A PRELIMINARY SOCIAL AND BIOLOGICAL IMPACT ASSESSMENT FOR THE BIOLOGICAL CONTROL OF CHESTNUT BLIGHT IN AZERBAIJAN

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By

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ABSTRACT

The presence of chestnut blight, *Cryphonectria parasitica*, was first reported in Azerbaijan in 2008 by the Azerbaijan State Institute of Botany in cooperation with Iowa State University. By 2010, the fungus was present in all of the country's chestnut growing territory. In the region, blight poses a threat to the genetic resources of the European chestnut, *Castanea* sativa, as the Caucus countries of Azerbaijan, Armenia and Georgia along with Eastern Turkey are located within the center of origin and highest genetic diversity for the species. Additionally blight threatens the food sovereignty of chestnut producing communities as diminishing harvests strip away rural viability for these highland inhabitants, many of whom are ethnic minorities. Possible agronomic and policy responses include 'no response,' species and variety replacement, as well as plant breeding to introduce blight resistance to the Caucus chestnut varieties. However, a thorough consideration of community priorities, available resources and international interests in plant genetic resources and food sovereignty leaves the implementation of biological control as the most highly recommended response. Based on the results of twenty-two household interviews conducted in two chestnut cultivating communities in 2010, and on a review of pertinent literature, this work represents a preliminary social and biological impact assessment for the implementation of biological control of chestnut blight using the technique of applied hypovirulence.

BIOGRAPHICAL SKETCH

Jeffrey Robert Wall Junior was born in Denver, Colorado and grew up in Irving, Texas, the eldest of four boys. He completed his undergraduate education in Anthropology and Geology at the College of Charleston in South Carolina between 2000 and 2004, whereafter he moved to Cairo, Egypt and taught English composition and history to fifth and sixth grade Egyptian children. Jeffrey was employed for several years in the organic vegetable farming sector in upstate Pennsylvania and the Southern Tier of New York State where he worked as a cultural facilitator and translator for Egyptian field crew at Norwich Meadows Organic Farm and helped to establish the Ant Hill Organic Farm in Honesdale, Pennsylvania. He completed Peace Corps Service in Azerbaijan between 2009 and 2011 in fulfillment of a Master of Professional Studies in International Agriculture and Rural Development at Cornell University.

DEDICATION

Dear Ben Andrew,
I leave you in the mornings but leave my heart behind for you to sleep next to.
Dear Shira,
you are my heart.

ACKNOWLEDGEMENTS

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INTRODUCTION

As the Greek traveler Xenophon documented, chestnut was an important food for the people of the Caucasus as long ago as the fourth century B.C. In fact, the tree and its use spread from this region around the Black Sea and eventually to mainland Europe. The center of highest genetic diversity for European chestnut, *Castanea sativa*, is found in the Caucuses and Eastern Turkey, a fact which highlights the importance of this population as a genetic resource for current and future breeding challenges. In Azerbaijan, the onset of chestnut blight, the fungus *Cryphonectria parasitica*, is a threat to this genetic diversity and to the livelihoods and agro-ecosystems of numerous chestnut cultivating communities.

The presence of chestnut blight was first identified in Azerbaijan in 2008 by the Azerbaijan State Institute of Botany in cooperation with Iowa State University. By 2010, the pathogen had spread throughout the entirety of the national chestnut growing territory, a contiguous cultivated forest area covering more than four thousand square kilometers of the lower Caucus Mountains. Cultivation, harvest and sale of chestnuts is the primary agricultural activity of numerous communities in the north-west of Azerbaijan. For these growers and collectors, chestnut sales make up the largest contribution to their income portfolio after employment-based income.

The need for the current impact assessment has grown out of the efforts of chestnut growing communities to solicit a response from governmental and/or international agencies to the problem of chestnut blight in Azerbaijan. In the early stages of community engagement, over a period of one year, a series of community meetings in five villages were organized in order to identify strategies to respond to the chestnut blight. These meetings produced a remarkable consensus. Villagers agreed that: first, chestnut cultivation should remain the primary land use strategy in their territory; and second, the unique and favored local chestnut varieties must remain viable. Further, research participants identified priorities for participating organizations and research personnel: any action should focus on developing one, attention (*diqqət*) and two, a cure (*dərmon*). There continues to be a need for attention as Azerbaijan's governmental institutions have yet to develop any response to the chestnut blight. To date, despite efforts by the Azerbaijan State Institute of Botany as well as the Food and Agricultural Organization of the United Nations, there has been no acknowledgement of the presence of chestnut blight from the relevant governmental organizations in Azerbaijan.

The objective of an impact assessment is to methodically evaluate all possible responses to an indentified problem including the possibility of doing nothing. Put simply, it is the process of "identifying future consequences of a proposed action." (IAIA 2013) This impact assessment will demonstrate how the results of community based research including focus groups and twenty- two in-depth household interviews support the application of hypovirulence as the most promising first-step towards addressing this problem. Chapter one will explore the potential of biological control efforts to conserve the valuable genetic resources of the European chestnut in its center of diversity. Chapter two will explore the human dimension of plant genetic resource conservation through the frame of food sovereignty. Appendix one will take the form of the official impact assessment, a document designed for translation into Azerbaijani and for delivery to key personnel within the Ministry of Agriculture, Ministry of Ecology and Natural Resources and the State Phytosanitary Control Service.

To date, there has been no effort in Azerbaijan, Georgia, Armenia, or Daghestan to control the spread of blight. In Turkey, minor trials have demonstrated the efficacy of applying hypovirulence. This was performed in central Turkey, not in the east where genetic diversity has been demonstrated to be highest for the species (Mattioni 2010). Research in Georgia and in Turkey has demonstrated the suitability of biological control measures in those countries by isolation and characterization of local *C. parasitica* populations (Celiker and. Onogur 2009). Nowhere have on-farm trials of significant scale been arranged to demonstrate the efficacy of hypovirulence application as a biological control in the center of diversity for European chestnut. This lack of precedence makes it advisable to formulate a social and biological impact statement in advance of implementing such a trial in Azerbaijan.

History of Chestnut Blight and the Discovery of Hypovirulence

The origins of the chestnut blight, *Cryphonectria parasitica*, are in East Asia. There, unlike the United States and Europe, the local chestnut trees were effectively immune to the ascomycete fungus. Asian chestnut as well as several oak species can host this fungus without suffering a deterioration of health, consequently they can act as carriers in situations when they are transplanted (Adamcicova et al. 2010). Susceptible trees , such as European and American chestnut, exhibit a rapid decline in health beginning with the deterioration of the inner cambium which eventually forms open ruptures in the outer bark known as cankers. From the canker the fungal network girdles the trunk, interrupting transfer of nutrients resulting in defoliation and deterioration of upper limbs. This, in turn, immediately diminishes nut production and more often than not leads to the death of the tree above the root zone, as the roots are spared the effects of *C. parasitica* infection.

In the early twentieth century, chestnut varieties from East Asia were imported into the United States. Growers and researchers were experimenting with these exotic breeds, planting and grafting them to local stock. Hailed then as a "valuable acquisition," (Sterling 1903) such imports are today known to have led to the introduction of *C. parasitica* to the United States. In Europe, the first reports of *C. parasitica* on European chestnut, *Castanea sativa*, came from the area around Genova, Italy in 1938. Blight spread in all directions in a constantly pressing frontier and continues to do so. Today it is present in nearly all eastern and western European countries where chestnut is grown as well as in Greece and Turkey (Robin and Heiniger 2001). In Azerbaijan, blight was first observed in 2005 and its presence was announced through a publication in 2008 (Aghayeva and Harrington 2008).

In Europe, where the native species of chestnut is the moderately resistant *Castanea sativa*, the blight epidemic unfolded differently. Initial damage to chestnut crops in the infected areas was severe. In Ticino, Italy, between 1957 and 1959 the proportion of blighted trees rose from 14% to 65% (Heineger and Rigling 1994).
By 1964, however, a new and hopeful phenomenon was discovered and analyzed in Como, in the north of Italy. There, trees which had previously been infected and which were declining in health were observed to be in recovery. Disease samples from these trees were taken and under analysis were found to be remarkably less virulent, a phenomenon known as hypovirulence (Heineger and Rigling 1994). This phenomenon had occurred naturally and attempts were made to understand it in the hopes that the

process could be utilized in blight control. Hypovirulence in chestnut blight has since become the most well known case of a fungal-virus interaction pattern. Strictly speaking, the fungus becomes infected with a naturally occurring virus, the spread of which within the fungal population diminishes its overall virulence against the host tree population. (Milgroom and Cortesi 2004).

Almost since its discovery, hypovirulence has been utilized by scientists and growers as a biological control of *C. parasitica*. By introducing non-infected *C. parasitica* strains to infected strains in the lab, a virulent native fungus can be converted to hypovirulence. These cultures can be applied infected trees at the canker. The likelihood successfully infecting *C. parasitica* with a hypovirus is a function of the intra-specific biological diversity of the local *C. parasitica* population. In Azerbaijan, this has been evaluated through collection and characterization of *C. parasitica* samples (Wall 2012).

The Significance of Chestnut in Azerbaijan

The Caucus nations of Armenia, Georgia, and Azerbaijan all reserve a significant role for the chestnut in their cuisine. Contemporary Azerbaijanis commemorate most special occasions such as weddings and funerals with a stewed chestnut and meat pilaf. The general public acknowledges the fine quality and uniqueness of local chestnut in stark contrast to their feelings about imported chestnuts from China and Turkey, which are considered vastly inferior. Nationwide there is clear knowledge that a disease has diminished harvests, as price per kilo has risen more than 400% in the last decade (Wall 2012). Moreover, European chestnut, *Castanea sativa*, is native to Eastern Turkey and to the Caucuses, situating Azerbaijan near the center of genetic diversity for this widespread and valuable crop (Mattioni 2010).

The continuation of chestnut cultivation is a matter of rural viability for the communities where it is grown. Currently the advances of blight threaten this viability. The highland locations suitable to chestnut are not suitable for many other crops due to the dramatic topography, cooler average temperatures, and rocky soils. For growers, the cultivation of chestnut is by far the largest feature of their income portfolio after employment-based income. Based on the results of questionnaires conducted in two villages, chestnut sales provide 39% of annual income, and 73% of agricultural income (Wall 2012).

Institutional Context for Conservation and Intervention in Azerbaijan

Environmentally, Azerbaijan's forests are just beginning to recover in the wake of a century of deforestation. Central Asia as a whole has recovered great areas of forest since the Soviet economic collapse after 1990 (FAO 2011). Forest resources of Azerbaijan have undoubtedly regenerated. However, overgrazing and unregulated forestry have led to half of the country's total land area being classified as "eroded." (UNDP 1999)

Today, there is arguably a great deal of public awareness for environmental issues in Azerbaijan. A case in point is the Presidential Declaration of 2010 as the "Year of Ecology in Azerbaijan." Television, radio, and news publications have created awareness of climate change as a global phenomenon. Even so, amongst Azerbaijanis, ecology was a major concern of only 7.7% of respondents of a nationwide survey conducted in 2009 (Freidrich et al. 2009). Azerbaijan's forests figure prominently in the national environmental discussion. As stated clearly in the National Environmental Action Plan (NEAP), it is the stated goal of the State Committee on Ecology to "Increase the area occupied by forests." (NEAP 1998) Tree planting was a focus of the president's declared Year of Ecology with 14,400 acres being planted in trees in the first half of 2010. An addendum to the NEAP entitled "Strategic Governmental Priorities after 2000" advocates that local government "end illegal logging and reforest 15,500 hectares." There is little to no consensus between ministries as to which logging activities are legal. "It is simpler and cheaper, even including payoffs to police, to cut wood illegally." (Shelton 2003)

To date, there has been no formal acknowledgement by influential public institutions of the arrival and spread of the known chestnut blight *Cryphonectria parasitica*. The formal stance of the Ministry of Ecology and Natural Resources, as expressed in a 2011 press conference, was that there is no chestnut blight in Azerbaijan (Elshan Nur, personal communication). This conflicts with the ongoing research and outreach of the Azerbaijan State Institute of Botany in Baku, who isolated and identified the blight in 2008, coined the term, *şabalıd xərçəngi* (chestnut cancer), and have produced information pamphlets on the subject for tree owners and forestry personnel. Additionally, television media has produced several news segments on the shrinking supply and subsequent rising prices of chestnuts, though these have not reported on the fungal pathogen (Kanal On Üç program manager Mike Raybourne personal communication). By producing the present impact assessment, the objective is to alert decision-making offices in Azerbaijan, to evoke a formal acknowledgement of the presence of chestnut blight and to trigger the empowerment of key working institutions in the country for the implementation of biological control trials in the country.

Chapters one and two have been produced for publication in peer-reviewed journals Appendix A has been produced as an impact assessment for translation into Azerbaijani and delivery to key personnel in the Ministry of Agriculture and the State Phytosanitary Control Service. It will follow the protocol of an official impact assessment and must also accomplish several essential objectives. First, it must conform to the protocol of official language and rhetoric in Azerbaijan. By doing so, it will ensure the safety of individuals willing to promote it. While neutralizing language will maintain a position of praise for the nation of Azerbaijan and its government, a second objective must be met: the presence of chestnut blight in Azerbaijan must be acknowledged and understood as a challenge for which the public institutions of Azerbaijan is uniquely fit. Finally, these objectives must be accomplished at an appropriate bureaucratic level for the optimal network of ministries and personnel to be activated. It is necessary to target an official level from which it will be possible to leverage all necessary forms of permission and resources.

CHAPTER ONE

Socioeconomic and Biological Feasibility of *In-Situ* Conservation of European Chestnut through Biological Control of Chestnut Blight in Azerbaijan

ABSRACT

The arrival and spread of the chestnut blight in the Caucasus has compromised the livelihoods of chestnut farmers and is causing rapid genetic erosion in the center of diversity for the European chestnut, Castanea sativa. In Azerbaijan, blight was first reported in 2008 and is currently present in all chestnut growing regions. The present work was undertaken to determine the socioeconomic and biological suitability of Azerbaijan for implementation of in-situ conservation of European chestnut using a biological control technique known as applied hypovirulence. It is hypothesized that applied hypovirulence will provide successful biological control due to the likelihood of low genetic diversity of the fungal pathogen in Azerbaijan. The socioeconomic suitability of Azerbaijan's chestnut growing communities for an in-situ conservation effort is supported by the results of in-depth household budget interviews from chestnut growing households which suggest strong local socioeconomic incentive for the continuation of chestnut cultivation.

INTRODUCTION

Agricultural biodiversity or agro-biodiversity is a subset of earth's greater biological diversity and refers to the number and diversity of flora and fauna associated with agricultural ecosystems. This includes crops, domestic animals and their wild relatives, as well as all insects, fungi, and bacteria whether beneficial, neutral or pests (Altieri 1987; Lenné and Wood 2011). Crop diversity is a subset of this category and refers to the inter-specific and intra-specific genetic diversity of human cultivated plant species. The genetic erosion of crop species caused by the steady and persistent disappearance of traditional crop varieties due to human-introduced diseases, climate variability and replacement with ‘elite’ varieties has been considered a threat to world food security for decades (Vavilov 1926; FAO 1973; Harlan 1992). Organized efforts to conserve crop diversity consist of two complementary approaches, *ex situ* and *in situ* (Maxted et al. 1997). *Ex situ* efforts collect and safeguard germplasm off-site in centralized locations such as seed or tissue banks and botanical gardens. These collections are easily accessible to breeders around the world. Germplasm can be obtained quickly and preserved for the foreseeable future. *In situ* programs focus on the maintenance of target crops and their wild relatives in their native agro-ecosystem and/or cropping practice. Conservation of a crop population *in situ* can be accomplished via the establishment of a reserve or alternatively through an intervention, policy, or regulation that ensures continued cultivation by local growers on-farm (Wale 2011). This type of conservation has the advantages of interacting with and reinforcing the community of growers along with their knowledge systems for the continuation of crop diversity, maintaining the biotic community associated with annual crops including pollinators and beneficial mycorrhizae, and guaranteeing the continued adaptation and evolution of the target population to a dynamic state of pest pressure and climate change (Prance 1997).

In situ techniques for crop diversity conservation have been said to be “in their infancy.” (Maxsted 1997:18) Methods, practices, criteria and standards for the implementation of *in situ* conservation face a myriad of complex challenges in dealing with local threats. *In situ* conservation efforts contrast with *ex situ* efforts as they are compelled to fully engage the social context. This context may include farming communities, local entrepreneurs, organizations as well as governments. Reserves modeled on conservation of wild species apply poorly to conserving target species that exist solely in the cropping repertoire of indigenous farmers, and depend on annual human activities such as planting, weeding and harvesting for survival. Furthermore, cultivated tree species require significant space for their maintenance. Thus on-farm or *circa situ* conservation methods exist to maintain crop diversity within their current production systems (Kanowski and Boshier 1997). The stage for *in situ* conservation of the majority of crop genetic diversity in the world is by and large the landscapes, fields and home gardens of the rural poor in developing countries. The socioeconomic reality of specific farming communities can determine the fate of the crop varieties which they decide annually to either grow or abandon, to let stand or to cull. Research to understand contextual decision-making of small farmers in the developing world towards crop diversity lies at the heart of in-situ conservation strategy (Brush 1995; Jarvis 2008; Wale 2011). There is strong consensus that on-farm conservation efforts must work synergistically with local socioeconomic reality to have meaningful long-term impact.

