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Agricultural Biodiversity in the Tajik Pamirs

A Bridge Between Market Development and Food Sovereignty

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This study investigates the role that local fruit varieties can play in achieving the dual objectives of food sovereignty and income generation in the Tajik Pamir Mountains. In this very harsh environment, agriculture is characterized by a great diversity of fruit varieties central to local food culture and household security. Local fruit trees can grow in poor soils on slopes and their resistance to diseases, cold, and ultraviolet light give them marked advantages over introduced varieties. However, the humanitarian crisis following the collapse of the Soviet Union and recent efforts by development organizations to create markets by introducing exotic varieties are negatively affecting agricultural biodiversity (agrobiodiversity) and, potentially, household security. A study was carried out in 3 districts of the Gorno-Badakhshan province to investigate the household consumption and market potential of products derived from local varieties of apple, apricot, and mulberry and how these products could be better exploited to benefit community livelihoods and agrobiodiversity conservation. Results show that fruit represents the farmers' main source of food and income. Many local varieties are maintained for a variety of reasons related to household consumption, whereas the main reason for cultivating introduced varieties is income generation. Great care must therefore be taken in planning market strategies: a pure market focus will almost certainly endanger household security, whereas a strategy linking income generation through the commercialization of crop varieties to the promotion of qualities central to household needs will improve diversity and public health. The opportunities identified to help enhance the market potential of local fruits and maintain the Pamir's unique biocultural heritage include efforts to raise public awareness among producers and consumers of the nutritional and medicinal properties of local varieties; training for pest management, processing, and packaging; and the establishment of farmers' cooperatives.

Keywords: *Local fruit varieties; market chain; local communities; livelihoods; mulberry; cultural identity; food security; agrobiodiversity; Pamirs; Tajikistan.*

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Introduction

In the harsh environment of the Pamir Mountains of Afghanistan and Tajikistan, food scarcity has been an element of everyday life ever since agriculturalists settled in the area thousands of years ago (Nabhan 2008). This scarcity has been aggravated in the past by wars, revolutions, and natural disasters; it may intensify as climatic changes destabilize harvests and as global cultural and economic forces begin to change food preferences and displace local crop varieties (Karamkhudoeva et al 2009).

Addressing food sovereignty and security in this complex social–ecological context requires efforts, not only to increase food production and support local subsistence agriculture, but also to conserve the diversity of locally adapted fruit crops, grains, and legumes that have helped people survive for many centuries and have nourished a unique local culture (Pimbert 2009). The value of agricultural biodiversity (agrobiodiversity) is recognized both at the level of individual households, where it contributes to food security, health, and income and helps reduce vulnerability (Koziell and McNeill 2003; Roe and Elliot 2004), and as a public good, in helping societies cope with change and unforeseen events (Smale and Bellon 1999). The use of local agrobiodiversity can contribute to dietary diversity and proper nutrition and can therefore play a potentially important role in countries where diet-related diseases (eg obesity, cardiovascular disease, and degenerative diseases as well as "hidden" hunger resulting from micronutrient deficiencies) pose increasingly severe risks to public health (Frison et al 2006).

Losing crop diversity means losing resources to safeguard food, health, and cultural well-being (Woube 2009) and, for many of the world's rural poor dealing with isolation, inadequate markets, food crises, climate change,

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FIGURE 1 The Western Pamiri agricultural landscape: villages are nestled along river beds or on alluvial fans—usually the only flat land found in this region. (Photo by Frederik van Oudenhoven)



and malnutrition, conserving crop diversity is less a choice than a basic necessity for survival. The people of the Pamirs are no exception. Pamiri agriculture is characterized by a great diversity of unique fruit varieties, which have a prominent place in local food culture. A recent study found 33 commonly cultivated varieties of apple, 40 apricot varieties, and 37 mulberry varieties (Bioversity International 2010).

Fruit trees, though usually grown in irrigated orchards, are also often planted along roads and can be found in ravines and on mountain slopes near sources of water (Figure 1). It is difficult to overestimate their importance: in a region where arable land is extremely scarce, fruit trees can be cultivated on rocky, sloping surfaces where grains and vegetables do not grow. Particular traits, such as early ripening and resistance to cold, drought, and ultraviolet radiation give local varieties advantages over introduced ones that often do not cope well with local conditions. (Other than apple, very few introduced fruit varieties are grown in the Pamirs.) Local fruit varieties are preferred for their taste; in addition, they possess medicinal and health properties and are used by the Pamiri people as a principal remedy in treating sicknesses and ailments (Kassam et al 2010).

Global development assistance to smallholder farmers has increasingly focused on the role of markets in providing livelihood benefits. From an initially narrow focus on boosting farm production, research and development activities now often seek to facilitate farmers' access to markets (Shepherd 2007). In Tajikistan, as in other Central Asian countries, the post-Soviet transition to a market economy has been unquestioned as the basis for rural development. Development activities emphasize small business support, market access, and the production of marketable commodities, with the introduction of marketable exotic fruit, grain, and vegetable varieties.

