty of Social Sciences
Charles University in Prague

Author:	Bc. Nicholas Tyack
Supervisor:	Prof. Ing. Milan Scasny, CSc.
Defense Planned:	June 2016

Proposed Topic:

The economic value of crop diversity in the Czech Republic

Motivation:

Crop diversity, technically referred to as plant genetic resources for food and agriculture, has played an essential role in improving agricultural productivity in the 20th century. For example, the crossing of an Indonesian and Taiwanese rice variety and the subsequent release of semi-dwarf rice type IR8 by the International Rice Research Institute (IRRI) led to "quantum leaps" in yield potential from six to ten tons per hectare in the tropics and helped launch the Green Revolution in Asia (Peng and Khush 2003).

Plant genetic resources are more important than ever today. Up to double the amount of food that is presently produced may be required by 2050 to feed a population of around 9 billion (Godfray et al. 2010). At the same time, normal growing season temperatures are expected to exceed the most extreme seasonal temperatures recorded from 1900 to 2006 by the end of the 21st century, which will likely have severe effects on the cultivation of many crops (Battisti and Naylor 2009; Lobell et al. 2008).

However, the economic literature on the value of crop diversity is limited, particularly in the Czech Republic. Without robust estimates of the economic benefits of conserving and using plant genetic resources to breed new crop varieties, it is harder to justify the costs of these activities and it is likely that this will lead to a systematic underinvestment in this area, with a corresponding negative impact on social welfare in the coming century.

Hypotheses:

1. Hypothesis #1: The economic value of crop diversity in the Czech Republic is significant (that is, there is unique crop diversity in the Czech Republic that contains valuable traits).
2. Hypothesis #2: The operations of the Czech gene bank are socially beneficial: in other words, the economic benefits of the gene bank's operations outweigh its costs.
3. Hypothesis #3: The Czech public, farmers, and breeding companies place a value on the country's crop diversity that can be measured.

Methodology:

I plan to begin testing hypothesis #1 by collecting information regarding crop diversity that is held / extant in the Czech Republic and determine what valuable traits are contained within them, what valuable genes have been provided to elite crop varieties, and what crop varieties are unique to the country and its *ex situ* holdings.

I plan to test hypothesis #2 by collecting information from the Czech gene bank in Prague-Ruzyne on its costs as well as any estimates of the benefits provided by the institution. I plan to investigate approximations of the benefits of the organization's distributions of crop diversity by contacting local breeding companies within the Czech Republic (such as Selgen, A.s., based in Stupice) to determine how much value they see in the organization's operations. I plan to consider and utilize approaches documented in the literature to the extent possible, including: 1) the cost-benefit approach; and 2) the insurance value approach, which models the economic value of gene bank holdings under hypothetical future shocks to agricultural production, such as increased growing season temperatures or the outbreak of a pest or disease.

Last, I plan to test hypothesis #3 by using contingent valuation methodologies such as discrete choice experiments (DCE) to estimate the value Czech farmers and the Czech public place on crop diversity, and also to analyze the extent to which Czech farmers buy their seeds from Czech companies. Last, I hope to use the DCE approach to place an economic value on the distribution service the Czech genebank provides each year by circulating seed varieties that are requested by various individuals, institutions, and firms.

Expected Contribution:

I plan through my work to broaden the literature on the economic value of crop diversity in the Czech Republic, and also to use some novel approaches to valuing these resources (such as discrete choice experiments).

Outline:

1. Motivation: plant genetic resources (i.e., crop diversity) are essential for breeding new crop varieties that are more productive and resilient, and will be even more important in the 21st century given climate change and a rapidly growing population. However, the literature on the economic value of crop diversity is limited, particularly in the Czech Republic.
2. Review of the literature on the economic valuation of plant genetic resources and genebanks, including both cultivated crop diversity and crop wild relatives.
3. Summary of the plant genetic resources of the Czech Republic, the country's breeding and seed sector, and which crops are most important in terms of agricultural production.
4. Methods: I will describe the methodologies used to estimate the economic value of plant genetic resources in the Czech Republic, such as for example discrete choice experiments (DCE).
5. Results: I will discuss the results of my analysis.
6. Conclusion: I will summarize the findings of my work and discuss their significance for future policy.

Core Bibliography:

Alston, J.M., Chan-Kang, C., Marra, M.C., Pardey, P.G. & Wyatt, T.J. 2000. A meta-analysis of rates of return to agricultural R&D: ex pede herculem? IFPRI Research Report No 113. Washington DC, International Food Policy Research Institute.

Asfaw, S. & Lipper, L. 2011. Economics of PGRFA management for adaptation to climate change: a review of selected literature. Background Study Paper No. 60 for the Commission on Genetic Resources for Food and Agriculture. Rome, FAO.

Battisti, D.S., Naylor, R.L., 2009. Historical Warnings of Future Food Insecurity with Unprecedented Seasonal Heat. Science 323, 240-244.

Brennan J.P. & Malabayabas, A. 2011. International Rice Research Institute's contribution to rice varietal yield improvement in South-East Asia. ACIAR Impact Assessment Series Report No. 74. Canberra, Australian Centre for International Agricultural Research. 111 pp.

Brown, G.M. 1990. Valuing genetic resources. G.H. Orians, G. M. Brown, W. E Kunin & J.E. Swierzbinski, eds. Preservation and valuation of biological resources. University of Washington Press, Seattle, pp. 203-226.

Carson, R., and Czajkowski, M. 2012. The Discrete Choice Experiment Approach to Environmental Contingent Valuation. Centre for the Study of Choice (CenSoC) Working Paper Series, No. 12-003.

Garming, H., Roux, N., Van den Houwe, I. 2010. The Impact of the Musa International Transit Centre. Bioversity International.

Godfray, H.C.J., et al., 2010. Food Security: The Challenge of Feeding 9 Billion People. Science 327, 812-818.

Gollin, D. And Evenson, R.E. 1998. An Application of Hedonic Pricing Methods to Value Rice Genetic Resources in India. In *Agricultural Values of Plant Genetic Resources*, by Robert E. Evenson, Douglas Gollin, and V. Santaniello, 139-50. Wallingford, UK: CABI.

Haab, T.C., and McConnell, K.E. 2002. Parametric Models for Contingent Valuation. In *Valuing Environmental and Natural Resources – The Econometrics of Non-Market Valuation.* Edward Elgar Publishing, Inc., Northampton, Massachusetts, U.S.

Hein, L., and Gatzweiler, F. 2006. The Economic Value of Coffee (Coffea Arabica) Genetic Resources. *Ecological Economics* 60(1): 176-85.

Lobell, D.B. et al., 2008. Prioritizing Climate Change Adaptation Needs for Food Security in 2030. Science 319, 607-610.

Peng, S., Khush, G.S. Four Decades of Breeding for Varietal Improvement of Lowland Rice in the International Rice Research Institute. *Plant Prod. Sci.* **6**, 157-164 (2003).

Xepapadeas, A., Ralli, P., Kougea, E., Spyrou, S., Stavropoulos, N., Tsiaousi, V., Tsivelikas, A. 2014. Valuing Insurance Services Emerging from a Gene Bank: The Case of the Greek Gene Bank. *Ecological Economics* 97: 140-49.

Zohrabian, A., Traxler, G., Caudill, S., Smale, M. 2003. Valuing Pre-Commercial Genetic Resources: A Maximum Entropy Approach. *American Journal of Agricultural Economics* 85(2): 429-36.

Nicholas Tyack

Author **Supervisor**

Chapter 1

Introduction

The goal of this thesis is to estimate the economic value of specific components of crop diversity in the Czech Republic. Crop diversity, or plant genetic resources for food and agriculture (PGRFA), includes both cultivated crop varieties (both modern and traditional) and the wild relatives of crops. There is an incredible diversity of crop varieties worldwide, with more than 100,000 varieties of rice, for example; and the use by plant breeders of the genetic diversity contained within these resources is one of the primary drivers of increases in agricultural productivity. For example, the crossing of rice varieties from diverse backgrounds and the subsequent release of semi-dwarf rice type IR8 by the International Rice Research Institute (IRRI) resulted in increases in yield potential from six to ten tons per hectare in the tropics and helped launch the Green Revolution in Asia (Peng and Khush 2003). Though the increased use of fertilizers and pesticides helped to improve agricultural productivity during the second half of the 20th century, the use of plant genetic resources also played an essential role. It is estimated that approximately half of the increase in the production of wheat, rice and maize during the Green Revolution was contributed through the breeding of new varieties, which relied on tapping into the diverse genetic makeup of a wide range of the many varieties of these crops (FAO 1997). Similarly, it has been estimated that about half of the gains in U.S. agricultural yields between 1930 and 1980 came as a result of the use of genetic resources (OTA 1987).

Unfortunately, the development of improved crop varieties, along with other pressures such as land clearing, development, urbanization and the spread of pests and diseases, has led to the loss of traditional, less profitable varieties, (FAO 1997). Such genetic erosion has led to the increased homogenization of agricultural production, and undermined the resilience of the overall agricultural system by limiting the genetic resources available for breeding more productive and resistant crop varieties in the future. For example, of the 7,098 apple varieties that were grown in the United States between 1804 and 1904, about 86% have been lost, along with 95% of the cabbage, 91% of the field maize and 81% of the tomato varieties grown during the 1800's in the U.S., while in the Netherlands, the top three varieties of nine major crops cover 81-99 percent of the respective areas planted (FAO 1997).

The loss of this crop diversity is problematic because the genetic diversity found within the hundreds of thousands of crop varieties around the world is essential for breeding new, more productive crops in the future. The Green Revolution, the mechanization of agriculture, and the increased use of fertilizers and pesticides have all enabled global food production to keep up with population growth. However, the number of undernourished people today is still significant, at around 800 million, (FAO 2015), and the food price crisis in 2007-2008 (in which world food prices spiked dramatically, pushing 75-80 million into hunger) revealed the vulnerability of the global food system (von Braun and Tadesse 2012). Furthermore, by 2050, approximately twice as much food as was produced in 2000 will have to be grown on the same amount of land while using less pesticides and fertilizers to feed a projected future population of 9.6 billion (FAO 2010).

In addition to these already substantial challenges, climate change is projected to have a number of negative impacts on agriculture, including increased temperatures, an increased frequency of drought, reduced irrigation water availability, and an increased frequency and severity of extreme weather events such as floods, severe storms, heat waves and forest fires (Sutton et al. 2013). Agricultural adaptation costs needed to keep child malnutrition numbers in 2050 to no-climate-change levels have been estimated at \$7.1-\$7.3 billion (in 2000 US\$) per year (Nelson et al. 2010), and agricultural pests and diseases are also projected to become more prevalent and damaging in a warming climate (Andersen et al. 2004). By the end of the 21st century, normal growing season temperatures are expected to exceed the most extreme seasonal temperatures recorded from 1900 to 2006 (Battisti and Naylor 2009).

It is thus essential to identify the causes and drivers of the loss of crop diversity around the world, and clearly determine a strategy for reversing the trend so as to ensure that these genetic resources are available when they are most needed. At the root of the seed banking crisis described above is that farmers, the traditional managers of crop diversity, are turning away from old landraces and traditional crop varieties and adopting new, improved varieties. While farmers may grow more than one type of a given crop, either for personal consumption or to hedge risks such as weather or uncertain market demand, participants in modern, connected agricultural markets are likely to abandon old crop varieties and choose improved, high-yield crop varieties that maximize their profits. This trend puts pressure on crop diversity, causes genetic erosion, and ultimately leads to the irrevocable loss of crop varieties.

In addition to farmers, however, there are two other major groups in the seed banking sector that might be expected to reverse the loss of crop diversity: private plant breeding companies and public or non-profit genebanks, both of which maintain collections of crop varieties in cold storage and cryopreservation facilities. Plant breeding companies such as Syngenta or Monsanto can be expected to conserve a certain number of crop varieties in their own private genebanks to have them available for breeding activities. However, crop breeding firms are not likely to conserve the socially optimal amount of crop diversity for several reasons. First, companies are likely to focus on the most valuable crops and the traits that farmers are most willing to pay to have in seeds. They are thus likely to under-conserve or not conserve varieties of low value crops, regardless of their value for food security and the livelihoods of poor, subsistence farmers. Second, because such companies are likely to focus on maximizing profits over a relatively short time-period (less than a decade), they are unlikely to conserve crop varieties that do not have direct relevance to their current efforts. Last, private breeding companies are likely to "free-ride" off of the work of public genebanks. In other words, because public genebanks conserve a considerable quantity of crop diversity, private breeding companies are likely to invest less into the conservation of genetic resources than they would otherwise and instead rely on the public system for the long-term conservation of genetic resources.

Unlike private breeding companies, the goal of public genebanks is not to maximize profitability but rather to maximize social welfare. Public and non-profit seed banks are thus the best candidates to reverse the trend of genetic erosion and the reduction in the overall number of crop varieties. However, public and non-profit seed banks face other challenges. While they are not profit-driven like private breeding companies, they do face funding constraints set by the government and the altruism of donors. That makes their operations vulnerable to financial crises and budget cuts during periods of austerity, or simply routine under-funding. Due to the insufficient incentives for farmers and private breeding companies to conserve the socially optimal amount of crop diversity, it is necessary that public genebank systems have strong support from the public sector. To obtain an appropriate level of financial support from governmental budgets, however, it is essential that rigorous estimates of the diverse economic values of crop diversity are produced in order to justify expenditures on the conservation of these genetic resources.

This thesis uses stated preference techniques to estimate the economic value of crop diversity to the Czech public. The empirical work focuses on the value of the crop diversity held by the National Programme on Conservation and Utilization of Plant Genetic Resources and Agrobiodiversity in the Czech Republic, and seeks to empirically investigate the following three hypotheses:

1. The economic value of crop diversity in the Czech Republic is significant (that is, there is unique crop diversity in the Czech Republic that contains valuable traits);
2. The operations of the Czech genebank are socially beneficial: in other words, the economic benefits of the genebank's operations outweigh its costs;

3. The Czech public, farmers, and breeding companies place a value on the coutnry's crop diversity that can be measured.

I chose to empirically test these hypotheses by focusing specifically on three types of Czech crop diversity: fruit trees, wine varieties and hops. I chose these crops because the many varieties of each are usually very distinguishable, and are present in recognizable Czech products such as beer, wine, fruit brandies, fruit, jams, etc., that are of general interest to the Czech population. In addition, I also value the conservation of "general," unspecified crop diversity in order to address my second hypothesis (since the Czech genebanks conserve many crop varieties in addition to hops, fruit trees, and wine varieties). Methodologically, I use an online stated preference survey to elicit preferences for the conservation of each type of crop, and focus on the value the Czech public places on crop diversity. Stated preference methods ask respondents to express their preferences for hypothetical goods or services, and are particularly useful for valuing goods or services such as crop diversity conservation for which there is no well-functioning market.

This work is significant in that it elicits the value that the Czech public places on conserving Czech crop diversity, providing an approximation of the aggregate social benefits of crop conservation activities. In contrast, most past work has dealt with farmer preferences. We demonstrate a strong preference for conserving fruit trees over hops and wine varieties, and derive positive mean WTP values for the general Czech population (ages 18 to 69) of **167 Kč ($6.80)** and **56 Kč ($2.30)** for the conservation of general crop diversity and fruit trees, respectively. Summed across the adult Czech population, we obtain an aggregate country-wide WTP figure of **~1.25 billion Kč (~$50.5 million)** for the conservation of general crop diversity.

The thesis has the following structure. In the second chapter, I review the literature on the economic valuation of crop diversity, starting with a description of the types of value provided by crop diversity and the general valuation techniques used in this research area, and finish by focusing more closely on past literature that uses stated preference approaches to value crop diversity. In the third chapter, I provide a brief overview of the Czech agriculture sector as well as the Czech National Programme for the Conservation of Crop Diversity. In the fourth chapter, I describe the methodology used to collect and analyze the data, and in the fifth chapter I present the results of the study. The sixth chapter discusses the results as well as potential biases associated with the data collection methods and the econometric approaches used to analyze the data. The seventh chapter presents my conclusions, and makes suggestions for future research directions.

Chapter 2

Literature Review on the Economic Valuation of Crop Diversity

2.1 Introduction to the topic

The economic value of crop diversity - from crop varieties conserved in genebanks and landraces grown in farmers' fields to related species living in wild populations – has been estimated using a multitude of approaches. The most direct form of economic value associated with crop diversity originates from either the cultivation of a crop variety to produce a harvest or its use in breeding to create a new, improved variety. Many past studies that estimate the economic value of plant genetic resources focus on their use in breeding and the associated economic impacts. However, the value of crop diversity is broad and includes many forms of value that should be distinguished. Section 2.2 reviews past methodologies used to estimate the economic value of conserving cultivated crop diversity most directly related to the use of such resources in breeding new crop varieties and focusing on the corresponding increases in agricultural productivity or resilience provided by such investments; Section 2.3 provides a broad overview of the *types* of economic value provided by crop diversity; and Section 2.4 focuses specifically on past studies that employ stated preference methods to value crop diversity and thus share the methodological approach utilized in this thesis.