According to the Greek traveler Xenophon, chestnut was a prominent food for the people of the Caucasus as far back as the fourth century B.C. (Xenophon 1889). The tree and its use as food and timber spread from this region around the Black Sea and eventually to central and western Europe. The center of highest genetic diversity for *Castanea sativa* Mill. remains in the Caucasus and Eastern Turkey (Villani 1994; Mattioni 2010). This fact highlights the importance of this population as a genetic resource for current and future European chestnut breeding. The onset of chestnut blight, caused by the fungus *Cryphonectria parasitica,* is a threat to this genetic diversity and to the livelihoods of chestnut cultivating communities.

The origins of the chestnut blight fungus, *Cryphonectria parasitica*, are in East Asia. Its spread in North America and Europe is attributed to the importation of infected timber and nursery stock (Anagnostakis 1987). Susceptible tree species such as the American and European chestnut, *Castanea dentata* and *Castanea sativa*, respectively, exhibit a rapid decline beginning with the deterioration of the inner cambium which eventually forms open ruptures in the outer bark known as cankers. From the canker the fungal network girdles the trunk, interrupting transfer of nutrients resulting in defoliation and death of upper limbs. Since the roots of the tree remain relatively intact under *C. parasitica* infection, the result is a recurrent sprouting stump, the shoots of which grow out for several years but typically die back from blight before maturation (Heiniger and Rigling 1994).

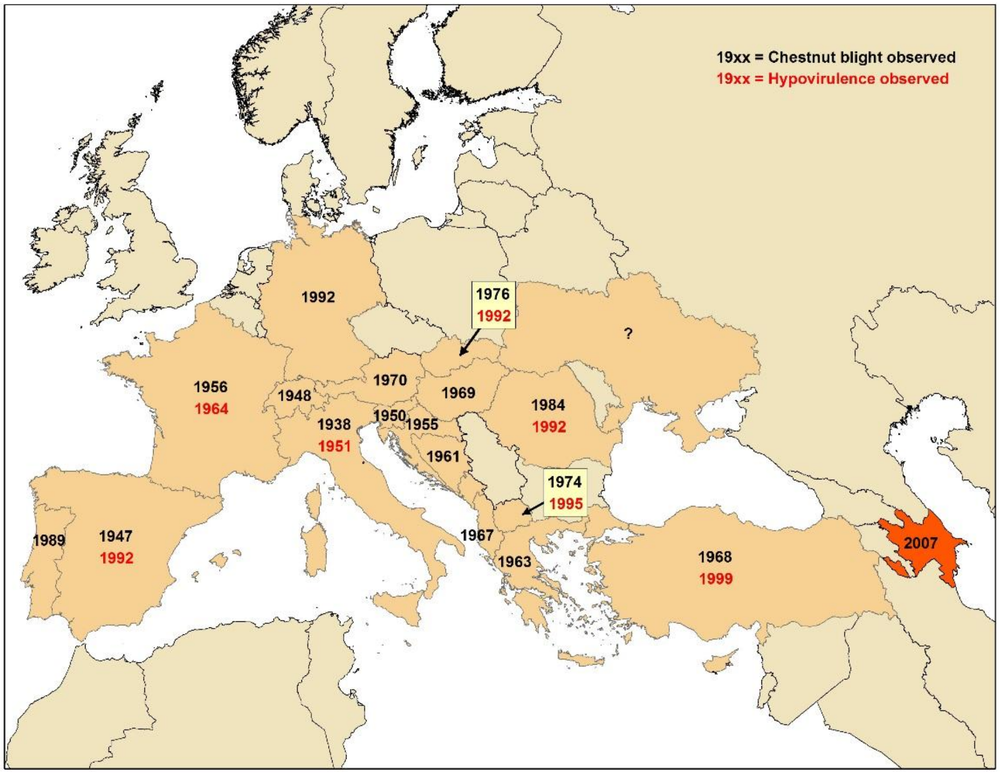

Figure 1 Reports on *C. parasitica* throughout Europe and Turkey (adapted from Robin and Heiniger 2001) with Azerbaijan marked by the author.[1]

In Europe, the first reports of *C. parasitica* on European chestnut, *Castanea sativa*, came from the area around Genoa, Italy in 1938, from where it has radiated gradually outward over the continent, slowed only by water and colder climate. Though the early years of the epidemic were reminiscent of the near total destruction of forest population in the United States, events in Europe unfolded differently. Initial damage to chestnuts in the infected areas was severe. By 1964, however, a new and hopeful phenomenon was discovered and analyzed in Como, northern Italy. There, trees which had previously been infected and which were declining in health were observed to be in recovery. *C. parasitica* samples from these trees were taken and under analysis were found to be remarkably less virulent and most importantly, transmissible. This phenomenon is known as *hypovirulence* (Heineger and Rigling 1994). This phenomenon

[1] Blight was noted in 2003, but official report was made in 2008 (Aghayeva and Harrington 2008).

had occurred naturally and attempts were made to understand it in the hopes that the process could be utilized in blight control. Today we know that hypovirulence in *C. parasitica* occurs when the fungus becomes infected with a naturally occurring virus, also likely from East Asia, the spread of which within the fungal population diminishes its overall damage to chestnut trees (Milgroom and Cortesi 2004).

In European chestnut, applied hypovirulence has been demonstrated to effectively inhibit the spread of *C. parasitica* within treated trees (Heiniger and Rigling 2009) and among neighboring trees (Hoegger et al. 2003). In this technique, the naturally occurring viral pathogen of *C. parasitica* known as *Cryphonectria hypovirus* 1 (CHV-1) is used to manually infect *C. parasitica* in the laboratory. This hypovirulent culture can then be applied to trees at the canker, the central point of infection, from where it may spread within the fungal population.

The successful spread of the hypovirus within the natural population of *C. parasitica* is determined by a factor known as vegetative compatibility. Vegetative compatibility allows for the diffusion of the hypovirus between fungal populations. Strains of *C. parasitica* which demonstrate successful transfer are identified by their same vegetative compatibility (v-c) type. High genetic diversity of the *C. parasitica* population is represented by a high diversity of v-c types. Presence of high v-c type diversity within a geographic space will inhibit the spread of a manually introduced virus. Low v-c type diversity in a geographic space allows for more likely transfer and diffusion within that population (Milgroom and Cortesi 2004).

Table 1 V-C type diversity of *C. parasitica* in new and expanding populations

Country /Region	First Observation	Sampling	V-C Types Observed	% Dominant v-c type	Source
Turkey, Aydin	1967 (Akdogan and Erkman 1968)	2011	2	EU-1=77%	Erincik
Turkey, Black Sea Region	1967 (Akdogan and Erkman 1968)	2009	5	EU-1=90.8% EU-12=6.8%	Akilli
Turkey, Izmir	1967(Akdogan and Erkman 1968)	2011	2	EU-12=70%	Erincik
Croatia	1955(Halambrek 1988)	2004-2006	18	EU-1=40.9% EU-2=21%	Krstin et al
Spain, Asturias	1982 (Valtezate 2001)	2005-2007	3	EU-1=94.6% EU-13=5%	German Gonzalez-Varela
Romania	1984 (Florea and Popa 1984)	1993-2001	1	EU-12=100%	Radoscz
Ukraine	2001 (Radoscz 2001)	1993-2001	1	EU-12=100%	Radoscz
Herzogovina	1961(Uscuplic 1961)	2001	29	EU-12=30% EU-2=18%	Trestic
Portugal, Tras-os-Montes	1989 (Abreu 1992)	2007	9	EU-11=80.2% EU-12=7.1%	Bracanga
Slovakia	1976 (Juhasova 1999)	1997	4	EU-12=93%	Adamcikov a
Greece	1963 (Biris 1964)	1998-2003		EU-12=88% EU-2=6%	Perlerou
Macedonia	1974 (Papazov, cited in Sotrovski 2004)	1995	5	EU-12=96% EU-2=3.5%	Sotiriviski
Switzerland (Weggis, **Choex, Murg)**	1986 (Heineger and Stadler 1990) 1989 (Heineger and Stadler 1990)	1990-1996	2 1	EU-1=73% EU-6=27% EU-?=100%	Hoegger
Sicily, **Bulgaria,** **Romania**	Late 1950's (in Milgroom et al 2008) 1980's (Iliev and Mirchev 1992) 1984 (Florea and Popa 1984)	1995 and 2008	8	EU-12= 82% EU-10=10%	Milgroom et al. 2008

Table 1 lists the results of a number of surveys of the v-c type of *C. parasitica* populations of recent origin or in its outer range in Europe. Except for Tras-os-Montes, Portugal, in all sites where *C. parasitica* was not observed prior to 1970 only one or two v-c types represent more than 90% of the most recent collected samples. In many cases, the period between first observation and most recent sampling spans more than twenty years. This provides considerable evidence in the European context that the chestnut blight fungus is less genetically diverse at the edges of its expansion than in the regions where it was originally introduced. This phenomenon has been well observed elsewhere as with Dutch Elm disease, *Ophiostoma ulmi* (Brasier 1988). "In general, the highest diversity is related to a longer presence of chestnut blight." (Montenegro et al 1978) Genetic diversity in a given area is commonly low at the margins of its range and high in its center. V-C type diversity is likely to be low in Azerbaijan due to its very recent arrival and its position in the range of *C. parasitica* in Europe. This allows us to hypothesize that the conditions in Azerbaijan are favorable for the application of hypovirulence as a biological control.

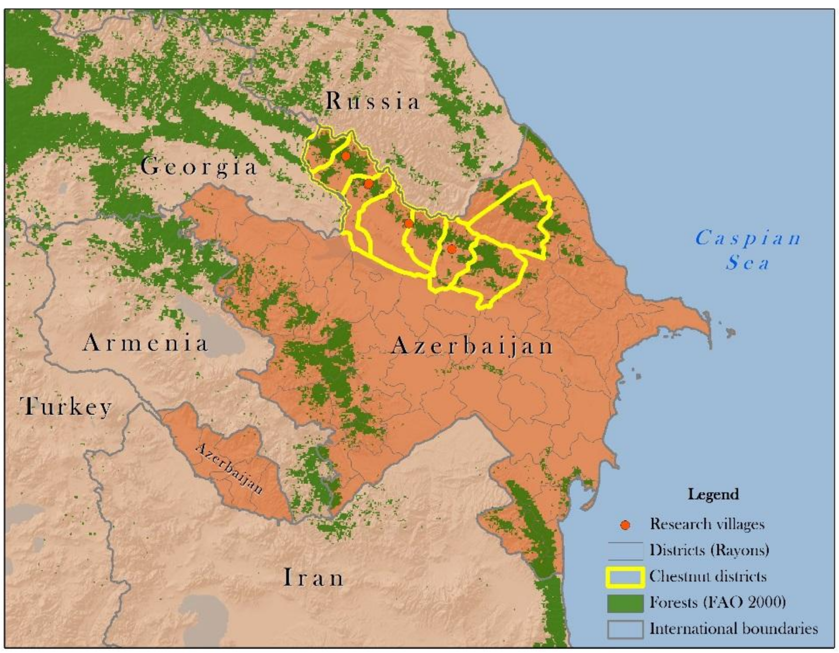

Figure 2 Azerbaijan and the Zone of Chestnut Cultivation

In Azerbaijan the chestnut is grown between 500 and 1700 meters above sea level in the north western part of the country in a band that runs nearly 200 kilometers from southeast to northwest and spans just twenty to twenty-five kilometers in width. This is a feature of the narrow elevation range of the tree. This totals over four thousand highly heterogeneous square kilometers of territory for the chestnut. This zone runs across seven distinct governed regions of Azerbaijan. Since 2003, there have been reports of chestnut blight in the Sheki-Zaqatala economic region of Azerbaijan and later the fungus was isolated, identified and the pathogenicity was tested (Aghayeva and Harrington 2008). Today, in all investigated chestnut-growing sites throughout Azerbaijan, blight infects the majority of trees and kills more than half (Wall 2012).

The present study sought to evaluate contemporary socioeconomic and biological conditions in order to determine the feasibility of implementing an *in-situ* on-farm conservation effort for European chestnut in Azerbaijan utilizing the application of hypovirulence. The objectives were first, to better understand the cultural and economic experience of chestnut growing communities and households to determine whether or not a conservation effort could reinforce or leverage existing incentives for the continuation of widespread chestnut cultivation and second, to determine the feasibility and desirability of an effort to apply hypovirulence as a biological control of the pathogen.

MATERIALS AND METHODS

Between 2009-2010 twenty-two households (n=22) in two villages, Jar in Zaqatala Region and Chinarli in Qax Region, participated in semi-structured interviews and a household budget questionnaire focused on chestnut cultivation and sale. Villages and households were selected using a process of participatory rural appraisal designed to select an economically diverse set of households actively engaged in the production and/or collection and sale of chestnut. Ten families in each community were selected for the interview and questionnaire session. In the case of Jar, two additional families requested to be interviewed and to complete the questionnaire. The questionnaire was composed of a total of 28 questions divided into five sections: family structure, non-agricultural income, non-chestnut agricultural income, chestnut production figures and income, and household and work-related costs, those of chestnut production and all other expenses related to income earning. Interviews were conducted apart from the questionnaire and strove to create a wider conversation about the general livelihood strategies of the family.

The Practice of Chestnut Production in Jar and Chinarli Villages

A diverse set of chestnut production practices can be observed in the territory of Jar and Chinarli villages. This is in part a function of the diverse traditions of the different ethnic groups. In our observations certain cultivation patterns can be associated with particular ethnic groups. The Avar of Jar grow chestnuts close to home often within the walls of their property, the Tzakhour in Chinarli cultivate chestnut in removed gardens and do not grow them within the walls of their property.[2] There is also a unique complex of production opportunities in the same village site. Home sites, alleys and road ways, nearby slopes, peripheral garden plots, forest edges, and remote forest groves are all utilized for chestnut production, yet each calls for particular and strategic cultivation, harvest, and post-harvest activities.

Chestnut production revolves around the annual cycle as well as the life cycle of individual trees. Taken as a whole, production is surprisingly light on labor. Chestnuts produce nuts once a year, and apart from harvest and post-harvest, trees require little maintenance beyond careful cultivation and planting of seedlings, and their subsequent

[2] The authors observed that Georgian residents of Qax City, Azerbaijan, conduct annual collection of chestnuts by arranging large excursions into forested areas inhabited by other ethnic groups. That Georgians primarily engage in wild forest collection and do not commonly cultivate chestnuts through transplanting or grafting has also been observed in Georgia (Dr. Daniel Rigling personal communication).

protection from grazing cattle, sheep and goats through the maintenance of cages and fences made from thorns, thistles, branches and/or wire. In fact, one very successful chestnut grower made the claim that "chestnuts do not love manure," discouraging even fertilization. The one task which is encouraged locally which is said to facilitate pollination is the keeping of bees around the village during the chestnut flowering season.

Cultivation

Individual trees may begin as cuttings or as seeds planted in nursery like conditions, typically adjoining vegetable plots. These can be easily weeded and watered in the routine maintenance of the home garden. Seedlings are grown for a year or more before being transplanted. Vigorous seedlings are chosen for transplanting to a chosen location. Vegetative propagation by direct-planting and grafting of cuttings is also practiced. Where these seedlings or cuttings are planted outside of the home walls and within the reach of free ranging cattle, sheep or goats, a cage is constructed of sticks, thorns and/or wire to protect the young tree. If establishing trees in locations remote from the village, it is particularly recommended here to plant near the banks of the river, but all manner of landscape features which capture sunlight can be chosen as well.

Harvest

Harvest, collection and storing occurs over a period of two weeks to a month, usually at the end of September or the beginning of October, and comprises the vast majority of labor required in chestnut production. If a tree is judged to be ready, the work of hitting begins from below with the use of a *chabuk* or "branch." This is a smooth, flexible, and light-weight pole of various length from a short sturdy three meter stick to a spindly and formidable six meter pole. Without exception, the *chabuk* is a specially selected and crafted branch from the hazelnut shrub. It is sanded for smoothness and is chosen for its straightness and firmness. While hazelnut is not a major crop in Jar, it is for the lowland Avar community of Danaçı. The Avar kinship network is utilized to acquire these hazelnut branches which are visible as they dangle out of the windows of small sedans on their way up the valley at harvest time. In Chinarli, hazelnut and chestnut are grown as companion crops in many private groves, assuring these villagers an abundant supply of branches.