In the Pamirs, where government presence is weak, most of these initiatives have been led by foreign aid agencies. This process has been relatively top-down, with little attention paid to indigenous visions of development. As a consequence, local sources of resilience have largely been neglected. Historically, the Pamiri population subsisted on extensive agriculture. Family allowances during Soviet times led to a 5-fold increase in population (Breu and Hurni 2003); this created demands for food, met only through major imports from other regions of the Soviet Union. Emergency relief provided food aid,

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while the development programs sought to decrease aid dependency by supporting a rediversification of household agriculture and small-scale production activities to fuel a modest market economy. In this context, food sovereignty and agrobiodiversity were of lesser concern.

A second reason for the near absence of indigenous food plants in development projects is the (perceived) nature of markets. Economic development and increased access to inputs and markets are generally considered to have a negative effect on agrobiodiversity maintenance (Van Dusen and Taylor 2005). Except for niche products made with special crop varieties, the benefits derived from maintaining high crop diversity are rarely compensated in markets. Farmers in developing countries thus seldom have economic incentives to conserve diversity (Kontoleon et al 2009) and may easily sacrifice other incentives (eg taste, health, security, and culture) when the push for commercialization is strong. This danger exists in the Pamirs (Roy 2010).

Taking into consideration these barriers to incorporating agrobiodiversity and Pamiri cultural institutions into markets and development activities in general, the present study sought to respond to a strong willingness among farmers, local scientists, development workers, and other stakeholders to collaborate on overcoming them (van Oudenhoven et al 2008). The present study, conducted throughout 2009 in 3 valleys of the Western Tajik Pamirs, investigates the market potential of local products derived from apple, apricot, and mulberry. The investigation was a joint effort by Bioversity International, the Swiss College of Agriculture (SHL), the Pamir Biological Institute (PBI), and the Mountain Societies Development Support Programme (MSDSP) of the Aga Khan Foundation. It concludes that a market system founded on quality, local identity, and solidarity is feasible; appropriate to the history and current context of the Pamirs; and promising in terms of improving community livelihoods, conserving agrobiodiversity, and achieving food sovereignty.

Socioeconomic and geographical context

Tajikistan is one of the least accessible countries in the world, with its high mountainous terrain and remoteness; this is compounded by ineffective infrastructure and a weak governance and regulatory framework. It was, and remains, the poorest of the countries that emerged from the former Soviet Union. Its fragile economy, strongly reliant on agriculture and remittances from migrant laborers working in Russia and Kazakhstan (half of the country's labor force works abroad [CIA 2010]), is vulnerable to unexpected shocks. The severe 2007–2008 winter, the 2007 world food crisis, and the global economic crisis brought more than half of the population below the poverty line (Aga Khan Foundation et al 2009). Recent clashes between military and extremist militant groups show the risk for potential spillover into Tajikistan of insurgent activities in Afghanistan or the recent ethnic unrest in neighboring Kyrgyzstan (Andrew and Butt 2010).

The Pamir mountains (*Pomir*, in the local language, means "Roof of the World" or, some say, "Feet of the sun") extend across Afghanistan, China, Kyrgyzstan, Pakistan, and Tajikistan. The heart of the Pamirs—the High Pamirs—is located in the Gorno-Badakhshan Autonomous Oblast (GBAO) in the southeastern part of Tajikistan (Figure 2). The majority of the Pamiri population belongs to the Nizari Ismaili branch of Islam, whose members consider the fourth Aga Khan their spiritual leader. Land resources are scarce. In the Western Pamirs, where the main economic activity consists of a form of combined mountain agriculture (the cultivation of wheat, barley, potatoes, pulses, fruit trees, and vegetables in combination with animal husbandry using the more expansive grazing areas [Stöber and Herbers 2000; Herbers 2001]), arable land accounts for only 0.4% of total land area (Hergarten 2004). Following the humanitarian crisis after the collapse of the Soviet Union and the civil war, crop production increased to a level of approximately 70% self-sufficiency by the year 2000 and remains at that level today (Breu and Hurni 2003).

Economic and agricultural development in the Pamirs is shaped primarily by the system of parallel governance formed by international development agencies operating in the region, most notably the Aga Khan Foundation. Nascent local and regional trade in agricultural products is limited by a poor (market) infrastructure, but current investments in industries, infrastructure, education, and tourism are already leading to drastic change. The nature of these changes will very much depend on whether traditional agriculture, as a reflection of local culture, is allowed to define and inspire development.