2.2 Economic value of cultivated crop diversity

Cultivated crop diversity, including both landraces and improved varieties, has undeniable value arising from both direct cultivation as well as the use of crop varieties in breeding new, improved crop types. This value has been demonstrated through substantial increases in agricultural productivity as a result of breeding efforts that rely upon a wide range of crop varieties from around the world, and documented by a number of analyses investigating the economic value provided by crop diversity.

Many studies have tried to illustrate the value of crop diversity by showing how various crop varieties (particularly landraces) led to the improvement of agricultural productivity through breeding and the release of new, improved varieties (Evenson and Gollin 1997; Evenson and Gollin 2003). For example, Gollin and Evenson (1998) find based on the breeding of new rice varieties in India that the economic benefits of such increases in agricultural productivity were likely to greatly outweigh the costs of conserving the Indian rice collections. Johnson *et al.* (2003) find that the cumulative value of increased production due to improved bean varieties between 1970 and 1998 was around 1.15 billion US$.

Others have used a cost-benefit approach to estimate the internal rate of return of investments in genebanks and crop improvement through breeding. For example, Brennan and Malabayabas (2011) estimate that the International Rice Research Institute’s total investment in rice improvement has yielded an internal rate of return of 28 percent and a benefit-cost ratio of 21.7, based strictly on benefits enjoyed in Vietnam, the Philippines, and Indonesia. A similar study investigating the economic impact of breeding for leaf rust resistance in spring bread wheat at the International Maize and Wheat Improvement Center (CIMMYT) found that the internal rate of rate of the Center’s research investment was 41 percent, with a benefit-cost ratio of 27:1 (Marasas, Smale & Singh 2003).

Last, Xepapadeas *et al.* (2014) use a probabilistic model to approximate the so-called insurance value provided by wheat landraces and wild relatives (associated with the possibility of using these genetic resources to recover commercial agricultural production if a catastrophic event like a disease or pest epidemic seriously disrupts the cultivation of a given crop) held in the Greek genebank at Thessaloniki in the case of future shocks. The authors find that the Greek genebank likely provides a minimum of around 3 million euros in insurance value each year, considerably more than the annual conservation costs associated with the maintenance of the collection. Another study, utilizing a maximum entropy method within the search theoretic framework, finds that even among poorly characterized materials in the U.S. national germplasm system, the lower-bound estimates of the marginal benefits of conserving an additional accession are likely to be significantly higher than the upper-bound cost of conservation (Zohrabian *et al.* 2003).

2.3 Types of value

The first report on the State of the World's Plant Genetic Resources for Food and Agriculture divides the economic value of genetic variability or diversity in crop varieties into 1) portfolio value; 2) option value; and 3) exploration value. Portfolio value refers to the ability of genetic diversity to provide stability to agricultural systems, in the sense that a portfolio of crops or crop varieties can help to smooth yield variability in the face of events like droughts or outbreaks of pests and diseases to which a single crop variety may be vulnerable. Option value is the insurance provided by genetic diversity against future challenges, such as new pests and diseases, changing climates or evolving market conditions. Last, exploration value is associated with the potentially valuable but unknown genes and traits found within plant genetic resources that may be discovered and provide value in the future (FAO 1997).

Garming *et al.* (2010) describe a similar framework of value in their report on the impact of the Musa International Transit Centre, using a general taxonomy of the value of crop diversity as found in Koo and Smale (2003): current use value, expected future use value, and option value. Current use value is rooted in the contribution of a given crop variety to the improvement of crop production in the present. For example, if a crop variety is used in breeding to create an improved variety with resistance to some pest that boosts yields by 5 percent, its current use value would be calculated as the market value of the 5 percent of the harvest produced using that improved variety. Future use value is associated with the contribution of a given crop variety to the improvement of crop production in reaction to an anticipated future problem, such as reduced availability of irrigation water. Last, Garming *et al.* (2010) define option value as being that provided by preserving the possibility of finding useful genes to cope with future shocks and challenges that are *not* anticipated, in contrast with expected future use value.

Finally, in a report on identifying the economic benefits of the International Treaty on Plant Genetic Resources for Food and Agriculture, Moeller and Stannard (2013) present a broader and more detailed typology of the economic values of crop diversity based in the total economic value approach. They describe the direct use values associated with the contributions of PGR (cultivation, use in breeding, etc.), as well as option value, but also describe passive use values including 1) indirect use values, which arise from the contribution of crop genetic resources to surrounding habitats and ecosystems; 2) quasi-option values, which are associated with the extra value attached to future information that is obtained through the preservation of a genetic resource (information that could not have been acquired had the crop variety been irreversibly lost); and 3) non-use values such as existence and bequest value. Existence value refers to the value individuals and societies place on simply knowing that something exists (even if it is never used), while bequest value refers to the satisfaction they obtain by knowing that a resource will be passed on to future generations.

Unfortunately, it is not always possible to use market data (“revealed preferences”) or the other techniques described in Section 2.2 to identify these so-called “passive use values,” which include existence, bequest, and option values, as described above. Stated preference methods, including contingent valuation techniques, are sometimes the only approach available for estimating the value of these other "non-use" values (Krutilla 1967; Carson and Czajkowski 2012), and thus offer a methodology for estimating the total economic value of public goods such as crop diversity.

2.4 Stated preference approaches to valuing crop diversity

This thesis uses stated preference techniques to estimate an approximation of the total economic value of Czech crop diversity, and seeks to contribute to the stated preference literature for plant genetic resources. Past work has sought to use stated preference methods to elicit values of crop genetic resources not directly dependent on their use in breeding new, improved crop varieties. These studies can be split roughly into those that used contingent valuation techniques, and those that employed discrete choice experiments.

Several studies have used contingent valuation techniques to estimate the value of crop diversity. First, Poudel and Johnsen (2009) used an open-ended bidding game approach to estimate the willingness of Nepalese farmers to pay for the conservation of rice landraces, finding a mean willingness to pay of USD 4.18 for *in situ* and USD 2.20 for *ex situ* conservation per landrace per year. However, open-ended approaches, which ask respondents directly how much they are willing to pay, have been criticized for not providing a realistic, market-like situation (Bateman *et al.* 2002). More recent studies have used dichotomous or closed-ended questions, which provide a discrete bid and ask the respondent if they accept or do not accept the offer. Krishna *et al.* (2013) used a double-bounded dichotomous choice approach to estimate the minimum amount farm households in India would be willing to accept (WTA) to conserve rare but less productive varieties of different minor millet species. They found that the mean farmer WTA values for cultivating one of the minor millet varieties on 0.10 acres of land under monocropping ranged from 148.85 to 982.21 Rupees per year, depending on the millet variety (with 1 US$ being equivalent to Rs. 46.64 on average during the period of the study, meaning the mean farmer WTA values varied between about $3 and $21). More recently, Rocchi *et al.*

2016 used a single-bounded dichotomous choice model to elicit use and non-use values for an old Italian tomato variety, "Pomodoro di Mercatello," focusing on the population of the city where it is grown and sold, and derived an estimate for WTP to "adopt" a tomato plant of the variety for conservation of 14.49 euros (a proxy for non-use value).

Other studies analyzing the economic value of crop diversity use the discrete choice method, which allows respondents to choose between multiple alternatives (instead of just two, as in contingent valuation approaches). For example, Birol *et al.* (2006) utilized the choice experiment method to approximate the private benefits farmers obtain from four types of agrobiodiversity found in Hungarian home gardens, using a willingness-to-accept approach: crop variety richness, including fruit trees; integrated crop and livestock production; soil micro-organism diversity; and crop landraces. All of these factors were found to be significant in farmers' choice of home gardens, with agro-diversity being the most important attribute – the respondents on average required between 100 and 404 euros (in 2002 prices) per annum and household to give up this attribute of their home gardens. Birol, Kontoleon and Smale (2006) similarly combined revealed preference (a discrete choice, farm household model) and stated preference (a choice experiment model) approaches to investigate the questions described above, confirming the validity of the stated preference results.

Other, more recent papers have also favored the discrete choice method. Birol *et al.* (2007) used a choice experiment and latent class model approach to estimate the value Mexican farmers place on three components of crop diversity (crop species richness, maize variety richness and the presence of maize landraces) maintained in traditional *milpa* production systems, which are characterized by a set of crops and practices that are associated with the cultivation of traditional maize varieties. They show that many of the *milpa* farmers are willing to accept relatively substantial declines in yield to be able to continue to cultivate maize landraces instead of improved or genetically modified varieties. Asrat *et al.* (2010) also analyzed the incentives and constraints facing small farmers, using choice experiments to investigate the preferences of Ethiopian farmers for crop variety attributes such as environmental adaptability and yield stability. And most recently, Sardaro *et al.* 2016 employed choice experiments, using a latent class model, to investigate how much olive farmers in Apulia, Italy would require to be compensated to grow traditional, landrace varieties of olive trees on their land through a regional conservation programme, instead of more modern, improved olive varieties.

In conclusion, most of the past studies have focused on the value of crop diversity on-farm, while few have used stated preference techniques to investigate the value of crop diversity held *ex situ* in field collections, cold storage, and cryopreservation facilities. Almost all of the studies described in this section (2.5) also elicit the preferences of *farmers* for the conservation of crop diversity, and not those of the general public. Since most countries have public conservation programs for crop diversity on the national level, however, the value placed by the general public on the conservation of crop varieties is also of interest. While a sample representative of the general population may have a smaller mean WTP per individual than a sample consisting entirely of farmers, who directly use crop diversity to make a living, calculating the mean WTP of a country's residents allows the estimation of the aggregate WTP for crop conservation on a country-wide level. In addition, using stated preference methods to focus on the general public makes it possible to capture the "passive use values" of crop diversity, which are of significance for the public as well as for farmers.

Chapter 3

The State of Crop Diversity in the Czech Republic

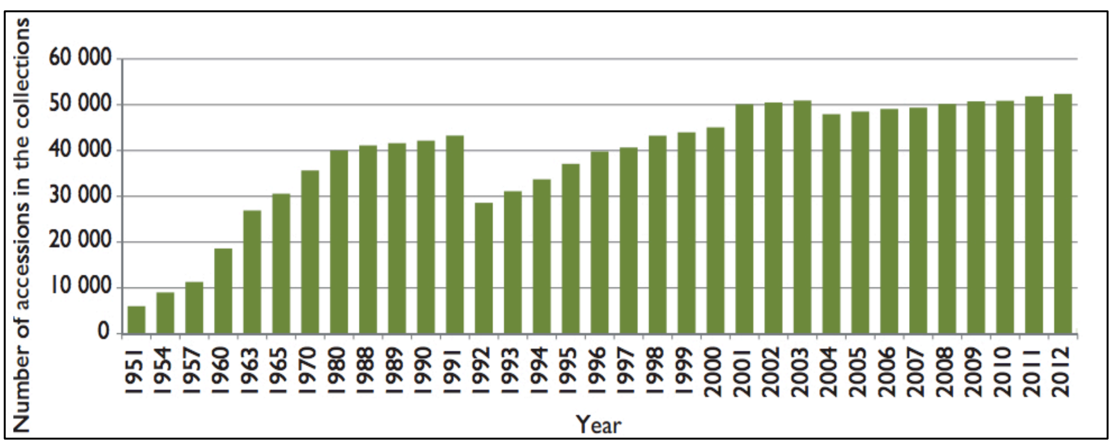
3.1 Agriculture Sector of the Czech Republic

The Czech Republic is an industrial country with an agriculture sector characterized by intensive production. The country has approximately 37,000 square kilometers of agricultural land, just under half of the total land area of the Czech Republic, with about 27,500 square kilometers of arable land, 8,750 square kilometers of grasslands, and about 460 square kilometers of vineyards, hop-gardens and orchards (FAO 2004). Wheat, rapeseed, sugar beet, barley and potatoes have been the most valuable crops in recent years in terms of overall production, according to FAOSTAT. The value of the domestic Czech seed market in 2011 has been estimated at US$300 million (Moeller and Stannard 2013), and in 2013, the value added by the Czech agriculture sector amounted to approximately 2.6 percent of the country's GDP (World Bank 2015).

3.2 *Ex Situ* Conservation of Crop Diversity in the Czech Republic

The Czech Republic's publically-held collections of plant genetic resources (PGR) are maintained through the National Programme on Conservation and Utilization of Plant Genetic Resources and Agrobiodiversity, which was launched in 1993 when it was decided to split the PGR collections of Slovakia and the Czech Republic. The Programme is supported by national legislation, in Act No. 148/2003 Coll. On Conservation and Utilization of Plant and Microbial Genetic Resources for Food and Agriculture and Decree No. 458/2003 Coll (Dotlačil et al. 2013). The leading institution of the Czech National Programme is the Crop Research Institute in Prague-Ruzyne, founded in 1952, which coordinates the activities of the sixteen participating organizations, including public research institutions such as the Viticulture Research Station in Karlstejn and private businesses such as the Hop Research Institute, Ltd. in Žatec and the Potato Research Institute, Ltd. in Havlíčkův Brod (Dotlačil et al. 2013).

Figure 3.2.1 Total number of varieties held in the Czech collections, 1951-2012
Source: Dotlačil et al. 2013



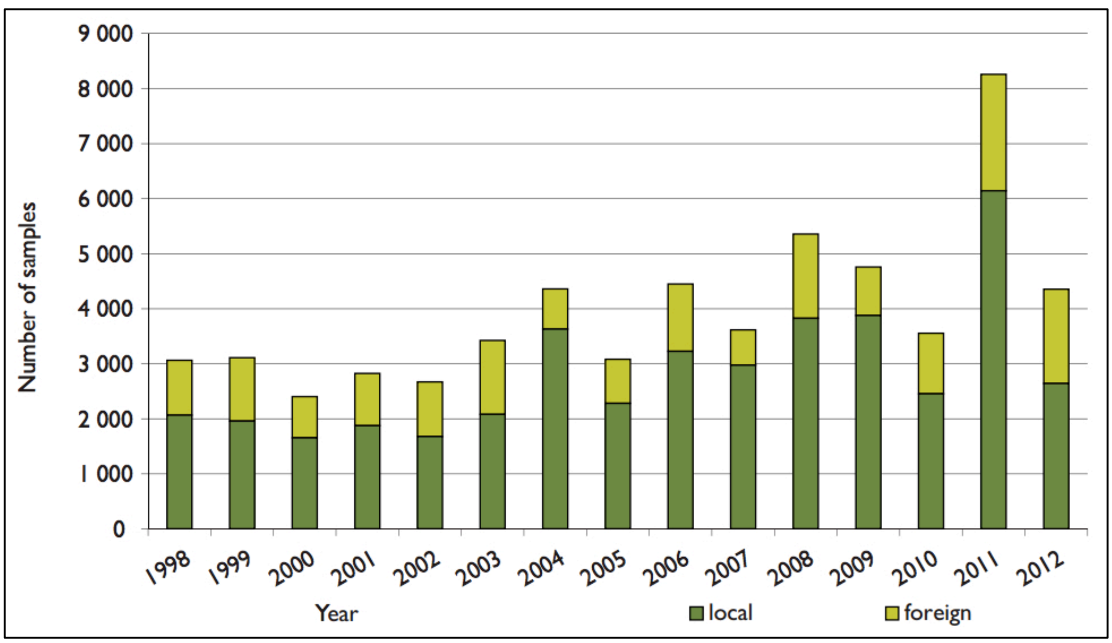
The Czechoslovak collections of crop diversity grew rapidly between in the 1950s through the 1980s, increasing from 6,000 accessions in 1951 to 45,500 in 1988 (Figure 3.2.1). At the end of 2012, the accessions in the Czech collections reached 52,600, and now number over 53,000. The majority of the Czech PGR collections are held by the Crop Research Institute, which maintains a little over half of the nation's accessions (around 26,700), including a large wheat collection and other cereal crops and some neglected and minor crops. The rest are divided between the other institutions participating in the Czech National Programme (Table 3.2.1). Cereals comprise about 40 percent of the total number of accessions, with vegetable accessions constituting 15 percent, legumes representing 11 percent of the accessions, and the rest being made up of fodder crops, fruit plants, potatoes and root crops, and others. A substantial number of the Czech holdings are safety duplicated at the Slovak genebank in Piešťany. Evaluation and characterization activities are undertaken each year to provide more information on the characteristics of the Czech holdings to users, and information on Czech crop diversity has been available online through the EVIGEZ information system since 1994, though the database of the collections has recently been switched over to a new system, GRIN-GLOBAL (Dotlačil et al. 2013).