With the *chabuk* the work is straightforward if not tiring to the shoulders: one simply whacks at the large bright green and spiny fruits that one can reach. There are two guidelines which ought to always be followed according to local farmers. First, one should always whack downward so as to ensure that the final location of the fruit is nearby. Second, hitting fruits directly above yourself or your co-worker is discouraged. Consideration for people around the tree which is being worked on is of dire importance due to the danger of injury from the sharp spines of the chestnut husk.

What cannot be knocked down from the ground must be got at by climbing the tree. All but the smallest trees are climbed, as it is unacceptable to leave more than a couple of nuts on the tree before the work is considered finished. Two or more *chabuks* must be hauled precariously up to the heights of the tree and moved around to different "stations" through great care and difficulty. Many trees are enormous and climbers are obliged to work their way to their very tops and to the farthest stretch of their highest limbs. While propped, pinned, or leaning to get in the whacks, the *chabuk* wielder must often receive the blows of the chestnut burrs as they fall as they are not at liberty to dodge or block, so tenuous is their position.

The fruit of each tree is collected separately in order to begin the sorting which maintains the categories of large, medium and small nuts as well as nuts of strong and light color. This is essential for receiving the best possible price for each category at the market or from the wholesaler. Burrs are collected one by one with either gloves, or more preferably, with a small tool known in Avar as a *masha.* Like tongs, the *masha* stays open until it is squeezed to grab a spiny chestnut burr. The preferred collection sack is the flour sack. The whole burr, husk and all is tossed in the sack un-separated from the nut. Each sack is stuffed to maximum capacity, and the total number of sacks in a day can be noted and used to estimate the amount harvested. When all is said and done, each sack contains about six kilograms of sellable nuts.

Postharvest

Sacks are carried to a piling place chosen for its cool shady qualities, its dryness, and its concealment from other villagers. These piles are a further step in sorting. Large nuts go with large, small with small, robust color with robust color, etc. Each sack is considered uniform and is dumped on a pile. These piles should be transported and combined with other piles in a location which is deemed more secure and under closer watch. However, this is particularly a challenge for collection activities that are arranged in more distant and wild chestnut groves. For this purpose we have seen the enlisted help of a truck driver.

The piles will remain in their final location after undergoing a specific storage procedure. Piles are covered in ferns (*Matteuccia struthiopteris*). This layer of ferns should amass to be about sixty centimeters thick. Ferns are held in place and the structure of the pile is established with a layer of medium-sized branches. These ferns represent an entire activity in their own right as they must be wild harvested soon before or at the same time as the chestnut piling. Respondents maintain that this work may be performed by men or women.

There are two clear reasons given for the piling of chestnuts in this way. One, piling and covering eases the work as the husks fall off by themselves and at the time of final collection for sale they are easily separated from the nut with the use of a special raking process. Two, this storing procedure keeps the product fresh while prices rise slowly around the country.

Sale and Use

The period during which research was conducted (2009-2010) was characterized by an especially high price for the chestnut. This is in no doubt partly due to the chestnut blight decimating national yields. Consequently, the vast majority of the harvest documented in this work was destined for market and not for home consumption. Fortunately, most research participants would talk excitedly about those times when the sale price for chestnut was so remarkably low that it was the prerogative of each family to cook chestnuts for home consumption in a number of different ways.

The distribution mechanisms of chestnut in the Azerbaijani market would look familiar to one with experience of an Azerbaijani bazaar. The vast majority of produce of all research participants was sold in the domestic markets of Azerbaijan in one way or another, and no-one interviewed knew of their product leaving the Caucasus. Middle men (*ara adamlar*), characterized by their empty Lada or Volga sedans with mounted steel racks on the roofs, would arrive in villages at the early onset of chestnut collection and knock on gates or call in the streets. This would continue throughout the season. All households would ideally hold onto their product and await the predictably high prices around New Years. However, nuts already separated from the husk at time of harvest and nuts of lesser quality and size are eligible for early sale. Furthermore, many cannot afford to wait, and happily accept the ready cash. Less than a third (7 out of 22) of respondent households sold their chestnuts at this low rate, most likely due to acute financial need.

Throughout the country chestnut is a signature ingredient in a pilaf (*şabalıd plovu*) served at weddings, funerals and holidays, in which the chestnut is stewed with mutton or beef, dried fruit and served over buttery saffron rice. Less ubiquitous uses include *şabalıd dolması*, stuffing and rolling cabbage leaves with diced chestnut, beef and spices. A dramatically more exhaustive menu can be described by villagers where chestnut has sometimes served as a low-cost starch. It is boiled, mashed and drizzled with butter and persimmon molasses. It can be simply boiled or roasted on a stove-top and eaten one after another as a snack. Ş*abalıd şorbası,* a soup of chestnut cooked in stock and spiced lightly with turmeric has been a staple of many a soviet winter in these highlands.

RESULTS

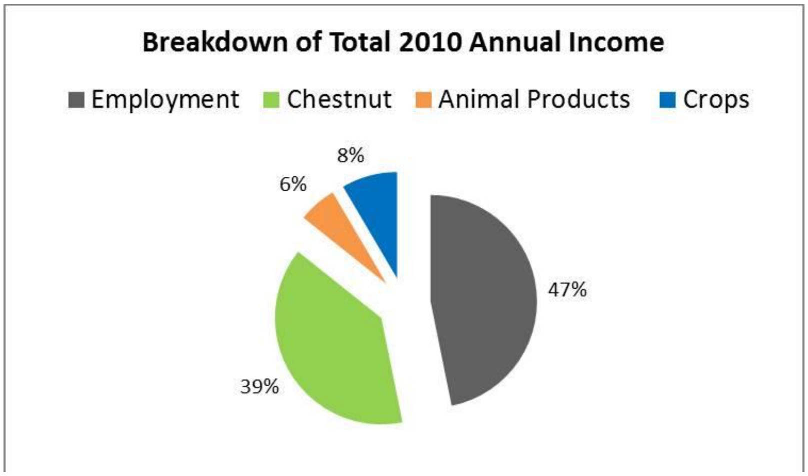

Figure 3 Total community income breakdown by income type; N=22

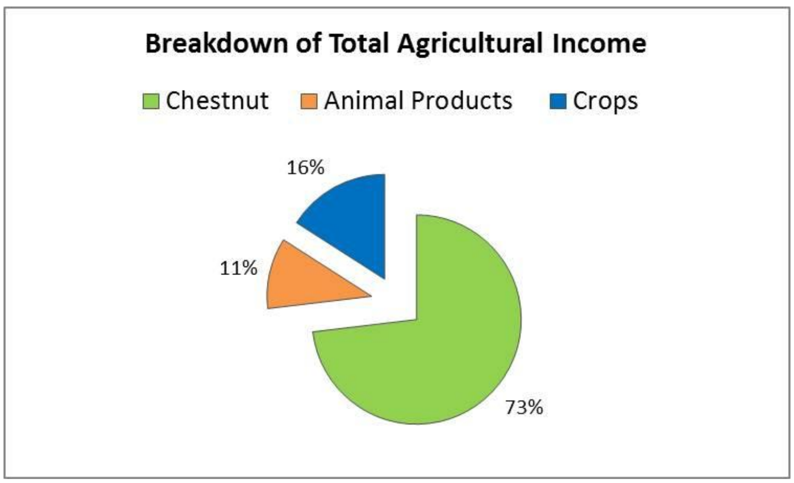

Figure 4 breakdown of total agricultural income; N=22

Results clearly show major importance of chestnut-based income to households in these two towns. Where the average teacher earned 2720 Azerbaijani Manat per year (1 AZN≈$1.2)1 by comparison, average chestnut sales per household were 2997 AZN in 2010. This figure was much higher in Jar than in Chinarli; 4450 AZN and 1254 AZN respectively. The average household in both villages included 4.5 residents, resulting in a per capita income of 666 AZN in 2010 from chestnut sales.

Chestnuts contributed 39% of the total income recorded in both villages, though when disaggregated this figure is higher in Jar than in Chinarli with respectively 45% and 24% of total annual income coming from the sale of chestnut. Of total annual agricultural income chestnut represents more revenue than any other agricultural product in these two villages. Within the agricultural portfolio, chestnut income composes 73% of all agriculturally related income, 81% in Jar and 52% in Chinarli. All other crops combined make up just 17% of the total annual income of these two villages.

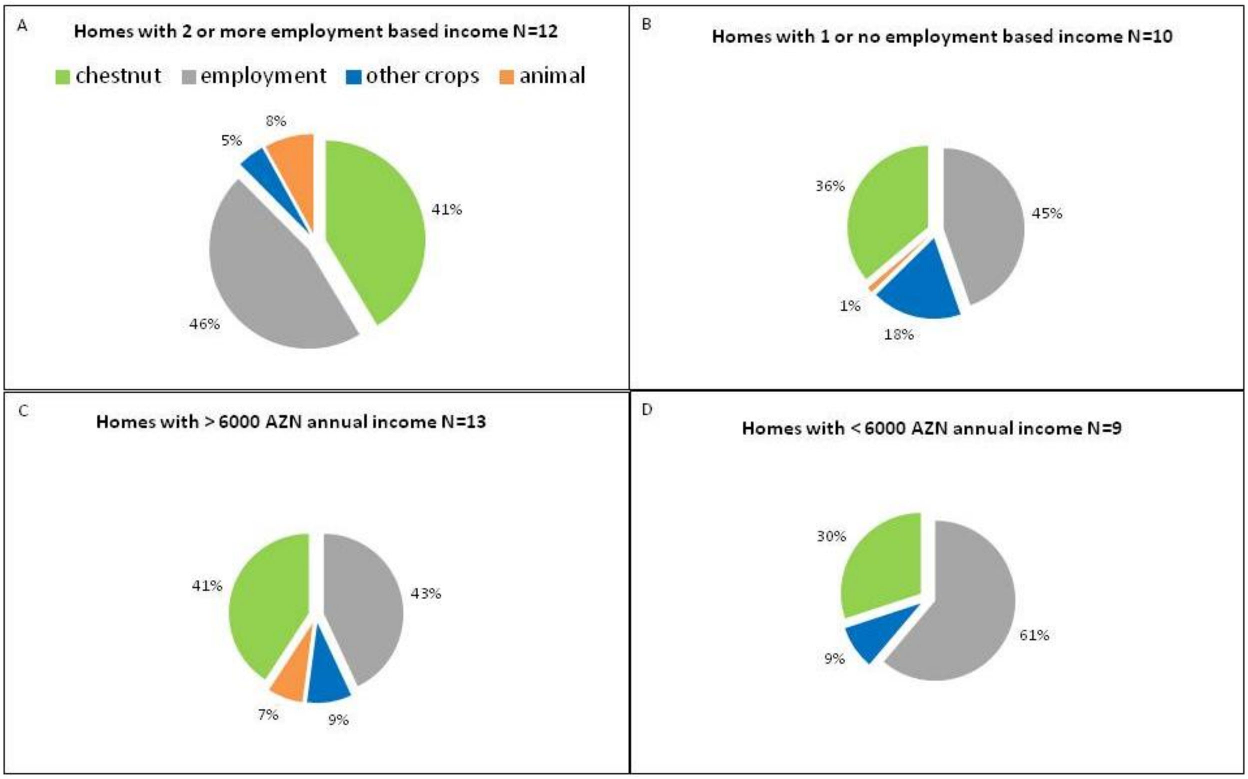

Figure 5 Household chestnut sales as a factor of employment based income and total annual household income

An assumption that the more financially disadvantaged homes are more dependent on chestnut-based income is not supported by results. Those homes with higher employment-based incomes sell more chestnuts. Figure 5 shows that on average, chestnut income is a larger proportion of total income in those homes where more than two people earn non-agricultural income (41%) than in those homes where one or fewer persons earn non-agricultural income (35%). Here it is important to address the question as to whether this is a factor of available labor within the household. This appears unlikely as the average number of people living in households with two or more and zero or one sources of employment-based income differ only slightly with respectively 4.6 and 4.3 people per household.

The data also suggest that chestnut income represents a larger proportion of total income in those homes that earn more than 6,000 AZN per year than in those homes which earn less than 6,000 AZN per year. This is also not likely a factor of the number of people in the household as the average number of people living in households with income more and less than 6,000 AZN is respectively 4.7 and 4.2.

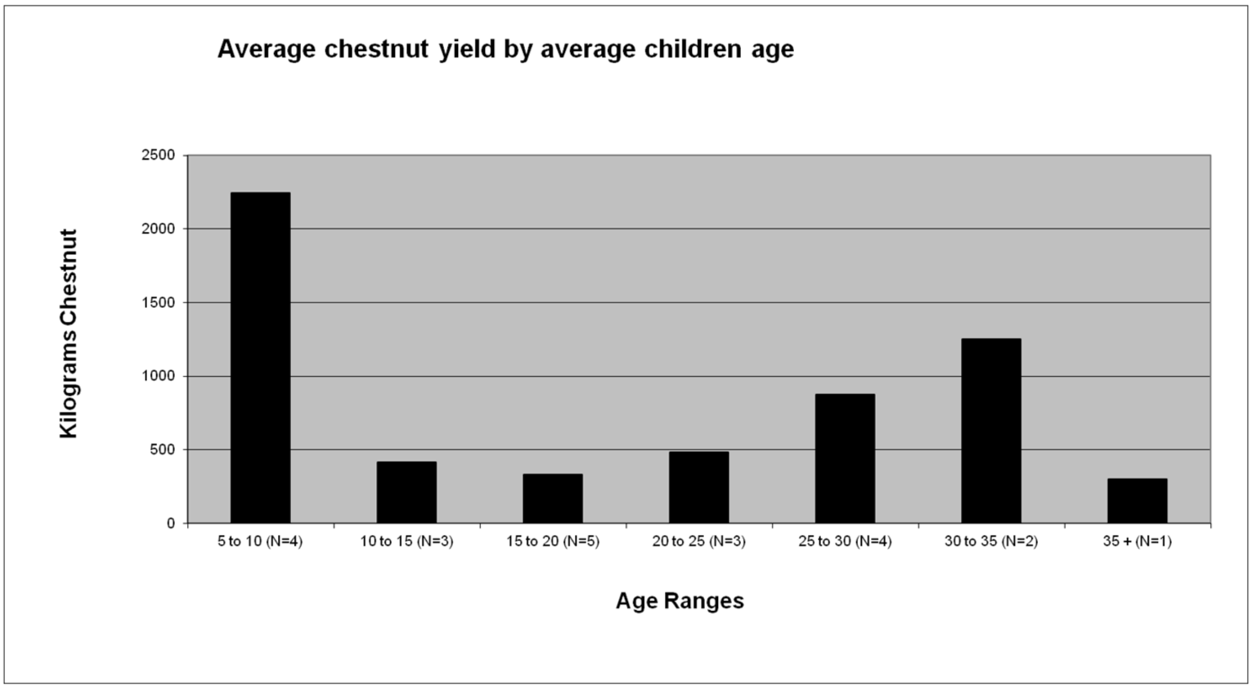

Figure 6 Chestnut collection by household as a factor of average age of children in that household

Larger family networks can consist of several households which altogether own a certain number of trees and lay claim to harvesting rights in certain areas farther afield. From all these resources, chestnut harvesting activity is apportioned according to social norms. Primarily, the right to harvest farther afield in more difficult terrain is apportioned by a decision-making process of each family group. Some families collectively agree to forgo their right, possibly due to time and labor constraints. There is no evidence that larger family groups forego their collecting rights due to lack of need. However, between households in a larger family group, as Figure 6 shows, families where the average child age falls between five and ten years of age harvest more chestnuts. Whether they are encouraged to harvest more chestnuts or whether they are simply allowed to by the larger family has not been determined. However, no evidence suggests that those in need within a community tend to harvest more chestnut. This suggests it is socially appropriate for families with younger children to express more ambition and maximize their chestnut sales. Likewise, Figure 6 shows that at the twilight of retirement, older couples with children between 30 and 35 access and sell more chestnuts.

DISCUSSION

Socioeconomic Significance

Results indicate that chestnut production clearly presents a profitable use of time when compared to non-agricultural employment. It is critical to recognize that the only intensive labor requirements for chestnut production fall within a three to four week window around the mid-Fall harvest time. Using the figure of 1.35 sacks/human hour (Wall 2012) and utilizing the local knowledge that a single sack of chestnuts in the husk reliably yields 6 kg of sellable nut yields a figure of 4.44 kilograms collected per hour (Wall 2012). 4.4 kilograms at the average 2010 price of 3.36AZN/kg shows an hourly earning of nearly 15 AZN per hour. Again the average 2010 income from chestnut for research participants was 2,997 AZN. An average teacher salary based on participants in this research was 2720 AZN/year or 3.8 AZN/hour. Other average salaries from the participant pool include that of truck drivers at 7,200 AZN/year and firemen at 4,800

AZN/year.

