

The Role of Local Institutions in the Conservation of Plant Genetic Diversity

Evan Dennis¹, Jaralkasim Ilyasov², Eric Van Dusen³, Sergey Treshkin², Marina Lee², Pablo Eyzaguirre¹

¹ International Plant Genetic Resources Institute, Rome, Italy; ² International Plant Genetic Resources Institute, Tashkent, Uzbekistan; ³ University of California at Berkeley, Department of Economics

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Introduction

Farmers' decisions that promote the production and use of local varieties in agricultural systems are important for the *in situ* conservation of globally important plant genetic resources (Brush, 1999, pp. 7-8; Eyzaguirre, 2001. pp.1-2). Maintaining traditional varieties that remain central to farmers' livelihood strategies demand policies that build upon local values, cultures, and traditional resource rights. Support for the conservation of plant biodiversity needs to begin by identifying the existing community-level institutions that govern tenure and access to land and associated biological resources and then considering how they are affected by changes in policy frameworks. Community institutions provide sets of rules, norms, and guidelines- sometimes contradictory- that establish the framework in which farmers' make decisions about which varieties to cultivate. Institutions may include local traditions, market forces, or cultural values; and unless carefully coordinated, the various institutions often provide contradictory sets of incentives. Understanding the mechanisms linking competing local-level and formal national institutions to individual decision-making, requires a strategy to systematically identify the total number and various types of pathways by which local institutions influence individuals' choices.

This paper presents a theoretical framework grounded in an empirical study of community-level institutions important to the maintenance of plant genetic resource diversity in the Samarkand region of Uzbekistan. From May to August 2003 our team administered 400 household surveys and 80 group surveys of socioeconomic and institutional factors associated with farmers choices on crop diversity. In addition the team collected ethnobotanical and agromorphological data about local fruit varieties in 20 villages in the region. Based on a preliminary analysis of that data, we identify a set of guidelines for comparing local institutional characteristics between households, and reference a preliminary analysis of the collected data. These guidelines provide a means to better understand the institutions that surround and condition the social and biological processes whereby farmers maintain significant amounts of agricultural biodiversity. Among the more fundamental institutions are those governing land tenure and access to plant genetic resources. In this paper, the identification of the local land tenure and resource management institutions provides a baseline for developing policies that promote the continued use of agricultural biodiversity as a means to advance more secure livelihoods for farmers in Central Asia.

The Institutional Context of Farmers Decision-Making

By lowering the costs of conveying, coordinating, and measuring variety specific information and materials, institutions play a paramount role in the exchange and use of plant genetic resources (PGR) essential to farmers' livelihoods. Institutions are "the humanly devised constraints that shape human interaction...[and] reduce uncertainty (North, 1990, 4)." As "complexes of norms and behaviors...serving a collectively valued purpose," they "persist over time" as the smallest units of organized social, cultural, and political development (Uphoff, 1986, 8)." We can apply this concept of institutions to farmers' knowledge of crops, cultivation techniques, taste preferences, their customs and traditions that are shaped and transmitted via interactions among individuals in an agrarian setting. Viewed within the context of a social framework, a farmer's cultivation decisions are not made independently from the community in which he lives. The individual farmer's choices are situated in a context of social and moral obligation; the world around him mediates his preferences, determines his abilities to access seed and information, and assigns values to his choices.

Agreement about the meaning of objects and actions, which are embodied as customs, tradition, and ritual, facilitate the movement of information and material among individuals (Blumer, 1966, 539). The significance of such cultural institutions as pathways for conveying values and knowledge over multiple generations was demonstrated in Berlin's research about folk taxonomy of plants among indigenous communities of Mexico. "In a comparison of relatively complete inventories of plant species between two Mayan-speaking communities separated 1200 years ago," Berlin found "that the number of cognate forms drop from 87% cognates for cultivated species" to 17 percent for plant species only sporadically managed (Berlin, 1992, 205). The amount of environmental knowledge transmitted over generations via the naming of the natural world correlated highly with the importance of the plant within everyday life. Cultural institutions did the best job accurately transmitting information most commonly used. The information associated with intermittently managed plant species, less important than cultivated species to livelihoods of agricultural communities, was less systematically preserved. Just as cultural institutions transmit names, community institutions transmit information about the uses, cultivation strategies, and processing of crop varieties- components of the seed system that are as important for variety maintenance as actual planting material.

Institutions also facilitate exchange and movement of materials in the more prosaic sphere of economics. They provide frameworks constraining actions to facilitate transactions between communities of farmers. Institutions minimize PGR transaction costs by establishing norms to bring together interested individuals, promoting an environment where opportunism can be minimized, and reducing the costs of learning about novel plant varieties. "The absence of constraints...can lead to exchange not taking place at all because the exchange is unenforceable. Informal constraint can take the form of agreed upon lower costs...[etc]. Such organizations and institutions that make norms of cooperative behavior (informal constraints) effective are ... a major part of the story of more complex exchange through history (North, 1990, 41)."

The norms and cultural behaviors (e.g., institutions) that are formally transmitted through rules and precedents in association with criteria for membership are commonly defined as "organizations". Organizations provide institutional structures within which individuals may interact according to agreed rules and procedures around a shared purpose. According to

Norman Uphoff “organizations, whether institutions or not, are structures of recognized and accepted rules, supported by rules, procedures, and precedents (Uphoff, 1986, 9).” Organizations are socially constructed objects, “not self existing entities with intrinsic natures (Blumer, 1969, 539),” with defined membership criteria. Organizations and institutions are essential components of the system of exchange and movement of plant genetic resources and related information. They are used by farmers when obtaining access to seed and agricultural information. While these are most commonly seen as seed companies or formal extension services or development projects, there are also local institutions and organizations that are important for the exchange of information and plant genetic resources that are often ignored and poorly understood. This lacuna is the result of the fact that the local institutions for plant genetic resources are often embedded in other cultural institutions or organizations, or they are so universally shared in a given cultural context that they do not stand out. North writes that “...[C]ulture defines the way individuals process and utilize information and hence may affect the way informal constraints get specified (North, 1990, 42).” The studies undertaken in Uzbekistan suggest that these less visible institutions and organizations play a central role in shaping and passing information between community members that can influence individual farmer’s choices and access to new planting techniques or crop varieties. More formal organizations, such as growers associations, can also minimize the economic costs associated with obtaining access to planting material, including the normal costs of purchasing and transportation expenses.