Table 3.2.1 Member Institutions of the Czech National Programme on Conservation and Utilization of PGR and Agrobiodiversity

Institution	***Collections held***	***Public/Private***
Crop Research Institute - Prague (CRI)	Cereals and minor crops	Public
Center of Applied Research – Olomouc	Vegetables and herbs	Public
Viticulture Research Station – Karlštejn	Wine grapes (*Vitis*)	Public
Silva Tarouca Research Institute	Ornamental species	Public
Institute of Botany – Pruhonice	Irises	Public
Mendel University – Lednice	Fruit trees and berries	Public
Agricultural Research Institute Kroměříž	Spring barley, oat, rye	Private
AGRITEC Research, Breeding and Services	Legumes and fibre plants	Private
Potato Research Institute – Havlíčkův Brod	Potatoes	Private
Hop Research Institute, Ltd. - Žatec	Hops	Private
Research and Breeding Institute of Pomology	Fruit trees and berries	Private
Research Institute of Fodder Crops - Troubsko	Fodder crops	Private
OSEVA PRO, Ltd. – Zubří	Grasses	Private
OSEVA PRO, Ltd. – Opava	Oilseed crops	Private
Viticulture Breeding Station Znojmo, Plc.	Wine grapes (*Vitis*)	Private

The Czech Republic is a Contracting Party to the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), which requires members to provide access to publically held crop diversity freely to those who request it for research, breeding and training, and also adheres to the associated Standard Material Transfer Agreement. Figure 3.2.2 presents the number of seed samples provided by the Czech National Programme between 1998 and 2012 to local and foreign requestors. In addition, the Czech Republic is also party to the Convention on Biological Diversity (CBD), and follows the international genebank standards outlined by the United Nations Food and Agriculture Organization's Commission on Genetic Resources for Food and Agriculture (CGRFA). The Czech Republic joined the European Cooperative Programme for Plant Genetic Resources in 1983, which now includes 44 countries, and is also active in AEGIS, the European genebank integration project (Dotlačil et al. 2013).

Figure 3.2.2 Number of accessions distributed by the National Programme, 1998-2012



3.3 *In Situ* Conservation of Crop Diversity in the Czech Republic

There is some on-farm conservation of fruit tree landraces (including apples, pears, cherries and plums) and under-utilized field crops such as hulled wheat species and buckwheat. Inventory and monitoring of landraces has been carried out and guides *in situ* conservation activities (Dotlačil et al. 2004). The Czech Republic is the birthplace of many fruit tree cultivars and remnant fruit trees exist among fields, old groves, country lanes, wind-breaks and abandoned orchards. Hundreds have been registered, evaluated and tagged with GPS coordinates by the National Programme (Paprštein et al. 2010).

3.4 Hop, Wine & Fruit Tree Diversity in the Czech Republic

Hops, wine grapes and fruit trees are all important crops with long histories of cultivation in the Czech Republic, and are used to brew beer, wine-making, and the production of fresh fruit, jams, preserves, and brandies such as slivovice and hruškovice. Varieties of all three crop types are currently conserved by the Czech National Programme (Dotlačil *et al.* 2013).

Hop varieties have been maintained in Žatec since 1927, and now are conserved by the Department of Genetics and Breeding of the Hop Research Institute, Ltd. The Institute currently conserves both cultivated and wild hops, as well as varieties originating from both the Czech Republic and from other countries.

Wine varieties in the Czech Republic are conserved by two main publicly supported institutions: the Viticulture Station in Vrbovec and the Viticulture Research Station in Karlštein. The Viticulture Station in Vrbovec conserves collections of grape vine, and is engaged in both breeding new wine cultivars as well as the reintroduction of local or old wine types such as Ryzlink buketový, Semillon, and Veltlínské červenobílé, while the Viticulture Research Station in Karlštein conserves many varieties of wine, and also works to coordinate the activities of the other Czech national Vitis collections.

Last, fruit tree varieties are conserved by the Research and Breeding Institute of Pomology Ltd., in Holovousy. The Institute currently conserves fruit tree varieties, including many apple tree, pear, plum, sweet cherry, and sour cherry varieties. In addition, Mendel University’s Faculty of Horticulture in Lednice conserves many varieties of apricots as well as varieties of peaches and nectarines. Collecting activities are carried out to rescue old fruit cultivars traditionally grown on the territory of the Czech Republic, and on-farm plantations have been established for the maintanence of landrace fruit tree varieties in recent years, including the Orchard of Reconciliation in Neratov (in the Orlické Mountains), and other plantations in the Giant Mountains and Bohemian Forest national parks.

All of the organizations described here receive funding from the National Programme and freely distribute their material for the purpose of further breeding, research and education to all domestic as well as foreign users.

Chapter 4

Methodology

4.1 Overview

In this thesis, I analyze the preferences of Czechs for conserving crop diversity in general and for specific types of crops. Data were collected with the Computer-Assisted Self Interviewing (CASI) method, using an online survey instrument. A major objective of the survey was to derive a mean willingness-to-pay (WTP) among the Czech population for conserving different types of crop diversity.

One component of the survey focused on eliciting the preferences of Czechs for conserving "general" crop diversity, meaning their WTP for an additional variety of an unspecified crop type currently conserved by the Czech national programme for the conservation of agricultural biodiversity, including oil crops such as canola and sunflower, legumes such as lentils and chickpeas, vegetables, potatoes, and cereals such as barley and wheat. I use a contingent valuation approach in this portion of the survey: specifically the double-bounded dichotomous choice method. Analysis of this portion of the survey enabled the derivation of a mean WTP of the Czech population for the conservation of an unconserved, unspecified crop variety for 10 years.

The other component of the survey uses a discrete choice experiment approach to elicit preferences for the conservation of hop, fruit tree and wine varieties, which asks the respondent to choose between several options characterized by varying attribute levels. Analysis of their responses enabled the derivation of a mean WTP of the Czech population for the conservation of fruit tree varieties, again for 10 years.

4.2 Analytical approach

Overall, this thesis uses stated preference methods to value the conservation of crop diversity. A stated preference survey can be simply defined as a "survey that asks agents questions that embody information about preferences," as opposed to revealed preference methods, which rely on data from observed behavior (Carson and Louviere 2011).

While many services can be valued based on the functioning of markets, in which consumers reveal their willingness-to-pay every time they pay for a service, and service providers reveal their willingness-to-accept every time they sell a service, this information is not available when a market for a given service does not exist. Unfortunately, no well-developed market for the conservation of crop diversity currently exists in the Czech Republic. In the Czech case, crop varieties are currently conserved through a publicly funded program, the National Programme on Conservation and Utilization of Plant Genetic Resources and Agrobiodiversity, and not through a functioning private market. This lack of a market for crop diversity conservation led to the decision to employ stated preference methods to analyze the economic value of Czech crop diversity.

In short, stated preference methods allow information to be gathered about the preferences of respondents by observing choices in hypothetical situations presented in a survey. Essentially, the survey creates a hypothetical market for a non-market good or service, making it a more flexible tool than revealed preference techniques that rely on existing market data. In many cases, stated preference techniques are the only approach available for the economic valuation of certain goods and services.

In this thesis, I use two specific stated preference techniques to create hypothetical market situations in order to elicit preferences among the Czech public for the conservation of different types of crop diversity. These are the double-bounded dichotomous choice approach and the discrete choice experiment approach. The double-bounded dichotomous choice section involved in this case asking the respondent whether they were willing to pay a given amount to conserve a certain number of currently unconserved non-specified crop varieties. If they refused, a follow-up question was asked at a lower bid level, while if they accepted, a follow-up question was asked at a higher bid level. The discrete choice experiment section asked respondents to decide between conserving a certain number of currently unconserved hop, fruit tree, or wine varieties (depending on the cost and number of varieties, which varied), or the status quo, an option requiring no payment. The dichotomous choice and the discrete choice experiments belong to the same group of elicitation methods, as noted by Carson and Louviere (2011). It is the number of alternatives in the choice task (k=2 vs. k>2) and the possibility to use multiple choice tasks that define the distinction between the two approaches.

4.3 Experimental design

This section describes the design of the two choice experiments, including the attribute levels and choice attributes used in both. Both choice experiments ask the respondent to decide whether they are willing to make a one-time payment (in Czech crowns) into a public fund to conserve a certain number of currently unconserved crop varieties for 10 years. It was decided to use a voluntary payment as opposed to a yearly tax in order to avoid any negative feelings respondents might associate with involuntary taxation as a payment vehicle.

Explanatory variables

The survey included a number of questions to gather data that could potentially be used in the econometric models as explanatory variables. These included questions requesting information about the following:

- Income (personal and household)
- Educational attainment
- Region of residence

- Gender
- Drinking habits
- Attitudes about climate change
- Gardening habits

Information was also gathered about whether the respondent was employed in the agricultural sector; owned or worked for a vineyard or hop farm; worked at a brewery; regularly visited farmers' markets; was a farmer; or had ever taken part in the yearly hop harvest in the Czech Republic.

4.3.1 Design for "general" crop diversity experiment

I used only two attributes (each with five levels) for the general crop diversity experiment, which was analyzed using a double-bounded dichotomous choice model: cost, and the number of currently unconserved, "unspecified" crop varieties in the Czech Republic to be conserved for 10 years by the hypothetical program (and which could include oil crops such as canola and sunflower, legumes such as lentils, potatoes, cereals such as barley, vegetables, and others). Table 3.3.1 below lists the five attribute levels used in this choice experiment.

Table 3.3.1 Attribute levels for "general" crop diversity experiment

	Level 1	**Level 2**	**Level 3**	**Level 4**	**Level 5**
# of varieties conserved	5	10	15	25	35
Cost (CZK)	50	100	200	300	500

Given that there were only two attributes included in this experiment, each with five levels (yielding 25 total combinations of cost and # of varieties conserved), it was possible to use a full factorial design.

4.3.2. Design for "specific" crop diversity discrete choice experiment

The specific crop diversity experiment focused on three crop types: hops, fruit tree, and wine varieties. As opposed to the general crop diversity experiment described above, the discrete choice experiment approach used in this portion of the survey requested that respondents choose between several choices, instead of just responding "Yes" or "No" to a proposed conservation plan. Figure 3.3.1 provides an example of the choice cards used in this experiment, in the Czech language, in which there is a "Status Quo" option (0 costs and 0 varieties conserved, a "hop conservation" option, a "wine conservation" option, and a "fruit tree" conservation option.

Figure 3.3.1 Example choice card, specific crop discrete choice experiment

VÝBĚROVÁ KARTA

Plodina	**Vinná réva**	**Chmel**	**Ovocné stromy**	**Současný stav**
Počet dalších odrůd, které budou uchovány	15 odrůd	35 odrůd	35 odrůd	Žádná nová odrůda
Jednorázová platba	100 Kč	250 Kč	300 Kč	0 Kč
Jakou možnost preferujete?	☐	☐	☐	☐

Each of the conservation cards offers to conserve a given number of currently unconserved varieties of the type of crop listed (hops, fruit trees or wine) for 10 years at a certain cost. There are five levels for the cost and quantity of crop varieties conserved, as shown in Table 3.3.2 (which presents the attribute levels for this choice experiment). Originally, all three crop types had the same bids, or costs (50, 100, 200, 300, and 500 CZK); however, the pilot data (with n=~170) revealed that fruit trees were greatly preferred over hops and wine, and wine was slightly preferred over hops, so the bids for both hops and wine were lowered to reflect this.

Table 3.3.2 Attribute levels for specific crop diversity experiment

	Level 1	Level 2	Level 3	Level 4	Level 5
# of varieties conserved	5	10	15	25	35
Cost (CZK) - hops	25	50	100	150	250
Cost (CZK) - wine	25	50	100	200	250
Cost (CZK) – fruit trees	50	80	120	200	300

Full factorial design was not possible due to the high number of permutations because of the greater complexity of this choice experiment, and so a D-efficient design was generated using NGENE software (Choicemetrics, 2014), a software program designed to create experimental designs for stated choice experiments. The design was created using the following functions that describe the indirect utility for each alternative:

$$U(alt1) = b1(0.5) * HOPS[5,10,15,25,35] + b4 * [-1.0]*\text{COST}[0.25,0.5,1.0,1.5,2.5]$$

$$U(alt1) = b2(1.0) * FRUIT[5,10,15,25,35] + b4 * [-1.0]*\text{COST}[0.50,0.8,1.2,2.0,3.0]$$

$$U(alt1) = b3(0.55) * WINE[5,10,15,25,35] + b5 * [-1.0]*\text{COST}[0.25,0.5,1.0,2.0,2.5]$$

$$U(alt4) = b6[-1]$$

Prior coefficients for the utility components resulting from conserving hop, fruit tree and wine varieties were originally set in the pilot based on the author's judgement according to the approach laid out in Bliemer and Collins (2016). I hypothesized that hops would be preferred (prior coefficient estimated at 1.0), followed by wine (0.70) and then fruit trees (0.60). However, the pilot data revealed that the opposite was in fact true, and so priors were re-estimated based on the pilot data, resulting in the final priors shown in the equations above.

The design for the "specific" crop diversity experiment resulted in 100 unique choice situations divided into 25 blocks; see Annex II.

4.4 Data collection

The survey instrument was drafted in English, translated into Czech, and programmed into an online format. In addition to the double-bounded dichotomous choice experiment designed to elicit preferences for the conservation of general crop diversity (Choice Task 1) and the discrete choice experiment designed to elicit preferences for the conservation of hop, fruit tree and wine varieties (Choice Task 2), there were also two other experiments included in the survey that are the beyond the scope of this Master's thesis (Choice Task 3 and Choice Task 4). Choice Task 2 and Choice Task 3 were always grouped together, and for half of the surveys came before Choice Task 1 and for half of the surveys came after Choice Task 1 (in order to control for any bias caused by the ordering of the experiments). Choice Task 4 always came after the other three choice tasks. In other words, the ordering of the choice tasks alternated between "Choice Task 1 – Choice Task 2 – Choice Task 3 – Choice Task 4" and "Choice Task 2 – Choice Task 3 – Choice Task 1 – Choice Task 4." The order was assigned to each respondent at random.

The general structure of the questionnaire was as follows:

- Questions to confirm the quota filling and screening questions
- Questions about values and attitudes towards crop diversity
- Explanatory text about crop diversity and its importance
- Choice Tasks 1-3
- Explanatory text relevant for Choice Task 4
- Choice Task 4
- Sociodemographic information and other attitudinal questions

Funding obtained from the Grant Agency of Charles University was used to finance data collection, with several firms being contacted to submit bids in response to a tender. The winning firm – STEM/MARK - offered a sample size of **1,414 interviews**, which were split between 2/3^{rds} representative of the Czech population, and 1/3rd representative of the South Moravia region. The decision to run a sub-sample representative of South Moravia was made because of the importance of agriculture in the region and because of the high number of home gardens maintained by South Moravian households. The representativeness of each sample (both Czech representative and South Moravian) was controlled through quota selection depending on region, age, gender, education, and size of the place of residence of the respondent. The quotas were satisfied for each of the sub-samples independently, and were taken from past surveys conducted by the Centrum pro otázky životního prostředí of Univerzita Karlova.

Data were collected with the Computer-Assisted Self Interviewing (CASI) method, using an online survey instrument. The survey instrument was programmed and maintained by the Centrum pro otázky životního prostředí of Univerzita Karlova, as were the output data matrices making up the database of results. The hired firm (STEM/MARK) was responsible for incentivizing respondents to answer to the survey, to manage the quotas, and to carry out the data collection according to the standards of the international research association ESOMAR. Respondents were sampled from an internet panel, properly managed by Český Národní Panel.

A 3-day pilot was run to collect initial data and to allow the survey instrument and experiment designs to be optimized. After ~170 interviews were completed, data collection was paused for preliminary analysis and optimization of the priors and bids. The bids for the general crop conservation experiment were found to be close to optimal, so no changes were made to the design of this particular experiment. The bids for the specific crop conservation experiment were found to be high, so they were lowered for the main wave of the survey. In addition, the original priors were found to be incorrect (in the pilot, hops were hypothesized to be the preferred crop type, but the pilot data suggested that fruit trees were preferred), and so these were revised as well, and the bids for conserving hops and wine were lowered below those for conserving fruit trees. NGENE software (Choicemetrics, 2014) was used to create a new efficient design for the specific crop conservation discrete choice experiment based on the new priors and bid levels.

The main wave of the survey was administered over a 5-day period in the summer of 2016, with the updated design. The winning firm managed the process of incentivizing respondents to complete the survey, while the quotas for the two sub-samples were managed via a website pulling data directly from the survey data as each questionnaire was completed.

4.5 Data analysis

Data were analyzed using the software package R and SAS. The two sets of data from each choice experiment were analyzed separately, using the two respective econometric approaches used for double-bounded dichotomous choice experiments and discrete choice experiments.

