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AgTCA TAJIKISTAN

AGRICULTURAL TECHNOLOGY COMMERCIALIZATION ASSESSMENT

JUNE 2014

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ACRONYMS

ADB	Asian Development Bank
AgTCA	Agricultural Technology Commercialization Assessment
BRAC	Bangladesh Rural Advancement Committee
CEDAW	Convention on the Elimination of All Forms of Discrimination Against Women
DOCs	Day-old chicks
EAT	USAID Enabling Agricultural Trade project
EBRD	European Bank for Reconstruction and Development
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FAST	USAID Farmer Advisory Services Tajikistan project
FEZ	Free economic zone
GDP	Gross Domestic Product
GERES	Groupe Energies Renouvelables, Environnement et Solidarités
GoTJ	Government of Tajikistan
HA	Hectare
ICT	Information and communications technology
ILRI	International Livestock Research Institute
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
IRRI	International Rice Research Institute
KG	Kilogram

LUC	Land use certificate
MoA	Ministry of Agriculture
MT	Metric ton
NADF	National Association of Dekhan Farms
NATC	National Agricultural Training Center
NGO	Non-governmental organization
ProApt	USAID Productive Agriculture in Tajikistan project
SPS	Sanitary and phytosanitary
TAFF	Tajik Agricultural Finance Framework
TajStat	Statistical Agency under the President of the Republic of Tajikistan
TBT	Technical barriers to trade
TJS	Tajikistani sonomi
UN	United Nations
UPOV	International Union for the Protection of New Varieties of Plants
USAID	United States Agency for International Development
USAID/Tajikistan	USAID Mission in Tajikistan
USD	United States dollars
VAT	Value-added tax
WFP	World Food Programme of the United Nations
WTO	World Trade Organization

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INTRODUCTION

The adoption of agricultural technologies at scale is essential to improve agricultural production and marketing, farmer income, and food security. Yet the commercialization of new agricultural technologies often faces substantial challenges. A successful strategy to bring agricultural technology to scale must be based on strong practical and theoretical evidence of the technology's potential as well as a well-informed action plan to address key challenges within the enabling environment that limit technology distribution and/or adoption at the smallholder level.

This report addresses constraints to and opportunities for the scaling of agricultural technologies for the horticulture and livestock sectors in Khatlon province in Tajikistan. Its findings pertain to a short list of proposed technologies selected by the United States Agency for International Development (USAID) Mission in Tajikistan with potential to improve production in the onion, orchard, beef, dairy, and poultry sectors. Each technology is analyzed for its potential impact on smallholder income, enabling environment obstacles to its commercialization or adoption, and market opportunity for the affected commodity. The report aims to inform the investment strategies of USAID, the Government of Tajikistan (GoTJ), and other donors seeking to increase access to and adoption of these technologies.

AGRICULTURE IN TAJIKISTAN

Tajikistan is a small, landlocked, low-income country located in Central Asia. Despite having only 7 percent arable land, agriculture is a cornerstone of the economy; the sector employs around 75 percent of the labor force and contributes 20 percent to gross domestic product (GDP).[1] Of approximately 8 million Tajiks, over 70 percent live in rural, agricultural areas.[2] Tajikistan's major agricultural products include cotton, grain, dried and fresh fruits, vegetables, cattle, sheep, and goats.[3] Livestock production accounts for a significant portion of total agricultural production. Factors limiting land use for agriculture include the country's mountainous topography, water, electricity, and salinization constraints, and lack of mechanization. These geographical and infrastructural limitations, along with constraints within the enabling environment for agriculture, prevent the sector from reaching its full potential.

Tajikistan's tumultuous history has adversely affected the current state of the agricultural sector. Its transition from a Soviet Republic to an independent nation was a difficult process, delayed by a five-year civil war that destroyed infrastructure and disrupted market linkages. Since peace was negotiated in 1997, the country has tried to address the destruction of property, displacement of people, and decline of industrial and agricultural production that had taken place. Though agricultural production has increased since 1997, Tajikistan is still considered a food insecure country with 46 percent of Tajiks living below the poverty line.[4]