Community-level organizations for the collective management of natural resources have been shown by Ostrom to responsibly and rationally manage scarce resources under a variety of circumstances (Ostrom, 1990). The most successful examples are organizations managing a distinct resource from which users directly obtain tangible and soon-realized benefits. PGR, unlike other natural resources such as forests or water, does not derive its value solely from the physical artifact itself - the proteins that make up the genes. Much of its value is determined when engaged in a relationship with the ecosystem, farmers, and scientists. Genetic varieties are valuable because they contain characteristics *that are different from the characteristics of other varieties*. The value that plant genetic resources provide to breeders, farmers, humanity, and the ecosystem is an ability to adapt to changing environmental, market, and social conditions.

The benefits of PGR are neither soon realized nor particularly tangible; and no examples of natural resource management organizations like those described by Ostrom exist for managing PGR at a community level in Uzbekistan. Three of six variables Ostrom identified as consistently influencing the outcome of collective action fluctuate or are not quantifiable for PGR (Ostrom, 1990, 186).¹ Plant genetic resources are not managed in the same way as other resources, and in turn, this makes organizations around them difficult to measure by traditional criteria. Although all of the farmers we interviewed in Uzbekistan shared a common interest in, and lament the loss of, local plant diversity (one of the six variables identified by Ostrom as requisite for successful management), farmers are incapable of developing organizations specifically to manage PGR. PGR is a unique example where locally shared norms may not translate into organizations for the direct management of a natural resource. Plant genetic resources are managed indirectly, via the promulgation of shared cultural and taste preferences.

¹The three fluctuating variables are 1) the total number of participants minimally necessary to achieve the collective benefit, 2) the discount rate in use, and 3) the total number of decision-makers (Ostrom, 1990, 186)

The goal of this paper is to test whether differences in the numbers and types of local institutions and organizations influence a region's agricultural biodiversity by affecting the movement of genetic resources (crop varieties) within villages, between villages, and over the region as a whole. Our research in rural Uzbekistan presents and tests a methodology for studying the social mechanisms and institutions influencing individual crop choices and the consequences on the local and regional biodiversity. We hypothesize that the more influential an individual's decisions are on their peers, the greater the cultivation of local landraces, and the greater the amount and use of crop genetic diversity at the village or district level.

An individual farmer growing a cultivar that has genetic diversity value produces a positive externality for his neighbors if it is circulated and used in creating a robust and stable regional production system. Given this premise, our second hypothesis is that the interplay between the private good and the public externality of individual cropping decisions determines the extent to which individuals' decisions affect other members of the community. The speed at which local plant varieties spread and foreign varieties are adopted contributes to the rate of change in a region's agricultural biodiversity. This can result in the genetic erosion of some crops as traditional cultivars with unique traits are displaced; or alternatively it could result in a situation where traditional cultivars along with new and modern cultivars are more widely exchanged and used as farmers adapt to new environmental, economic, and policy conditions.

The impacts of institutional changes affecting farmer decision-making in Central Asia are as yet not understood, they can be favorable or unfavorable to biodiversity and secure livelihoods. Our study aims to provide some preliminary local-level data that may help explain the institutional change process and suggest policy responses to achieve biodiversity conservation and rural development goals.

Mapping and Measuring Institutional Pathways

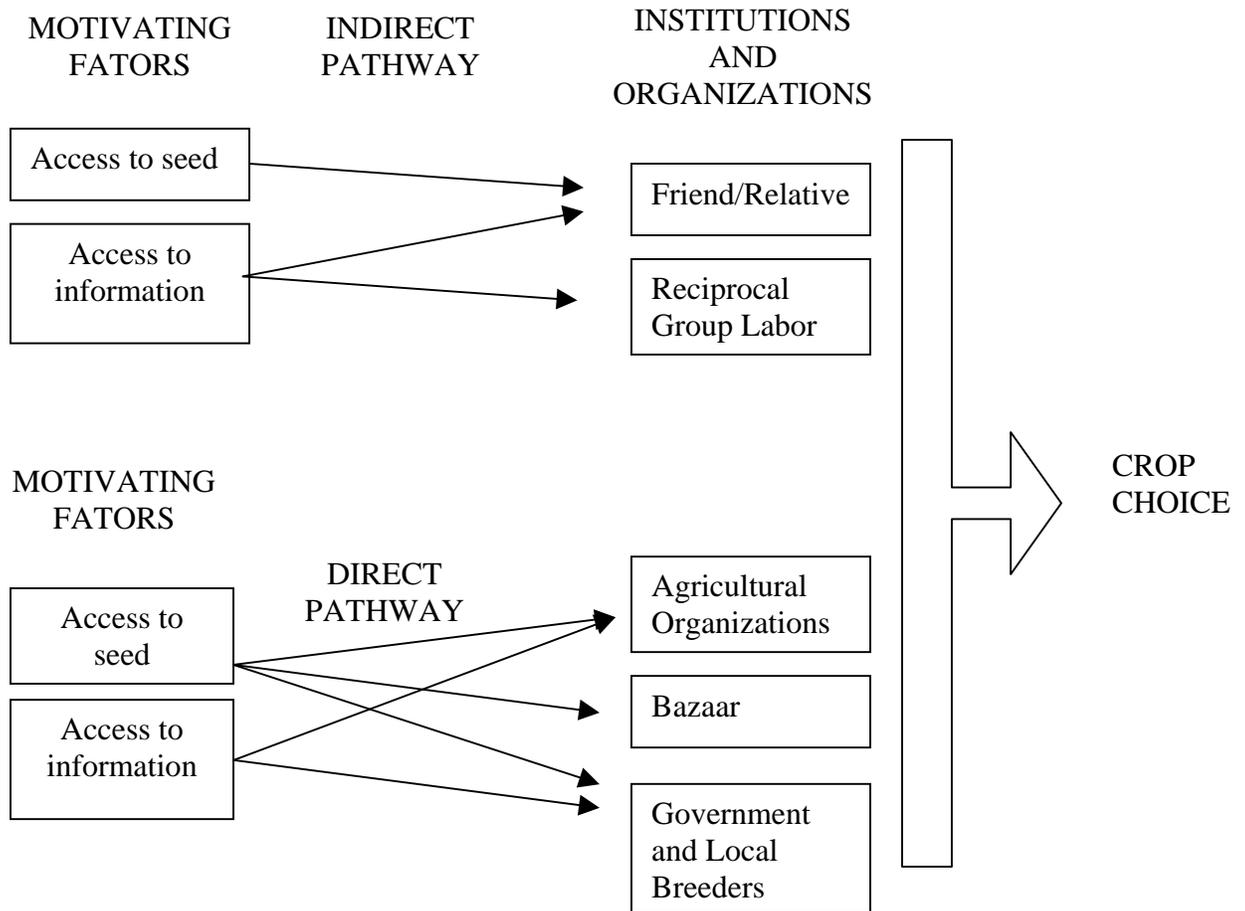
The starting point for describing and measuring the institutional framework was to identify those organizations and institutions through which people socialize to share information. Not all institutions and organizations for socialization are germane to PGR, however there are sets of institutions that operate in each village that comprise the institutional landscape in which farmers decide what to plant. These institutions reflect the power, social, and economic relationships in the locality. Based upon our initial research in Uzbekistan, we compiled a list of the institutions and organizations operating at the village level that farmers use to gain access to seed and agricultural information. We also interviewed other actors in the agricultural system including middlemen, processors, state collective farms, and input suppliers to develop a complete picture of the institutional framework. We catalogued the larger social, communal, and political frameworks that determine where and when farmers can gain access to seed and information, and other needed agricultural inputs like water and fertilizers.