Future attempts to expand tree treatment with hypovirulence beyond trials will likely find receptive response among chestnut harvesting households. Arguably, results confirm that there is a role for ambition and investment in the overall amounts of chestnut which a family harvests, sorts, stores and finally sells. This motivation, however, is subject to social prescription. The kinship network acts as an arbitrator of ambition, allowing for increased resource collection by households with young children.

Significant questions remain regarding the socioeconomic fabric of a community characterized by such economic heterogeneity. What can account for the disparity in chestnut-based incomes? Why are the poor less engaged in harvest or wild collection? In 2009, what conditions enabled a single household managing 0.6 ha to earn 14,400 AZN more from chestnut and 17,000 more in total than a household which manages 2 ha? The difference between the highest income derived from chestnut (15,000 AZN) and the lowest (67.50 AZN) is considerable and cannot be attributed to the size of landholding. Again, kinship networks make the difference.   Traditionally, homes are inherited by the youngest son in the family, who must care for his parents in their old age. This ensures that only certain families occupy land on which chestnuts have been established. The existence of more than 25 highly productive mature chestnut trees on 50 year old, Allahiar Baba's, homestead is a tribute to the father from whom he inherited the land. Likewise, the paltry presence of a single mature chestnut tree on Vugar's land is the result of land inheritance patterns or past decision making, perhaps during a time when the going price of chestnut was *xırda* (small change).

The disparity observed in chestnut-based income is currently acute due to the recent and dramatic increase in the price of local chestnuts which has followed the ravages of chestnut blight, but it does point to a remarkably diverse complex of household economic strategies which operate in these rural communities. From these strategies, two patterns emerge. First, it is clear that kinship networks act as a managing unit to direct access and exploitation of available resources. This includes a multi-generational dimension, such as the trees planted by a direct ancestor and the inheritance of harvest rights. It is also very real in day-to-day and annual decision making. This is evidenced by the higher collection rates of families with children between five and ten years of age. Similarly, it is likely that older households whose older children have moved away pass on their collection rights to households with more immediate and substantial food requirements.

Second, based on the observation that wealthier households collect and sell more chestnut, there is an observable barrier to entry in the chestnut market that is based in activities conducted in the past and inheritance patterns. This barrier to entry is characterized by the access to productive trees which were established 25 or more years ago by elder or past generations. The same is true for the access rights to particularly privileged collection sites; these are also inherited from elder and past generations and prescribed annually to particular households based on family decision-making. Additionally, in communities where chestnut trees are commonly established on the property of the home, the local adherence to ultimogeniture, or inheritance by the last born, ensures that youngest sons and their families enjoy significantly more access to older established trees and the larger harvest they provide.

Without a legacy of established productive trees or a persistent practice of collection, it is less likely that a household will have an abundant supply of chestnut to sell or eat, though it can contribute to it's next generation by planting more chestnut trees.

Conservation Significance

Results also allow for the estimation of chestnut population and range in Azerbaijan. Geographically and numerically, the population of chestnut is currently large enough and widespread enough to comprise a genetically viable population if conserved. The following criteria are met:

- number of trees conserved to make a viable population: suggested minimum 500-5000 (Brown and Moran 1981; Namkoong and Kang 1990; Krushce and Geburek 1991; Franklin 1993; Nunney and Campbell 1993).
- sufficient geographic space to maintain an effective breeding unit: suggested minimum 25-50 hectare (Hamrick and Murawski 1990).

In total, twenty-two households which comprised the research participants owned over 650 trees, with an average of thirty trees per household. Extrapolated onto just one of the village sites, Jar, with just over 755 households (State Statistical Committee of Azerbaijan 2009) yields the figure of 22,660 trees owned and managed by Jar residents. There are dozens of such villages across the five regions of north-west Azerbaijan engaged in chestnut cultivation, harvest, and sale, an area which covers more than 4,000 square kilometers.

CONCLUSIONS

Social and biological circumstances for conservation of chestnut encourage trials for the application of hypovirulence as a biological control of chestnut blight in

Azerbaijan. The high demand for chestnut in Azerbaijan continues to drive farmer incentive to continue cultivation, collection, and sale of this traditionally important crop. Complementarily, the low v-c type diversity characteristic of recently expanding chestnut blight populations such as those in Azerbaijan encourages the application of hypovirulence to biologically control local populations of *C. parasitica.*

Efforts to treat trees with a biological control will likely meet with significant enthusiasm from tree owners. Currently hypovirulence application is the only option which meets the criterion for a desirable intervention that villagers stipulated in community meetings: that first, chestnut cultivation should remain the primary land use strategy in their territory; and second, the unique and locally preferred chestnut varieties must remain viable (Wall 2012). When asked, many farmers expressed willingness to engage with a fee based inoculation program, claiming that the high value of productive chestnut trees was a worthy investment.

Number and geographic range of treated specimens must be set to ensure the successful genetic conservation of European chestnut in its center of genetic diversity. Genetic conservation efforts are by definition not ideal. They are defensive actions taken against a wide range of threats in a particular area at a particular time. The goal is to achieve optimal results in unfortunate circumstances. A strategy to apply a biological control mechanism against *C. parasitica* could be an integral feature of a larger effort to ensure the continuation of significant chestnut populations in Azerbaijan if several important measures are established with the project design.

First, a sufficient number of trees must be inoculated to conserve a viable genetic population. For this reason, trials should lead to a marketable agricultural amendment or service in the event that they prove effective. Individual trees produce enough income to warrant moderate financial investment. This can play out between the public sector, the private sector, and individual farmers. The effects of trials could be magnified many-fold in the event that hypovirulent culture transitioned from a scientific material to become a marketable agricultural application. Such a successful transition could have a meaningful genetic impact on *C. sativa* as many more trees survive over a larger and more densely represented geographic space.

Second, the geographic space of inoculated specimens should be expanded in any way possible and in excess of agriculture. There is abundant state land currently maintained as reserves in Azerbaijan. Though there is no official estimate of chestnut population on this land, it is certain that there are substantial numbers. These should also undergo inoculation at the hands of state or cooperative programs increasing the survival rate of trees and the geographic distribution of surviving trees even further. In addition, state involvement should be considered for another reason: to add voice to the value of these genetic resources by training forestry and agricultural ministry personnel.

Finally, and with strong emphasis, indigenous knowledge of chestnut diversity, of both domesticated and undomesticated varieties must be explored and taken into account. The level of actively conserved intra-specific variation may be a factor of the range of farming practices into which any one species is incorporated (Kanowski and Boshier 1997). This range is broad indeed in Azerbaijan as cultivation is practiced in many ways. This includes but is not limited to growing saplings from seed, raising young trees in nursery like conditions, grafting with indigenously managed superior stock and wild seasonal harvesting from favored 'wild' specimens, seemingly undomesticated varieties in the natural forest community. The knowledge of the primary custodians of chestnut germplasm in the Caucasus will be essential to the application of hypovirulence or any other biological control measure against *Cryphonectria parasitica*, and to targeted conservation of the genetic diversity of the European chestnut.

CHAPTER 2

Food Sovereignty and Plant Genetic Resources: A Case from Azerbaijan

ABSTRACT

Food sovereignty asserts the right of people and peoples to the endogenous and participatory achievement of their food security. Among its boldest principles is the assertion that access to the productive resources of agriculture can bring about world food security more surely than access to food itself. Productive resources are defined as land, credit, technology, markets, extension services and seed. An international debate over sovereignty and seeds, or germplasm, has been ongoing since the early 1980's. Criticism of the imbalanced flows of plant genetic material from the "gene-rich" global south to the "gene-poor" global north culminated in the 1983 FAO International Undertaking on Plant Genetic Resources. The resolution of the Undertaking settled on a series of international standards and compensation arrangements for the free exchange of germplasm between nations via their respective national programs. Food Sovereignty logically challenges the current framework for plant genetic resource conservation and trade in that it envisions more participatory power for citizenry over public institutions while simultaneously envisioning an emboldened reincarnation of these institutions, capable of challenging the exogenous forces of globalization. The case of Azerbaijan and the circumstances of chestnut-growing communities offer a unique venue for the exploration of food sovereignty principles and an on-the-ground threat to a genetic resource. Based the results of twenty-two extended interviews and household budget questionnaires conducted in two chestnut growing communities, this paper explores the context for plant

genetic resource conservation and management in Azerbaijan through the prism of food sovereignty.

Introduction

The food sovereignty of rural residents of Azerbaijan dramatically increased following the nation-wide redistribution of land and the formal legalization of the sale of agricultural products that followed the end of the Soviet collectivized agriculture and the formation of the independent Republic of Azerbaijan. However, in the aftermath of Soviet institutional collapse, land access arrived without commensurate access to productive resources such as agricultural extension, agricultural credit programs, or active agricultural research institutions. Critically, financial and human resources dedicated to national plant breeding and the maintenance of national plant genetic resources experienced a sharp decline. (FAO 2006)

Though Azerbaijan continues to supply plant accessions to the international community, the breakdown of effective public and private research institutions ensures that Azerbaijan's agriculturalists derive little benefit from the international plant genetic resource networks. Practicing agriculturalists such as the chestnut growing communities of Azerbaijan actively maintain their cultivation practice in the center of highest genetic diversity for the European chestnut tree, *Castanea sativa*. Their livelihood and the genetic diversity of the European chestnut are currently under threat with the arrival of the chestnut blight, caused by the fungus *Cryphonectria parasitica*. Currently there is no indication that their threatened yet invaluable genetic stewardship are candidates for attention or action on the part of local institutions.

Food Sovereignty

The term food sovereignty originated in Mexico as *la soberanía alimentaria* and proliferated within agrarian social movements, academic and activist networks starting in Central and South America before spreading globally. The global farmers organization, Via Campesina, defined food sovereignty as "the right of each nation to maintain and develop its own capacity to produce its basic foods respecting cultural and productive diversity," in their 1996 founding declaration, "The Right to Produce Food and Access to Land: Food Sovereignty: a Future without Hunger." The multipronged advance made by Via Campesina and subsequent food sovereignty activists has employed social pressure through protest, and targeted policy advocacy through lobbying and dialogue in international policy centers.

Today hundreds of scholarly publications contain the words food sovereignty or the Spanish, *la soberanía alimentaria*. Food sovereignty conferences in several countries have drawn peasants, activists and political figures from around the world. Seemingly food secure residents of developed Europe and the U.S. have also energetically taken up the cry for food sovereignty (see First Nations Development Institute, Euskal Herriko Nekazarien Elkartasuna, Detroit Black Community Food Security Network). Finally, national governments of a growing number of countries have established legal code based on food sovereignty (Edelman 2013).

This rapid and vast conceptual and rhetorical dissemination has challenged scholars to understand and articulate the core values, conceptual boundaries, and the material implications of food sovereignty. The jury is still out as to whether food sovereignty is a "proposal" (Paul Nicholson in Patel 2009:679), a "right" (Declaration of

Nyéléni 2007:1), a policy framework, or an alternate paradigm. Many have contrasted food sovereignty with food security (Patel 2009:663; Wittman 2011; McMichael 2008; Declaration of Atitlan 2002). Still others have focused on the implications of the movement for control of and access to such productive resources as land, credit, national plant genetic resources and agricultural research and extension (Quaye et al. 2009, Pimbert et al. 2011).

Woven throughout food sovereignty rhetoric, there is a common driving assault against a regrettable but common framing to the discussion of global food security. In universities, policy institutes, governments and in popular media, developed world citizens are commonly asked, "1 Billion Hungry: Can We Feed the World?" (Conway 2012) "Can Science Feed the World?" (Nature 2010) "Can we feed nine billion people by 2050 or will we starve?" (De Nazareth 2012) These prompts hinge on an a-factual representation of global food production and consumption as, globally, more than two billion people practice and subsist on a forgotten agriculture, one operating without modern chemical inputs and plant varieties (Pretty 1995). Small local farms produce the majority of consumed food in Africa (Asenso-Okyere and Benneh 1997) and 41% of that in South America (Browder 1989). Furthermore, developing world countries significantly out-produce developed countries in three out of four of the world's staple crops (FAO STAT 2010). Food sovereignty advocates for the right of small farmers to *produce* food and openly challenges claims that the world's small farmers lack capacity to contribute to global food supply. Among its boldest principles is the assertion that national policies which facilitate increased access to the productive resources of agriculture will bring about world food security more surely than will access to food itself. Seed, both improved and traditional, is consistently identified as an essential productive resource for the small-holder production championed by Via Campesina and others. Food sovereignty publications and declarations have called for reform for plant genetic resource utilization and management, though specific reforms have not been posited consistentlyt.

Seeds and Sovereignty

Pat Mooney's book, Seeds of the Earth, provoked a remarkable and widespread public debate. Published in 1979, the work laid out a corporate genealogy of private seed development enterprises and its role in the genetic erosion of global crop genetic diversity. In doing so, Mooney could not fail to elaborate on the role of the international Consultative Group on International Agricultural Research (CGIAR) centers in the procurement and preparation of germplasm and its subsequent delivery to the corporate seed pipeline. Mooney described the enormous disparity in influence between nations from the global socio-economic South and those from the North in the decision-making process regarding these crop genetic resources, which were largely sourced in the South, but transported to and maintained in the North. Seasoned agricultural corporations remained predictably quiet to the publication of this critical piece, but it would be accurate to state that the scientists and personnel who staffed the international research centers, the plant breeders and conservationists engaged in the curation and utilization of plant genetic resources, were stunned (Brown 1988, Harlan 1988). The charges were equated with colonialism, and many of the internationally oriented plant breeders and crop curators at the time were devoted to well-regarded causes such as plant improvement for food insecure regions and advising the development of national breeding centers in developing countries. Many caught up in the accusations of Mooney's work were very conscientious and critical development thinkers themselves. Otto Von Frankel, for instance, published some of the earliest criticism of the Green Revolution in his book, Genetic Dangers in the Green Revolution (1970).

The narrative of the dispute begins with the arduous and long-term efforts of agricultural scientists to rally recognition and support for the cause of conserving crop genetic resources. These efforts were nothing short of a tide of activism at the time, drawing on the legendary Russian plant scientist Nikolay Vavilov (1887-1943), who centered his career around the conservation of the genetic basis of modern crop production (Nabhan 2009). On the European continent, more than thirty years after Vavilov's expeditions, the importance of genetic resources was receiving its first recognition within the FAO (Frankel 1988). The foundation of the International Board for Plant Genetic Resources (IBPGR) in 1974 and the implementation of collection expeditions were the result of years of advocacy by a "small and committed cadre of agronomists." (Coup and Lewins 2007:7) The work of the IBPGR consisted primarily of the ex-situ conservation, collecting plant accessions from all over the world and returning those accessions to modern facilities, mostly in Europe, for proper storage and maintenance. Many of these preserved landraces and wild relatives have disappeared from their native contexts and would otherwise be lost. These genetic resource collections were understood as entirely public property, and exchange within the system of international crop improvement has remained unencumbered by costs and/or tariffs.

However the rise of prominence of the private seed sector and that sector's ready access to this common property began to stir up suspicion from Southern representatives at the FAO. Mooney's work catalyzed a sentiment which had already been present. It was feared that under the auspices of plant genetic resources conservation and international collaboration in plant breeding, germplasm that had been acquired freely and without restriction was reincarnating as patented, elite crop varieties which were being marketed and levying steep costs around the world, unsettling the very rural communities where the raw material of varietal development had been sourced. The concept of national sovereignty over its germplasm began to resonate with those national representatives whose nations experienced this formula.

The publication, Seeds and Sovereignty (Kloppenburg 1988) based on works published in the 1986 Annual Meeting of the Advancement of Science, was the synthesis of the plant breeding community's perspective on the more controversial points raised in Seeds of the Earth and elsewhere. Throughout the chapters, western authors chastise the politicization of a scientific process, the management of plant materials. It was argued by public and private plant breeders that the exotic germplasm collected and managed by the centres, was rarely and only arduously incorporated into elite varieties (Cox et al 1988, Brown 1988). It was argued that an understanding of germplasm based on other natural resource exploitation such as mining made no biological sense (Harlan 1988). It was argued that no national or regional agriculture was without its own daunting ‘genetic debt’ to other domestication centers of the world (Kloppenburg). Finally, it was argued that these collections were conducted within a civilized and supportive framework consisting of international experts, national ministries, national and regional plant breeding centers and gene-banks. Jack Harlan elaborates on the cooperative nature of an plant collection expeditions.