Khatlon province, in southern Tajikistan, is one of two major agricultural zones in Tajikistan. Khatlon is still in transition from a cotton-dominated agricultural system operated by state-owned collective farms during the Soviet era (known as kolkhozes and sovkohzes) to a more market-oriented arrangement with production on recently-privatized farmland. Land reforms have aimed to break up larger plots into smaller plots and make them available to commercially-oriented farmers and households for food production. These reforms and others, such as creating more secure and marketable land use rights, have helped drive productivity gains and welfare gains for farmers.[5]

After independence, Tajikistan's 562 collective farms were divided into tens of thousands of small, independent farms.[6] Many of these newly-minted farmers previously worked as laborers on the collective farms; others were employed in non-agricultural jobs. Almost all lacked the business and marketing skills needed to run a successful small farm. Farmers strongly need access to business training and affordable capital to improve their operations. The inability to access credit to finance investment is keenly

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[1] Much of the arable land (roughly 80%) is pasture land.

[2] Feed the Future, Tajikistan Fact Sheet (Tajikistan Fact Sheet), available at http://www.feedthefuture.gov/sites/default/files/country/strategies/files/ftf_factsheet_tajikistan.pdf.

[3] United States Central Intelligence Agency (CIA), The World Factbook: Tajikistan, available at https://www.cia.gov/library/publications/the-world-factbook/geos/ti.html.

[4] Tajikistan Fact Sheet.

[5] United Nations Food and Agriculture Organization (FAO), *Sources of Agricultural Productivity Growth in Central Asia: The Case of Tajikistan and Uzbekistan* (2009). FAO Regional Office for Europe and Central Asia, *Policy Studies on Rural Transition No. 2009-5*, available at http://www.fao.org/docrep/017/aq337e/aq337e.pdf.

[6] USAID, *Feed the Future Tajikistan FY 2011-2015 Multi Year Strategy*, available at http://www.feedthefuture.gov/sites/default/files/country/strategies/files/ftf_tajikistan_multi-yearstrategy.pdf.

felt throughout the rural areas and in particular in Khatlon province. With few options for upgrading, farmers continue to use the worn-out infrastructure and equipment from the Soviet period and employ low levels of improved inputs such as seed, fertilizer, and pesticides.[7] The depleted state of soil fertility further exposes the country's farmers to crop failures.

Khatlon has the largest population (over 2.5 million), agricultural area (33 percent), and cropped area (49 percent) in Tajikistan, with 60 percent of cotton, 50 percent of cereals, and 40 percent grazing for livestock, making it significant in terms of its contribution to Tajikistan's agricultural activity.[8] The province's location in southwestern Tajikistan gives it a favorable climate for the production of high-value horticultural export crops such as onion and stone fruit. Yet Khatlon has the largest number of people living below the poverty line and the highest rates of under-nutrition in the country.[9] USAID, through its Feed the Future Strategy, is working with the GoTJ to improve farmer livelihoods and nutrition throughout Khatlon province.

AgTCA: A TOOL FOR ASSESSING THE SCALABILITY OF AGRICULTURAL TECHNOLOGIES

The Agricultural Technology Commercialization Assessment (AgTCA) assesses the potential for widespread commercialization and adoption of new agricultural technologies. AgTCA evaluates constraints to and opportunities for bringing technologies to scale through an evaluation of the agribusiness enabling environment (i.e., the legal, regulatory, policy, and institutional framework that governs the agricultural sector) as well as a technical assessment of the benefits of the technology itself. The diagnostic results in recommendations for interventions and reforms needed to create the market conditions for private-sector investment in technology. The assessment is conducted on the basis of a preselected list of commodities and technologies and is intended to inform USAID strategies for bringing these technologies to scale.

The AgTCA methodology examines the environment for technology commercialization and adoption through three lenses:

- **Market Opportunity.** A market analysis is conducted to assess the extent and nature of output market opportunity for the target commodities to ensure that a market exists for the improved quality or quantity of production the proposed technology is intended to create.
- **Technology Impact.** Each technology is analyzed to determine the effect of the technology on the production system and its potential impact on smallholder income. This analysis compares the farmers' current economic situation with pilot data from scaling activities in the host country or similar contexts.
- **Enabling Environment.** An enabling environment assessment is conducted to determine whether—under existing conditions—technology suppliers face disincentives to production, importation, and distribution of agricultural technology attributable to the legal, regulatory, and institutional environment in which these companies operate. The feasibility of adoption of the proposed technology at the farm-level, due to various factors of production, gender considerations, or technical and cultural concerns, is also assessed.