We theorize that access to seeds and access to agricultural information about when and how to cultivate are the motivating factors around which farmers organize. Our survey revealed that farmers choosing to plant new varieties of fruit trees are concerned with where and how to gain access to the most appropriate varieties (genetic diversity) and where and how to obtain information about the proper cultivation of varieties that are not traditional to the village. As has been demonstrated elsewhere, traditional systems are not closed and isolated with respect to the

flow of genetic material (Louette, 1999, 133; Perales, 2003). Within traditional agrarian societies there is a strong motivation to share material and information about plant varieties, traditional or new. This cultural institution is central to the management of crop genetic diversity. Seen in this light, a seed system is a form of collective behavior that is neither hierarchically organized nor formalized in the eyes of those who participate in it. It is an evolving pattern of collective action based on local norms. Consequently, collective action around plant genetic resources is extremely adaptable.

In rural Uzbekistan, agriculture is a near universal occupation and it is common for men and women to talk about the topic whenever and wherever they meet. Much sharing of agricultural information occurs through institutions of friendship or familial relations and in forums with a primary purpose unrelated to agriculture. In such instances the pathway between access to agricultural information and particular institutions or organizations is indirect. Organizations and institutions that are indirect pathways are significant to the exchange of information and material because they bring people together; and because agriculture is a common topic of conversation, expertise and experiences are shared. Participating in an organization or institution with a primary purpose related to agriculture is a direct pathway to receiving access to seed and information. Figure 1 shows the kinds of relationships between motivating factors and pathways, and provides examples of institutions and organizations associated with each type.

Figure 1



Some of the groups listed in figure 1 such as agricultural groups are formal, recognized by the State as legal entities. Other relationships through which access is gained are more situational or personal and not recognized by the State- a common example are sons who have migrated to a different district or region and bring back foreign seeds.

The bazaar or marketplace straddles both classifications; it is a formal open access organization with clear rules to which everyone belongs while at the same time constituting an informal institution transmitting norms for the exchange of materials and information. The authorities allow bazaars to operate regularly during the springtime although their wares are unregulated by the State. Bazaars provide a direct pathway to seed but are usually an indirect pathway for information. Information on local seeds is not exchanged within a well-defined system of intellectual property rights. The most formalized organizations are the government run plant research institutes. Regulated by the State, the research institutes provide guarantees and insurance² on both the seed and the information about the seed that is not as readily available from the informal seed system. In this way the formal public seed and germplasm institutions actually reduce transaction costs in the classic sense by ensuring viability and providing accurate information on the variety.

² Farmers may return varieties to the research institutes if they are the inappropriate types.

For farmers planting traditional varieties maintained in local seed systems, trust underlies every exchange of PGR material and information. The vigor of the seed and the accuracy of received agricultural information can only be validated after significant costs in time and land have been sunk. It is therefore not surprising that trust in the accuracy of the information associated with seed or germplasm are real concerns of farmers. Farmers minimize transaction costs such as seed failure or disease that may result from growing impure or locally bought or bred varieties by accessing materials through institutions and organizations in which they have high levels of trust. Trust based upon social capital-“the web of social relations that underpins all human actions and that...defines their outcomes” (Forni, 1998)- facilitates transactions. Social relationships remain the predominant source of information about other’s trustworthiness and agricultural knowledge, and they are used to assess the trustworthiness of PGR material and the accuracy of agricultural information. Trust underlies the use of institutions like village elders, friends, and relatives as sources of agricultural information and seed.

The strongest social capital accompanies kinship relations. In discussions with farmers, we found that friendships and family ties remain the paramount factors when identifying trustworthy sources in the informal seed system. In rural Uzbekistan, many marriages are arranged by fathers as a means to strengthen family alliances, and Uzbek culture esteems responsibility to the extended family. Tradition expects a brother in law’s family to support a widow and the majority of business ventures are partnerships between brothers, fathers, uncles, and cousins. A tacit trust between friends or relatives attenuates the risk of malicious transactions. Understanding the movement of seed and information at the farmer-level requires acknowledging the different levels of trust in the set of local institutions and organizations functioning at the village level.

Distinguishing among indirect and direct pathways for accessing agricultural information and PGR material internalizes the dual producer and consumer roles of households in the seed system and recognizes the importance of farmer’ trust levels in the choice of institutions and organizations that they use as sources. Patterns of access explain how culture, norms, and organizations shape PGR exchanges among different actors - allowing some actors to interact while keeping others apart; and patterns of access can explain why some institutions and organizations are utilized for seed and information more than others. With this new perspective, we may eventually be able to model the impact on the seed system of normative and institutional changes resulting from policy.

Institutions and Organizations in Rural Uzbekistan

Uzbek traditions of cultivating fruit in garden plots go back for millennia and associations with fruit varieties continue to be a form of village identification. Fruit cultivation and cultural institutions continue to structure everyday life and remain central in the lives of everyday farmers. Below, each institution or organization operating at the community-level is described in brief. The inclusion of both direct and indirect pathways for access to seed and agricultural information reflects our interest in the entire institutional structure of the village. The Urgut district of the Samarkand region where we undertook our research is famous for its grape varieties and tobacco cultivation. According to village historians, before the Soviet apparatus collectivized land every family had old gardens located some distance from their house where they cultivated local and ancient fruit varieties.

Mahalla (Neighbourhood)

In Uzbekistan acting like a good neighbour is an ethnic and national obligation. Villagers are obligated to participate in both celebratory and memorial festivals for their neighbours and neighbours may share food or other useful things. During our discussions with farmers we were told that neighbours provide unsolicited agricultural information, and that our respondents often provide advice to neighbours. However, the friendly exchange of information is becoming scarcer as communities are adopting a more modern understanding of the competitiveness and the value of information.