4.5.1 General crop diversity experiment

The general crop diversity experiment used the double-bounded dichotomous choice format, which first asks the respondent whether they are willing to pay a given amount to achieve a certain objective (in this case the conservation of a given number of unconserved crop varieties), and then asks a follow-up question with a higher bid (if the initial response was "yes") or a lower bid (if the initial response was "no"). This approach falls under the general category of binary choice models, which are designed to model the "choice" between two discrete alternatives (pay or not pay for the option), and models the data as utility-maximizing responses within a random utility context. This approach has been shown to offer asymptotically greater statistical efficiency than the simpler single-bounded dichotomous choice method (Hanemann *et al.* 1991). This approach also has the advantage that it can be analyzed using the single-bounded dichotomous choice method (by simply ignoring the answers to the second question) as well as the double-bounded method.

The data from the "general" crop diversity experiment were analyzed using the maximum likelihood estimator associated with the double-bounded dichotomous choice approach. We can describe this estimator as follows (using the same framework as Hanemann *et al.* 1991).

In the double-bounded dichotomous choice (DBDC) approach, we start with a first bid B_i. If the respondent responds "yes" to this first bid, the second bid (B_i^u) is larger than the first bid ($B_i < B_i^u$). If the respondent responds "no" to the first bid, however, the second bid (B_i^d) is some number lower than the first bid ($B_i^d < B_i$). The four outcomes of the DBDC experiment are thus "yes-yes," "yes-no," "no-yes," and "no-no." We can denote the probabilities of these outcomes as π^{yy}, π^{nn}, π^{yn}, and π^{ny}, respectively. Using these probabilities, and assuming that the respondents are utility-maximizing, we can express the formulas for the likelihoods.

First, for π^{yy}, the probability that the respondent responds "yes-yes:"

$$\pi^{yy}(B_i, B_i^u) = \Pr\{B_i \leq \text{max WTP and } B_i^u \leq \text{max WTP}\}$$

$$= \Pr\{B_i \leq \text{max WTP} | B_i^u \leq \text{max WTP}\} \Pr\{B_i^u \leq \text{max WTP}\}$$

$$= \Pr\{B_i^u \leq \text{max WTP}\} = 1 - G(B_i^u; \theta)$$

This follows from the fact that if $B_i < B_i^u$, $\Pr\{B_i \leq \text{max WTP} | B_i^u \leq \text{max WTP}\} \equiv 1$.

In the case of "no-no," we can similarly use the information that $B_i^d < B_i$ to conclude that $\Pr\{B_i^d \leq \text{max WTP} | B_i \leq \text{max WTP}\} \equiv 1$, and express the probability that the respondent responds "no-no" as:

$$\pi^{nn}(B_i, B_i^d) = \Pr\{B_i > \text{max WTP and}$$

$$B_i^d > \text{max WTP}\} = G(B_i^d; \theta)$$

For "yes-no," it holds true that $B_i < B_i^u$, giving us:

$$\pi^{yn}(B_i, B_i^u) = \Pr\{B_i \leq \text{max WTP}$$

$$\leq B_i^u\} = G(B_i^u; \theta) - G(B_i; \theta)$$

And finally, for "no-yes," it holds true that $B_i < B_i^u$, giving us:

$$\pi^{ny}(B_i, B_i^d) = \Pr\{B_i \geq \text{max WTP}$$

$$\geq B_i^d\} = G(B_i; \theta) - G(B_i^d; \theta)$$

The second bid in the last two examples (π^{nn} and π^{ny}) allows the placement of an upper and lower bound on the respondent's unobserved true WTP, while the second bid in the first two examples (π^{yy} and π^{nn}) allows us to improve the single bound by raising the lower bound or lowering the upper bound.

Given a sample of N respondents and bids of B_i, B_i^u, and B_i^d (used for the *i*th respondent), we obtain the following log-likelihood function, with d_i^{yy}, d_i^{nn}, d_i^{yn}, and d_i^{ny} being binary-valued indicator variables:

$$\begin{aligned} \ln L^D(\theta) = \textstyle\sum_{i=1}^{N} \{ & d_i^{yy} \ln \pi^{yy}(B_i, B_i^u) \\ & + d_i^{nn} \ln \pi^{nn}\left(B_i, B_i^d\right) \\ & + d_i^{yn} \ln \pi^{yn}(B_i, B_i^u) \\ & + d_i^{ny} \ln \pi^{ny}\left(B_i, B_i^d\right)\} \end{aligned}$$

The Maximum Likelihood estimator for the double-bounded model, $\widehat{\theta^D}$, is the solution to the equation $\frac{\partial \ln L^D(\widehat{\theta^D})}{\partial \theta} = 0$.

In this case, the asymptotic variance-covariance matrix for $\widehat{\theta^D}$ is given by:

$$V^D\left(\widehat{\theta^D}\right) = \left[-E\,\frac{\partial^2 \ln L^D\left(\widehat{\theta^D}\right)}{\partial\theta\partial\theta'}\right]^{-1} \equiv I^D\left(\widehat{\theta^D}\right)^{-1}$$

This outlines the basic econometric approach modeled in R to analyze the response data for the general crop diversity portion of the research.

4.5.2 Specific crop conservation experiment

A discrete choice experiment (DCE) was used in the second set of choice tasks to elicit preferences for the conservation of hop, wine and fruit tree varieties. Whereas the double-bounded dichotomous choice format in the general crop conservation experiment had a "yes" or "no" answer, allowing it to be analyzed with a binary choice model, the discrete choice experiment used in the specific crop conservation experiment had multiple responses and thus a multinomial model was used.

Multinomial logit (MNL) models are used to model relationships between a response variable with more than two possible values and a set of regressor variables. Typically, they are used to analyze data resulting from discrete choice experiments in which the respondents are required to choose between multiple options, each of which has unique characteristics.

There are two main types of MNL models used to analyze the choice of an individual among a set of J alternatives: *conditional logit* and *generalized logit*. The main difference between the two is that conditional logit focuses on the characteristics of the alternatives in the choice set, while the general MNL model focuses on the characteristics of the respondent (and uses these as explanatory variables).

For example (following Hoffman & Duncan 1988), if we let Z_{ij} stand for the characteristics of the *j*th alternative for individual *I*, with the corresponding vectors of the parameters denoted by β, with J being the number of unordered alternatives, then we can calculate the choice probability P_{ij} that individual i chooses alternative j in the generalized logit as:

$$P_{ij} = \frac{exp(Z_{ij}\alpha)}{\sum_{\mathrm{k=1}}^{J} \exp(Z_k\alpha)}$$

Similarly, if we let X_i stand for the characteristics of individual I and the corresponding vectors of the parameters be denoted by β, then we can calculate the choice probability P_{ij} that individual *i* chooses alternative *j* in the conditional logit as:

$$P_{ij} = \frac{exp(X_i\beta_j)}{\sum_{\mathrm{k=1}}^{J} \exp(X_i, \beta_k)}$$

The likelihood function used for the estimation of both the conditional and generalized MNL logit can be written as follows:

$$\log L = \sum_i \sum_j y_{ij} P_{ij}$$

This general approach was used to identify both how the cost and quantities of hops, fruit tree and wine varieties affected the respondents' choice, as well as the effect the respondents' own characteristics (such as income or region) had on their choices.

Chapter 5

Results

This chapter presents the final outcomes of the study, for both the general and specific crop conservation experiments. A brief overview of the main results are provided, followed by a more in-depth presentation of the results for each experiment.

5.1 Overview

Analysis of the dichotomous choice data from the general crop conservation experiment **gave a positive mean WTP of 167 Kč ($6.80)** of the Czech population for the conservation of additional, unspecified general” crop diversity for ten years**.** The South Moravian sub-sample was shown to have a **greater mean WTP of 213 Kč ($8.65)** than the Czech representative sub-sample for general crop variety conservation. These estimates produce an **aggregate WTP of the Czech population (ages 18-69) of ~1.25 billion Kč ($50.5 million)** for the conservation of general crop diversity, and **~410 million Kč ($16.8 million)** for the conservation of fruit trees.

The results of the discrete choice experiment **show a positive mean WTP of 56 Kč ($2.30) for the conservation of fruit trees**, but not for hops or wine varieties. Again, the South Moravian sub-sample was shown to have a higher **WTP of 130 Kč ($5.30)** than the Czech representative sub-sample**.** A number of variables related to the socioeconomic details and habits of the respondents were found to have a significant effect on their WTP for fruit tree, wine variety or hop conservation, including their gender, age, the respondents' drinking habits, and whether or not he or she cultivates crops for their own personal consumption.

5.2 "General crop conservation" experiment results

The "general crop conservation" experiment used a double-bounded dichotomous choice experimental design, allowing the data to be analyzed using both single-bounded and double-bounded dichotomous choice models (SBDC and DBDC, respectively). The results of the simple model (analyzed using SBDC and DBDC) for the Czech representative and South Moravian sub-samples are presented in Table 5.2.1, while the results of the extended model (analyzed using DBDC) for the Czech representative and South Moravian sub-samples are presented in Table 5.2.2. The analysis used a logistic distribution.

5.2.1 Simple model results

Analysis of the data collected for the "general crop diversity" experiment revealed a positive mean WTP for both the Czech representative and South Moravian samples, using both the SBDC and DBDC models. We report mean WTP values calculated using the equation "-1/(bid coefficient)" from a model excluding the "varieties" variable (see Annex III). The WTP estimates for the South Moravia sample was consistently higher than those for the Czech representative sample, using both SBDC and DBDC. We report the DBDC results as the main outcome of the experiment given the greater information used by the DBDC model.

For the Czech representative sample (n=731), we find a **mean WTP per person of 167 Kč ($6.80).** The variable "varieties," indicating the number of "general" crop varieties conserved, was not found to be significant in predicting whether or not the respondent agreed to the bid. For the South Moravia sample (n=418), we find a **mean WTP per person of 213 Kč ($8.65).** The variable "varieties" was found to be significant for the South Moravian sample at a 5% level, and had a positive coefficient of 0.021, indicating that the number of varieties being conserved had increased the probability that the respondent agreed to the bid.

The significance of the variable “varieties” allows us to calculate the mean WTP for conserving a single additional “general” crop variety for ten years, using the following equation, where α is the coefficient on “varieties” and β is the coefficient on “cost:”

$$\frac{-\alpha}{\beta}$$

Using this equation, we obtain a mean marginal WTP for the South Moravia subsample for conserving an additional unspecified crop variety for ten years of 4.35 kč ($0.18).

5.2.2 Extended model results

For the extended models (5 and 6) shown in Table 5.2.2, and analyzed using DBDC, seven additional covariate variables were added: personal income (in 1,000 Kč intervals), age (continuous), gender (with male=1), village (a dummy variable coded as 1 if the respondent was from a town of population 5,000 or below), educhigh (a dummy variable coded as 1 if the respondent completed a degree post-secondary school, such as bachelor, magister or Ph.D.), gardener (a dummy variable coded as 1 if the respondent personally cultivates crops for his or her own consumption), and AgAdapt (a dummy variable coded as 1 if the respondent agreed that it is important that measures be taken to help Czech agriculture adapt to climate change).

The DBDC logit analysis showed that only the variables “Age” and “AgAdapt” were significant for the Czech representative sample. “Age” had a negative coefficient, indicating that older respondents were *less* likely to accept the proffered bid, and was significant at the 5% level. The variable “AgAdapt” had a positive coefficient, indicating that respondents who agreed that it is important that measures be taken to help Czech agriculture adapt to climate change were *more* likely to accept the proffered bid, all else being equal, and was significant at the 1% level.

Table 5.2.1 Simple model estimation results (1-4) for Czech representative and S. Moravian samples, analyzed with SBDC and DBD

Model 1: SBDC, simple model, Czech representative sample

	Coefficient	*Std. Error*	*z*	*Pr(>|z|)*	
Varieties:	0.0011704	0.0069694	0.168	0.86664	
Bid:	-0.0031096	0.0005067	-6.137	<0.00001	***

Number of Obs.: 731
Log-likelihood: -485.7057
Distribution: logistic
Adjusted pseudo-R^2: 0.0341

Mean WTP: 321 CZK

Model 2: SBDC, simple model, S. Moravia sample

	Coefficient	*Std. Error*	*z*	*Pr(>|z|)*
Varieties:	0.0243879	0.0095779	2.546	0.0109**
Bid:	-0.0024158	0.0006645	-3.636	0.0003**

Number of Obs.: 418
Log-likelihood: -279.3732
Distribution: logistic
Adjusted pseudo-R^2: 0.0253

Mean WTP: 412 CZK

Model 3: DBDC, simple model, Czech representative sample

	Coefficient	*Std. Error*	*z*	*Pr(>|z|)*
Varieties:	0.0009717	0.0062230	0.1562	0.8759
Bid:	-0.0059904	0.0002970	-20.1729	<0.00001 ***

Number of Obs.: 731
Log-likelihood: -989.572320
Distribution: logistic

Mean WTP: 167 CZK

Model 4: DBDC, simple model, S. Moravia sample

	Coefficient	*Std. Error*	*z*	*Pr(>|z|)*
Varieties:	0.020501	0.0087344	2.347	0.019**
Bid:	-0.0047125	0.0003216	-14.654	<0.0000

Number of Obs.: 418
Log-likelihood: -555.894727
Distribution: logistic

Mean WTP: 213 CZK

Table 5.2.2 Extended model estimation results (5-6) for Czech representative and S. Moravian samples, analyzed with SBDC and DB

Model 5: DBDC, extended model, Czech representative sample

	Coefficient	*Std. Error*	*z*	*Pr(>|z|)*
Varieties:	-0.0001244	0.0064243	-0.0194	0.98455
Pincome	0.0141635	0.0089851	1.5763	0.11495
Age	-0.0111041	0.0048964	-2.2678	0.02334***
Gender	-0.2069550	0.1465786	-1.4119	0.15798
Village	-0.0599500	0.1489715	-0.4024	0.68737
EducHigh	-0.0925145	0.1536751	-0.6020	0.54717
Gardener	0.1985243	0.1507735	1.3167	0.18794
AgAdapt	0.9455387	0.1583260	5.9721	< 2e-16 ***
Bid:	-0.0063179	0.0003153	-20.0387	< 2e-16 ***

Number of Obs.: 709 Distribution: logistic
Log-likelihood: -943.902306

Model 6: DBDC, extended model, S. Moravia sample

	Coefficient	*Std. Error*	*z*	*Pr(>|z*
Varieties:	0.0255402	0.0093281	2.7380	0.00618
Pincome	0.00732380.	0.0103083	0.7105	0.477
Age	0.0015972	0.0069389	0.2302	0.81795
Gender	0.0665424	0.2087608	0.3187	0.74998
Village	0.0847649	0.2028401	0.4179	0.67603
EducHigh	0.0304957	0.2898959	0.1052	0.91622
Gardener	0.5931164	0.2170453	2.7327	0.00628
AgAdapt	0.7494088	0.2151993	3.4824	0.00049
Bid:	-0.0049148	0.0003437	-14.2998	< 2.2e-1

Number of Obs.: 396 Distribution: logistic
Log-likelihood: -509.960223

The variable “AgAdapt” was also found to be significant (at the 1% level) and had a positive coefficient in the South Moravian sample. The variable “Gardener” was also found to be significant at the 1% level, and had a large positive coefficient of 0.59, indicating a strong positive influence on the willingness of the respondent to pay the bid amount they received. Last, the “Age” variable was not found to be significant in the South Moravian sub-sample.

5.2.3 Aggregate WTP results for “general crop” conservation

Estimates of aggregate WTP for general crop conservation for the Czech Republic and South Moravia were calculated using the mean WTP figures per person for each of the sub-samples: 167 Kč ($6.80) for the Czech representative sub-sample and 213 Kč ($8.65) for the South Moravian sub-sample. These figures were multiplied by estimates of the population of ages 18-69 (since the survey specifically targeted respondents within this age range) obtained from the Český statistický úřad (the Czech Statistical Office) website (www.czso.cz). We obtained populations of just below 7.5 million and just over 1 million individuals for this age range in the Czech Republic and South Moravia, respectively.

Using the population estimates obtained, we calculate an aggregate WTP of **~1.25 billion Kč (~$50.5 million)** for general crop conservation in the Czech Republic and **~176 million Kč (~$7.15 million)** for general crop conservation in South Morava.