> *As for robbery, I am reminded of my first and most intensive plant exploration to Turkey in 1948. The collection was made with the full approval of the Turkish Government and the full support of Turkish scientists. We sat down together and planned the operation in outline....The expedition resulted in the acquisition of over 12,000 accessions, one of the largest on record. Was this robbery? Of course not.* (Harlan 1988)

What Harlan fails to interrogate is the Turkish government and military's representation of many of its own citizens, Kurds, Armenians, Assyrians, and Laz among them, who may have contributed to the collected germplasm, but who would likely derive little benefit. Harlan, who throughout his career exuberantly lauded the role of traditional farmers in the development of mankind's genetic estate, does not consider it his purview whether the collected plant material would benefit the contributing farming communities or not. It is enough that Harlan expresses his confidence in the skills and facilities of Turkish plant breeding institutions. However, public assets such as breeding institutions remain underdeveloped if not absent in many nations of the world where such plant explorations have taken place. Further, community level participation and mutual benefit cannot be assumed based on ready military and governmental cooperation. Appropriately or not, Harlan others have left consideration for the human dimension of collection expeditions beyond governmental cooperation for others.

Food sovereignty and plant genetic resource conservation

Food sovereignty has weighed in on the evolving legal and rhetorical framework around plant genetic resource conservation, and by doing so applies to a large population of farmers, like chestnut growers in Azerbaijan, who maintain and steward the vast majority of crop genetic diversity in the world’s agricultural systems. The 1996 Via

Campesina declaration, placed the indigenous management of crop varieties and seeds in a prominent position in their overall agenda:

> *Genetic resources are the result of millenia of evolution and belong to all of humanity. They represent the careful work and knowledge of many generations of rural and indigenous peoples. The patenting and commercialization of genetic resources by private companies must be prohibited. The World Trade Organization's Intellectual Property Rights Agreement is unacceptable. Farming communities have the right to freely use and protect the diverse genetic resources, including seeds, which have been developed by them throughout history. This is the basis for food sovereignty.*

However, subsequent declarations and scholarship have not expounded on this issue enough to produce a practical first step towards a policy prescription. Likewise, there has been little articulation with the rich vein of dissent to current germplasm conservation efforts where preference for *in situ* crop diversity conservation and efforts to build equitable compensation into the international plant genetic exchange are currently growing.

Most of the world's remaining crop diversity is maintained by small farmers in developing counties (Altieri and Merrick 1987; Vavilov 1926; FAO 1973; Harlan 1985). *In situ* conservation programs focus on the maintenance of target crops and their wild relatives in their native agro-ecosystem and/or cropping practice. Conservation of a crop population *in situ* can be accomplished via the establishment of a reserve or alternatively through an intervention, policy, or regulation that ensures continued cultivation by local growers on-farm (Wale 2011). This type of conservation has the advantages of interacting with and reinforcing the community of growers for the continuation of crop diversity, maintaining the biotic community associated with annual crops including pollinators and beneficial mycorrhizae, and guaranteeing the continued adaptation and evolution of the target population to a dynamic state of pest pressure and climate change (Prance 1997).

With rising controversy around bio-prospecting and biotechnology, developing countries are growing increasingly sensitive about the export of their valuable germplasm to predominantly developed world facilities (Juma 1989; Brush 1995). Importantly, increasing recognition is being paid to the unique abilities of *in situ* efforts to maintain the genetic diversity of complex agro-ecosystems and to maintain recalcitrant species such as woody perennials. *Ex situ* conservation depends on sampling which will always carry the risk of causing genetic drift within the conserved population (Hokanson et al. 1999). Conserving populations through reserves or the continuation of traditional agricultural cropping systems can maintain a much larger base of intra-specific and inter-specific diversity than can removal and storage of target species. Importantly for food sovereignty, this practice can reinforce the essential practices which have contributed to the genetic stewardship of countless useful species.

A Case From Azerbaijan

In northwest Azerbaijan, a blight is threatening the livelihoods of chestnut growing communities (Wall 2012). The center of origin and the region of highest genetic diversity for European chestnut is in Eastern Turkey and the Caucus countries of Armenia, Georgia and Azerbaijan (Villani 1994; Mattioni 2010). The chestnut blight fungus, *Cryphonectria parasitica* (Murill) Barr, has recently arrived and has caused tremendous damage to chestnut trees and their crop (Aghayeva and Harrington 2008). A procedure known as applied hypovirulence has been demonstrated to control the spread of blight and allow treated European chestnut trees (*Castanea sativa* Mill.) to recover

(Hoegger et al. 2003, Heineger and Rigling 2009). Currently, there is no initiative within the Republic of Azerbaijan or any Caucus country to address the chestnut blight through hypovirulence application or by any other means.[3]

Between 2009-2010 twenty-two households (n=22) in two villages, Jar in Zaqatala Region and Chinarli in Qax Region, participated in semi-structured interviews and a household budget questionnaire focused on chestnut cultivation and sale. Villages and households were selected using a process of participatory rural appraisal designed to select an economically diverse set of households actively engaged in the production and/or collection and sale of chestnut. Ten families in each community were selected for the interview and questionnaire session. In the case of Jar, two additional families requested to be interviewed and to complete the questionnaire. The questionnaire was composed of a total of 28 questions divided into five sections: family structure, non-agricultural income, non-chestnut agricultural income, chestnut production figures and income, and household and all work-related costs, those of chestnut production and all other expenses related to income earning. Interviews were conducted apart from the questionnaire and strove to create a wider conversation about the general livelihood strategies of the family with particular attention paid to modern history and to the distinct role of each generation present in the household.

A Short History of Rural Sovereignty in Azerbaijan

During the centuries before 1996, land and other means of agricultural production in Azerbaijan were primarily controlled by those other than small farmers. Prior to

[3] This observation is made based on extensive correspondence and personal meetings with personnel from the Azerbaijan State Institute of Botany, the Azerbaijan Genetic Resource Institute, the Agricultural University of Georgia, the Armenian National Agrarian University. and the regional Forestry Office of the Food and Agricultural Organization of the United Nations in Ankara, Turkey.

Russian colonization and dating to the Persian Safavid dynasty (1501-1722 C.E.), local lords, khans or *begs*, ruled over territories, commanded the peasantry, and enjoyed the only official land ownership (Alstadt 1992). Russian colonization (ca. 1800 C.E.) imposed the category of "state" land onto the majority of all lands formerly owned by khans and *beg*s and these were apportioned among Russian-appointed entrepreneurs and colonists, and worked by "state peasantry". What "private land" remained was left to former *beg*s and khans to manage under traditional social arrangements (Yalçin-Heckman 2010). Finally, following the Bolshevik takeover of Azerbaijan in 1920, collectivization of land and agriculturally related property put "private" and "state" land under the direct control of the Azerbaijan Soviet Socialist Republic.

A modern history of agriculture and rural society in contemporary Azerbaijan begins with the shift from collectivization to private enterprise ushered in by the unprecedented land re-distribution of 1996 which distributed land free of charge across the entire registered rural population. The scarce literature which exists on this subject consists of recent historical accounts and a remarkable and contemporary rural ethnography by Lale Yalçin-Heckman. A brief synopsis of the life of a contemporary middle-aged farmer in Azerbaijan may speak starkly to a major shift in food sovereignty in his/her lifetime. The disintegration of the U.S.S.R., experienced over several years, and with recurring tumult, brought about a near total change in the social environment of agriculture.

Those men and women who are today over sixty years old and who worked as agriculturalists under Soviet rule worked as conscribed labor on a kolkhoz (*kolxoz*), a collective farm owned and managed by the state. Six days a week they would make their way back and forth to the farm facilities, walking or carried in the back of a dump truck. Once there, they would be occupied with a rote task such as pesticide preparation and application, tractor maintenance and driving, or the establishment and maintenance of tobacco seedlings in a greenhouse setting. The kolkhoz planting schedule was state-mandated as were all input applications. The produce was typically for export. As one interviewee so clearly stated, "the fruits of your labor were shipped out and you never saw them again." This life was inherited by the younger generation unless a young man or woman showed more promise in their education. Many individuals had established a non-agricultural career prior to the collapse of the Soviet Union, but had turned to an agricultural livelihood in the absence of other alternatives afterwards.

Figure 7 A Sunday bazaar in Azerbaijan (Photographed by author)

1976 marked a major change in local rural policy (Wall 2012). It was at this point that the prohibition on private household agricultural production was lifted. Households were assigned small plots known as *agrots* in which to grow supplementary produce outside of their kolkhoz obligations. This hybridized system would soon prove critical in a period of major instability. As events in capital cities like Moscow, Baku, and Yerevan descended into disorder, and the conflict between Azerbaijan and Armenia over the territory known as Nagorno-Karabakh began to rage, the rural districts of Azerbaijan were plagued with all manner of uncertainty, from unreliable food inventory in depots and shops to the theft of kolkhoz machinery and produce and the sudden arrival of destitute refugees and internally displaced people. Rural inhabitants would spend the next several years acquiring the necessities of life by only the most uncertain means, but household production, sanctioned since 1976, would provide critical relief.

Eventually, a rare act of resolve from the capital of the newly formed Republic of Azerbaijan under its third president, Heydar Aliyev, would become manifest in rural Azerbaijan. The wholesale re-distribution of public land (*torpaq paylaşmaq*) sanctioned and carried out, would put some 0.4-0.6 hectares under the nominal ownership and management of millions of individual rural households. Perhaps due to the refracted effects of capitalist "shock therapy," markets for produce, developed organically and informally under Soviet rule, became legitimate and allowed for the outright sale of produce and the selective purchase of desirable goods. Though still contending with enormous complications such as corruption, treacherous lending institutions, and chronic rural underdevelopment, farmers have undeniably experienced an explosion of options, possibilities, legitimacy and access to productive resources.

Differing Perspectives of Land Reform in Azerbaijan

The wholesale re-distribution of land in Azerbaijan occurred beginning in 1996. It was the result of an arduous and contested process. As witnessed in the agricultural policy of other former soviet or communist countries such as Russia and Ukraine, the large state land holdings lent themselves well to informal takeover by strong actors and transition into large corporate ventures. Among these post-soviet cases, that of Azerbaijan and of its Caucus neighbors Armenia and Georgia, stood out by implementing comprehensive transition to farming sectors based on small individual farms (Dudwick et al. 2007). This was accomplished by dismantling state and collective farm facilities en masse. It was Azerbaijan's third president and the perceived father of the modern nation, Heydar Aliyev, who personally saw to this and summoned the political will necessary for effecting this major reform in 1995. He forcefully followed up with further legislation in 1998 (Dudwick et al. 2007). Though Heydar Aliyev's presidential career was not without controversy, his land reform policies, and the enormous effort which he applied towards their implementation impressed western observers.

> *In three short years between 1995 and 1998 the share of arable land controlled by corporate farms--the successors of collective and state farms--declined from 90% to 20% and since 2001 sown land in corporate farms has remained at a negligible 2% of cultivated area*. (Lerman and Sedik 2010:65)

There is unease in this applause. Dudwick et al. sum up this sentiment in the title of their chapter, "*Azerbaijan: With some of the poorest governance indicators in the CIS, how did Azerbaijan implement a land reform that was viewed by farmers as quite fair and that led to a substantial increase in productivity*?" In other words, how has Azerbaijani agriculture confounded grim international expectations? Here, it is important to recognize that there is simultaneity to the production of the available scholarly accounts. What little literature exists in English on the performance of the agriculture sector following land reform in Azerbaijan is cropping up only recently, after several years of watchful silence. The following discouraging qualities in the agri-business environment were documented early on and continue to be pervasive: legal and regulatory weakness, ubiquitous barriers to investment, weak infrastructural development, and corruption (Csaki and Kray 2005). It can be argued that it is the unlikely and highly impressive aggregate figures themselves which have drawn the eye of investigators.

Available figures from World Bank Surveys in 1995 and 2003 (Kauffman and Kray 2003) and those from the State Statistical Committee of Azerbaijan (2002) suggest a dramatic recovery of gross agricultural output and productivity following the reform towards individualized farming. "There is a clear link between the individualization of Azerbaijan's agriculture and economic recovery." (Lerman and Sedik 2010:96) Though, in almost all estimates, agricultural productivity has yet to reach the gross agricultural output levels of 1980-1985, there has been a spectacular recovery from the calamitous decline which began under Mikhail Gorbachev. The upward trajectory of gross agricultural output appears destined to surpass that of the most productive years of agriculture in Azerbaijan under the Soviet Union.

The copious evidence attributing the surge in capacity of a national agricultural sector solely to the inclusion and empowerment of small farmers makes a strong case for the arguments of food sovereignty. However, this remarkable achievement should not be equated with a perceived rural victory for Azerbaijan's farming community. Between the statistical representation of aggregate agricultural achievements and the local perception and experience of events there is a wide gulf in scholarly accounts. Aggregate figures mask the lived challenges of rural Azerbaijan where the documented experience of agricultural households demonstrates an uncertain and fitful transition to the market economy and individualized production. Among rural Azerbaijanis there are an impressive variety of local perspectives and experiences.

In perhaps the only thorough ethnographic account of rural people's experience of land reform in Azerbaijan, Lale Yalçin-Heckman investigates the issue of uncultivated *pay* land (*pay torpaqları*), land distributed under land reform, in the rural district (*rayon*) of Şemkir. In her research site of Tezekend, land reform "was implemented in the field of laws and legal regulations, on the one hand, and in the workings of local power holders on the other." (Yalçin-Heckman 2010: 66) This is not to say that reform was entirely thwarted by local corruption. It is simply to articulate a matter of course in Azerbaijan, that structural power undergoes many translations between the national political center and on-the-ground implementation. In fact, after sharing several accounts of significant aberrations from the law, Heckman goes on to state, "in short, large landowners were few in the vicinity of Tezekend." What is truly noteworthy considering the dismal local governance indicators at that time is that these breaches did not become the norm.

Yalçin-Heckman's results are an exemplar of the ground-truthing power of ethnography- driven investigation. Her rural research participants attest that their use of land is limited by the capacity required to produce. In a self-assessment of the household economic situation, no household which cultivated their *pay* land in addition to their home-garden assessed their economic situation as bad or very bad, but just thirteen percent of homes cultivated all land available to them. Though 96% had access to both household gardens and *pay* land, access proved insufficient. In the communities of Leninabad and Düzqışlaq small households and those with a female head of household, in other words the more economically vulnerable, were least likely to cultivate their *pay* land. Factors identified as correlated to the active cultivation of *pay* land include:

- kinship network extent and household composition-particularly availability of young men
- kolkhoz experience of head of household [Leninabad and Düzqışlaq]
- means; ability to "afford to cultivate more land." (Yalçin-Heckman 2010:183)
- *pay* land needed for animal grazing [Pir Settlement]

The need for skill and information is uniquely critical for Azerbaijani *pay* land, where land is laid out for commercial production. In some cases, members of households in Leninabad and Düzqışlaq who had management and production experience in the collective farming system offered their household the additional capacity necessary for the cultivation of *pay* land, leading to increased prosperity. *Pay* land is generally structured as long narrow strips, laid out for mechanical cultivation. Currently, most *pay* land is devoted to the mechanical production of cereal, forage, and where there are large local buyers and/or processors, onions, beets, fruits and nuts. In many cases, such as pomegranate and hazelnut groves, land was inherited from the kolkhoz system as established orchards and has been maintained as such within the individualized system. The role of skill and information in the gulf between access and agricultural capacity in Azerbaijan has proven to be a critical opportunity for cooperative agricultural extension.

Livelihood and Sovereignty

Table 2 Aggregate figures: Chestnut Production in Jar and Chinarli (1 AZN ≈1.2 USD)

2010	Jar	Chinarli	Total Average
Average Landholding (Hectares)	1.3	1.1	1.2
Total Landholding (Hectares)	15.1	11.3	26.4
Average Harvest per Household (kilos)	1,400	282	892
Total Harvest of Participants (kilos)	16,800	2,815	19,615
Average Harvest per Hectare per Household (kilos)	1,110	250	744
Average Chestnut Sales per Household (AZN)	4,450	1,254	2,997
Total Chestnut Sales of Participants (AZN)	53,400	12,538	65,938
Average Total Annual Income per Household (AZN)	9,824	5,169	7,708
Total Income of Participants (AZN)	117,884	51,690	169,574
Average Non-Agricultural Income per Household (AZN)	4,301	2,778	3,609
Total Non-Agricultural Income of Participants(AZN)	51,614	27,782	79,396
Average Agricultural Income per Household (AZN)	5,523	2,391	4,099
Total Agricultural Income of Participants (AZN)	66,270	23,908	90,178
Chestnut Sales as Percentage of Total Income of Participants	45.3%	24.3%	38.9%
Chestnut Sales as Percentage of Total Agricultural Income of Participants	80.6%	52.4%	73.1%

Table 1 shows results from the questionnaires. Data on land distribution represented in Azerbaijan State Statistical Committee and World Bank documentation and reviewed by Lerman and Sedik is somewhat challenged by figures generated by household interviews. This is born out in Table 1 as well as by the work of Yalçin-Heckman. "On a per capita basis 70% of families received up to 0.5 hectares per person and another 25% received between 0.5-1.5 hectares." (Lerman and Sedik 83) The primary unit for agricultural policy in Azerbaijan is the household (*təsurafat*) and per capita figures can be misleading. Lerman and Sedik qualify this figure by stating, "among families, 83% received not more than 3.5 hectares in total." (Lerman and Sedik 83) Figures generated from household interviews are lower in this investigation. Again, this is supported by the work of Yalçin-Heckman; "only 5% of recipients (households) had received land shares larger than 200 *sotkas* (2 hectares)." (Yalçin-Heckman 2010: 88) 68.9% of recipients received shares between 0-1.19 hectares. Table 2 shows an average land holding of just 1.2 hectares for both Jar and Chinarli villages.