Suhbot -

The *suhbot* is the most common organization in rural Uzbekistan. Groups of a dozen acquaintances and friends gather bi-weekly for entertainment and socializing at a different member's house each meeting. The *suhbot* is a Central Asian tradition that regained popularity in the 1970s when the old custom incorporated a ritual of reciprocal exchange of consumer goods. The *Suhbot* provides members access to capital using a simple ROSCO mechanism. At each meeting participants contribute a small and equal sum of money, which is then given to the host. The honor of hosting the *suhbot* rotates among the group members. In most cases in Urgut, the amount contributed at each meeting was indexed to the price of meat as a safeguard against inflation. Some respondents belonged to more than one *suhbot*. In our section describing data results, the number indicator after the term *suhbot* refers to the 1st or 2nd *suhbot* to which a respondent belonged.

Mahalla committee

The *mahalla* is a traditional local-level organization serving as the judiciary of the village and it applies local norms of trust and fairness to disputes within the village. Officially, the *mahalla* is an administrative unit defined by a neighborhood block and sometimes centered around a tea-house (*chayhana*) where social and ritual functions are performed.

The *mahalla committee* provides a forum for male elders, farmers and community leaders to discuss community problems and take voluntary collective action (*hashar*). *Mahalla* members sometimes discuss the erosion of genetic diversity in the village, although they more often discuss exigent threats to agriculture³. As a forum to discuss problems and share solutions, the *mahalla* facilitates awareness about local varieties and the movement of information necessary for their proper cultivation. In its judicial role, the *mahalla* effectively minimizes the risk that diseased, under performing, or improper genetic material or agricultural information will knowingly and maliciously be sold or given away in a transaction. Unfortunately, the *mahalla* is ineffective in situations of crop failures caused by improper seed materials or information that was provided without malicious intent.

Weddings

The wedding is the most important cultural and religious ceremony in village life and most of the weddings occur during the springtime, summer, and fall. Almost the entire village as well as young people from surrounding villages attend the two-day long festivities of dancing, music, and food. Wedding celebrations are the primary location where young couples meet and serve as

³Problems discussed by the mahalla committee are often those resulting from the industrial farming practices implemented under the Soviets. Issues discussed include a rising water table, a spreading fungus epidemic affecting fruit trees, a diminishing crop yield, and the drought which occurred in both 2000 and 2001.

places where reciprocal gifts are exchanged. Relatives assist each other financially, using presents as loans against the costs of future weddings in their own immediate family. At weddings men don't talk about work per se, but they discuss interesting developments in agriculture. They take advantage of the preparation day before the wedding to talk about farming with people whom they don't otherwise have time to see.

***Hudoyi*, Holidays and Religious Rituals**

In Uzbekistan, villagers celebrate a mix of patriotic holidays, Muslim rituals, Zoroastrian traditions. Holidays include Navruz (21st of March), Independence Day (1st of September), Iyd-al-Fitr (After Ramadan), and Iyd-al-Adha (After the Pilgrimage). Other festivals include Mustaqilik, Children's day, New Year's Eve, Yilboshi (beginning of a year), and Darveshona. The most prominent Muslim custom is the *hudoyi*, meaning thanksgivings to Allah. The *hudoyi* involves giving food to the community or poorer community members as a public act of sacrifice. It is performed for a variety of reasons including a death in the family, the success of a family member (e.g. a promotion or a return from abroad), or the purchase of an expensive item (e.g. a car). The *hudoyi* is commonly celebrated multiple times a year and it is a common cause of hardship for families who often accrue debt in order to celebrate it on a member's behalf.

Hashar

Hashar is reciprocal self-help and it either can be publicly organized by authorities for the construction of a community good (e.g. the cleaning of drainage ditches or the building of a communal football pitch) or it can be privately organized by individuals (e.g. building a house, harvesting, planting and sowing). Participants in *hashar* don't receive payment for their services but are traditionally fed for the day or receive a share of the day's harvest. During discussions we learned feeding *hasher* helpers was becoming more expensive, and in many communities people were hiring day labourers instead of organizing private *hashers*. However, *hashers* remain the second most important source of labour (~ 15% according to group interviews in villages with men) after the family unit. In villages in the Urgut, *hashar* is necessary for the cultivation of grapes, which require covering with mud during the winter seasons and uncovering during the spring.

Other gathering spots

Villages gathered frequently at a variety of locations to discuss the day's events and share agricultural and social gossip. People commonly gather at the *butka*- local shops, at schools after the last bell, at mosque, around the water pump, at the *guzar* (the center of the village), or at the *chaykhana*- the traditional teahouse where villagers drink tea and relax.

Bazaar

For millennium great bazaars have operated in Uzbekistan and bazaars helped established the Uzbek's historic reputation for trading products between the East and the West. Nowadays, a bazaar culture encouraging sellers and buyers to openly bargain, continue to make selling in the bazaar cost effective for *dekhons* (peasant farmers). *Dekhons* normally sell beside middlemen and retail operators in the bazaar and pay a small cash fee- a *patta*- to the bazaar manager for the rent of a space.

During the planting months every spring, a bazaar specializing in seeds and saplings operates in Urgut district. Varieties from the formal seed sector (the Shreder Institute) are sold alongside saplings from local breeders and individual *dekhons*. Local bazaars, smaller in size and offering,

also operate. Their prices are generally lower than district or city bazaars but every village is near a local bazaar and the transportation costs are less than traveling to the district bazaar, which can be up to ninety minutes away. The costs of obtaining price and demand information from state or legal institutions are much higher than from obtaining information directly from the bazaar.

Shirkat (formerly *kolhoz*, *sovhozes*, and *jamoas xujaliks*)

The *shirkat* is the last remaining structure of the collective farm system from the Soviet period. The controlled and gradual destatization of state structures has become the dominant feature of the Uzbek economic transition since 1991 and has allowed the government to retain centralized control over economically vital cotton and wheat crops (Bloch, 2002). The *shirkat* is the main producer of agricultural products and the sole major employer of the local labor. Between 1991 and 1996 *shirkats* became the largest employer (Bloch, 2002). Many women who identified themselves as housewives were registered in *shirkats* as workers, where about half of the workers are women (Thurman, 2001, 15). In most *shirkats* the majority of land is distributed under contract to family *pudrats* (work units) that contract with the administration to work the land. Usually *shirkats* provide *pudrats* with land, machinery, water, fertilizers, seeds (saplings) and chemicals, receiving either in-kind or cash payment. Many *pudrats* feel that they do not receive a fair portion of the harvest and that the *shirkat* doesn't fulfill its obligations to them. *Shirkats* are currently administered as sharecropping companies and rent land to families for 1, 2, 3, 5 or 10 year leases to grow specified crops -usually wheat and cotton.