The resulting report synthesizes these findings to determine which technologies have the greatest potential for scale and impact on smallholder income.

An AgTCA diagnostic was conducted in Tajikistan from January 13-31, 2014 to assess opportunities for scaling agricultural technologies for the horticulture and livestock sectors in Khatlon province. The findings from this assessment are based on substantial research and over 150 in-country interviews with smallholder producers, input providers, processors, traders, industry associations, consumer organizations, donors, academics, and government staff in Dushanbe and Khatlon province.

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[7] Many agro-processors are operating very old (on average 19-year-old) equipment, drastically reducing their productivity. For example, a recent World Bank survey indicated that Khatlon agro-processors operate at about 66% capacity about 50% of the time. Lack of electricity, water, and sufficient supplies of suitable commodities were cited as reasons for underutilization of their plants and machinery. World Bank Agriculture and Rural Development Sector Unit, Europe and Central Asia Region, *Republic of Tajikistan Rural Investment Climate Assessment* (2013) (World Bank Rural Investment Climate Assessment).

[8] Ministry of Agriculture of the Republic of Tajikistan, UN FAO and UN World Food Programme (WFP), *Crop and Food Security Assessment Mission Report: Tajikistan* (Dushanbe: September 2011), available at http://www.fao.org/docrep/015/an110e/an110e00.pdf.

[9] Tajikistan Fact Sheet.

HOW THIS REPORT IS STRUCTURED

The Enabling Environment for Agricultural Technology in Tajikistan

The report begins with an overview of key aspects of the enabling environment that inform the technology-specific findings explored throughout the report. The section examines technology suppliers' access to new research, constraints to business entry and operation, and transaction costs that discourage investment in Khatlon province. In addition, the section examines farm-level constraints to technology adoption, including access to critical inputs such as land and water, the availability of finance, and access to agricultural advisory services.

Women and Agricultural Technology in Tajikistan

This section provides an overview of women's role in agriculture as it pertains to their access to and incentives to invest in new technologies. It examines both the enabling environment issues that affect men's and women's access to productive resources and the household dynamics that facilitate or limit the capacity of women farmers to adopt new technologies. Gender analysis is further integrated throughout the report through an evaluation of the relevance of the proposed technologies to men's and women's current economic activities and the extent to which women would benefit from increased income as a result of the new technology. Gender analysis of each technology incorporates three key elements: (1) the potential impact on women's time and labor, (2) the extent to which women provide input into the productive decisions associated with the targeted commodity, and (3) the extent to which women have access to income derived from increased sales of the targeted crop or livestock by-product, or other income-related implications (e.g., wage labor).

Commodity-Specific Findings

The chapters on onions, orchard production, beef, milk, and poultry contain in-depth analysis of each commodity and the agricultural technologies proposed to increase production and income for smallholder farmers in Khatlon. Each chapter examines in turn (1) market opportunity for the subject commodity, (2) the potential impact of the proposed technology or technologies on smallholder income and women, and (3) constraints at the farm-level or technology supplier level that would limit the potential to bring these technologies to scale.

Conclusions are drawn regarding the overall utility and scalability of the proposed technology(ies). With an eye toward encouraging technology distribution and adoption, each chapter concludes with recommendations for reforms to the enabling environment or support to farmers and agribusinesses to overcome these barriers. In addition, recommendations are made regarding how the incentives to adopt the technology might be augmented to attract women farmers, to increase women's access to the benefits derived from the technology, or to design a distribution model that would respond to the needs of women farmers.

Summary of Recommendations

The final chapter of the report summarizes the findings across all chapters and proposes priorities for USAID investment in light of overall market opportunity, potential impact of the technology, and the availability of viable commercial pathways to technology commercialization and adoption.

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THE ENABLING ENVIRONMENT FOR AGRICULTURAL TECHNOLOGY IN TAJIKISTAN

Tajikistan ranked 143rd out of 189 economies in the World Bank's Doing Business report for 2014.[10] Burdensome taxes, complex permitting and transport and trading issues together with only intermittent access to electricity, and exorbitant credit rates add up to a crushing environment for small business, particularly in Khatlon province.