Though average landholdings per household appear roughly equal, each household of Chinarli includes a one-half hectare lowland *pay* landplot in their total land estimates, and so this equality is deceptive. This formerly kolkhoz land is considered too far away to maintain effectively and it cannot support chestnut cultivation. Furthermore, this half-hectare is hardly utilized. The great majority of households in Chinarli, 80%, allow another grower to cultivate the land in exchange for roughly 200 kilos of wheat berries per year which they use for chicken feed.

Analysis of land use can confirm the preferential role of chestnut production practice in these villages. Both villages together own an average of 34 trees per hectare. Jar possesses an average of 28 trees per hectare and Chinarli 47 per hectare adjusting for Chinarli residents' *pay* landholdings unsuitable for chestnut cultivation. On such small landholdings, this hints at a large proportion of space devoted to chestnut trees. When one considers the abundance older larger trees, it is clear that the residential, cultivated and surrounding landscape is crowded with chestnut trees. Land in chestnut production can serve many other functions. Between the trees, whether they are in yards or in forest, animals graze, hay is harvested, vegetable gardens are established. True to observations, respondents confirm that chestnut cultivation predominates in the residential areas and the surrounding landscape.

Due to the disparate and informal nature of chestnut cultivation and collection, production figures per hectare are based on rough estimates. Still, analysis confirms the observation that chestnut trees and their harvests are more substantial in Jar. Per hectare, Jar produces 1,110 kilograms of chestnut. The kilogram per hectare figure of 250 for Chinarli is distorted by the one-half hectare of lowlands that factors into everyone’s total land figures. Discounting .50 hectare per household the production figure is still a lower 450 kilograms per hectare.

What is clear is that chestnut income is the primary source of agricultural income in both communities (73%), and as measured against overall average income, contributes slightly less than employment-based income, 38.9% vs. 47%. This, too, is a bit deceiving. Over one quarter (28.5%) of employment-based income of respondents comes from pensions collected on past employment, often employment from Soviet times. This speaks to the weak potential of new income-based employment to stand in for the ever-decreasing chestnut yields due to blight.

Discussion and Conclusion

Figure 8 Azerbaijanis sample pomegranate varieties at a national pomegranate festival (photographed by author)

Where will we turn?

In my conversations with chestnut farmers, they made every attempt to stay hopeful. The harvest of 2010 was not a bad one compared to that of 2009. There were many trees left standing, especially old growth and small saplings which growers would soon recruit from home gardens to replace the trees in groves and distant forest which were killed by the blight. Offering my diagnosis of the chestnut blight and sharing the history of blight in Europe and the U.S., I bore terrible news, forcing farmers to consider their worst fear whilst in a face-to-face conversation with a foreign guest. This is a social challenge for a people who prefer to treat guests to a worry-free and childlike state of enjoyment by showcasing their pastoral bliss, and plying the guest with feast-like portions of food and local spirits. Upon hearing the news that the blight would certainly get worse, that it would diminish chestnut production by up to eighty percent in a matter of years, farmers often shouted in exasperation, "but where will we turn?" (*Amma hara dönəcəyik?*) The frequency of this question along with its anxious tone has reminded me again and again that the blight threatens something at the core of this community: their ability to ensure basic conditions: where they can live, who from among their children can afford to live with them and not migrate in search of cash income. Though the aggressor is a fungus, this amounts to an infringement on food sovereignty, the ability of a people to determine their food production systems.

For minorities, like the Avar of Jar and the Tsakhour of Chinarli, who reside in the remote highlands of Azerbaijan and who face chronic challenges in finding employment and business opportunity in the larger Azerbaijani society, income derived from chestnut production is one among a dwindling number of financial resources which prevent economic migration. There are very few economic threads sustaining these communities. Remittances from employment outside of Azerbaijan are important but cost these minority groups that which is most precious to them, their actual numbers. Those who are away sending money back are most certainly not here; they cannot give weight to these communities and the issues they face at home. Though not an assault in the sense familiar to Caucasus residents, the blight has mounted a formidable attack on the numerous villages where chestnut is grown.

The twin stance of food sovereignty, that local food security is best served by the devolution of agricultural decision-making to the local level and that a nation-state apparatus should be sufficiently powerful to defend and facilitate rural productivity and viability (Via Campesina 1996), is suited to the case of chestnut growers in Azerbaijan. The interests of plant genetic resource conservation dove-tail with this stance as well. The chestnut growing community of Azerbaijan, like many around the world whose practices steward invaluable genetic resources for an economically important species, harbor the most genetically diverse population of European chestnut, *Castanea sativa*. Under the threat of chestnut blight, this regenerative stewardship will be served well by an institutional intervention. The local need for intervention is evident. In the case of hypovirulence application, local institutions will require external assistance. The ability to draw together collaborations is a state capacity in itself. Such co-operations can strengthen local skills and capacity.

Yet there are many reasons why such an acute agricultural issue may not alight on the radars of state officials: the crop involved is seen to have minor economic significance nationally, the crop is ignored for cultural reasons (i.e. cassava, Nweke 2002), or it may be a disempowered national minority who are experiencing the problem. There is, however, an explanation which may synthesize all of the above, one which comes to us by way of an old woman and yam grower in Kenya whose knowledge of yams was neglected in a national extension questionnaire. Jon Moris explains that following the completion of a formal questionnaire,

> *an old woman asked if she could now please tell us some facts...[Yams], she insisted, were very important for poor women like herself who only had a little land. Now she was old and would soon die: could we please convey her observations to the Agricultural Department....* [But] *there was no one to receive the old woman's tape-recorded empirical observations, garnered over a lifetime of growing yams. The extension system was entirely oriented towards receiving messages from its research scientists.* (Moris 1991:55)

Robert Chambers employs industry terms to categorize this top-down orientation as "output oriented" as opposed to "client oriented" (Chambers and Jiggins 1987:39). There are few mechanisms for incorporating farmer concerns in this model, and such concerns maintain a low priority in the overall process. Pressure groups including governments and firms provide research funding, reinforcing the orientation of the process. Industrial and marketable agricultural products are privileged. Governments typically prioritize crops which are suitable for export, urban markets, commodity reserves and subsidized food programs. This output orientation is especially inclusive of demands from industry, large-farmer associations, food processors, and consumers, and not those of resource poor farmers (Bonny et al. 2005).

In the wake of an era in which the decentralization and diminished internal capacity of nation-states has been structurally encouraged if not guaranteed, newly born states like that of Azerbaijan have experienced little pressure from the international community to develop robust programs like those which bolster the agricultural sector in developed nations. On the contrary, U.S. and European actors have found such venues ripe for the exercise of their own state, non-governmental and corporate institutional capacity. Plant breeding, genetic resource conservation and agricultural extension represent one dimension of a consistently underdeveloped internal state capacity.

Since its inception, Food Sovereignty advocates have conducted a heated yet fruitful dialogue with the FAO and have nudged the FAO definition of food security to include such phrases as "physical, *social* and economic access to sufficient, safe and nutritious food that meets their dietary needs and *food preferences*" (FAO 2001, italicized by author). This paper holds that the fertile cross-pollination between an international organization of the size and reach of the FAO and a budding social movement cannot be explained as the result of fierce political pressure. Rather, it is the common pool of right-to-food aspirations which has resonated in the interactions between the FAO and food sovereignty advocacy, and which has allowed tremendous in-roads to form for the rhetorical advance which speaks to empowering farmers and consumers as stake-holders and providers in the global food system.

Likewise, there is a growing recognition that the rhetorical framing unique to food sovereignty can readily weigh in on the issue of plant genetic resource conservation and the underprivileged position of the essential custodians of these genetic resources, traditional farmers in largely decentralized nations-states. Out of the more than eighty papers which emerged from the 2013 Yale hosted conference, "Food Sovereignty: A Critical Dialogue," thirteen made a specific original argument regarding crop genetic resources. Even as the drastic rural reform in Azerbaijan can be said to have introduced a sharp increase in the food sovereignty of their peoples and that this same reform has been linked to strong recovery of national agricultural productivity, the case of an endangered livelihood and genetic resource from this country can "shed light on larger issues" (Kassam 2009:89) such as the pursuit of food sovereignty in decentralized nations, and hopefully on a commendable course of action for plant genetic curators, state personnel and politicians alike.

CONCLUSION

The present thesis has been produced in order to affect policy in Azerbaijan. Specifically, the objective is to engender the creation of a policy to address chestnut blight where no such policy exists. To this end, chapters one and two represent scholarship designed to serve as a resource for the production of a policy recommendation document, an impact assessment, which has been included in the appendix. This work has identified and attempted to answer the below questions as a means of producing a compelling case for the Azerbaijani national government to allow or sponsor the implementation of biological control of chestnut blight:

- What is the larger importance of conserving chestnut populations from the international and Azerbaijani National Government perspective?
- What common ground can be leveraged to successfully advocate for intervention?

Clearly certain individuals such as chestnut farmers would argue that their ability to maintain their livelihood, residence and way of life is of very large importance. However, the perspective of state planners and regulators in Azerbaijan will not likely find such individual or small rural community testimony sufficient grounds for attention or action. Larger importance is therefore defined here as an affiliation between the spread of chestnut blight and concerns which resonate with present government personnel and policy agendas. Plant genetic resource conservation and food sovereignty were selected for their ability to span the distance between this localized agronomic problem and the stated and observed agenda of the Azerbaijani national government and pertinent international actors.

These selected issues were arrived at after a highly selective process. Shared objectives with functional correlates at the local, national and international level were few. Take for example the general issue of environmental conservation and forestation. Azerbaijan's Minister of Ecology and Natural Resources, Huseynqulu Bagirov, has the following to say:

> *We [Azerbaijan] are positioned at the crossroads of two contrasting terrains. On one side, there is green, blossoming vegetation; on the other, barren desert and monotonous brown wasteland... History has treated us ruthlessly on many occasions. But we no longer want to allow things to remain as they are… We want to take our destiny in our own hands and make a firm, decisive, irreversible stand.... We want to be a flourishing nation, characterized by lush green landscapes - which, indeed, is the true essence of our spirit and nature.* (Shakiliyev 2003)

Conventional international objectives for conservation and environmental improvement are not easy to locate within the words of Mr. Bagirov. National sovereignty and the endogenous cultivation of valuable national resources maintain a high importance in many areas of Azerbaijani policy.

For the purposes of advocating biological control of chestnut blight, there is evidence here that the Ministry of Ecology and Natural Resources and others may agree. For one, chestnuts are integral in forest composition in the north-west especially cultivated forest peripheral to highland residential areas. Second, a locally managed technical intervention like the one in question is a good example of making a firm, decisive stand towards environmental stewardship.

On the local level, efforts to treat trees with a biological control will likely meet with significant enthusiasm from tree owners. Currently hypovirulence application is the only option which meets the criterion for a desirable intervention that villagers stipulated in community meetings: that first, chestnut cultivation should remain the primary land use strategy in their territory; and second, the unique and locally preferred chestnut varieties must remain viable (Wall 2012). When asked, many farmers expressed willingness to engage with a fee based inoculation program, claiming that the high value of productive chestnut trees was a worthy investment.

Finally, and with strong emphasis, indigenous knowledge of chestnut diversity, of both domesticated and undomesticated varieties must be explored and taken into account. The level of actively conserved intra-specific variation may be a factor of the range of farming practices into which any one species is incorporated (Kanowski and Boshier 1997). This range is broad indeed in Azerbaijan as cultivation is practiced in many ways. This includes but is not limited to growing saplings from seed, raising young trees in nursery like conditions, grafting with indigenously managed superior stock and wild seasonal harvesting from favored 'wild' specimens, seemingly undomesticated varieties in the natural forest community. The knowledge of the primary custodians of chestnut germplasm in the Caucasus will be essential to the application of hypovirulence or any other biological control measure against *Cryphonectria parasitica*, and to targeted conservation of the genetic diversity of the European chestnut.

For minorities, like the Avar of Jar and the Tsakhour of Chinarli, who reside in the remote highlands of Azerbaijan and who face chronic challenges in finding employment and business opportunity in the larger Azerbaijani society, income derived from chestnut production is one among a dwindling number of financial resources which prevent economic migration. There are very few economic threads sustaining these communities. Remittances from employment outside of Azerbaijan are important but cost these minority groups that which is most precious to them, their actual numbers. Those who are away sending money back are most certainly not here; they cannot give weight to these communities and the issues they face at home. Though not an assault in the sense familiar to Caucasus residents, the blight has mounted a formidable attack on the numerous villages where chestnut is grown.

The twin stance of food sovereignty, that local food security is best served by the devolution of agricultural decision-making to the local level and that a nation-state apparatus should be sufficiently powerful to defend and facilitate rural productivity and viability, is suited to the case of chestnut growers in Azerbaijan. The interests of plant genetic resource conservation dove-tail with this stance as well. The chestnut growing community of Azerbaijan, like many around the world whose practices steward invaluable genetic resources for an economically important species, harbor the most genetically diverse population of European chestnut, *Castanea sativa*. Under the threat of chestnut blight, this regenerative stewardship will be served well by an institutional intervention. The local need for intervention is evident. In the case of hypovirulence application, local institutions will require external assistance. The ability to draw together collaborations is a state capacity in itself. Such co-operations can strengthen local skills and capacity.

In the wake of an era in which the decentralization and diminished internal capacity of nation-states has been structurally encouraged if not guaranteed, newly born states like that of Azerbaijan have experienced little pressure from the international community to develop robust programs like those which bolster the agricultural sector in developed nations. On the contrary, U.S. and European actors have found such venues ripe for the exercise of their own state, non-governmental and corporate institutional capacity. Plant breeding, genetic resource conservation and agricultural extension represent one dimension of a consistently underdeveloped internal state capacity.

APPENDIX A—Impact Assessment for the Biological Control of Chestnut Blight

An Impact Assessment for the Application of Hypovirulence as a Biological Control of Chestnut Blight

Problem Statement and Rational for Intervention

Chestnut blight was first confirmed in Azerbaijan in 2008 by the Azerbaijan State Institute of Botany in cooperation with Iowa State University. Chestnut blight, *Cryphonectria parasitica*, is an ascomecyte fungus pathogenic to European and American chestnut species with a likely origin in East Asia. Though the European chestnut tree, *Castanea sativa*, expresses intermediate resistance to infection, the blight has historically caused tremendous decline in nut and timber production in the European territories it has reached, especially in combination with other stresses such as ink disease and drought.

In Azerbaijan, the habitat for European chestnut covers an area of 4,000 square kilometers in a highly heterogenous highland landscape in the north-west of the country. For numerous villages, the sale of chestnuts and the utilization of chestnut timber make a significant contribution to the viability of rural livelihoods. In a preliminary investigation of two distinct communities engaged in the chestnut production and collection, it was discovered that up to 73% of agricultural income in these communities was derived from the sale of chestnuts.

Azerbaijan along with Georgia and Eastern Turkey has been identified as the center of origin and the center of highest genetic diversity for the European chestnut species. The Azerbaijan National Academy of Sciences, under the auspices of diverse ministries such as the Ministry of Ecology and Natural Resources and the Ministry of Agriculture has fostered strong partnerships with a variety of international research institutions which have lead to a flourishing body of research since the birth of the independent Republic. Since 1994, Azerbaijan, through its Genetic Resource Institute has engaged in partnerships with numerous universities and has maintained a particularly rich cooperation with the United States Department of Agriculture Agricultural Research Service allowing for the ex-situ conservation of numerous accessions within the U.S. system.

This history of cooperation and the strength and breadth of the university sector in Azerbaijan provides a strong foundation for the implementation of a biological control effort of chestnut blight through the controlled application of the hypovirus CHV-1. Such an effort would demonstrate Azerbaijan's commitment to rural economic viability and to the protection of its magnificent agricultural and natural heritage. The agro-biodiversity found in Azerbaijan is nothing short of a world treasure, and the chestnut is a prime example. By engaging international expertise, staff and faculty of Azeraijani universities and government divisions will become proficient in a powerful technique in modern forest protection. This will allow further strengthen biological disease control as a pillar of Azerbaijan's practice of preserving environmental health.