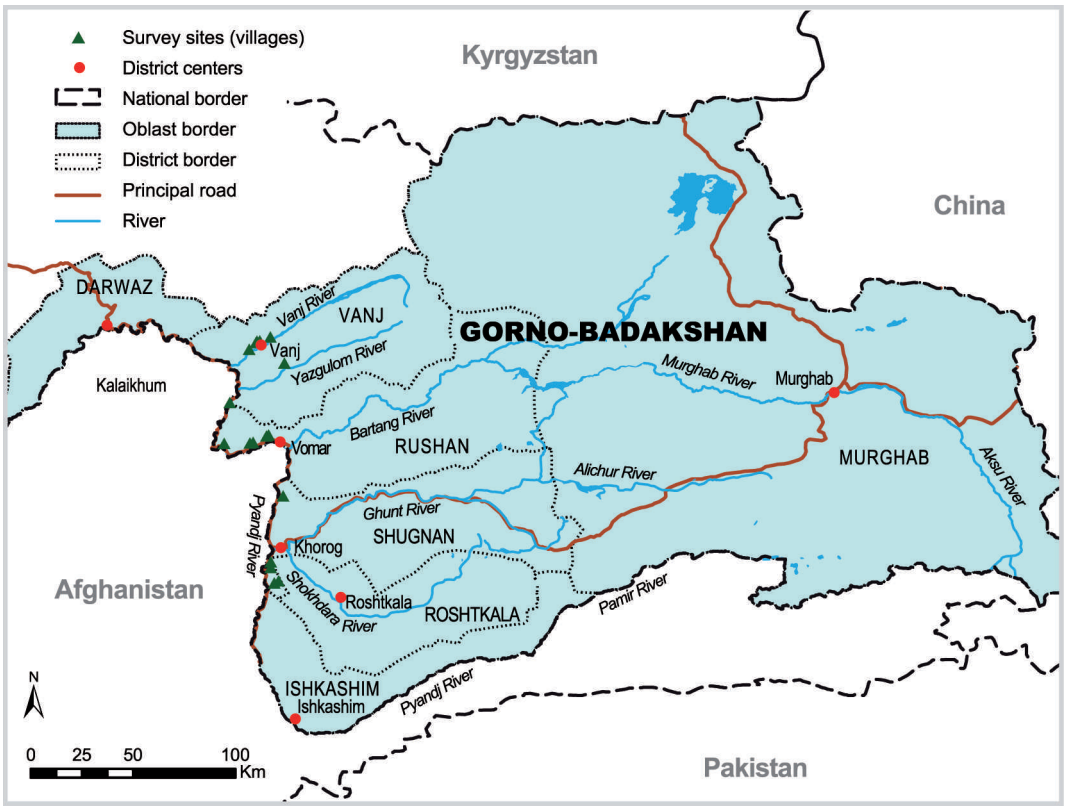
Methods

The analysis in this study included a household-level survey of farmers producing mulberry, apple, and apricot as well as a market chain analysis of these fruits and their derived products in western GBAO. The household survey involved individual interviews with 78 farmers in 18 villages in 3 districts: Shugnan, Rushan, and Vanj (Figure 2). These districts were selected on the basis of the importance played by these 3 fruit trees in local culture, food security, and markets. Vanj is the center of apple cultivation in the Pamirs and has the highest diversity of that crop; Rushan is known for its mulberries and apricots; and Shugnan is important for its proximity to Khorog, the capital of GBAO and its main market.

The survey interviews were carried out by 12 trained local farmers from the same districts, under the guidance

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FIGURE 2 The survey area in the Western Tajik Pamirs, GBAO Province. (Map by Frederik van Oudenhoven, adapted from http://www.pamirs.org/trekking.htm)



of researchers of PBI. Households were selected using purpose-sampling. To enhance the representativeness of the sample, families were selected to be of varying socioeconomic levels with different levels of dependence on fruit tree cultivation. A semistructured questionnaire was used to collect information about the reasons for cultivating and maintaining specific varieties (local and introduced), harvesting, processing, marketing, and the income generated from the sale of the particular fruits.

Results, which were triangulated with findings from previous work conducted by PBI and Bioversity International, provide a reliable picture of the situation in the Western Pamirs. Some bias is present because of the nonrandom sampling: selected farms are relatively close to main roads or district centers, which significantly overestimates the importance of markets and of selling produce compared to more remote areas.

An assessment of agrobiodiversity conservation options, market chains, market constraints, and opportunities for the 3 fruit species and their derived products was carried out through interviews with key informants (farmers, processors, retailers, and researchers) in Rushan and Shugnan and during a multistakeholder workshop in Khorog. The workshop, which made use of the participatory market chain approach (Bernet et al 2006; Box 1), was attended by a total of 30 participants with a good gender balance among market chain actors (farmers, processors, middlemen, and retailers), researchers, and development workers involved in supporting the production and marketing of the selected fruits. The workshop was designed to identify a list of current and most promising products; conduct a participatory analysis of market chains, main potentials, and constraints; identify product flows and links among market chain actors; and establish dialogue and trust among market actors as a first step toward cooperation. Lastly, the study—and the workshop in particular—were meant to raise the awareness of development organizations, government, and the private sector regarding the importance of local agrobiodiversity, its market potential, and the interventions needed.