Some *shirkats* specialize in fruit production (grapes in Urgut district) while others grow cotton and wheat. Until 1998 the *shirkat* also organized and administered all aspects of village social life, but now the *mahalla* committee has taken over community affairs such as the distribution of welfare, the maintenance of roads, and the resolution of conflicts. However, land remains under the purview of the *shirkat*, and the provision of electricity and water is still authorized by the *shirkat*. Newlyweds appeal to the *shirkat* for land on which to build a home and garden and they often must wait as long as 4 years before receiving a plot.

Most villagers are *dekhons*- small holder farmers cultivating between .08-.3 hectares of land. *Dekhon* families may also work on *pudrats* or for larger farmers called *firmirs*, who cultivate from 1-100 hectares.

Government Research Institute (Shreder Institute)

The Shreder institutes are government agricultural research institutes located throughout Uzbekistan and originally engaged in the production and distribution of local and foreign plant varieties for *shirkats*. The Shreder Institute now supply large *firmer*s, *dekhons*, and middlemen (usually Shreder workers) high quality, genetically stable, and disease-free saplings. At one time the Shreder research institutes were well funded by the Soviet government, but currently they operate with drastically reduced central funding. Aging Shreder scientists, dedicated to conserving local varieties and having knowledge of the local conditions, maintain a wealth of biodiversity in *ex situ* field genebanks throughout the country.⁴ The Shreder Institute is considered to be the most reliable and best source of seed by all strata of agricultural workers. Shreder laborers who sell cuttings and saplings from the institute's collection in the district and regional markets maximize the institute's impact.

Findings

The data presented below were collected from a household survey administered in 127 randomly selected households in 10 villages in the Urgut district of Uzbekistan. We measured levels of participation in various organizations and institutions, the frequency with which people talked about fruit, and where farmers accessed foreign PGR material. We inquired about all institutions and organizations in which farmers participated in order to document both direct and indirect pathways of the seed system.

Agricultural Information.

Agricultural information comprises the knowledge about planting, care, yield, and other information that farmers need when they obtain and cultivate a variety that is new to them. Access to agricultural information is a fulcrum around which institutions and organizations develop and the need for it motivates participation in existing multi-functional institutions and organizations. Farmers use multiple sources to acquire agricultural information, including *oxacols* (wise-men) in the village, the experts at the collective farm, and the farmer's organization to which they belong. In rural Uzbekistan, reliable agricultural information is almost exclusively conveyed through discussions, and it is rarely gathered from newspapers, radio, or the TV. We had identified several institutions and organizations during preliminary field visits as multi-purpose, or whose primary purpose was not to provide access to agricultural information or seed. These institutions were likely to be important for the exchange of all types of information, including agriculture.

In order to measure the efficacy with which multi-functional institutions and organizations served as pathways or mechanisms for the flow of seed and germplasm information, we compared the frequency with which members spoke about fruit in each organization and institution that served as an *indirect* pathway to agricultural information. We found that conversations about fruits took place in all types of organizations and institutions- even in semi-formalized gathering of friends that are a source of credit (the *suhbot*). We asked participants of eleven institutions and organizations to rank how often they talked about fruit according to rarely, sometimes, and often, and we found variation between groups in the frequency with

⁴ Some of the centers have 600 hectares of ex-situ orchards

which members discussed fruit. Table 2 shows the relative frequencies with which participants spoke about fruits. In the *Guzar* and *Suhbot(1)* and *Mahalla* villagers spoke about fruit most often. Some institutions and organizations that acted as *indirect pathways* were used by a higher percentage of participating individuals as a source of agricultural information, indicating that some institutions and organizations were more efficient than others, for those who participate in them.

Table 2 - % of Male Heads of Households in Urgut who Participate in the Organization and Talk About Fruit

Institution name	N =	% talk fruit rarely n=various	% talk fruit sometimes n=various	% talk fruit often n=various	Total % talk fruit n=various	% talk fruit often or sometimes n=various
Guzar	81	1%	57%	30%	87%	86%
Suhbot(1)	32	6%	54%	28%	88%	82%
Mahalla	83	1%	55%	25%	81%	80%
Chaykhana	8	0%	66%	13%	79%	79%
Hashar	69	1%	47%	25%	73%	71%
Suhbot(2)	119	8%	51%	10%	70%	61%
Wedding	119	8%	51%	10%	70%	61%
Market	85	14%	45%	11%	69%	55%
Other festival	79	9%	39%	9%	57%	48%
Work brigade	44	4%	27%	16%	47%	43%
Other	3	0%	39%	0%	39%	39%

Usually the frequency with which people spoke about fruit was related to the number of people using a particular institution or organization; but some institutions and organizations had many more users than others and were sources of agricultural information for a larger number of people. Table 3 shows the number of people who use the different institutions and organizations as *indirect* sources of agricultural information- defined as the number of people who talk about fruit often or usually. The Wedding and the *Suhbot(2)* were used by the greatest number of villagers as a source of agricultural information because they were the institution and organization in which most community members participated. As we will show below, although the Wedding and the *Suhbot(2)* placed low in the ranking of efficiency (Table 2), as forum for sharing agricultural information they were the most effective as *indirect pathways* for obtaining agricultural information for the community as a whole.

Table 3 - % of Male Heads of Households in Urgut who Participate in the Organization or Institution and Talk About Fruit

Name of Institution	Number of people talking sometimes or often about fruit	% of people talking sometimes or often about fruit
Suhbot	73	61%
Wedding	73	61%
Guzar	70	86%
Mahalla	66	80%
Hashar	49	71%
Market	47	55%
Other fest.	38	48%
Suhbot	26	82%
Work brigade	19	43%
Chaykhana	6	79%
Other	1	39%

Seed Access

Seed access comprises of the group of exchanges and transfers of genetic material that together with agricultural information are known as the “seed system”. Because all rural families cultivate a household plot and almost every citizen has a basic knowledge of agriculture, labor movements introducing immigrants to new crop varieties provide for a significant source of gene transfer within the country. Institutions of friendship, community identification, marriage and familial relations, and any organization that brings people together and provides an environment for socialization, create opportunities for seed access.