Intervention Objectives

The first objective in a biological control program of chestnut blight in Azerbaijan must be to establish trials in the lab and field context of Azerbaijan in order to demonstrate that the process is effective. Hypovirulent culture which has been developed from Azerbaijani chestnut blight samples must successfully infect a significant number of non-infected local strain in both a lab and field setting. This should occur in a number of designated sites with sufficient trees and be monitored over the course of two or more years.

In the event of successful trials the dissemination of hypovirulence application should strive to accomplish the following objectives:

1. successfully disseminate biological control capacity to rural districts engaged in the production, collection and sale of chestnut, possibly through Ministry of Agriculture personnel;
2. successfully inoculate, and thereby conserve, a genetically viable and representative population over a viable land area;
3. successfully disseminate biological control capacity to Ministry of Ecology and Natural Resources personnel for the continual application of hypovirulence in natural forest on state land;

Policy and Intervention Options

The following list is comprised of the known responses to the introduction of chestnut blight. They fall into two categories: one is to build resistance of local trees to blight while the other is to effectively weaken the disease itself. This is the same scenario in every new location, yet in every location unique circumstances determine which strategy is more applicable. In North America, for instance, the application of hypovirulent strains has never effectively weakened the disease, and the Asian American hybrid breeding program of the American Chestnut Foundation provide the best way forward. In Europe, hypovirulence has been observed to spread naturally when introduced into natural populations (Heiniger and Rigling 2009, Hoegger et al. 2003).

Replacement and Variety Improvement

Replacement

Local chestnut varieties can be slowly replaced with hybrid varieties or Asian varieties of chestnut which show strong resistance to blight. These could be imported immediately and be in place to supplement the declining production of native trees by the next decade. With the correct policy incentives, this could be entirely implemented by the private sector. Growers are commonly familiar with the local chestnut is a celebrated and favored variety. The introduction of new varieties could replace the local chestnut outright, thereby eliminating a favorite traditional product. In this same vein, genetic pollution from introduced varieties controlled trials. Such genetic contamination could easily cross national borders into Georgia and Armenia. The genetic diversity of the

European chestnut would be eroded in this scenario, an issue of particular importance in the Caucuses, included in the center of origin for C. sativa (Mattioni 2010, Villani 1993).

There is a high risk that imported seedlings will introduce new and destructive diseases and pests. The chestnut gallwasp has recently caused serious damage throughout Europe; it was imported along with chestnut plants from Asia. Additionally, imported seedlings may transport soil borne pathogens into a new location. Furthermore, the hybrid varieties which exist are not compatible with the less intensive cultivation style common to Azerbaijan. Bred for intensively managed orchard systems, commercial varieties such as those currently available in the market might not thrive in the forest or semi-domesticated environment like the chestnut of the Caucuses. The diverse highland topography, irregular weather patterns and various temperatures throughout the managed agricultural zones of highland Azerbaijan will likely prove challenging to varieties bred for uniform landscapes and optimal agricultural regimes.

Variety improvement through breeding

Some of these risks could be mitigated with a rigorous and highly regulated breeding program to breed the blight resistance of Asian varieties into local varieties. Importation and breeding from seed offers less risk of disease and pest importation than does importation of foreign seedlings. A breeding technique such as that utilized by the American Chestnut Foundation could ensure that after several generations, the genetics of new varieties would be predominantly Caucasian. This would likely cause less genetic erosion than the previous scenario. However, the costs and time required for such a program make it an unattractive option. Using the American case as a model, the American Chestnut Foundation has maintained its latest breeding program for more than twenty years and is still years from releasing a resistant variety. This is unlikely to prove satisfactory to the thousands of Azerbaijanis who would like to earn a livelihood in the immediate present. The result would be to replace the chestnut entirely in favor of another tree crop.

Blight control

Forest and orchard sanitation

The history of deploying large-scale forest sanitation measures in order to control the spread of chestnut blight is not encouraging. In Pennsylvania, U.S.A., for instance, the state disbursed $500,000 (today more than $11,000,000 adjusted for inflation) in 1911 to rid their state's forests of infected specimens. This effort proved entirely ineffective.

Small to medium scale sanitation measures, however, have been demonstrated to provide moderate relief of blight effects. These have the advantage of dissemination through training. Farmers and forestry personnel trained in basic sanitation measures could theoretically spread helpful practices across a wide area, slowing the spread of blight to new territory and repressing the progress of blight *in-situ*. Utilizing mudpacks to suppress canker growth shows particular promise. In medium and long term, however, these measures will not match the persistence of the chestnut blight fungus and the logistical challenge of sanitizing the enormous and disparate chestnut population of Azerbaijan.

No Action

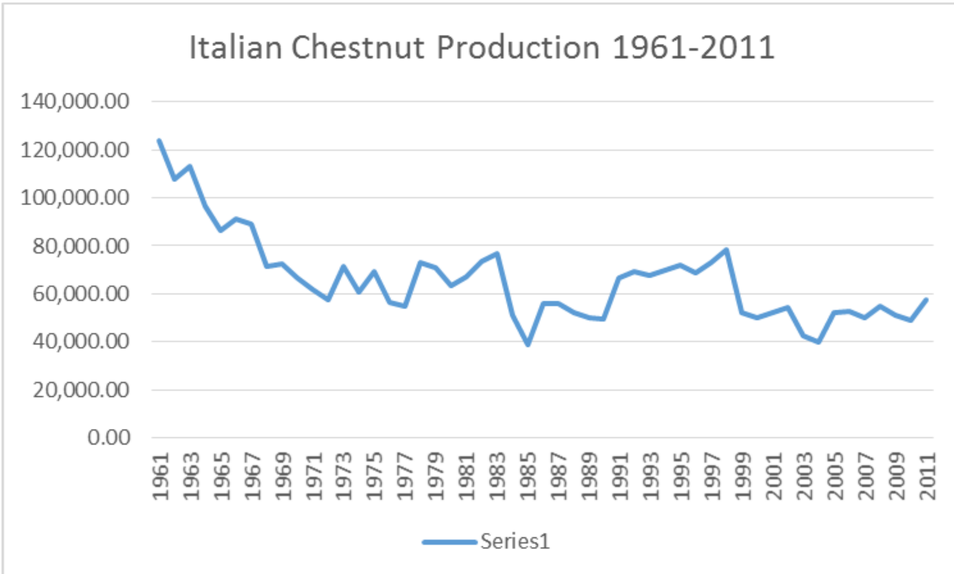

Figure 3 Decline in chestnut production over time in Italy in the years after the arrival of chestnut blight. Data adapted from FAO STAT 2010.

Left unaddressed, the chestnut blight is likely to cause significant damage to chestnut populations in both managed landscapes and in natural forests. Spread by the wind-borne and insect carried spores of the fungus, the effects of the pathogen are known to spread quickly and cause rapid damage. This is readily observable in Azerbaijan. Evidence from countries such as Italy (Figure 1) where the fungal pathogen has been present for decades offer a picture of the long term consequences for the production and collection of chestnuts over time. A mortality of 5.12% and severe damage rate of 15.48% has been observed in Portugal (Tizado et al. 2012), in areas where hypovirulence has yet to arrive.

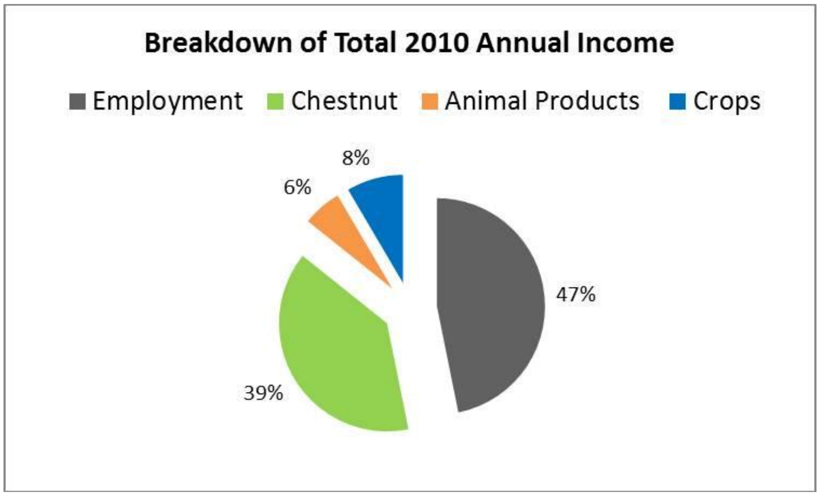

Figure 4 Breakdown of total income by source for 22 chestnut growing households (Wall 2012)

Economic necessity of rural communities and foresters in Azerbaijan may usher in a secondary cause of population decline as trees are harvested to make way for productive species and in order to salvage valuable timber before rot becomes severe. This is supported by Figure 2 which is derived from findings from of a preliminary investigation which shows the great economic contribution of chestnut sales to chestnut producing households, especially in relation to other forms of income.

Hypovirulence Application

Introducing European style hypovirulence to Azerbaijani populations of chestnut is the safest, most cost effective and appropriate measure to conserve chestnut production and local chestnut populations at this time. Before any other step is considered trials for this technique should be arranged and observed. If outcomes of trials are successful, the process should be repeated in numerous locations and monitored further.

Description and Scale of Consequences for Main Affected Groups

The main affected groups impacted by the advances of chestnut blight are the producers and sellers of chestnuts and the consumers of chestnuts in Azerbaijan. An investigation of the household economic importance of chestnut sales has demonstrated that chestnut-based income is indispensible to the livelihood of numerous highland communities. In fact, the basic climatic and geographic requirements for successful chestnut cultivation are common characteristics of marginal land: cooler temperatures, insignificant soil depth, variable photo period and a challenging topography of steep slopes, shadowy troughs and exposed ridges. Research has demonstrated that a dramatic decrease in chestnut-based income would eliminate 39% of the income of an average chestnut producing home. The opportunity cost of land will ensure that marginally productive chestnut trees will be replaced with whatever is at hand to recoup dwindling income.

Consumers have already experienced a sharp increase in the price of Azerbaijani chestnuts. To date, no published market analysis has investigated the impact of this ongoing change. The chestnut is integral in local cuisine and the preference for local chestnuts is widespread. The possible disappearance of local, Azerbaijani, chestnut would be considered a significant loss.

Risks and Assumptions

A full disclosure of the risks and assumptions of the proposed intervention will serve to increase the efficacy of decisions and actions of future policy generation on this matter. Of the following factors, only some may be addressed within project design. For others, such as the competing interests of the relevant ministries, diverse approaches must be employed. Finally, certain risks will remain present in all feasible scenarios. For instance, there is a real possibility that no efforts will successfully maintain chestnut production at even the current low levels.

- *Efficacy of hypovirulence* Though the application of hypovirulence as a biological control of chestnut blight with European chestnut dates back decades, conclusive proof of efficacy has remained elusive. Throughout the history of observations of hypovirulence in Europe it has proven difficult to identify manually applied hypovirulence from naturally spread hypovirulence and to credit the former with tree recovery. However, more recent experiments utilizing genetic markers have been able to observe effective transfer of hypovirulence from manual introduction. Vegetative compatibility within the fungal population has emerged as a key factor. Preliminary results show a low diversity of vegetative compatibility types in Azerbaijan which suggests that applied hypovirulence could be effective. However, a longer term perspective of fifty to one hundred years in which neighboring Russia and Georgia do nothing to control the spread of blight and consequently allow for the generation of diverse vegetative compatibility types illustrates the uncertainty of the efficacy of biological control without a commensurate regional cooperation. Fortunately, Georgia is participating in a biological control program through cooperation with the Food and Agricultural Organization of the United Nations and the Swiss Institute for Forest Snow and Landscape Research.

- *Soviet history* The lingering distrust of Azerbaijani officials for the importation of foreign biological material is understandable considering the historically non-transparent Soviet experimentation in the All Union biological weapons programming and specifically the suspected production of virus-derived biological weapons in Azerbaijan. The implementation of hypovirulence trials will require the importation of fungal cultures, sourced in Azerbaijan, that have been manually infected with a virus from outside Azerbaijan. The involved scientific community including scientists from Azerbaijan will have to answer to rightfully cautious officials. Considerable evidence which demonstrates the strong host specificity of the *Cryphonectria* virus must be combined with a commitment to rigorous management protocol to ensure that the required permissions are granted and for the consideration of all stakeholders. It deserves special mention that the *Cryphonectria* virus was unfortunately dubbed CHV, a term common to the entirely unrelated virus, *Cercopithecine herpesvirus*. This is a case of tragically poor name designation and CHV is simply an acronym for *Cryphonectria* Hypovirus.

- *Non-target impact;* To date, no incident of non-target impact has been reported in the application of the *Cryphonectria* hypovirus to control the spread of chestnut blight. However, adherence to protocol is still highly recommended.

- *Competing interests between the Ministry of Ecology and Natural Resources and the Ministry of Agriculture*; The chestnut is a fundamentally unique crop due to its role as a wild and domesticated tree. In Azerbaijan, as in many European contexts, chestnuts are gathered from both wild and domesticated specimens, from both private property and public land. Furthermore, in Azerbaijan there is likely significant chestnut populations on protected state land which remain uncollected. The productive nature and the private ownership of chestnut trees across the north-west ensure that the proposed intervention is agricultural in nature. The range and contiguity of the chestnut populations across the same region increase the likelihood that natural populations in protected areas will also be affected. The proposed intervention will therefore fall into a mixed domain between the Ministry of Ecology and Natural Resources as well as the Ministry of Agriculture. The experience and respected status of the Azerbaijan National Academy of Sciences will be integral in carving out the unique space necessary for project promotion, planning and implementation.

Wider Impacts

This demonstration of a biological control method will be 1.) the first measure taken to control the spread of blight in the Caucasus, 2.) a unique and significant contribution to the existing literature on hypovirulence application in the European context, 3.) a model for collaborative in-situ genetic resource conservation in Central Asia, and 4.) a potential remedy to a livelihood crisis for select villages of Azerbaijan.

WORKS CITED

Abreu C (1992) A hipovirulência como forma de luta natural contra o cancro do castanheiro. Revista das Ciências Agrárias 15:167–171

Adamcicova K, Kobza M, Juhasova G (2010) Characteristics of Cryphonectria parasitica isolated from Quercus in Slovakia. Forest Pathol 40:443-449

Adamcikova K, Juhasova G, Kobza M (2006) Genetic diversity of Cryphonectria parasitica populations in the Stiavnicko-Krupinska subpopulations in Slovakia. Plant Protection Sci. 42(4):119-124

Aghayeva D, Harrington T (2008) First report of Cryphonectria parasitica on chestnut (Castanea sativa) in Azerbaijan. Plant Pathol 57:383

Akdogan S, Erkman E (1968) Dikkat kestane kasseri görüldü. Tomurcuk. 1:4-5

Akkili S, Katircioglu Z, Maden S (2009) Vegetative compatibility types of Cryphonectria parasitica, causal agent of chestnut blight, in the Black Sea region of Turkey. Forest Pathol. 39:390-396

Alekperov A, Ruslan B, Agamirzayev C, Alekperov R. (2006) Geoenvironmental problems in Azerbaijan. In Tellam J (ed) Rivett M, Israfilov R, Herringshaw L. Urban groundwater management and sustainability. Nato Science Series. pp 39-58

Alstadt A (1992) The Azerbaijani Turks: Power and identity under Russian Rule. Hoover International Press. Stanford, California

Asenso-Okyere W, Benneh G (1997) Sustainable food security in West Africa. Dordrecht, Netherlands: Kluwer Academic Publishers

Altieri M, Merrick L (1987) In situ conservation of crop genetic resources through maintenanceof traditional farming systems. Econ Bot 41:86-96

Altieri M. (2009) Agroecology, small farms, and food sovereignty. Monthly Review

Anagnostakis S (1987) The classical problem of an introduced pathogen. Mycologia 79(1):23-37

Biris D (1964) The appearance of the fungus Endothia parasitica on chestnut in Greece. Forest Ann 68:26–27 (In Greek with English summary)

Bonny B, Prasad R, Narayan S, Varughese M. (2005) Participatory learning, experimentation action and dissemination (PLEAD): A model for farmer participatory technology evolution in agriculture. Outlook on Agricult. 34(2):111-115

Braganca H, Simoes S, Onofre N, Tenreiro R, Rigling D (2007) Cryphonectria parasitica in Portugal: diversity of vegetative compatibility types, mating types, and occurrence of hypovirulence. Forest Pathol 37:391-402

Brasier C (1988) Rapid changes in genetic structure of epidemic populations of Ophiostoma ulmi. Nature. 332(7):538-541

Brown A, Moran G (1981) Isozymes and genetic resources of forest trees. In: Conkle M (ed) Isozymes of north american forest trees and forest insects. USDA, Berkeley, California. pp 1-10

Brown W. (1988) Plant genetic resources: a view from the seed industry. in Kloppenburg J (ed) Seeds and sovereignty: the use and control of plant genetic resources. Duke University Press. Durham

Browder J (1989) Fragile lands in Latin America: strategies for sustainable development. Boulder, CO. Westview Press

Brush S (1995) In situ conservation of landraces in centers of crop diversity. Crop Sci 35:346-354

Celiker N, Onogur E (2009) Biological control of chestnut blight and prospects for the Future: Turkey a review. Actahort. 815

Chambers R, Jiggins J (1987) Agricultural research for resource poor farmers: Part I transfer-of-technology and farming systems sesearch. Agricult Admin and Extension. 27: 35-52

Collinson M (1987) Farming systems research: procedures for technology development. Experiment Agricult. 23:365-386

Conway, G (2012) One billion hungry: can we feed the world? Seminar Lecture, Cornell International Institute for Food, Agriculture and Development. October 11, 2012.