Agrobiodiversity and local communities' choices

Farmers cultivating apple, apricot, and mulberry own very small patches of land (0.3 ha on average). Together with grains, the target fruits (apple, apricot, and mulberry) represent the main staple crops grown by farmers in the Pamirs and are used both for food and for income generation. Farmers generally use their own apple, apricot, and mulberry seedlings or get them from

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BOX 1: The participatory market chain approach

The participatory market chain approach (PMCA) is a participatory research and development (R&D) method recently developed by the International Potato Center, Peru. By involving various market chain actors and supporting R&D organizations, this approach seeks to generate group innovations based on a well-led and well-structured participatory process that aims to stimulate interest, trust, and collaboration among members of the chain. The innovations can benefit the actors directly or indirectly. The approach foresees 3 phases, of flexible duration, depending on the context of application (Bernet et al 2006):

- First phase: the objective is to get to know the different market chain actors and their activities, interests, ideas, and problems.
- Second phase: the aim is to analyze potential joint business opportunities in a participatory manner.
- Third phase: the purpose is to implement joint market innovations for new products, new technologies, and/or new institutions.

The Papa Andina Initiative in Peru, Bolivia, and Ecuador is a successful example of the application of PMCA to foster market chain innovation in a way that benefits small farmers and other market chain actors and leads to the maintenance of local agrobiodiversity. Poor native potato producers and market actors identified new market opportunities together and developed new production processes and products. The result was higher prices and a more stable market for native potatoes, increased income and self-esteem for farmers, and an improved image of native potatoes (Devaux et al 2008).

For the present study, elements of the first phase of the PMCA were used—in particular, the organization of the multistakeholder workshop relating diverse actors currently involved in the production and marketing of the target fruits. Farmers to be invited to the workshop were identified based on their involvement in past projects led by Bioversity International and PBI. Processors and traders were selected with the help of MSDSP market experts. Retailers from Khorog were approached on the market and invited. Compared with other contexts, in which traders have been reluctant to share information (Giuliani 2007), the openness of traders invited to the workshop and their willingness to share their knowledge with the other market chain actors was remarkable (Giuliani and van Oudenhoven 2009). The event was a first step in promoting trust and collaboration among market chain actors and R&D agencies in order to consider how to overcome constraints and find innovations to improve the commercialization of the target fruits and products for the benefit of all actors.

BOX 2: Mulberry: a part of the culture and a source of livelihoods for communities in the Tajik Pamirs

Mulberry is an essential food for these valleys. During wars and crisis periods, mulberry played a crucial role in providing the main source of nutrition for the local population. In difficult times, when the availability of wheat is scarce, it still takes the place of bread and can account for more than 70% of a community's dietary intake (Mubalieva 2010).

In the Western Pamirs, women at the household level derive a number of products from mulberry (in our study, 12% of mulberry is consumed fresh and the rest is processed):

- Dried mulberry (*tut*). When it does not dry directly on the tree, the fruit is harvested and dried in the sun. *Tut* can be kept for more than 10 years and maintains its nutritional qualities for 2 years. (In our study area, 50% of mulberry is eaten dried)
- Ground dried mulberry (*pikht*) is obtained using large stones as pestle and mortar (Figure 3). Big flat stones with a rounded stone for crushing the berries can be seen in every yard (34% of mulberry is transformed into *pikht*). *Pikht* is consumed not only in sweets but also instead of bread. It is often mixed with other dried fruit, apricot nuts, walnuts, or toasted flax seeds. *Tut* and *pikht* are integral parts of the daily diet and are always offered to guests. They are also used for enhancing women's lactation and curing hypertension, kidney disease, and anemia.
- Mulberry syrup (*bekmez*) is made from fresh mulberry cooked for 2 to 3 hours. It looks like honey, with a very sweet taste (along with jam, 3.5% of mulberry is transformed into *bekmez*).
- Mulberry spirit (*dosti*). Thanks to the high sugar content, it is easy to distil alcohol. Before the introduction of vodka by the Russians, *dosti* was the main alcoholic beverage used in the area (about 0.5% of mulberry is used this way).