5.3 Specific crop conservation DC experiment results

The “specific crop conservation” experiment used a discrete choice design, allowing the data to be analyzed using multinomial logit models, which allow for more than two choice outcomes. We analyze the data using both a conditional logit model (which analyzes the choice among alternatives as a function of the characteristics of the alternatives, in this case cost and the type and number of crop varieties conserved) and a generalized logit model (which analyzes the choice among alternatives as a function of the characteristics of the respondents, such as education or income). The results of the conditional logit regressions for the Czech representative and South Moravian sub-samples (Models 7 and 8) are presented in

Table 5.3.1 Conditional logit results (Models 7 and 8) for Czech representative and S. Moravian samples

Model 7: Conditional logit results, Czech representative sample

	Coefficient	*Std. Error*	*t-value*	*Pr(>|t|)*
ASChops	-0.4878	0.0645	-7.56	<.0001***
ASCfruit	0.2018	0.0646	3.12	0.0018 ***
ASCwine	-0.3893	0.0641	-6.07	<.0001***
COST	-0.00363	0.00033	-10.95	<.0001***

	Coefficient	*Std. Error*	*t-value*	*Pr(>|t|)*
HOPS	-0.01494569	0.00256447	-5.8280	5.61e-09 ***
FRUIT	0.01603491	0.00215482	7.4414	9.97e-14 ***
WINE	-0.01006852	0.00249489	-4.0357	5.445e-05***
COST:	-0.00432461	0.00025939	-16.6719	< 2e-16 ***

No. of ID: 752
No. of obs.: 3008
Log-likelihood: -3931.8

Model 8: Conditional logit results, S. Moravia sample

	Coefficient	*Std. Error*	*t-value*	*Pr(>|t|)*
ASChops	-0.5662	0.0893	-6.34	<.0001*
ASCfruit	0.4098	0.0836	4.9	<.0001*
ASCwine	-0.141	0.0811	-1.74	0.082*
COST	-0.003167	0.00042	-7.56	<.0001*

	Coefficient	*Std. Error*	*t-value*	*Pr(>|t|)*
HOPS	-0.02322621	0.00357035	-6.5053	7.75e-11
FRUIT	0.02017263	0.00290365	6.9473	3.72e-12
WINE	-0.00560351	0.00307757	-1.8208	0.0686*
COST:	-0.00319812	0.00033369	-9.5840	< 2.2e-1

No. of ID: 427
No. of obs.: 1708
Log-likelihood: -2261.7

Table 5.3.1, while the results of the generalized logit regressions (Models 9 and 10) are presented in Table 5.3.2.

5.3.1 Results of conditional logit regression

The conditional logit analysis resulted in a positive mean WTP for conserving fruit tree varieties but negative WTPs for conserving hop and wine varieties for both the Czech representative and South Moravian samples. All variables were found to be significant. The coefficients for the variables "HOPS," "FRUIT," and "WINE" give the impact that the number of varieties of a given crop that are included in a choice have on the probability that the respondent chooses a given conservation program. The coefficients for the variables "ASChops," "ASCfruit," and "ASCwine" show the impact that the type of crop conserved has on the probability that the respondent chooses a given conservation program, regardless of the number of varieties included.

We can again use the following equation, this time to calculate the mean WTP to conserve addition fruit tree varieties in general, and the marginal mean WTP to conserve one additional fruit tree variety, where α represents the coefficients on "ASCfruit" and "FRUIT," respectively, and β is the coefficient on "cost" in these regression results.

$$\frac{-\alpha}{\beta}$$

Using this equation, we obtain a mean WTP for the Czech representative subsample for conserving an additional fruit tree variety for ten years of **3.70 kč ($0.15),** and for general fruit tree conservation of **55.58 kč ($2.26)** and a mean WTP for the South Moravia subsample for conserving an additional fruit tree variety for ten years of **6.28 kč ($0.26)** and for general fruit tree conservation of **129.40 kč ($5.26).**

5.3.2 Results of generalized logit regression

The choice data from the specific crop conservation experiment were also analyzed using a generalized logit model (which analyzes the choice among alternatives as a

Table 5.3.2 Generalized logit results (Model 9) for Czech representative sample

Model 9: Generalized logit results, Czech representative sample

	Coefficient	*Std. Error*	*t-value*	*Pr(>|t|)*
ASCwine	-0.5774	0.1049	-5.51	<.0001***
ASChops	-0.4918	0.1039	-4.73	<.0001***
ASCfruit	0.0803	0.0941	0.85	0.3935
Wmale	-0.013	0.005218	-2.48	0.013**
Hmale	0.000454	0.005617	0.08	0.9356
Fmale	-0.005789	0.004218	-1.37	0.17
Wage	-0.000467	0.000136	-3.44	0.0006***
Hage	-0.000463	0.000141	-3.29	0.001***
Fage	-0.000311	0.000108	-2.87	0.0041***
Wedulow	0.007532	0.005187	1.45	0.1465
Hedulow	0.0137	0.005349	2.56	0.0106***
Fedulow	0.004569	0.004209	1.09	0.2777
Wvillage	0.001192	0.005285	0.23	0.8216
Hvillage	-0.005936	0.005452	-1.09	0.2762
Fvillage	0.008262	0.004308	1.92	0.0551*
Wpinc	0.007388	0.002898	2.55	0.0108**
Hpinc	0.004266	0.003278	1.3	0.1931
Fpinc	0.006639	0.002346	2.83	0.0047***
Wpincmiss	-0.007206	0.0165	-0.44	0.6621
Hpincmiss	0.0165	0.0158	1.05	0.294
Fpincmiss	0.000266	0.0123	0.02	0.9827
Wgardener	0.0112	0.005076	2.21	0.027**
Hgardener	0.001289	0.005221	0.25	0.8049
Fgardener	0.0132	0.004078	3.22	0.0013***
Wdrinker	0.0149	0.005421	2.75	0.006***
Hdrinker	0.027	0.005562	4.85	<.0001***
Fdrinker	-0.007211	0.004689	-1.54	0.1241
Wwinelover	0.0177	0.005296	3.34	0.0008***
Hwinelover	-0.008431	0.006534	-1.29	0.1969
Fwinelover	-0.004951	0.004896	-1.01	0.3119
COST	-0.003488	0.00034	-10.25	<.0001***
Wpraha	0.0154	0.007643	2.02	0.0434**
Hpraha	-0.0197	0.0102	-1.94	0.0526*
Fpraha	0.008862	0.006372	1.39	0.1643
Wusti	0.006313	0.0114	0.56	0.5782
Husti	0.033	0.009328	3.54	0.0004***
Fusti	-0.001197	0.009378	-0.13	0.8985
WMorava	0.0243	0.007546	3.23	0.0013***
HMorava	0.007329	0.009377	0.78	0.4345
FMorava	0.00446	0.00654	0.68	0.4952

No. of ID: 752 No. of obs: 3008

Log Likelihood: -3826 LogL(0): -4170

Table 5.3.3 Generalized logit results (Model 10) for the S. Moravian sub-sample

Model 10: Generalized logit results, S. Moravia sample

	Coefficient	*Std. Error*	*t-value*	*Pr(>|t|)*
ASChops	-0.2061	0.1336	-1.54	0.1228
ASCfruit	-0.5456	0.1491	-3.66	0.0003***
ASCwine	0.3358	0.1191	2.82	0.0048**
Wmale	0.006773	0.007008	0.97	0.3338
Hmale	0.0196	0.007859	2.5	0.0124**
Fmale	-0.002272	0.005843	-0.39	0.6974
Wage	-0.000395	0.000165	-2.39	0.0169**
Hage	-0.000535	0.000192	-2.79	0.0053***
Fage	-0.000179	0.000136	-1.31	0.1888
Wedulow	0.0159	0.006272	2.54	0.0112**
Hedulow	0.0223	0.007092	3.15	0.0017***
Fedulow	-0.001785	0.005492	-0.32	0.7452
Wvillage	-0.004944	0.006513	-0.76	0.4477
Hvillage	-0.005965	0.007588	-0.79	0.4318
Fvillage	-0.004345	0.00553	-0.79	0.432
Wpinc	-0.002171	0.003203	-0.68	0.4978
Hpinc	0.001445	0.00358	0.4	0.6865
Fpinc	0.003548	0.002413	1.47	0.1416
Wpincmiss	0.0265	0.0151	1.76	0.0788*
Hpincmiss	0.0000734	0.0207	0	0.9972
Fpincmiss	-0.001664	0.0137	-0.12	0.9035
Wgardener	0.0126	0.006614	1.9	0.0572*
Hgardener	-0.005489	0.007432	-0.74	0.4602
Fgardener	0.0158	0.005864	2.69	0.007***
Wdrinker	0.0125	0.006989	1.79	0.0731*
Hdrinker	0.0191	0.007703	2.48	0.0131**
Fdrinker	-0.004854	0.006216	-0.78	0.4349
Wwinelover	0.0107	0.006956	1.53	0.1253
Hwinelover	0.001565	0.008232	0.19	0.8492
Fwinelover	-0.001539	0.00626	-0.25	0.8059
COST	-0.003124	0.000429	-7.28	<.0001***

No. of ID: 427 No. of obs: 1708

Log Likelihood: -3826 LogL(0): -4170

function of the characteristics of the respondents) and the results of the analysis are presented in Tables 5.3.2 and 5.3.3. For the Czech representative model, we used a number of variables related to the respondents' socioeconomic characteristics, habits, and preferences. These included a dummy variable for the male gender, an age variable, a dummy variable for low education, a dummy variable for living in a village, a variable for personal income (coded in intervals of 10,000 Kč) as well as for "missing income," the same dummy variable for "gardener" as before (someone who produces crops for their own consumption), a dummy variable "drinker" for frequent drinkers (who drink on average more than twice a week), a dummy variable for "winelover" (those who prefer wine over beer or fruit brandies), and dummy variables for respondents coming from Prague, Ústecký kraj, and South Moravia.

The interactions of the selected covariates with the probabilities of choosing the fruit tree, hop, and wine variety conservation programs are shown in Table 5.3.2 for the Czech representative sub-sample. For example, male respondents were shown to select the wine conservation program significantly less frequently than female respondents (as shown by the regression results for "Wmale"). Other socioeconomic characteristics were also shown to have significant interactions with the probabilities of choosing different conservation plans. Age was shown to have a significantly negative effect on choosing to conserve any of the crops. Respondents with low education were shown to choose to conserve hops significantly more frequently, while those from villages were shown to choose to conserve fruit trees significantly more frequently, all else being equal. Higher personal income was shown to be significantly associated with a higher probability of choosing conservation programs for wine and fruit tree varieties. And respondents who declined to share their personal income were not shown to have significantly different preferences for choosing any conservation plan from the general population.

The variables related to the respondents' habits were also shown to have some significant interactions. "Gardeners" were shown to pick wine and fruit tree conservation programs significantly more frequently, while frequent drinkers were shown to select wine and hop conservation programs significantly more frequently.

Last, “wine lovers” were shown to pick wine conservation programs significantly more frequently.

Each of the geographic dummy variables were also shown to have at least one significant interaction each. Respondents from Prague were shown to pick wine conservation programs significantly more frequently than the general population, and hop conservation programs significantly less frequently. Respondents from Ústecký kraj (a major hop-producing region) had significantly higher preferences for hop conservation, and respondents from South Moravia (a major wine-producing region) had significantly higher preferences for wine variety conservation.

The South Moravia sub-sample was analyzed with a similar model included the same variables except for the exclusion of the Prague, Ústecký kraj, and South Moravia dummy variables. The “male” dummy variable had a positive, significant interaction with conserving hops, while “age” had a significant (and negative) interaction with both wine and hops. The low education variable was significant and positive for wine and hops, meaning that those with low education chose to conserve wine and hops significantly more often than the general sample. The “village” and “pincome” variables were not found to be significant in the South Moravian sub-sample; however, the missing income variable was found to be significant and positive for wine.

Last, the variables related to the respondents’ habits were also shown to have some significant interactions for the South Moravian sub-sample. The “gardener” dummy variable was significant and positive for conserving fruit tree and wine varieties, as in the Czech representative sample, and the frequent drinker dummy variable was also found to be positive and significant for wine and hops, as before. The “winelover” variable was not found to have any significant interactions.

5.3.3 Aggregate WTP results for fruit tree conservation

As in section 5.2.3, estimates of aggregate WTP for the conservation of additional fruit tree varieties for the Czech Republic and South Moravia were calculated using the mean WTP figures per person for each of the sub-samples: 56 Kč ($2.26) for the

Czech representative sub-sample and 129 Kč ($5.26) for the South Moravian sub-sample. These figures were multiplied by the same population estimates described above, of just below 7.5 million and just over 1 million individuals for the 18-69 age range in the Czech Republic and South Moravia, respectively (that were obtained from Český statistický úřad).

Using the population estimates obtained, we calculate an aggregate WTP of **~415 million Kč (~$16.8 million)** for fruit tree conservation in the Czech Republic and **~107 million Kč (~$4.4 million)** for fruit tree conservation in South Moravia.

5.4 Relevance of results for original hypotheses

In this section, I relate the results of both experiments to my three original hypotheses from the thesis proposal.

Hypothesis #1: The economic value of crop diversity in the Czech Republic is significant (that is, there is unique crop diversity in the Czech Republic that contains valuable traits).

The methodology of the study did not directly address whether there is unique crop diversity in the Czech Republic that contains valuable traits, though this has been shown by studies of the diversity of traditional fruit tree landraces present on the Czech territories (Paprštein *et al.* 2003). However, the present work does confirm that crop diversity in the Czech Republic does have significant economic value, by providing an estimate of the value placed by the Czech public on four different components of Czech crop diversity. Based on the Czech representative sample (n=731), we estimate that the Czech population between the ages of 18 and 69 would be willing to pay an approximate ~**415 million Kč ($16.8 million**) for the collection and conservation over ten years of currently unconserved fruit tree varieties. In addition, we also estimate (based on the analysis of the survey results for the Czech representative sample) that the Czech public (for ages 18 to 69) would be willing to pay an approximate **~1.25 billion Kč ($50.5 million)** to collect and conserve "general" crop varieties that are not currently conserved for ten years. Through their answers, the respondents demonstrated the value of Czech crop diversity by showing a willingness to pay to conserve, for example, a unique Czech variety of fruit tree with valuable traits, such as resistance to pests and disease, hardiness, taste, etc.

Hypothesis #2: The operations of the Czech gene bank are socially beneficial: in other words, the economic benefits of the gene bank's operations outweigh its costs.

While the way the choice experiments were worded make the results better suited to estimating the social benefits of a new program to conserve crop diversity, the results (mean WTP estimates for the conservation of varieties of fruit trees and general crop diversity for 10 years) do provide us with figures that can be used to give us a rough sense of the order of magnitude of social benefits flowing from the conservation services provided by the Czech National Programme on Conservation of Plant Genetic Resources. We estimated an aggregate WTP of the Czech population (ages 18-69) for 10 years of general crop conservation of **~1.25 billion Kč ($50.5 million).** We can compare this with the current annual costs of the Czech National Programme for the Conservation of Plant Genetic Resources, which are about **36 million Kč ($1.46 million) per year** (*pers. comm., V. Holubec*). Over a ten year period, these annual costs amount to about 360 million Kč ($14.6 million), more than **three times less** than the estimate of aggregate WTP for general crop conservation over a ten year period calculated using the survey data. These results support the hypothesis that the operations of the Czech genebank system are socially beneficial, since it was shown that the Czech public are willing to pay more than three times more than they currently do in taxes to support the conservation of crop diversity.

Hypothesis #3: The Czech public, farmers, and breeding companies place a value on the country's crop diversity that can be measured.

This study confirmed the part of this hypothesis related to the Czech public by demonstrating that Czech citizens place a measurable value on the country's crop diversity (it was decided to focus on the Czech public instead of Czech farmers and breeding companies). We found that the general Czech population (ages 18-69) would be willing to pay on average **56 Kč ($2.30)** for the conservation of fruit tree varieties, and **167 Kč ($6.80)** for the conservation of general crop diversity. In aggregate, this translates to a total willingness to pay for the Czech public (ages 18-69) for fruit tree conservation over 10 years of **~410 million Kč ($16.8 million),** and of **~1.25 billion Kč ($50.5 million)** for the conservation of general crop diversity.

Chapter 6

Discussion

6.1 Overview

This section of the thesis discusses the results of the survey, as well as potential biases associated with the data collected for this study and the econometric approaches used to analyze the data.

6.2 Use of single-bounded vs. double-bounded dichotomous choice models for data analysis

We report the mean WTP figures for general crop conservation resulting from the double-bounded dichotomous choice model analysis, since this model has been shown to use more information and be more statistically efficient than the single-bounded approach (Hanemann *et al.* 1991). However, some biases have been identified with the double-bounded approach. Chief among these is the so-called "shift effect" whereby respondents are found to be more likely to answer "no" to the follow-up question if they answered "yes" to the initial question. In one case, the reason this effect can take place has been qualitatively confirmed through interviews with the respondents, who described the feeling of "being cheated" after they had first agreed to a more favorable bid (Krishna *et al.* 2013).

In spite of this potential source of bias, we opt to report the DBDC results since they allow the use of more information. Furthermore, for both the Czech representative and South Moravian samples the mean WTP calculated using the DBDC model was lower than that calculated using the SBDC model (the mean WTP for conserving "general crop diversity" for the Czech representative population was calculated as being 167 Kč using the DBDC method and 321 Kč using the SBDC). Thus, the mean WTP estimates calculated using the DBDC model represent more conservative figures, and reporting them instead of the SBDC estimates helps to ensure that the social welfare benefits of crop conservation are not overstated by the study.