Coup S , Lewins R (2007) Negotiating the Seed Treaty. Practical Action Publishing. Warwickshire, U.K.

Cox, Thomas S., J. Murphy, and M. Goodman. (1988) The contribution of exotic germplasm to American agriculture. in Kloppenburg J (ed) Seeds and Sovereignty: The Use and Control of Plant Genetic Resources. Duke University Press. Durham

Csaki C, Kray H (2004) The agrarian economies of Central-Eastern Europe and the Commonweath of Independent States: an update on status and progress in 2003. Environmentally and Socially Sustainable Development Working Paper 38. World Bank. Washington D.C.

Declaration of Atitlan, Guatemala. (2002) Indigenous Peoples' consultation on the Right to Food: a global consultation. Atitlan, Solola, Guatemala

Declaration of Nyéléni (2007) Sélingué, Mali

Marianne D (2012) Scientific American. July 27, 2012

Dodd N (1949) The Food and Agricultural Organization of the United Nations: Its history, organization, and objectives. Agricult History. 23(2): 81-86

Dudwick N, Fock K, Sedik D (2007) Land reform and farm restructuring in transition countries: the experience of Bulgaria, Moldova, Azerbaijan, and Kazakhstan. World Bank. Washington D.C.

Edelman, Marc (2013) Food sovereignty: forgotten geneologies and future regulatory challenges. Food Sovereignty: A Critical Dialogue. International Conference Yale University

Erincik O, Ozdemir Z, Durdu O, Doken M, Acikgoz S (2011) Diversity and spatial distribution of vegetative compatibility types and mating types of Cryphonectria parasitica in the Aydin Mountains, Turkey. Eur J Plant Pathol 129:555-566

FAO (Food and Agricultural Organization) (1973) Survey of crop genetic resources in their centres of diversity. Rome

FAO (2001) The state of food insecurity in the world 2001. Rome

FAO (2006) Country report on the state of plant genetic resources for food and Agricultutre: Azerbaijan. Rome

FAOSTAT. (2010) Country rank in the world by commodity: corn, wheat, maize, potato. Rome

FAO (2011) State of the world's forests. Rome

Florea S, Popa I (1984) Diseases of the edible chestnut reported in the fruit growing area of Baia Mare. In: Cercetarea stiintifica in sluiba productiei pomicole 1969–1989. Bucuresti. pp 365–372

Frankel O (1970) Genetic dangers in the Green Revolution. International Federation of Agricultural Producers

Frankel O (1988) Genetic resources: evolutionary and social responsibilities. in Kloppenburg J (ed) Seeds and Sovereignty: The Use and Control of Plant Genetic Resources. Duke University Press. Durham

Franklin J (1993) Preserving biodiversity: species, ecosystems or landscapes? Ecol Appl 3:202-205

Freidrich, Ebert, Stiftung (2009) Azerbaijan in 2008: sociological monitoring, comparative analysis of findings of sociological survey held in the Republic by totals of 2006, 2007, and 2008. Baku.

Gonzalez-Varela G, Gonzalez A, Milgroom M (2011) Clonal population structure and introductions of the chestnut blight fungus, Cryphonectria parasitica, in Asturias, northern Spain. Eur J Plant Pathol. 131:67-79

Gurer M, Ottaviani M, Cortesi P (2001) Genetic diversity of Cryphonectria parasitica in two chestnut-growing regions in Turkey. Forest Snow Landsc Res 76(3):383-386

Halambek M (1988) Chestnut blight in Yugoslavia. EPPO Bulletin. 16:533-535

Hamrick J, Murawski D (1990) The breeding structure of tropical tree populations. Plant Spec Biol 5:157-165

Harlan J (1988) Seeds and sovereignty: An epilogue. in Kloppenburg J (ed) *Seeds and Sovereignty: The Use and Control of Plant Genetic Resources*. Duke University Press. Durham

Harlan J (1992) Crops and man. American Society of Agronomy. Madison, WI

Harutunyan A, Hovhanisyan M (2009) Armenia:following chestnut Footprints: cultivation and culture, folklore and history, traditions and uses. Centro de Ricerca per la Frutticoltura. Rome, Italy

Heiniger U, Rigling D (1994) Biological control of chestnut blight in Europe. Annu Rev Phytopathol 32:581-599

Heiniger U, Rigling D (2009) Application of the Cryphonectria virus (CHV-1) to control the chestnut blight: experience from Switzerland. Acta Hort. 815: 233-245

Heiniger U, Stadler B (1990) Chestnut blight north of the Alps. Schweizerische Zeitschrift fuer das Forstwesen. 141:383-388

Hoegger P, Rigling D, Holdenrieder O, Heiniger U (2000) Genetic structure of newly established populations of Cryphonectria parasitica. Mycol Res 104(9):1108-1116

Hoegger P, Heiniger U, Holdenreider O, Rigling D (2003) Differential transfer and dissemination of hypovirus and nuclear and mitochondrial genomes of a hypo-virus infected Cryphonectria parasitica strain after introduction into a natural population. Appl Environ Microbio 69(7):3767-3771

Hokanson S, Forsline P, McFerson J, Lamboy W, Aldwinckle H, Luby J, Djangaliev A. (1998) Ex situ and in situ conservation strategies for wild Malus germplasm in Kazakhstan. Acta Hort 484:85-92

Ibarra B, Barreau A,Del Campo C, Camacho C, Martin G, McCandless S (2011) When formal and market-based conservation mechanisms disrupt food sovereignty: impacts of community conservation and payments for environmental services on an indigenous community of Oaxaca, Mexico. International Forestry Review. 13(3): 318-337

Iliev S, Mirchev S (1992) Creating, growth and health status of the chestnut plantations (Castanea sativa ill.). 131–136 (in Bulgarian)

International Association for Impact Assessment. (2013). http://www.iaia.org/

Jankovsky L, Haltofova P, Palovcikova D (2010) New findings and vegetative compatibility groups of Cryphonectria parasitica (Murrill) M.E. Barr in the Czech Republic. Plant Protect Sci 46(1):28-33

Jarvis D, Brown A, Cuong P, Collado-Panduro L, Latournerie-Moreno L, Gyawali S, Tanto T, Sawadogo M, Mar I, Sadiki M, Hue N, Arias-Reyes L, Balma D, Bajracharya J, Castillo F, Rijal D, Belqadi L, Rana R, Saidi S, Ouedraogo J, Zangre R, Rhrib K, Chavez J, Schoen D, Sthapit B, De Santis P, Fadda C, Hodgkin T(2008) Global perspective of the richness and evenness of traditional crop-variety diversity maintained by farming communities. P Natl Acad Sci USA 105(14):5326-5331

Juhasova G (1999) Hubové choroby gaštana jedlého (Castanea sativa MILL.). VEDA, vydavateľstvo SAV, Bratislava

Juma C (1989) The gene hunters: biotechnology and the scramble for seeds. Zed Books. London

Kassam K (2009) Biocultural diversity and indigenous ways of knowing: human ecology in the Arctic. University of Calgary Press. Calgary, Alberta, Canada

Kanowski P Boshier D (1997) Conserving the genetic resources of trees in situ. In: Maxted N, Ford-Lynch B, Hawkes J (ed) Plant genetic conservation: the in-situ approach. Chapman and Hall. London. pp207-219

Kauffman D, Kray A, Mastruzzi M (2003) Governance matters III: governance indicators for 1996-2002. World Bank Policy Research Working Paper 3106. World Bank. Washington D.C.

Kelsey F, Zenos A (1889) Xenophon’s anabasis: books I-IV. University Press, John Wilson and Son. Cambridge

Körtvely A (1970) A gesztenye endótiás kéregelhalása. Növényvédelem 6:358–361

Krstin L, Novak-Agbaba S, Rigling D, Krajacic M, Perica C (2008) Chestnut blight fungus in Croatia: diversity of vegetative compatibility types, mating types and genetic variability of associated Cryphonectria hypovirus 1. Plant Pathol 57:1086-1096

Krushce D, Geburek T (1991) Conservation of forest gene resources as related to sample size. Forest Ecol Manag 40:145-150

Lappe F, Collins J, Fowler C (1977) Food First: beyond the myth of scarcity. Devo Press.

Lenné J, Wood D (2011) Agrobiodiversity revisited: agrobiodiversity management for food security: a critical review. CABI. Aberdeenshire, U.K.

Lerman Z, Sedik D (2010) Rural transformation in Azerbaijan. Lexington Books. Plymouth, U.K.

Mattioni, C., Martin M, Cherubini M, Taurchini D, Villani F (2010) Genetic diversity in European chestnut populations by means of genomic and genic microsatellite markers. Tree Genet Genomes 6:735-744

Maxted N, Ford-Lynch B, Hawkes J (1997) Complementary conservation strategies. In: Maxted N, Ford-Lynch B, Hawkes J (ed) Plant genetic conservation: the in-situ approach. Chapman and Hall. London. pp15-39

Mazoyer M, Roudart L (2006) A history of world agriculture: from the neolithic age to the current crisis. Monthly Review Press.

McMichael P (2008) Peasants make their own history, but not just as they please... *Journal of Agrarian Change*. 8(2,3): 205-228

Milgroom, M, Cortesi P (2004) Biological control of chestnut blight with hypovirulence: a critical analysis. Annu R Phytopathol 42:311-338

Milgroom M, Sotirovski K, Spica D, Davis J, Brewer M, Milevs M, Cortesi P (2008) Clonal population structure of the chestnut blight fungus in expanding ranges in southeastern Europe. Molecular Ecology. 17:4446-4458

Montenegro D, Aguin A, Sainz M, Hermida M, Mansilla J (2008) Diversity of vegetative compatibility types, distribution of mating types and occurrence of hypovirulence of Cryphonectria parasitica in chestnut stands in NW Spain. Forest Ecol and Management. 256: 973-980

Moris J (1991) Extension alternatives in tropical Africa. London: ODI, AAU Occasional Paper 7

Mooney P (1979) Seeds of the earth: a private or public resource? Canadian Council for International Cooperation. Manitoba, Canada

Nabhan G (2009) Where our food comes from. Island Press. Washington

Namkoong, G, Kang H (1990) Quantitative genetics of forest trees. Plant Breeding R 8:139-188

Nature (2010) Can science feed the world? Cover. July 29

NGO/CSO Forum for Food Sovereignty (2002) Food sovereignty: an action agenda. Rome

Nicastro J (2012) FAO accepts to debate food Sovereignty. Latin America Press.

Nunney L, Campbell K (1993) Assessing minimum viable population size: demography meets population genetics. Trends in Ecol and Evol 8:234-239

Nweke F (2002) The cassava transformation: Africa's best-kept secret. Michigan State University Press. East Lansing, Michigan

Patel R(2009) What does food sovereignty look like? Journal of Peasant Studies. 36(3): 663-706

People’s Food Sovereignty Network (2007) People’s food sovereignty statement

Perlerou C, Diamandis S (2006) Identification and geographic distribution of vegetative compatibility types of Cryphonectria parasitica and occurrence of hypovirulence in Greece. Forest Pathol 36:413-421

Pimbert M, Barry B, Berson A, Tran-Thanh K (2011) Democratising agricultural research for food sovereignty in West Africa. International Institute for Environment and Development. CNOP, Centre Djoliba, IRPAD, Kene Conseils, URTEL, Bamako and London

Prance G (1997) The conservation of botanical diversity. In: Maxted N, Ford-Lynch B, Hawkes J (ed) Plant genetic conservation: the in-situ approach. Chapman and Hall. London. pp15-39

Pretty J (1995) Regenerating agriculture. World Resources Institute. Washington, D.C.

Quaye W, Adofo K, Madode Y, Abizari A (2009) Exploratory and multidisciplinary survey of the cowpea network in Tolon-Kumbungu district of Ghana: A food sovereignty perspective. African Journal of Agricult Research. 4(4): 311-320

Radocz L (2001) Study of subpopulations of chestnut blight (Cryphonectria parasitica) fungus in the Carpathian basin. Forest Snow Landsc Res 76(3):368-372

Reardon J, Simon A,Perez R (2010) Agroecology and the development of indicators of food sovereignty in Cuban food systems. Journal of Sust Agricult. 34: 907-922. 2010

Robin C, Heiniger U (2001) Chestnut blight in Europe: diversity of Cryphonectria parasitica, hypovirulence and biocontrol. Forest Snow Landsc Res 76(3): 361-367

Rosset P (2008) Food sovereignty and the contemporary food crisis. Development. 51(4): 460-463

Ruttan V, Hayami Y (1972) Strategies for agricultural development. Food Research Institute Studies in Agricultural Economics, Trade and Development. 9(2): 129-148

Shakiliyev M (2003) Planting the future. Azerbaijan International. Winter (11.4): 30-35. Baku.

Shaw J (2007) World food security: a history since 1945. Palgrave Macmillan. New York, New York

Shelton N (2003) Azerbaijan: environmental conditions and outlook. Journal of the Human Env. 32(4):302-306

Sotirovski K, Papazova-Anakieva I, Grunwald N, Milgroom M (2004) Low diversity of vegetative compatibility types and mating type of Cryphonectria parasitica in the southern Balkans. Plant Pathol 53: 325-333

State Committee on Ecology and Control of Natural Resources Utilization (1998) National Environmental Action Plan. Baku, Azerbaijan

State Statistical Committee of Azerbaijan (2002) Agrarian Reforms in the Republic of Azerbaijan. Baku

State Statistical Committee of the Republic of Azerbaijan (2009) Population by ethnic groups, by native language and freely command of languages

Sterling E (1903) Chestnut culture in North Eastern United States. J. Lyons company. Albany, NY

Tomlinson M (2007) School feeding in east and southern Africa: improving food sovereignty or photo opportunity? Health Systems Research Unit, Medical Research Council

Trestic T, Uscuplic M, Colinas C, Rolland G, Giraud A, Robin C (2001) Vegetative compatibility in Bosnia-Herzegovina, Spain, and France. Forest Snow Landsc Res 76(3):391-396

United Nations Development Programme (1997) Azerbaijan human development report 1997

United Nations Development Programme (1999) Azerbaijan human development report 1999. Baku

Uscuplic M (1961) Occurrence of sweet chestnut blight in Bosnia. Narodni Sumar. 10(12):581–588

Valdezate C, Alzugaray R, Landeras E, Braña M (2001) Situación actual de Cryphonectria parasitica (Murril)Anderson, cancro cortical, en los castañares asturianos. Boletín de Sanidad Vegetal Plagas 27:401–410

Vavilov, N (1926) Studies on the origin of cultivated plants. Bulletin Appl Bot 261-128.

Via Campesina (1996) The right to produce and access to land: food sovereignty: a future without hunger. Rome, Italy

Villani F, Pigliucci M, Cherubini M (1994) Evolution of Castanea sativa Mill, in Turkey and Europe. Genet Res 63(2):109-116

Wale E (2011) Introduction: setting the scene for GRPI economics. In: Wale E, Drucker A, Zander K (ed) The economics of managing crop diversity on-farm: case studies from the genetic resources policy initiative. Earthscan. Washington. pp3-21

Wall J (2012) The important role of chestnut production in northern Azerbaijan and strategies for conservation in the face of blight, Cryphonectria parasitica. MPS Project Report. Cornell University. Ithaca, New York

Wittman H (2011) Food sovereignty: a new rights framework for food and nature? Environ and Society: Advances in Research. 2(2): 87-105

Windfur M, Johnsén J (2005) Food sovereignty: towards democracy in localized food systems. ITDG Publishing. Warwickshire, U.K.

Yalçin-Heckman L (2010) Return of private property: rural life after agrarian reform in the Republic of Azerbaijan. Transaction Publishers. Piscataway, New Jersey