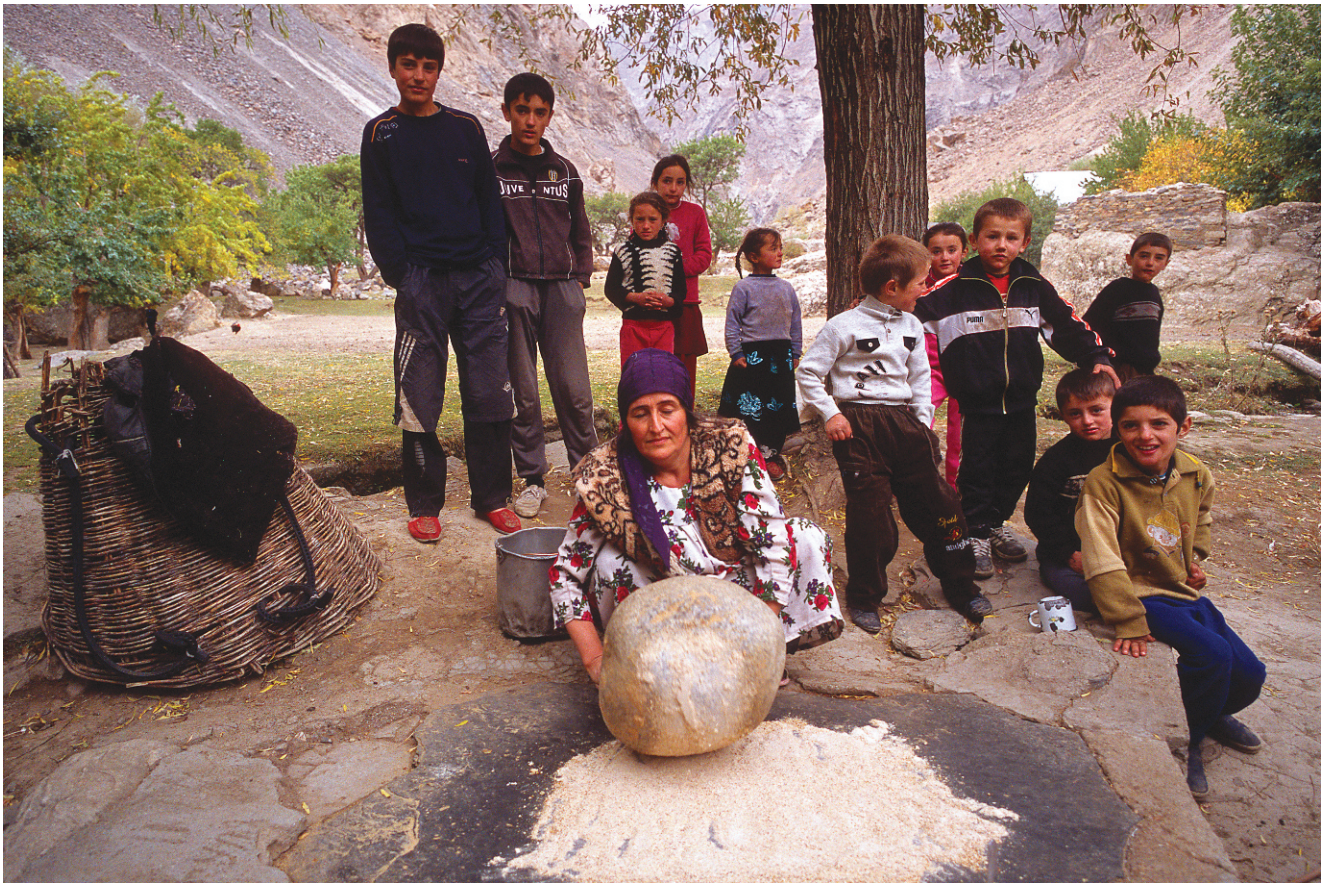
relatives living in the same village. Other crops cultivated by these farmers include cherry, pear, plum, peach, walnut, potato, vegetables, wheat, vetch, and beans.

Of the great diversity of fruit crops still cultivated by the surveyed farmers, most varieties are local (*Supplemental data*, Table S1; http://dx.doi.org/10.1659/MRD-JOURNAL-D-10-00109.S1). A number of introduced apple varieties are cultivated mainly because of their market appeal. As shown in Table S1, the most frequent reason given for cultivating the local varieties is household consumption—based on good taste, medicinal qualities, high sugar content, etc—while the main reason for cultivating introduced varieties is income generation.

Suitable varieties of the 3 fruit species are used for processing, which is always done at the household level (though some small village cooperatives have recently started to process fruits as well). Apple is mainly consumed fresh (90.5%) and is only occasionally dried or transformed into juice or jam (the remaining 9.5%). Apricots are also mainly consumed fresh (58%); the rest is dried (32%) or is used for cooking or to produce jams and compotes (10%). The different uses of mulberry are described in Box 2. The simple tools used to process the fruits include sun drying, preserves, and the grinding of dried mulberries with large stones to produce flour (Figure 3). Sometimes water or electric mills are used to produce larger quantities, but the quality is lower. Water mills can be used only in winter when temperatures are cold enough to prevent the fruits from sticking to the millstone.

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FIGURE 3 A mother in the Yazguliam valley in the western Tajik Pamirs preparing *pikht* for her children. (Photo by Frederik van Oudenhoven)



Market chain analysis: opportunities and constraints

Approximately 40% of apple yield is used for household consumption and 60% for income generation; for apricot and mulberry only 20% of production is sold. The income generated by marketing these crops and the derived products generate an average of 63.5% of a household's yearly income. More than half of the interviewed farmers sell their produce to traders or local middlemen. In some valleys, these individuals know the farmers and come to the farm to buy products. They then bring these products to the markets in Khorog or the main district centers and sell them directly to consumers or, more often, to retailers. Some farmers sell products to traders who transport them to the capital, Dushanbe, and a small number of farmers sell their produce directly to consumers at the markets of Khorog and Dushanbe or—as is the case in particular with mulberry—along the road. Others give their products to relatives, who transport them to the markets.