6.3 Comparability of results between the general and specific crop diversity experiments

In this section, I discuss the comparability of the results of the general crop diversity experiment – analyzed with contingent valuation methods (specifically double-bounded dichotomous choice) – and those of the specific crop diversity experiment, which used a discrete choice experimental set-up, and was analyzed with a multinomial logit model.

Carson and Czajkowski (2012) report that different elicitation formats used in stated preference studies systematically yield different estimates of WTP. While seemingly problematic, these differences and divergences have been predicted by neoclassical theory and are consistent with the assumption that respondents act as standard rational maximizing economic agents (Carson and Groves 2007).

This finding means that the estimates of mean WTP for fruit tree and "general," unspecified crop diversity are not directly comparable, since the underlying data were collected using different frameworks and the figures are calculated using different econometric models.

The choice was made to use different elicitation formats in order to investigate the preferences of the Czech public for the conservation of hop, fruit tree, and wine varieties together, to answer the question of what *specific* crops Czechs care about conserving the most, and then to answer the broader question of how much Czechs care about conserving crops in general. This led to the decision to use the discrete choice experiment approach for the three specific crop types, in order to examine preferences *between* the three, and the double-bounded dichotomous choice approach to elicit WTP for crop conservation in general.

While this choice means that we cannot directly compare the estimates of mean WTP for fruit trees and unspecified crop diversity, we can more generally compare the estimates. We derived a mean WTP for the conservation of general crops of 167 Kč ($6.80), almost three times greater than the mean WTP derived for the conservation of fruit trees of 56 Kč ($2.30). Based on this comparison, we can conclude that it is likely that Czechs have a higher WTP for conserving crop diversity in general than paying just to conserve a specific component of crop diversity (in this case fruit trees).

6.4 Negative WTP for hop and wine conservation

Contrary to our expectation, we obtained negative WTP values for the conservation of hop and wine varieties as a result of the conditional logit analysis of the specific crop diversity experiment. Intuitively, this finding seems unlikely, as it suggests that on average Czechs would be willing to pay so that hop and wine varieties are *not* conserved. More evidence that this result should not be taken at face value is that many respondents selected the hop and wine conservation options, demonstrating a positive WTP in these cases.

A possible explanation is that the status quo and fruit tree conservation options were selected so much more frequently that the presence of hop or wine conservation on a choice card seemed to lower the probability that the card would be chosen. Because each choice card only contained one crop to be conserved, other than the status quo (respondents were asked to choose between the status quo and hop, wine, and fruit tree options), this may have led to the negative coefficients for the variables “ASChops,” “ASCwine,” “HOPS,” and “WINE.”

Future work to identify more realistic WTP estimates for hop and wine conservation in the Czech Republic might remove the fruit tree component of the choice experiment (since this crop type was shown to be greatly preferred to hops and wine) and also lower the bid amounts.

6.5 Insights from protests and comments

The general comments from the respondents and the reasons given for why bids were refused gave insight into the reasoning of the respondents. There were many positive comments stating that the questionnaire was interesting and that the cause was worthy, however the comments also revealed reasons why respondents were not willing to contribute.

Some respondents cited that the bids were too high, that they were "důchodce" (on pension), or that the payment did not fit into their budget. Others responded that they did not trust the information.

Two of the main reasons stated for why respondents refused to pay were that 1) conservation of crop diversity was the state's responsibility, or 2) that the respondent distrusted the state (or other managing entity) to handle the money and implement the conservation program. This can be seen in the following quotes from the comments received:

1. "Je to věc státu" (it is a matter of the state).
2. "Znovu opakuji že dokud bude v České republice panovat tento zlodějský systém, nedám na nic podobného ani halíř" (I repeat that as long as the Czech Republic is ruled by the theft system, I will not give even a penny);

   "Nikde není potvrzeno že bude peněz použito na tento program a nedojde k rozkradení peněz tak jak to v České republice je pravidlem" (Nowhere is confirmed that the money will be used for this program and not stolen as is the rule in the Czech Republic).

These comments provide valuable insight into how a future questionnaire might be phrased differently to lower the proportion of protests, for example by providing more information on how the program would be run (e.g., as a private non-profit with oversight from a well-respected international consulting firm) to cut down on the percentage of respondents who distrust that their funds would be used properly for crop conservation.

6.6 Potential biases associated with the survey implementation

In this sub-section, I discuss potential biases that may have arisen as a result of the how the survey was implemented.

The data used in this research were collected with the Computer-Assisted Self Interviewing (CASI) method, using an online survey instrument. Other data collection methods for stated preference work include face-to-face interviews, telephone interviews, mail surveys, and written, hard-copy questionnaires. CASI was selected because of its lower cost (enabling a higher sample size), higher efficiency, and improvement of the response rate. In addition, computerized methods of data collection have been shown to have a positive effect on data quality. There are fewer interviewer and respondent errors, since a computerized questionnaire can disallow certain types of mistakes, and it has also been shown that respondents are often less inhibited in a computer-assisted self-interview, since their answers are completely anonymous (Hox & Snijkers 1995). Another benefit was that the data could be automatically entered into a database.

The online survey method used for data collection in this study does however have some potential biases. First, it reaches only those who have access to a computer and the internet. This screens out a whole group of people. Second, it also selects for individuals who elect to participate in the online survey panels used by the market research firm selected for this study. In spite of these potential biases, CASI was deemed to be the best approach for data collection for this study.

6.7 Potential biases associated with the use of stated preference methods

In this section, I discuss some of the potential biases associated with the use of stated preference methods in general, and relate them specifically to this thesis.

Some of the main potential sources of bias in stated preference studies include the following, as described by Tietenberg (2012):

1. Strategic bias – occurs as a result of the respondent stating values that are lower or higher than his or her real WTP for strategic reasons.
2. Information bias – occurs when survey respondents have little experience or knowledge of the goods or services included in the questionnaire.
3. Starting-point bias – occurs when the first bid value influences how respondents respond to the bids that follow.
4. Hypothetical bias – arises when the respondent is asked to pay for goods or services that do not currently exist, and can lead the respondent to overstate their WTP.
5. Discrepancy between WTP and WTA results – Studies have shown that WTA figures for the loss of a given good or service are consistently higher than WTP for the gain of the same good or service.

While these biases may have affected the estimates reported in this survey, steps were taken to mitigate them. Information was provided to try to lessen the impact of information bias by educating the respondents about crop diversity. Strategic bias may also have affected the results; however, a review of comments revealed that many of the respondents took the survey seriously and took their budget constraint into account when making the decision. Last, while hypothetical bias may have had an effect, most Czechs have at least some experience with fruit trees and the other crop varieties included in the survey, and thus are likely to have not been overly affected by this source of bias.

Furthermore, while there has been criticism of stated preference methods (Hausman 1993), a NOAA panel convened by the U.S. government and co-chaired by Nobel Laureates Kenneth Arrow and Robert Solow concluded that the general approach is valid for estimating the value of environmental goods and services, and that "CVM studies can produce estimates reliable enough to be the starting point of a judicial or administrative determination of natural resource damages, including lost passive values" (Carson and Czajkowski 2012; Arrow *et al.* 1993).

Chapter 7

Conclusion

Crop diversity, or plant genetic resources for food and agriculture (PGRFA), is valuable both for efforts to breed new, improved crops and through direct use by farmers and consumers. However, the industrialization of agriculture and the development of improved, modern crop varieties has led to the loss of many traditional and less profitable varieties. Public genebanks such as the Crop Research Institute in Prague have taken up the work of conserving the substantial number of extant crop varieties for the public's benefit. However, research into the economic valuation of crop diversity is limited, particularly in the Czech Republic. Without robust estimates of how the Czech public values the conservation of crop diversity, it is harder to decide the appropriate costs of these activities.

This study for the first time uses stated preference methods to demonstrate the value of four types of crop diversity to the Czech public: hops, fruit and wine varieties and "general" crop diversity. We derive a mean WTP for Czech individuals between the ages of 18 and 69 of **56 Kč ($2.30)** for fruit tree conservation and **167 Kč ($6.80)** for the conservation of general Czech crop diversity. Positive mean WTP values were not found for the conservation of hop or wine varieties.

This research demonstrates that the Czech public places a measurable value on the country's crop diversity, and also identifies important sociodemographic, attitudinal and habit-related factors determining those with the highest WTP for crop conservation. We found that respondents from South Moravia were generally willing to pay more for the conservation of both general crops and fruit tree varieties. In addition, respondents who agreed that it was important to make investments to help adapt the Czech agriculture sector to climate change were significantly more likely to agree to pay to conserve general Czech crop diversity.

In addition, our results also permit the rough comparison of the social benefits and costs of the Czech National Programme for the Conservation of Plant Genetic Resources. We estimated an aggregate WTP of the Czech population (ages 18-69) for 10 years of general crop conservation of **~1.25 billion Kč ($50.5 million).** This estimate of the benefits of crop diversity conservation can be compared with the costs of the Programme over a ten year period of 360 million Kč ($14.6 million). This result supports the hypothesis that the operations of the Czech genebank system are socially beneficial, since it shows that **the Czech public are willing to pay more than three times more than they currently do in taxes to support the conservation of crop diversity in the country.**

Future work might focus on several areas. First, improved estimates of the value the Czech public place on the work of the Czech National Programme for the Conservation of Plant Genetic Resources could be approximated by re-formulating the WTP questions to a hypothetical situation where public funding was no longer available for the program due to budget requests, and the survey took the form of a request to the public from the current Programme staff for voluntary public funding. This would provide a more accurate estimate of how the public values the program then the more general approximation reported in this thesis. Second, a follow-up survey could be designed to derive estimates of mean WTP for conserving hop and wine varieties, by lowering the bids and eliminating the “fruit tree conservation” option.

Perhaps of greatest policy relevance is the finding of the Czech public’s large willingness to pay for the conservation of fruit tree varieties of **~410 million Kč ($16.8 million).** The Czech Republic is the birthplace of many fruit cultivars and many of these are at risk due to the continuing destruction of old plantations and country lanes (Paprštein *et al.* 2010). The results of this study indicate that the public would strongly support an aggressive campaign to identify and conserve native fruit tree varieties that are currently unconserved. Beyond their use in family gardens, these fruit tree varieties could contribute to the Czech economy through use by small distilleries, makers of jams and preserves, or cider companies such as F. H. Prager, which prides itself on using "staré, lokální odrůdy" (old, local varieties) of apples to achieve a unique, Czech taste.

Bibliography

Alston, J.M., Chan-Kang, C., Marra, M.C., Pardey, P.G. & Wyatt, T.J. 2000. A meta-analysis of rates of return to agricultural R&D: ex pede herculem? IFPRI Research Report No 113. Washington DC, International Food Policy Research Institute.

Arrow, K.R.; Solow, R.; Portney, P.R.; Learner, E.E.; Radner, R.; Schuman, H. 1993. Report of the NOAA panel on contingent valuation. *Federal Register* 58:4601-4614.

Asfaw, S. & Lipper, L. 2011. Economics of PGRFA management for adaptation to climate change: a review of selected literature. Background Study Paper No. 60 for the Commission on Genetic Resources for Food and Agriculture. Rome, FAO.

Bateman, I.A., Carson, R.T., Day, B., Hanemann, M., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., Özdemiroglu, E., Pearce, D.W., Sugden, R., Swanson, J., 2002. Economic Valuation with Stated Preference Techniques: A Manual. Edward Elgar, Cheltenham, UK.

Battisti, D.S., Naylor, R.L., 2009. Historical Warnings of Future Food Insecurity with Unprecedented Seasonal Heat. Science 323, 240-244.

Birol, E.; Kontoleon, A.; Smale, M. 2006. Combining Revealed and Stated Preference Methods to Assess the Private Value of Agrobiodiversity in Hungarian Home Gardens. EPT Discussion Paper 156. Washington, D.C.

Birol, E.; Smale, M.; Gyovai, A. 2006. Using a Choice Experiment to Estimate Farmers' Valuation of Agrobiodiversity on Hungarian Small Farms. *Environmental & Resource Economics* 34:439-469.

Birol, E.; Villalba, E.R.; Smale, M. 2007. Farmer Preferences for *Milpa* Diversity and Genetically Modified Maize in Mexico. IFPRI Discussion Paper 00726. Washington, D.C.

Bliemer, M.C.J. & Collins, A.T. 2016. On determining priors for the generation of efficient stated choice experimental designs. *Journal of Choice Modelling,* available online 6 April 2016, doi:10.1016/j.jocm.2016.03.001.

Brennan J.P. & Malabayabas, A. 2011. International Rice Research Institute's contribution to rice varietal yield improvement in South-East Asia. ACIAR Impact Assessment Series Report No. 74. Canberra, Australian Centre for International Agricultural Research. 111 pp.

Brown, G.M. 1990. Valuing genetic resources. G.H. Orians, G. M. Brown, W. E Kunin & J.E. Swierzbinski, eds. Preservation and valuation of biological resources. University of Washington Press, Seattle, pp. 203-226.

Carson, R., and Czajkowski, M. 2012. The Discrete Choice Experiment Approach to Environmental Contingent Valuation. Centre for the Study of Choice (CenSoC) Working Paper Series, No. 12-003.

Carson, R.T., and T. Groves. 2007. Incentive and informational properties of preference questions. *Environmental and Resource Economics* 37:181-210.

Carson, R.T., and J.J. Louviere. 2011. A Common Nomenclature for Stated Preference Elicitation Approaches. *Environmental and Resource Economics* 49:539-559.

Dotlačil, L.; Zedek, V.; Papoušková, L.; Faberová, I.; Holubec, V. 2013. *20 Years of the National Programme on Conservation and Utilization of Plant Genetic Resources and Agrobiodiversity.* Published by the Ministry of Agriculture of the Czech Republic. Prague, Czech Republic.

Evenson, R.E.; Gollin, D. 1997. "Genetic Resources, International Organizations, and Improvement in Rice Varieties." *Economic Development and Cultural Change* 45 (3): 471–500.

Evenson, R.E.; Gollin, D. 2003. *Crop Variety Improvement and Its Effect on Productivity: The Impact of International Agricultural Research.* Wallingford, Oxon, UK: CABI.

Food and Agriculture Organization of the United Nations. 1997. *The State of the World's Plant Genetic Resources for Food and Agriculture*. Rome, Italy.

Food and Agriculture Organization of the United Nations. 2004. *Country Report on the State of Plant Genetic Resources for Food and Agriculture – Czech Republic*. Compiled by Ladislav Dotlacil, Iva Faberova, and Zdenek Stehno; Research Institute of Crop Production, Praha-Ruzyne.

Food and Agriculture Organization of the United Nations. 2010. *The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture*. Rome, Italy.

FAO, IFAD and WFP. 2015. *The State of Food Insecurity in the World 2015. Meeting the 2015 international hunger targets: taking stock of uneven progress.* Rome, FAO.

Garming, H., Roux, N., Van den Houwe, I. 2010. The Impact of the Musa International Transit Centre. Bioversity International.

Godfray, H.C.J., et al., 2010. Food Security: The Challenge of Feeding 9 Billion People. Science 327, 812-818.

Gollin, D. And Evenson, R.E. 1998. An Application of Hedonic Pricing Methods to Value Rice Genetic Resources in India. In *Agricultural Values of Plant Genetic Resources*, by Robert E. Evenson, Douglas Gollin, and V. Santaniello, 139-50. Wallingford, UK: CABI.

Haab, T.C., and McConnell, K.E. 2002. Parametric Models for Contingent Valuation. In *Valuing Environmental and Natural Resources – The Econometrics of Non-Market Valuation.* Edward Elgar Publishing, Inc., Northampton, Massachusetts, U.S.

Hanemann, M.; Loomis, J.; Kanninen, B. 1991. Statistical efficiency of double-bounded dichotomous choice contingent valuation. *American Journal of Agricultural Economics* 73(4):1255-1263.

Hausman, J.A. (ed.). 1993. *Contingent Valuation: A Critical Assessment.* Amsterdam: North-Holland.

Hein, L., and Gatzweiler, F. 2006. The Economic Value of Coffee (Coffea Arabica) Genetic Resources. *Ecological Economics* 60(1): 176-85.

Hoffman, S.D.; Duncan, G.J. 1988. Multinomial and Conditional Logit Discrete-Choice Models in Demography. *Demography*, 25(3):415-427.

Hunter, D.; Heywood, V. 2011. Crop Wild Relatives: A Manual of *In Situ* Conservation, 1st ed. Earthscan, London.

Iltis, H. H. 1988. Serendipity in the exploration of biodiversity. What good are weedy tomatoes? Pages 98-105 in E. O. Wilson (ed.), Biodiversity, National Academy Press, Washington, D.C.

Johnson, N.L.; Pachico, D.; Voysest, O. 2003. The distribution of benefits from public international germplasm banks: the case of beans in Latin America. *Agricultural Economics* 29:277-286.