We examined whether particular institutions and organizations were better sources of access to seed than others. We inquired about the six most common organizations and institutions farmers identified during the background discussions as sources of foreign varieties of seeds. Three organizations were *direct pathways* by which farmers obtained seeds, and they were organized for the explicit purpose of providing seed; these included the Shreder Institute, the district bazaar, and the breeder. Farmers also said they received planting material from individuals with whom they have relationships and mutual obligations. Relatives, neighbors, and wise-men are *indirect pathways* by which farmers gain access to seed. We discovered a three-fold variation in the number of users of different sources for foreign seed. We were surprised to find that greater numbers of farmers said they used *indirect pathways* for accessing seed.

Table 4.

Number of Male Heads of Household who go to organization for foreign varieties of seed

Shreder	District. Bazaar	Breeder	Relative	Neighbor in Mahalla	Oxacol
33	13	22	40	38	30

The Shreder Institute was the only *direct pathway* that was frequently used as a source of seed—probably because it is the most trusted source of saplings in the country and provided the greatest selection. District bazaars were said to be the least utilized. We believe that this relates to the untrustworthiness of seeds obtained at bazaars, where there are no guarantees nor social capital infrastructure that can insure the seeds are safe. The findings suggest that the mechanism of trust in seeds plays an important role in determining where people go for seed.

Table 5.

No. Male Head of Household who find these institutions effective as sources for seed access

Formal/ Informal	Institution name	Number who use institution	Number of Users who Find it “Always” or “Usually” Effective	%of Users who Find it “Always” or “Usually” Effective	Effectiveness ratio
Formal	Shreder	33	29	88	0.63
Semi-For.	Breeder	22	18	82	0.50
Informal	Relative	40	28	70	0.45
Informal	Oxacol	30	12	40	0.41
Informal	District. Bazaar	13	8	62	0.41
Informal	Neighbor in Mahalla	38	20	53	0.39

Our second hypothesis was that direct pathways are more effective in providing access to foreign seed (new varieties) than *indirect pathways* as sources of seed. When farmers rank each institution and organization for its effectiveness, we found that some institutions rank by farmers as 88% “always” or usually “effective” while others rank as only 40% “always” or “usually” effective, even though they had the same number of users (See Table 5). Effectiveness is determined by asking respondents to rank on a scale of 1 to 5 how effective the institution or organization is as a source of foreign seed. Because “1” is the highest score, we took the inverse of the average of the sum of the responses. The effectiveness ratio provides a metric of how important a source is to the individuals who use it.

We found that the two most effective institutions, the Shreder Institute and the village breeder, are *direct pathways* to access seed. Less effective institutions for access to seed tend to be *indirect pathways*. The three most ineffective institutions or organizations are *oxacols* (wise men), the bazaar, and neighbors in the village. Although relatives are an *indirect pathway*, they rank third as an effective source of seeds because the strong feelings of trust facilitated by familial relations lower the risk of using seed obtained from this supplier. The low ranking of the bazaar (which had the same effectiveness ratio as *oxacols*) is a consequence of the low level of trust in the quality of the information received there. With little social capital between buyers and sellers in the bazaar, farmers face a risk that the material they obtain there is not the stated variety, is diseased, or may not produce well in their micro-environment.

According to farmers’ responses, the most effective sources of seeds are the formal seed sector supplied by governmentally trained plant breeders. The rural people have a history of interaction with scientific experts, agronomists, and horticulturists on state farms. Decades of dominance by agronomists of state farms operating according to “scientific principles” have contributed to a deep respect of farmers for “experts,” even as the environment has deteriorated around them. The formal system of Shreder institutes provides guarantees that its saplings are disease free and truly are the advertised varieties. Throughout Uzbekistan the Shreder institutes function as a decentralized research organization and raise revenue by selling planting material to *dekhons* (small farmers) and state farms, and by providing technical advice to *firmeres*. The institute’s plant breeders typically recommend five varieties in each village which are best suited to the local conditions. Varieties are offered at prices not greatly different from bazaar prices but more expensive than locally-bred saplings. Middlemen and Shreder workers who unofficially acquire planting material also routinely sell Shreder tree stock at the bazaar. Semi-formal, local plant breeders are also considered to be a highly effective source of seeds. Local plant breeders have proliferated since the population has been allowed to publicly engage in market relationships, and now there is nearly one local plant breeder in every large village

The third hypothesis we wanted to test was whether the number of organizations in which an individual participates is related to receiving more agricultural information and better access to seeds. Multiple factors determine a farmer’s decision about what crops and varieties he will grow. Simply correlating the number of varieties grown or some other index of crop diversity to the number of places the farmer obtains seed or agricultural information doesn’t account for other factors influencing crop diversity, such as markets. Furthermore, the relevance of particular indirect and direct pathways for access may be greater for some institutions than others. To sift out confounding factors we narrowed our examination to two indicators: the frequency with

which farmers talked about fruit in institutions and organizations and the number of places farmers go for foreign seed.

The number of places to which male heads of households go for foreign seeds varied six-fold between households (see Table 6). The plurality of men, 42%, went to only one source for their seeds and 9% of men went to all six sources about which we inquired.

Number of Organizations or Institutions from Which Male Heads of Households in Urgut District Obtain Foreign Varieties of Seed.

Table 6.

NUMBER OF DIFFERENT PLACES PEOPLE GO FOR SEED	# people	% of total
1	28	42
2	11	16
3	7	10
4	6	9
5	9	13
6	6	9
Total	67	100

There was equally great variation in the number of organizations and institutions in which male heads of households obtained agricultural information. Table 7 illustrates that most male heads of households belonged to 6-8 organizations in which they could discuss agricultural information, but some belonged to zero and others belonged to 10. The different numbers of groups to which an individual male head of household belonged reflected individual preferences for participating in local-level institutions.

Table 7

Number of Institutions and Organizations in Which Male Heads of Households in Urgut District Participate for access to agricultural information

Number of Organizations	Number of Household Heads	Percent of total Households n=127
0	7	5.5%
1	1	0.8%
2	6	4.7%
3	10	7.9%
4	12	9.4%
5	16	12.6%
6	23	18.1%
7	25	19.7%
8	23	18.1%
9	3	2.4%
10	1	0.8%

We calculated an independent t-test on the mean frequency with which male heads of households spoke about fruit trees comparing households participating in ≥ 6 organizations or institutions and those participating in < 6 households to determine whether those individuals who participated in more institutions and organizations spoke about fruit more (or less) frequently. Our findings are premised on the theory that men who talk more often about fruit receive more agricultural information than those who talk less frequently.