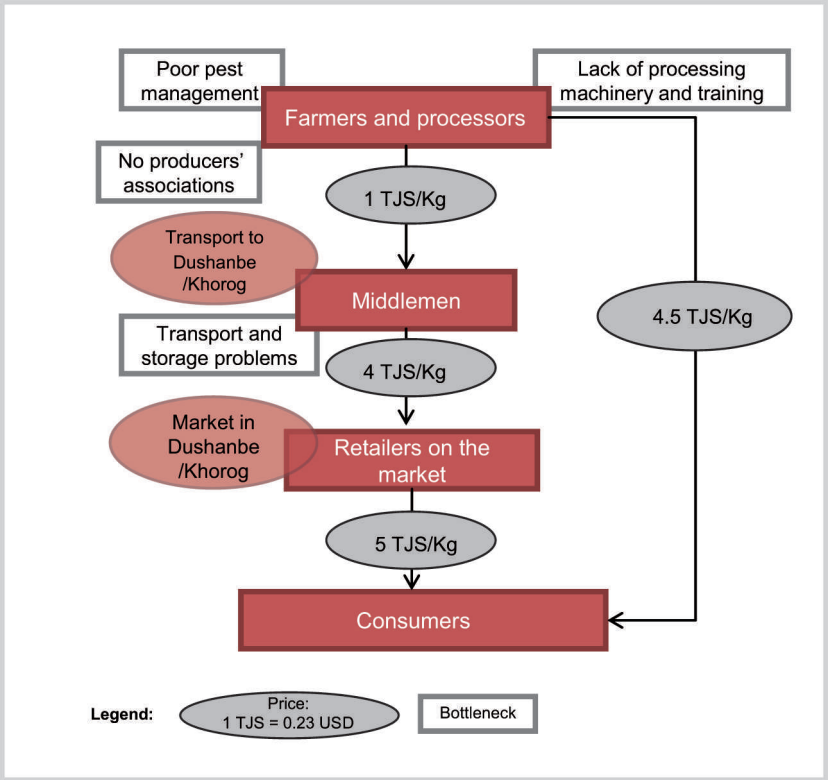
Traders and local middlemen travelling through the Pamirs have information about the market and about the sellers at the markets. Farmers lack this information, which weakens their bargaining position vis-à-vis traders and middlemen. Interestingly, all farmers who reported selling part of their produce did so partly (10% or more) through bartering. The greater the distance to markets, the more common this practice becomes. Figure 4 shows the market chain of dried mulberry fruits, as drawn by participants of the workshop, and the bottlenecks at each level of the chain.

A number of general bottlenecks were identified and discussed by the market chain actors.

- **At the production level:** (1) presence of pests (fruit moths and aphids); (2) lack of pesticides and inefficient pest management; (3) lack of equipment and mechanization in cultivating and harvesting; (4) lack of good-quality seedlings; and (5) lack of knowledge of gardening.
- **At the processing level:** (1) lack of suitable machinery, technology, and know-how for quality processing and (2) lack of storage facilities for conserving fruits and products.
- **At the marketing level:** (1) substantial obstacles to transportation to main markets in Dushanbe and Khorog; (2) lack of producers' organizations to strengthen market position; (3) lack of awareness about the qualities of local fruits among middlemen and

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FIGURE 4 Market chain of dried mulberry with bottlenecks. (Source: authors, present study)



consumers, resulting in low willingness to buy them at an acceptable price; (4) lack of proper packaging for conserving, transporting, and selling (Figure 5); (5) lack of labeling; and (6) negligible presence of local varieties in markets compared with exotic or imported (from neighboring China) varieties.

A number of opportunities to overcome the above constraints were identified during the workshops. These are summarized in Table 1.

Discussion

The focus of this study was 2-fold: (1) to understand the importance of agrobiodiversity—and, in particular, local fruit trees—to mountain communities and (2) to identify the role that markets play, or could play, in providing outlets, income opportunities, and incentives for increasing the production of fruit varieties. That said, it is important to note that the idea of a market-based economy has existed in the Pamirs only for some 15 years. Local views of a market often conflict with long-held cultural values (both socialist and pre-Soviet). Arguments between farmers from Vanj (who are traditionally more trade-oriented) and those from the other districts made these tensions very apparent during the workshop. These views require careful consideration to arrive at a balanced view of the need for markets and of their potential impacts on the cultural institutions currently underpinning the use of biodiversity.

In a number of documented cases, markets of local specialized products positively affect agrobiodiversity and the livelihoods of market actors. Experiences with the marketing of emmer in mountain regions of Italy have shown that trade-offs between income and conservation can be reduced with proper interventions. Giuliani et al (2009) showed that raising public awareness about the dietary benefits of neglected species like emmer helped bring substantial economic benefits to smallholder farmers. Such opportunities can exist for certain products in specific markets but may become threats where inappropriate promotion strategies or market forces that are not embedded in sustainability strategies override the balance of social, environmental, and economic benefits. Conversely, global forces such as trade globalization and consumer trends—usually threats to biodiversity and pro-poor growth—may become opportunities when put to proper use and as long as supply is realistic and market potential is sufficient (Will 2008).

The present study confirms that the high level of diversity in Pamiri fruit species is largely due to selection, improvement, and maintenance by farmers. Producing diverse fruit crop varieties, farmers guarantee a yearly harvest, both for household consumption as well as for income. In other remote areas, such as the rural Andes,

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FIGURE 5 Dried mulberry sold on the local market in Khorog. (Photo by Alessandra Giuliani)



indigenous people's livelihood security has been based on the consumption of tubers and grains, such as quinoa. Farmers have adapted and selected local varieties of these crops to reduce their vulnerability to a range of environmental risks (Hellin and Higman 2005). Pamiri farmers are astutely aware of the importance of maintaining this crop diversity: particular varieties are cultivated for particular reasons (see *Supplemental data*, Table S1; http://dx.doi.org/10.1659/MRD-JOURNAL-D-10-00109.S1), and knowledge about the nutritional and medicinal qualities of fruit varieties is often detailed.