Koo, B.; Smale, M. Economic Costs of Genebank Operation. In: JMM Engels, L Visser, Eds. *A guide to effective management of germplasm collections*. IPGRI Handbooks for Genebanks No. 6. Rome, Italy. 172.

Krishna, V.V.; Drucker, A.G.; Pascual, U.; Raghu, P.T.; King, E.D.I.O. 2013. Estimating compensation payments for on-farm conservation of agricultural biodiversity in developing countries. *Ecological Economics* 87:110-123.

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

Leeuw, E.D.D.; Hox, J.J; Snijkers, G. 1995. The effect of computer-assisted interviewing on data quality. A review. *Journal of the Market Research Society* 37(4):325-344.

Lobell, D.B. et al., 2008. Prioritizing Climate Change Adaptation Needs for Food Security in 2030. Science 319, 607-610.

Marasas, C.N.; Smale, M.; Singh, R.P. 2004. *The Economic Impact in Developing Countries of Leaf Rust Resistance Breeding in CIMMYT-Related Spring Bread Wheat.* Economics Program Paper 04-01. Mexico, D.F.: CIMMYT.

Moeller, N. I.; Stannard, C. 2013. *Identifying Benefit Flows: Studies on the Potential Monetary and Non-Monetary Benefits Arising from the International Treaty on Plant Genetic Resources for Food and Agriculture.* Food and Agriculture Organization of the United Nations. Rome, Italy.

Nelson, G.C.; Rosegrant, M.W.; et al., *The Costs of Agricultural Adaptation to Climate Change*, Development and Climate Change series, Discussion Paper Number 4. World Bank: Washington, DC. August 2010.

NRC (National Research Council) (1991) Managing Global Genetic Resources: The US National Plant Germplasm System. National Academy Press, Washington, DC.

OTA (Office of Technology Assessment). 1987. *Technologies to Maintain Biologicla Diversity*. USA. Government Printing Office, Washington D.C.

Paprštein, F.; Sedlák, J; Holubec, V. 2010. *In situ* Conservation of Fruit Landraces. *Czech J. Genet. Plant Breed.* 46:S57-S59.

Peng, S., Khush, G.S. Four Decades of Breeding for Varietal Improvement of Lowland Rice in the International Rice Research Institute. *Plant Prod. Sci.* **6**, 157-164 (2003).

Pimentel, D., Wilson, C., McCullum, C., Huang, R., Dwen, P., Flack, J., Tran, Q., Saltman, T., Cliff, B., 1997. Economic and environmental benefits of biodiversity. BioScience 47 (11), 747–757.

Poudel, D.; Johnsen, F.H. 2009. Valuation of crop genetic resources in Kaski, Nepal: Farmers' willingness to pay for rice landraces conservation. *Journal of Environmental Management* 90:483-491.

Prescott-Allen, C., Prescott-Allen, R., 1986. The First Resource: Wild Species in the North American Economy.

PricewaterhouseCoopers LLP (PwC). 2013. Crop wild relatives: A valuable resource for crop development. Accessed on August 11, 2013 at http://www.pwc.co.uk/sustainability-climate-change/publications/understanding-the-value-of-seeds.jhtml.

Rocchi, L.; Paolotti, L.; Cortina, C.; Boggia, A. 2016. Conservation of landrace: the key role of the value for agrobiodiversity conservation. An application on ancient tomatoes varieties. *Agriculture and Agricultural Science Procedia* 8:307-316,

Sardaro, R.; Girone, S.; Acciani, C.; Bozzo, F.; Petrontino, A.; Fucilli, V. 2016. Agro-biodiversity of Mediterranean crops: farmers' preferences in support of a conservation program for olive landraces. *Biological Conservation* 201:210-219.

Sutton, W.R.; Srivastava, J.P.; Neumann, J.E. 2013. *Looking Beyond the Horizon: How Climate Change Impacts and Adaptation Responses Will Reshape Agriculture in Eastern Europe and Central Asia.* World Bank: Washington DC.

Tietenberg, T., Lewis, L. (2012). Environmental & Natural Resource Economics: 9th Edition. Pearson Education, Inc.

United Nations. 2013. World Population Prospects – The 2012 Revision. New York.

Von Braun, J.; Tadesse, G. 2012. Global Food Price Volatility and Spikes: An Overview of Costs, Causes and Solutions. ZEF – Discussion Papers on Development Policy No. 161, Center for Development Research, Bonn, January 2012, pp. 42.

Witt, Stephen C. 1985. Biotechnology and Genetic Diversity. California Lands Project, San Francisco, California.

World Bank. 2015. Agriculture, value added (% of GDP). Accessed at http://data.worldbank.org/indicator/NV.AGR.TOTL.ZS/countries.

Xepapadeas, A., Ralli, P., Kougea, E., Spyrou, S., Stavropoulos, N., Tsiaousi, V., Tsivelikas, A. 2014. Valuing Insurance Services Emerging from a Gene Bank: The Case of the Greek Gene Bank. *Ecological Economics* 97: 140-49.

Zohrabian, A., Traxler, G., Caudill, S., Smale, M. 2003. Valuing Pre-Commercial Genetic Resources: A Maximum Entropy Approach. *American Journal of Agricultural Economics* 85(2): 429-36.

Annex I – Questionnaire

Úvod a souhlas

Děkujeme Vám za účast na tomto dotazníkovém průzkumu, který se zabývá zachováním rozmanitosti českých plodin. Doufáme, že bude pro Vás tento dotazník zajímavý.

Rádi bychom Vás ujistili, že s veškerými informacemi získanými v tomto dotazníku bude zaházeno důvěrně a anonymně, podle aktuálních právních předpisů. Veškeré informace budou použity **pouze pro výzkumné a nikoliv komerční účely.**

V tomto dotazníku nejsou žádné správné či špatné odpovědi. Zajímáme se pouze o Váš názor.

Tento dotazník je součástí výzkumného projektu Univerzity Karlovy v Praze a je dotován vnitřním grantem od Grantové agentury Univerzity Karlovy (GAUK).

Toto je dobrovolný dotazník

Účast na tomto průzkumu je naprosto dobrovolná. Zavřením Vašeho prohlížeče můžete dotazník kdykoliv ukončit. V případě, že dotazník nedokončíte, Vaše odpovědi nebudou použity. Za předčasné ukončení dotazníku nebudete nijak penalizován(a). Účast na tomto průzkumu s sebou nenese žádné riziko a Vaše odpovědi zůstanou zcela důvěrné a anonymní.

Váš souhlas s účastí

Pokud se rozhodnete vyplnit tento dotazník, souhlasíte s následujícím:

- Přečetl(a) jsem si úvod.
- Byl(a) jsem informován(a) o tom, že tento dotazník je dobrovolný.
- Dobrovolně souhlasím s účastí na tomto průzkumu.

SEKCE 0: Základní přehledové otázky

Jako první bychom Vám rádi položili pár otázek týkajících se Vaší osoby. Upozorňujeme, že tyto informace jsou zcela důvěrné a nebudou nikde zveřejňovány.

1. **Ve kterém kraji trvale žijete?**

[1] Hlavní město Praha
[2] Středočeský kraj
[3] Jihočeský kraj
[4] Plzeňský kraj
[5] Karlovarský kraj
[6] Ústecký kraj
[7] Liberecký kraj

[8] Královéhradecký kraj
[9] Pardubický kraj
[10] Olomoucký kraj
[11] Moravskoslezský kraj
[12] Jihomoravský kraj
[13) Zlínský kraj
[14] Kraj Vysočina kraj

2. **Jaké je Vaše pohlaví?**

[A] Muž
[B] Žena

3. **Jaký je rok Vašeho narození?**

4. Jaké je Vaše nejvyšší ukončené vzdělání?

[1]Neúplné základní a bez vzdělání.
[2]Základní.
[3]Vyučen(a) bez maturity.
[4]Střední odborné bez maturity.
[5]Vyučen(a) s maturitou.
[6]Střední odborné s maturitou (SŠ) a konzervatoře.
[7]Střední všeobecné s maturitou (gymnázium).
[8]Vyšší odborné (VOŠ - DiS., pomaturitním specializační studium).
[9]Vysokoškolské bakalářské.
[10]Vysokoškolské magisterské, inženýrské.
[11]Postgraduální vzdělání (Ph.D., CSc., Th.D., apod.).

5. Jaká je velikost obce či města, ve kterém žijete?

[1] Do 199 obyvatel
[2] 200 až 499 obyvatel
[3] 500 až 999 obyvatel
[4] 1 000 až 1 999 obyvatel

[5] 2 000 až 4 999 obyvatel
[6] 5 000 až 9 999 obyvatel
[7] 10 000 až 19 999 obyvatel
[8] 20 000 až 49 999 obyvatel
[9] 50 000 až 99 999 obyvatel
[10] 100 000 až 999 999 obyvatel
[11] 1 milion nebo více obyvatel

SECTION A. UŽÍVANÍ PLODIN

A1. Maté zahradu?

[1] Ano, v místě mého trvalého bydliště
[2] Ano, na chatě/chalupě
[3] Ano, v rámci společné zahrady
[4] Ano, v jiném slova smyslu
[5] Ne

A2. Pěstujete zeleninu, ovoce, vinnou révu, nebo jiné plodiny pro svou vlastní spotřebu?

[1] Ano
[2] Ne

A3. Pracujete v zemědělském sektoru?
[1] Ano
[2] Ne

A4. Jste zemědělec, sadař nebo vinař?

[1] Ano
[2] Ne

If answer yes, provide space to write name of crop(s) produced. **Jaké plodiny pěstujete? _**

A4a. Pracujete v chmelařství/vlastníte chmelnici?

[1] Ano, pracuji v chmelařství/na chmelnici
[2] Ano, vlastním chmelnici
[3] Ne, nepracuji ani nevlastním chmelařství/chmelnici

A4b. Pracujete na vinici/vlastníte vinařství?

[1] Ano, pracuji ve vinařství/na vinici
[2] Ano, vlastním vinici
[3] Ne, nepracuji ani nevlastním vinici/vinařství

A5. Pracujete v odvětví přímo závislém na zemědělském sektoru, například restauraci, pivovaru, baru atd?

[1] Ano
[2] Ne

A6. Pracujete v pivovaru?

[1] Ano
[2] Ne

A7. Pracoval(a) jste v rámci České republiky někdy (i v minulosti) na sklizni chmele?

[1] Ano
[2] Ne

A8. Pokud byste měl(a) možnost vybrat si mezi různými produkty z různých zemí, do jaké míry byste preferoval(a) české produkty – myslí se tím, že české pivo by bylo vyrobeno z chmele vypěstovaného v České republice; české víno by bylo vyrobeno z hroznů vypěstovaných v České republice atd.

Prosím, vyberte vždy jednu z následujících možností od 1 do 7 (1 =”vždy bych si vybral(a) výrobek z ciziny, 7 = “vždy bych preferoval(a) český výrobek”)

	Vždy bych si vybral(a) výrobek z ciziny	České výrobky i výrobky z ciziny jsou stejné kvality	Vždy bych si vybral(a) český výrobek	Nekupuji/nekonzumuji (např. víno nebo pivo)
	1	2	3	4
Pivo	□	□	□	□
Červené víno	□	□	□	□
Bílé víno	□	□	□	□
Ovoce jako jsou třešně a jablka	□	□	□	□
Sýr	□	□	□	□

A9. Byl(a) jste někdy na farmářském trhu? Pokud ano, jak často tam chodíte nakupovat?

[1] Nikdy jsem nebyl(a) na farmářském trhu
[2] Jednou ročně
[3] Jednou měsíčně
[4] Dvakrát měsíčně
[4] Jednou nebo vícekrát týdně

SEKCE B
Co znamená rozmanitost plodin a proč je důležitá?

Pojem rozmanitost plodin lze jednoduše vysvětlit tak, že jedna plodina může mít mnoho odrůd, které se navzájem mohou významným způsobem lišit a mohou mít unikátní charakteristiky.

Například, obrázek níže zobrazuje jednu odrůdu fazolí. (zdroj: Global Crop Diversity Trust Flickr).

Naopak následující obrázek vyobrazuje mnoho odrůd fazolí. (zdroj: Global Crop Diversity Trust Flickr):

Rozmanitost plodin má ekonomickou hodnotu a je nezbytná pro zajištění dostatku potravy. Je hodnotná především z těchto dvou důvodů:

- Genetická rozmanitost obsažená v odrůdách různých plodin je cenná pro vyšlechtění **nových, vylepšených odrůd plodin**, které jsou více **výnosné a odolné**.
- Různé odrůdy plodin také poskytují užitek a představují **hodnotu pro zemědělce**, kteří je pěstují, a také těm, kteří je poté **konzumují nebo dále využívají**.

Rozmanitost plodin je uchovávána v tzv. **genových bankách**, což jsou místa, kde se uchovávají a upravují semena, hlízy a vzorky nejrůznějších druhů plodin.

V České republice je rozmanitost plodin zachovávána veřejně financovaným Národním programem konzervace a využívání genetických zdrojů rostlin významných pro výživu a zemědělství.

ORDER=1 then the order is: B1a - B1b – B2 - C

ORDER=2 then the order is: B2 – B1a – B1b - C

If ORDER=1

ČÁST B1: VOLBA MEZI RŮZNÝMI DRUHY VÍNA, CHMELU A OVOCNÝMI STROMY

If ORDER=2

ČÁST B2: VOLBA MEZI RŮZNÝMI DRUHY VÍNA, CHMELU A OVOCNÝMI STROMY

Tato část dotazníku se zabývá rozmanitostí tří českých druhů plodin: odrůdami chmelu, ovocných stromů a vinné révy. Tyto druhy plodin jsou v současné době uchovávány ve třech institucích již zmíněného Národního programu a jsou volně zdarma dostupné veřejnosti pro pěstitelské, výzkumné a vzdělávací účely.

Rádi bychom se dozvěděli, zda jste ochoten(na) přispět **dobrovolný, jednorázový příspěvek** do veřejného fondu, který by **30 let financoval sbírání a uchovávání** určitého počtu českých odrůd chmelu, ovocných stromů nebo vinné révy, které v **současné chvíli nejsou uchovávány**. Díky tomuto fondu by mělo být zajištěno, že jednotlivé druhy plodin nebudou ztraceny a budou i nadále k dispozici nejen farmářům a konzumentům ale také šlechtitelům plodin, kteří pracují na vytváření vylepšených odrůd plodin.

V případě, že se rozhodnete souhlasit s příspěvkem, tak daný program bude financován a některé odrůdy plodin budou sesbírány a uchovány. Týká se to samozřejmě těch odrůd plodin, které do současné chvíle nebyly sesbírány a uchovány.

V případě, že se rozhodnete nesouhlasit s příspěvkem, tak tyto odrůdy nebudou sesbírány a existuje riziko, že budou nenávratně ztraceny.

Někteří lidé nejsou ochotni přispět na sběr a uchovávání jakýchkoliv odrůd plodin a mohou mít pro to různé důvody. Pokud si i Vy nepřejete přispět, prosím zaškrtněte políčko “Současný stav“ (což znamená „žádný příspěvek“).

Pokud se však rozhodnete přispět, berte v úvahu i Vaše **současné finanční možnosti**, a že budete mít o to méně na nákup jídla, oblečení atp.

Prosím, důkladně zvažte, jakou částku byste byl(a) ochoten(na) opravdu přispět s přihlédnutím na Váš současný rozpočet.

If ORDER=2

Také zkuste v průběhu vyplňování dotazníku zapomenout na to, jak jste odpovídal(a) v předešlé části a představte si, že jste nic nepřispěl(a) do fondu Národního programu.

END IF

Budeme se Vás ptát celkově **čtyřikrát**, a vždy zvolte tu odpověď, která bude nejblíže Vašemu osobnímu názoru. O otázkách uvažujte nezávisle. K již vyplněným se nevracejte.

ONLY USE THIS IF B2 CAME BEFORE. IF ORDER=1

Při odpovídání neberte v potaz částku, kterou jste chtěl (a) přispět v předchozích otázkách.

Níže se prosím podívejte na příklad výběrové karty.

Máte možnost výběru mezi současným stavem (tj. “žádný příspěvek”) a třemi programy pro uchovávání různých plodin (vinná réva, chmel, ovocné stromy). U každého programu jsou uchovávány různé počty odrůd plodin a to za jinou cenu.

Například při příspěvku 100 Kč bude zachováno 100 nových odrůd vinné révy (první možnost), nebo 80 odrůd chmele při příspěvku 500 Kč (druhá možnost) nebo 30 odrůd ovocných stromů za 300 Kč (třetí možnost).

Měl(a) byste si vybrat možnost, která je nejblíže Vašemu názoru. Mějte stále na paměti, že příspěvek pro daný program byste v budoucnu již nemohl(a) použít na nákup jídla, oblečení atp.