We observed that the difference in means of the two groups were not significant at the 5% level for every group. See Table 8. Individuals who participated in 6 or more did not necessarily speak about fruit more frequently. See Table 9. No correlation between institutional and organizational participation and the frequency with which one talks about fruit suggests that the quality of the source of seed information is more important than the quantity. The number of informal pathways used by men to learn agricultural information is not a good indicator for measuring the impact of the seed system on individual decision-making.

Table 8.
Independent T-test comparing the mean frequency with which male head of households participating in ≥ 6 organizations or institutions and < 6 organizations or institutions spoke about fruit.

		t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
Suhbot(1)	Equal variances not assumed	0	17.89555	1	0	0.217211	-0.45653	0.456534
Suhbot(2)	Equal variances not assumed	-1.54097	67.24363	0.12801674	-0.18466	0.119833	-0.42383	0.054512
Chaykhana	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Guzar	Equal variances not assumed	-0.74998	18.62516	0.46263337	-0.11795	0.157268	-0.44756	0.211666
Wedding	Equal variances not assumed	-1.54097	67.24363	0.12801674	-0.18466	0.119833	-0.42383	0.054512
Market	Equal variances not assumed	0.107921	13.68781	0.91562435	0.02157	0.199856	-0.408	0.451136
Mahalla	Equal variances not assumed	-0.46118	11.00704	0.65364715	-0.08333	0.180695	-0.48101	0.314343
Hashar	Equal variances not assumed	-2.09066	17.09236	0.05180405	-0.37879	0.181181	-0.76089	0.003314
Other	Equal variances not assumed	-1.82258	17.17054	0.08582965	-0.36765	0.201718	-0.79291	0.057619
Work Brigade	Equal variances not assumed	-0.94887	8.245089	0.36966662	-0.28235	0.297568	-0.96501	0.400306

Table 9. Mean frequencies with which male head of households participating in ≥ 6 organizations or institutions and < 6 organizations or institutions spoke about fruit.

		N	Mean	Std. Deviation	Std. Error Mean
Suhbot (1)	≥ 6	20	2.25	.639	.143
	< 6	8	2.25	.463	.164
Suhbot (2)	≥ 6	55	1.91	.554	.075
	< 6	32	2.09	.530	.094
Chaykhana	≥ 6	6	2.17	.408	.167
	< 6	0	.	.	.
Guzar	≥ 6	60	2.27	.548	.071
	< 6	13	2.38	.506	.140
Wedding	≥ 6	55	1.91	.554	.075
	< 6	32	2.09	.530	.094
Market	≥ 6	51	1.92	.627	.088
	< 6	10	1.90	.568	.180
Mahalla	≥ 6	60	2.25	.541	.070
	< 6	9	2.33	.500	.167
Hashar	≥ 6	42	2.17	.581	.090
	< 6	11	2.55	.522	.157
Other Festivals	≥ 6	34	1.88	.537	.092
	< 6	12	2.25	.622	.179
Work Brigade	≥ 6	17	2.12	.697	.169
	< 6	5	2.40	.548	.245
Other	≥ 6	1	2.00	.	.
	< 6	0	.	.	.

a t cannot be computed because at least one of the groups is empty.

Discussion

Our research addresses the current epistemology applied to the study of seed systems and focuses on a more detailed and empirical understanding of how seed systems function through local, farmer-level institutions. For example, research on maize in Mexico has yielded important insights about the seed system but the findings have been difficult to connect together. Smale et al showed that local customs and traditions shape farmer's valuation of phenotypic traits (Smale, 2001). Louette demonstrated that gene flow through the local-level informal seed system affects genetic diversity in the general maize population and contributes to the larger movement of alleles in Mexico (Louette, 1999). What is needed is a framework relating the institutional structures and customs identified by Smale, with the modes of information and seed exchange that govern the variation in PGR movement and use within a geographic area, as identified by Louette.

In this paper we propose a framework based on fieldwork in Uzbekistan. Our research recognizes that local organizations and institutions affect the seed system via two pathways. One pathway is those institutions and organizations that act as direct conduits through which farmers obtain access to agricultural information and seed. In a second pathway, institutions that have a primary purpose unrelated to agriculture or are multipurpose serve as indirect sources of seed and information. Indigenous farmers do not naturally distinguish between direct and indirect pathways, but when we inquired about where they obtained seed and information a pattern involving two-pathways emerged.

Most examinations of natural resource management tacitly internalize an assumption about management first made popular by Hardin's "Tragedy of the Commons" that natural resources must be actively managed by organizations and institutions (Hardin, 1968).⁵ Subsequent scholarship identified indigenous examples of organizations and institutions of direct management, even documenting the contribution of institutions of ritual and myth in motivating the continued cultivation of economically unimportant species. One example of how cultural institutions influence crop diversity is Dove's description of taro and archaic plant cultivation in Borneo motivated by a "focus on the past and ideological concerns...to meet the ritual needs of ancestral spirits in the community (Dove, 1999, 60)." Yet, an emphasis on the identification of specific indigenous institutions and organizations for the management of natural resources ignores the subtler and messier contributions to informal and indirect management made by information and culture flows within the community.

How and to whom information flows within a geographic area shapes the adoption of new crop varieties and the direction of selection pressure (Perales, 2003). Informal and indirect management, effected through a set of indigenous institutions and organizations whose primary purpose is not the management natural resources, exert a powerful effect on the distribution of plant genetic resources. In the villages we studied, the most utilized organizations and institutions for obtaining seed and information were multipurpose institutions or organizations with a primary purpose unrelated to agriculture. To focus on the direct institutions and organizations in Uzbek villages would have misdirected the study of the seed system and gene flow.

We inquired about how often people spoke about fruit trees in each of the institutions and organizations to which individuals belonged, and we found that in the *chayhana*, *suhbot*, *mahalla*, and *guzar* between 79% and 86% of farmers discussed fruit "often" or "sometimes". The pattern shows that multipurpose organizations and institutions occupy a highly important role in the movement of agricultural information in the seed system, contrary to the assumption introduced by Hardin regarding natural resource management. Data collected from group interviews with men in villages corroborates the household survey data findings, demonstrating that the greatest number of people exchange agricultural information at events organized for a primary purpose unrelated to agriculture, such as wedding and other festivals (Figure 2). The importance of village celebrated rituals as spaces for information exchange cannot be overemphasized. The past allows people to talk about the present (Bosch, 1977, 273) and indirect pathways of rituals, traditions, and norms are the conduits for agricultural information exchange in rural Uzbekistan.