These qualities, however, are unknown to consumers and middlemen, so that introduced fruit varieties are now preferred for their transportability and appearance. Farmers, faced with the dilemma of conforming to market preferences to have an income or running the risk of replacing trees that provide their families with security, often express their concern about the market attractiveness of their local fruits. In a similar situation, neglect of local knowledge linked to agrobiodiversity is believed to be one of the less visible root causes of food insecurity in Ethiopia, where high-quality food plant species are underused and mismanaged (Woube 2009).

But what may seem a threat to the conservation of local agrobiodiversity—the lack of overlap in reasons for cultivating local and introduced varieties—has, to the extent that markets are still incipient, also worked in its favor. Very few exotic varieties can be grown in the Pamirs, and those that can be grown do not compare favorably with local varieties in terms of taste and other characteristics. As long as household reasons remain important for cultivation, there is little danger that local varieties will be displaced by exotic ones. Nonetheless, implications for the design of market strategies are evident: a pure market focus will almost certainly endanger food security, whereas a strategy linking income generation through the commercialization of crop varieties to the promotion of qualities central to household needs will also improve diversity and public health.

Such "balanced" strategies to "make conservation and commercialization work" are increasingly common. One method is through collective action. Kruijssen et al (2009) indicate that in Thailand, a group of women started processing *cowa* fruit to better use available resources. Initial success and the presence of shared values proved to be an important basis for social learning and capacity building and, with the help of nongovernmental organizations and government agencies, catalyzed the institutionalization of collective action, aiding the acquisition of expertise and technical equipment. Public awareness campaigns underlining the nutritional, taste, and traditional values of local agrobiodiversity products helped change the fruit's poor image.

To achieve such results, external assistance is often needed (Meinzen-Dick and Eyzaguirre 2009). For example, in the Kolli Hills, India, the M.S. Swaminathan Foundation has supported local farmers in their efforts to increase markets for minor millets by developing new products and recipes (Gruère et al 2009). And the Papa Andina program (Devaux et al 2006) has helped smallholder farmers growing native potatoes in the Andes to develop value-added products to be sold in urban niche markets. This program promoted Andean products among urban consumers through packaging and advertisements featuring the diverse local potato varieties.

Conclusions and outlook

Farmers in the Tajik Pamirs face a number of problems that hinder the marketing of local fruit varieties. These problems include poor pest management, a lack of storage facilities, a lack of packaging to conserve products and attract consumers, and problems with transportation and marketing. Opportunities also exist. Yields of local varieties are steadier than those of exotic ones, and if development and research efforts could focus on improving the marketability of such varieties, families would not have to choose between income and security and could instead achieve both at the same time. Here lies tremendous potential.

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TABLE 1 Constraints and opportunities to exploit the market potential of local varieties of apple, apricot, and mulberry.

Level	Constraints	Opportunities
Production	• Presence of pests A lack of pesticides and inefficient pest management; good yields, but a lack of technology and mechanization for cultivating and harvesting; and spring frost and adverse weather conditions occurring more often in recent years.	• Pest management training Pesticides and training on pest management may tackle the problem of pests in cultivation.
Processing	• Lack of storage • Lack of processing technology A lack of suitable machinery, technology, and know-how for quality processing (large quantities of fruit are left to waste each year because of a lack of processing capacity). A lack of storage facilities for better conservation of fruit and products.	• Technology and training for processing for preserving and packaging Available technology coupled with training in processing, conservation, and packaging was identified as an opportunity to address the problems of low quality, conservation, and marketing of the products.
Marketing	• Transportation problems • Lack of proper packaging and labeling • Lack of producers' organizations Substantial obstacles to transportation to main markets in Dushanbe and Khorog (long distances with very difficult unpaved roads and prohibitively high transportation costs). A lack of producers' organizations for transportation and marketing of products. A lack of awareness among middlemen, traders, and consumers of the qualities of local fruit and, as a consequence, low willingness to buy these fruits at an acceptable price. A lack of proper packaging for better conservation, transportation, and presentation of the products on the markets. A lack of labeling and minimal presence at the markets of local varieties of these fruit crops and their derived products (compared with imported products).	• Access to market through farmers' markets • Cooperatives for storage and transportation • Mulberry Slow Food presidium Putting in place a farmers' market could improve access to consumers and their preferences and result in higher prices for goods. Besides, farmers could organize themselves in cooperatives to gather products and bring large amounts to market, sharing transportation expenses. A further opportunity: market these products as a package with dried fruit (eg for mulberry) produced from a number of local crop varieties. This product may address a niche market (ie the tourists who are visiting the area and are interested in local traditions and foods). The interest of the Slow Food Organization in establishing a presidium (Box 2) for a mulberry product originated in the Tajik Pamirs is seen as an opportunity for the mulberry producer and processor group to access the national and international market and increase public awareness of this local product.