VÝBĚROVÁ KARTA

Plodina	**Vinná réva**	**Chmel**	**Ovocné stromy**	**Současný stav**
Počet dalších odrůd, které budou uchovány	15 odrůd	35 odrůd	35 odrůd	Žádná nová odrůda
Jednorázová platba	100 Kč	250 Kč	300 Kč	0 Kč

Jakou možnost preferujete?	☐	☐	☐	☐

B1 Jsou Vám informace uvedené na výběrové kartě srozumitelné?

Číslo 7 znamená, že informacím zcela rozumíte, naopak, číslo 1 znamená, že informacím vůbec nerozumíte.

Informacím Informace jsou vůbec nerozumím zcela srozumitelné						
1	2	3	4	5	6	7
□	□	□	□	□	□	□

VOLBA 1

VOLBA 2

VOLBA 3

VOLBA 4

FILTR. KDYŽ alespoň jednou zvolen „současný stav“:

B2. Alespoň jednou jste zvolil/a „současný stav“. Můžete prosím uvést proč?

Prosím vyberte nejdůležitější důvod.

rotate responses, but 5 always the last one

[1] Programy jsou příliš nákladné a/nebo moje výdaje jsou již nyní příliš vysoké

[2] Nedůvěřuji zde poskytnutým informacím.

[3] Nemyslím si, že je potřeba uvedený program pro zachování odrůd plodin.

[4] Volba byla příliš obtížná.

[5] Jiné

a. Prosím upřesněte..........................

Preference uchování nespecifikovaných druhů plodin

If ORDER=2

Teď když jste vyplnil(a) hlavní část průzkumu, prosíme Vás, abyste zapomněl(a) na své předchozí odpovědi. **Představte si situaci, kdy jste u předchozích otázek neposkytl(a) žádnou platbu ani závazek do fondu pro uchovávání plodin.**

END IF

Následující část se týká rozmanitosti plodin v ČR, přičemž pod českými rodovými odrůdami budeme chápat jak ovocné stromy, chmel, vinnou révu, tak pšenici, olejniny (např. řepku a slunečnici), luštěniny (např. čočku), cizrnu, brambory, obilniny (např. ječmen), ovoce a spoustu jiných plodin, které jsou uchovávané v rámci Národního programu.

Zvažte prosím důkladně, jakou částku byste byl(a) ochoten(na) opravdu zaplatit s přihlédnutím na Váš současný rozpočet.

D1. Byl(a) byste ochoten(na) přispět **BIDD** Kč do veřejného fondu na **sběr a uchování** dalších **QUANTITYD** druhů **českých plodin** po dobu **následujících 30 let**? Tyto nově uchované odrůdy ještě nebyly nikde uchovány. Pokud nepřispějete, riskujete nenávratnou ztrátu těchto plodin.

1 Ano

0 Ne

IF D1=Yes

D2 Jestliže byste byl(a) ochoten(a) zaplatit předešlou částku, můžeme se Vás zeptat, zda-li byste byl(a) ochoten(na) zaplatit (BIDD*2) Kč k dosažení stejného cíle, tj. za sběr a uchovávání **QUANTITYD** druhů **českých plodin** po dobu **následujících 30 let**?

1 Ano

0 Ne

IF D1=No

D2 Jestliže byste nebyl(a) ochoten(a) zaplatit předešlou částku, byl(a) byste ochoten(na) zaplatit (BIDD/2) Kč k dosažení stejného cíle, tj. za sběr a uchovávání **QUANTITYD** druhů **českých plodin** po dobu **následujících 30 let**?

1 Ano

0 Ne

FILTR. KDYŽ alespoň jednou zvolen „Ne“:

D3 Alespoň jednou jste zvolil/a „Ne“. Můžete prosím uvést proč?

Prosím vyberte nejdůležitější důvod.

rotate responses, but 5 always the last one

[1] Tento program je příliš nákladný a/nebo moje výdaje jsou již nyní příliš vysoké

[2] Nedůvěřuji zde poskytnutým informacím.

[3] Nemyslím si, že je potřeba tento nový program.

[4] Volba byla příliš obtížná.

[5] Jiné

a. Prosím upřesněte..........................

SEKCE D. Postojové a preferenční otázky

D1. Jste abstinent?

[1] Ano
[2] Ne
[3] Nechci odpovědět

D2. Jak často pijete jakékoliv alkoholické nápoje (může být i jeden), včetně piva a vína?

[1] Jednou měsíčně nebo méně
[2] Dvakrát až čtyřikrát měsíčně
[3] Dvakrát až třikrát týdně
[4] Čtyřikrát a vícekrát týdně

D3. Preferujete pivo, víno nebo likéry vyrobené z ovoce jakou jsou slivovice nebo hruškovice?

[1] Preferuji pivo.
[2] Preferuji víno.
[3] Preferuji likéry vyrobené z ovoce jako je slivovice.
[4] Mám rád(a) všechny stejně.
[5] Nepiji ani jeden z uvedených alkoholických nápojů.

D4. Slyšel(a) jste někdy o klimatických změnách?

[1] Ano
[2] Ne

D5. Prosím, řekněte nám, co všechno víte o klimatických změnách (často nazývaných také jako globální oteplování), příčiny a důsledky klimatických změn, přizpůsobování se klimatickým změnám atp.

Prosím, označte v následující tabulce, co si myslíte (1 = máte pocit, že nevíte o tomto tématu vůbec nic, 7 = máte pocit, že víte o daném tématu mnoho)

	Nic nevím						Vím mnoho
D5a...příčiny klimatických změn?	1	2	3	4	5	6	7
D5b...přizpůsobení se klimatickým změnám?	1	2	3	4	5	6	7

D5c... potenciální důsledky klimatických změn?	1 2 3 4 5 6 7
D5d... potenciální důsledky klimatických změn na zemědělství?	1 2 3 4 5 6 7

D6. Které z následujících výroků podle Vás nejvíce vystihuje klimatické změny (globální oteplování)?

Mnoho vědců se domnívá, že klimatické změny…

[1] …se objevují a jsou nejvíce způsobeny aktivitami lidí.

[2] … se objevují, ale nejsou hlavním důsledkem aktivitou lidí.

[6]... se objevují, ale je nejasné, zda jsou hlavním důsledkem aktivity lidí.

[3] …se neobjevují.

2nd block

[4] Je zde hodně neshod mezi vědci, zda se vůbec změna klimatu děje.

3rd block

[5] Nevím, co k tomu říci.

[7] Jiné.

[qE6_more] Prosím vypište, specifikujte.................

D7. Prosím označte, do jaké míry Vy osobně souhlasíte nebo nesouhlasíte s následujícími výroky.

		Vůbec nesouhlasím			Neutrální názor			Zcela souhlasím	Nevím souhlasím
D7a	Zemské klima se mění.	1	2	3	4	5	6	7	88
D7b	Český zemědělský sektor je ovlivněn klimatickými změnami, při nejmenším některými negativními vlivy.	1	2	3	4	5	6	7	88
D7c	Je možné, že klimatické změny mohou mít v budoucnu negativní vliv na české zemědělství.	1	2	3	4	5	6	7	88
D7d	Je důležité, aby byla přijata opatření na pomoc českému zemědělství přizpůsobit se klimatickým změnám.	1	2	3	4	5	6	7	88
D7e	Klimatické změny jsou zapříčiněny lidskou aktivitou (jako je například spalování fosilních paliv – uhlí, ropa).	1	2	3	4	5	6	7	88
D7f	Současné klimatické změny jsou důsledkem přírodních procesů a nejsou důsledkem lidské aktivity.	1	2	3	4	5	6	7	88

SEKCE E. Informace o respondentovi

E1. Jaké je PSČ Vašeho trvalého bydliště?

E2. Jaký je Váš rodinný stav?

[1] Ženatý/Vdaná

[2] Odloučený (á) od partnera (legálně stále ženatý/vdaná)
[3] Rozvedený (á)
[4] Ovdovělý (á)
[5] Svobodný (á)
[6] Jiný

E3. Kolik dětí máte?

[1] 0
[2] 1
[3] 2
[4] … *(should be 0 to 9 and then vice)*

E4. Jste v současné době zaměstnán/a?

Prosím vyberte ze seznamu situaci v zaměstnání, která pro Vás platí (možno vybrat více možností).

[100] Placené zaměstnaní
- [1] 30 a více hodin týdně
- [2] méně než 30 hodin týdně
- [3] OSVČ

[200] Bez placeného zaměstnání
- [5] v důchodu
- [6] žena/muž v domácnosti
- [6b] žena/muž na rodičovské dovolené
- [8] student
- [9] nezaměstnaný/á
- [10] invalidní

[11] Jiný

E5. Jaký je Váš celkový osobní měsíční čistý příjem ze všech zdrojů po odečtení daní a odvodů?

Chtěli bychom Vám připomenout, že všechny informace, které nám sdělíte, zůstanou přísně důvěrné. (Prosíme, zahrňte všechny zdroje příjmů, jako např. rodičovské dávky a další státní podpory, výnosy a další příjmy…)

[0] Bez příjmu
[1] Méně než 7 500 Kč
[2] 7 500 až 9 500 Kč
[3] 9 501 až 11 500 Kč
[4] 11 501 až 13 500 Kč
[5] 13 501 až 15 500 Kč
[6] 15 501 až 18 500 Kč
[7] 18 501 až 22 000 Kč
[8] 22 001 až 27 000 Kč
[9] 27 001 až 35 000 Kč
[10] 35 001 až 40 000 Kč
[11] 40 001 až 50 000 Kč
[12] Více než 50 000 Kč
[888] Nechci odpovídat.

E5A. Je pro nás opravdu důležité, abychom znali příjem každého respondenta. Díky tomu budeme moci ověřit, zda je náš vzorek průzkumu reprezentativní. Mohl(a) byste nám sdělit více obecně, jaký je Váš osobní čistý měsíční příjem. Zjištěné informace jsou důvěrné a anonymní.

Bez příjmu	0
Méně než 15 000 Kč	1
15,000 Kč – 22,000 Kč	2
22,000 Kč – 30,000 Kč	3
30,000 Kč – 40,000 Kč	4
Více než 40 000 Kč	6
Nechci odpovídat.	999

E6. Jaký je celkový čistý měsíční příjem Vaší domácnosti ze všech zdrojů po odečtení daní a odvodů?

(Prosíme, zahrňte všechny zdroje příjmů, jako např. rodičovské dávky a další státní podpory, výnosy a další příjmy…)

[1] Méně než 11 000 Kč
[2] 11 000 až 15 000 Kč
[3] 15 001 až 19 000 Kč
[4] 19 001 až 22 000 Kč
[5] 22 001 až 25 000 Kč
[6] 25 001 až 28 000 Kč
[7] 28 001 až 32 000 Kč
[8] 32 001 až 36 000 Kč
[9] 36 001 až 40 000 Kč
[10] 40 001 až 50 000 Kč
[11] více než 50 000 Kč
[888] Nevím.
[999] Nechci odpovídat.

Toto je konec dotazníku. Velice Vám děkujeme za Vaše odpovědi a čas strávený vyplňováním.

V případě jakýchkoliv dotazů nás můžete kontaktovat na email: ntyack@gmail.com nebo napsat jakýkoliv komentář.

Annex II Experimental Design

Choice situation	alt1.wine	alt1.cost	alt2.hops	alt2.cost	alt3.fruit	alt3.cost	Block
1	35	50	15	50	25	200	1
2	15	100	15	50	25	120	1
3	10	100	15	50	25	120	1
4	10	100	5	150	35	80	1
5	25	250	25	25	10	50	2
6	5	50	5	150	5	300	2
7	15	25	10	50	10	300	2
8	10	100	5	150	35	120	2
9	15	250	15	250	5	80	3
10	15	25	15	150	10	300	3
11	25	250	25	50	10	50	3
12	10	250	10	250	5	200	3
13	25	100	35	250	15	50	4
14	25	25	15	50	15	200	4
15	35	200	35	25	10	80	4
16	35	25	35	50	25	300	4
17	5	200	5	150	35	50	5
18	5	100	10	100	35	80	5
19	25	250	25	250	10	50	5
20	25	50	10	100	25	120	5
21	10	250	5	150	5	300	6
22	10	25	15	250	5	200	6
23	25	25	25	50	15	50	6
24	15	50	35	250	15	50	6
25	5	250	10	250	5	300	7
26	35	250	35	25	10	80	7
27	10	250	5	150	5	200	7
28	35	25	35	50	25	200	7
29	35	200	35	25	15	50	8
30	5	200	5	150	35	120	8
31	5	200	10	100	35	120	8
32	10	250	10	150	5	200	8
33	25	25	25	25	15	200	9
34	15	250	15	25	10	300	9
35	35	200	35	25	15	80	9

36	25	200	25	25	10	50	9
37	15	50	25	25	15	300	10
38	15	250	15	250	5	120	10
39	35	50	35	50	25	200	10
40	15	50	15	100	25	120	10
41	15	50	25	250	10	80	11
42	15	200	15	25	10	300	11
43	5	200	5	100	35	80	11
44	10	100	25	50	25	120	11
45	5	100	5	100	35	120	12
46	5	100	5	150	35	120	12
47	10	100	10	100	35	120	12
48	25	25	35	250	15	80	12
49	25	25	25	100	15	50	13
50	15	50	15	150	10	300	13
51	5	100	10	100	35	120	13
52	35	50	35	50	25	300	13
53	15	50	10	50	10	300	14
54	5	200	10	250	5	300	14
55	5	200	10	100	35	80	14
56	25	25	25	100	15	200	14
57	15	50	10	100	25	120	15
58	10	200	5	150	5	200	15
59	25	25	25	50	15	200	15
60	5	200	5	150	35	80	15
61	15	50	25	250	10	50	16
62	25	25	35	250	15	50	16
63	25	25	25	25	15	50	16
64	25	25	25	25	15	80	16
65	35	50	35	25	10	80	17
66	5	100	5	150	35	80	17
67	10	100	10	150	35	120	17
68	5	200	10	250	5	200	17
69	35	250	35	25	15	80	18
70	25	250	25	25	10	80	18
71	15	250	15	250	5	50	18
72	35	25	35	25	25	300	18
73	35	25	15	50	25	200	19
74	5	200	5	100	35	50	19

75	35	25	25	50	25	200	19
76	35	100	35	25	10	50	19
77	10	250	10	250	5	300	20
78	35	50	15	100	25	200	20
79	5	250	5	250	5	300	20
80	10	100	5	100	35	80	20
81	25	25	25	150	15	200	21
82	35	50	25	50	25	200	21
83	35	100	35	25	10	80	21
84	35	50	35	25	25	300	21
85	5	100	5	100	35	80	22
86	10	100	10	100	25	120	22
87	15	200	15	100	10	200	22
88	5	250	5	150	5	300	22
89	15	50	15	50	25	120	23
90	10	100	10	50	35	120	23
91	25	50	35	250	15	50	23
92	10	200	10	250	5	300	23
93	25	25	25	50	15	80	24
94	10	50	15	100	25	120	24
95	5	200	5	150	5	300	24
96	10	200	15	250	5	50	24
97	35	250	35	25	15	50	25
98	15	250	10	150	5	50	25
99	10	100	5	100	35	120	25
100	15	200	15	150	10	200	25

Annex III – General Crop Experiment Simple Models

Model 1b: SBDC, simple model, Czech representative sample

	Coefficient	*Std. Error*	*z*	*Pr(>|z|)*	
Intercept:	0.5942599	0.1326424	4.480	<0.00001	***
Bid:	-0.0031125	0.0005065	-6.146	<0.00001	***

Number of Obs.: 731
Log-likelihood: -485.7198
Distribution: logistic
Adjusted pseudo-R^2: 0.0360

Model 3b: DBDC, simple model, Czech representative sample

	Coefficient	*Std. Error*	*z*	*Pr(>|z|)*
Intercept:	0.9513821	0.0062230	11.00	<0.00001***
Bid:	-0.0059930	0.0002970	-20.17	<0.00001***

Ω

Number of Obs.: 731
Log-likelihood: -989.593355
Distribution: logistic

Model 2b: SBDC, simple model, S. Moravia sample

	Coefficient	*Std. Error*	*z*	*Pr(>|z|)*	
Intercept:	0.5417633	0.1702459	3.182	0.01461	***
Bid:	-0.0024294	0.0006608	-3.676	0.000237	***

Number of Obs.: 418
Log-likelihood: -282.6642
Distribution: logistic
Adjusted pseudo-R^2: 0.0174

Model 4b: DBDC, simple model, S. Moravia sample

	Coefficient	*Std. Error*	*z*	*Pr(>|z|)*	
Intercept:	0.8270372	0.1091466	7.577	<0.00001	***
Bid:	-0.0047016	0.0003211	-14.652	<0.00001	***

Number of Obs.: 418 Distribution: logistic
Log-likelihood: -558.717996