Indirect pathways are also among the most important ways in which farmers gain access to seed and saplings. Relatives and *oxacols* (wise men) ranked fourth and third, respectfully, as the most effective sources of foreign seed (Table 5). In Uzbekistan, duty and responsibility to one's relatives and extended family members is considered paramount. Cultural norms revere familial relationships with the extended family and oblige the exchange of agricultural information and seed to relatives. These institutions contribute to relatives being most utilized source for seeds (Table 4).

⁵ Hardin argued explicitly that the commons must be exchanged for formalized private property legal system. A forgiving and prescient interpretation would restate Hardin's argument as a plea for the implementation of contemporarily appropriate norms with the requisite organizations to enforce them over natural resources.

The patterns that emerged from our analysis suggest that trust plays a prominent role in farmer's decisions about sourcing seeds. All planting material obtained through the informal seed system had a risk of disease or non-performance and farmers shared concerns that varieties purchased from the bazaar were not guaranteed to be the advertised variety or to survive under local conditions. In Uzbekistan, farmers continue to trust the formal system of seed supply established during the Soviet era, namely the Shreder Research Institutes. According to farmers, the most reliable source of foreign germplasm (in the form of fruit tree saplings) was the Shreder Institute. In group-surveys villagers consistently identified the Shreder Institute as the most important organization for obtaining foreign and modern seeds and for consultations on proper cultivation. In group interviews, community-members credited the Shreder Institute as being the most reliable. Household survey data corroborated the finding, ranking the Shreder Institute the highest in effectiveness as a source of foreign seed (Table 5). Local breeders even benefited from the recognition of the Shreder Institute. Associating with the institute gained local breeders a semi-formal status and the trust of farmers. Coupled with the accountability of supplying friends, neighbors, and fellow community members, this semi-formal status, conspired to make local breeders the second most effective source of foreign seed (Table 5).

Although the Shreder Institute and breeders were the most effective and trusted institutions, informal relationships with relatives and neighbors were the most utilized sources of modern and foreign varieties (Table 4). This reflected a greater trust in suppliers with which one had developed an informal relationship and a reliance on indirect institutions of friendship and familial bonds for access to modern and foreign varieties. Indirect institutions remain the most important institutions facilitating modern-seed variety exchange in Uzbekistan, and suggest that Louette's conclusions regarding Mexican maize- that the impact of informal seed exchange on the genetic diversity is massive- is equally true about fruit tree diversity in Uzbekistan (Louette, 1999, 133). The importance of trust and the role of indirect institutions are even more pronounced in the movement of ancient varieties.

Trust based on social capital and personal relationships with providers is a criteria used by farmers to assess the vigor of traditional-variety seed and the accuracy of associated agricultural information. Rural Uzbekistan is no exception from the pattern identified by Berlin of specialization of agricultural knowledge within communities (Berlin, 1992, 199). In Uzbekistan *oxacols* are considered the best sources of ancient and traditional varieties of seed and techniques, for which information is esoteric and seed is specialized, according to group-interviews with men. Because traditional plant varieties are adapted to unique micro-niches within individual villages, outside of the village, in other soils and ecological conditions, landrace genotypes and traditional cultivation techniques may not yield similar results. Thus, when locally adapted landrace seed and information is geographically distant, it is less valuable to farmers. Consequently, compared to village *oxacols* and neighbors, relatives ranked comparatively unimportant as sources of traditional landraces.

The significance of trust in motivating farmers' choices is reflected in attitudes toward material obtained from the bazaar. The bazaar was consistently mentioned as a source of modern/foreign varieties during group-interviews with men. But when ranked on a five point scale of importance in household surveys, it received only 3-4 points compared to a consistently award of 5 points to the Shreder Institute. And although *oxacols* were rarely mentioned as sources of modern seed in group-interviews, the bazaar tied with *oxacols* in effectiveness as a source of modern seed

(ranking fourth. In household surveys, only 13 respondents utilized bazaars as sources of foreign seed- compared to 40 who utilized relatives (Table 4). Responses toward the bazaar reflect a mistrust in the institution. Anecdotal evidence suggests that those farmers who used the bazaar as a source of fruit trees were individuals who demonstrated little interest in orchard cultivation.⁶

The institutional structure of fruit tree seed exchange in rural Uzbekistan demonstrates a dual system of seed exchange for foreign and traditional varieties. Information and PGR material of traditional varieties is exchanged mostly within the microgeography of the village and is held by *oxacols* who do not participate vigorously in the market. Younger men actively engage in the market and obtain modern varieties through further reaching networks of relatives, the Shreder Institute, and friends. Information flow is limited between younger farmers and *oxacols*, in part because the two groups participate in different sets of indirect institutions. This disconnect between the holders of traditional knowledge and those who engage in the market suggest that utilizing market forces may be ineffective in conserving traditional landraces. Supporting the exchange of agricultural information and material through community-level organizations and institutions may be a more promising alternative.

Conclusion

Local institutions and organizations are essential and influential components of a system of PGR exchange and cultivation. Both direct and indirect pathway organizations provide physical and social spaces for community members to develop relationships and gain access to seed and agricultural information. Norms and rituals that provide a language of the past with which current events can be understood in terms of past histories are passed through informal institutions (Dumont 1977, 7 cited in Dove, 1999, 61). Community-level organizations and institutions are the pre-eminent sources of traditional knowledge about local varieties and traditional uses, but they were also the most used sources for modern varieties. We have also described the paramount economic role played by informal institutions. According to Douglas North “Informal constraints that arise in the context of exchange but are not self-enforcing are more complex because they necessarily entail features that make the exchange viable by reducing measurement and enforcement costs” (North, 1991, 41).

The effective conservation of crop genetic resources *in situ*, particularly the traditional fruit and nut tree varieties that were first domesticated in Central Asia, will depend on a better understanding community-level institutions that maintain and exchange germplasm and information on the traits and uses of these cultivars. To this end this paper has provided some empirical methods for social institutional analysis and insights that may contribute to our understanding of how genetic resources and related information move within a complex environment of formal and informal institutions. Our findings suggest that maintenance of this complex web of pre-existing and multi-purpose institutions rooted in local cultures that function alongside formal state-supported germplasm institutions is the best way to maintain diversity in centers of crop genetic diversity.

⁶ When one of the authors was interviewing a farmer about the names and attributes of varieties in his home garden the farmer was unable to recall the name of a variety he had planted and demonstrate much interest in identifying it. He called the tree by the species name only. This farmer had bought the sapling at the bazaar.

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