Pests and diseases are increasingly common in the Pamirs (Karamkhudoeva et al 2009), and preliminary research indicates that local varieties have significantly higher pest and disease resistance. Research on pest management in the Pamirs should be intensified by PBI and supported by international research organizations, and farmers should be trained on integrated pest management to enhance the yield and quality of fruits. A promising example is an easily prepared broth of local alpine plants with insecticidal properties, developed by PBI, that kills up to 95% of pest insects (Karamkhudoeva et al 2009).

The particular varieties of apple, apricot, and mulberry that are most suitable for the production of specific products were identified in this study. Further studies should be carried out to better determine the biochemical and nutritional composition of different varieties; this can help improve and raise awareness of the quality of products. Simple technologies already in use in the Pamirs or in neighboring countries for the processing and packaging of fruits (such as machinery to extract juice, make jam, sterilize storage jars, or bottle and lid-up as well as packaging to lengthen the shelf life of the products), can be improved and disseminated, along with training on their use. Microcredit for producer groups will be necessary to facilitate this process. Some of this work is already being conducted by MSDSP but should focus more strongly on local crops.

To reach wider markets, smallholders need to group their produce together and make products more attractive, changing the image of local products that are often considered the "food of the poor" (Padulosi and Hoeschle-Zeledon 2004). Assistance will be needed to create cooperatives on the basis of existing village organizations and to gain access to suitable technology and know-how for processing and packaging. Such cooperatives could organize transportation to main markets (local and national), reduce dependency on intermediaries, or exert influence to ensure the sale of traditional fruit varieties. Supporting collective marketing actions in such a grassroots manner will ensure

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that local norms, values, and trust are maintained in the process (Kruijssen et al 2009).

An important idea suggested by farmers during the stakeholder workshop was the development of a "Pamiri Fruit Growers Association." This association, which would span different valleys, would help strengthen the interests and bargaining position of fruit-growing communities while simultaneously providing training, information, and seedling material; in this way, it would facilitate the conservation of agrobiodiversity. A follow-up on the practical realization of this and other ideas mentioned here should be part of a further study in collaboration with MSDSP and PBI.

To increase public awareness about the values of local fruits, "variety packages" aimed at local and national consumers as well as tourists—including different fruit varieties and a description of the origins of the fruits and their nutritional contents—could be launched. The interest of the Slow Food Organization in establishing a presidium (Box 3) for mulberry products from the Pamirs is an opportunity for the women involved in this producer group to access national and international markets and increase public awareness about the cultural dimension of Pamiri food. An analysis should be made of the potential impact of the presidium on the producers' livelihoods. Finally, public awareness of the nutritional and health qualities of local fruit varieties should be raised among producers and consumers.

In conclusion, local fruit trees in the Tajik Pamirs are mainly cultivated for household consumption but have great potential both for market development and for achieving food sovereignty. Interventions at the production level to improve cultivation and post-harvesting practices, enhance collective action, and raise public awareness for facilitating access to markets have been identified as tools to exploit this potential in a way that promotes the use and maintenance of local agrobiodiversity.

BOX 3: The Slow Food presidium for Tajik mulberry products

Slow Food is a global nonprofit organization founded in 1989 to fight the disappearance of local food traditions. Slow Food presidia are small projects that protect quality products that might soon disappear and the local plant varieties and traditions on which these products rely. In 2008, communities from 4 Tajik Pamir districts (Vanj, Yazguliam, Rushan, and Shugnan) joined forces with Slow Food International, PBI, and Bioversity International to establish the "Slow Food presidium for mulberry products," a small project working to preserve the Pamiri tradition of eating mulberry and using it for its many medicinal and health properties.

This new Slow Food presidium currently includes 23 producers, all of whom are women, who are committed to producing high-quality mulberry products using traditional methods. While the numerous constraints—just convening a single meeting of the producers is an enormous logistical challenge—make it too early to say whether the presidium can significantly contribute to market development, it has the potential to revive and revalue traditional methods of processing mulberry (Figure 3), help strengthen the cultural identity of the Pamiri people, and raise awareness about the uses of mulberry at national and international levels. One example of how this potential can be realized was the support provided to a number of women from the producer group that enabled them to participate in the international Terra Madre–Salone del Gusto event in Italy in October 2010. The event offered the group the opportunity to exchange ideas and products with other small food producers, to meet potential (international) trade partners and customers, and to make the Pamirs and its mulberries better known to the wider public (Terra Madre 2010).

Documenting the impact of the presidium on the livelihoods of the producer group's members and communities will be important to understanding the extent to which this and similar ideas can serve as examples to inspire other market-based solutions to poverty, biodiversity conservation, and food sovereignty in the region.

(Source: Silvia Weber, student at SHL)

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Supplemental data

TABLE S1 Varieties of apple, apricot, and mulberry with characteristics, reasons for cultivation, perceived reasons for their market potential, and relative quantities used for selling and household consumption.

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