A general lack of clarity within the legal and regulatory framework gives government officials, and the private sector, wide latitude to negotiate extra-legal arrangements in lieu of effective regulation, and corruption is rampant. As discussed below, this situation has its pluses—most of the corruption involves low value payments for speedy processing. As a result, agribusinesses reported that it is quite easy to manage the licensing and permitting processes. On the other hand, true regulatory enforcement is virtually nonexistent, allowing counterfeit and low-quality products to flood the market.

Value-added industry (such as for cotton and cement) is dominated by a few large, politically connected families. By contrast, small businesses such as input suppliers or traders are plentiful but lack incentives to invest and grow. Multiple sources suggested that staying small is a mode of survival—those that grow too large face harassment and the risk of being usurped by powerful interests.

At the farm level, despite years of donor assistance in legal and market reforms, the legacy of the Soviet period continues to permeate farming practices. Preferential water pricing structures, facilitated market linkages, and strong encouragement from GoTJ extension agents ensures that farmers continue to plant a high percentage of cotton, despite the 2007 "Freedom to Farm" bill that formally removed quotas for cotton production and other production controls.[11] Faced with numerous financial and marketing challenges, many farmers retain a romantic notion of the Soviet era of collective agriculture and look to the government (or donors) to provide for them.

For its part, the GoTJ faces a severe lack of funding and is greatly reliant on donors to support the implementation of government policies or provide services that it lacks the capacity to undertake. Donors and non-governmental organizations (NGOs), prevalent throughout the country since the civil war, have become a quasi-government and heavy drivers of the economy in many agricultural regions, providing services, finance, and employment to rural populations.

Tajikistan acceded to the World Trade Organization (WTO) in March 2013. The Tajikistan Ministry of Economic Development and Trade has developed a WTO implementation plan which, if implemented, would materially improve Tajikistan's economic position by opening export markets. However, the GoTJ has a long road ahead to achieve these milestones. In the interim, increased access to agricultural technologies that decrease the cost of production and increase farmers' profit margins are essential to kickstarting economic growth and reducing poverty in Khatlon province.

ACCESS TO RESEARCH

Access to research is critical to the commercialization of new agricultural technologies. Research often produces the new technologies or forms the basic building blocks for technology companies to use in developing innovative tools and products. Agricultural research is conducted by an array of actors, including international or government research institutes, universities, and private companies domestically or abroad.

In Tajikistan, the national system of agricultural research is housed within the Ministry of Agriculture (MoA). The horticulture and livestock institutes, amongst others, are very poorly supported and unable to deliver field-ready agricultural technologies, particularly new varieties of crops. The government has established procedures to monitor seed quality, but it is far from certain that sufficient budgetary resources exist to fulfill this mandate. There does not appear to be capacity for testing new varieties of crops for their adaptation to Tajik soils and climate. Systematic testing of new varieties, whether domestically created or imported, is not undertaken. Further, respondents noted a lack of effective linkages between the research institutes and the Agrarian University,

[10] World Bank, *Doing Business Report 2014*, available at http://www.doingbusiness.org/data/exploreeconomies/tajikistan/.

[11] GoTJ, Resolution No. 111 (March 5, 2007). Various national and local level government officials defended the focus on cotton as the key to jobs, industry, taxation (i.e., through value-added industry), and even to provide fuel for rural households (who typically use the cotton stalks for winter firewood).

which itself lacks sufficient students. Few young people in Tajikistan choose to pursue agricultural science and economics, preferring to seek work in the cities and abroad. Accordingly, new agricultural research and technology is largely imported. Most of the technologies researched for purposes of this assessment are fairly basic production practices rather than complex scientific innovations. However, the lack of an effective public mechanism for testing new or even imported technologies creates substantial commercial risks both for suppliers and farmers.

TECHNOLOGY COMMERCIALIZATION

For the most part, suppliers of agricultural technology in Tajikistan, such as input suppliers and animal feed manufacturers, operate in a laissez faire regulatory environment in which the bureaucratic burden of formal registration and licensing is fairly low, but there is very limited formal enforcement of the regulatory regime. In this environment, it is relatively easy for an entrepreneur to do as he or she pleases—for a fee—but nearly impossible to protect one's rights. Thus while it is not difficult to import new technologies, the government provides little to no protection for intellectual property rights or against competition from illegal imports.

In addition, agribusinesses above the farm level face high taxes, difficulties accessing credit, electricity shortages, trade barriers, and high transport costs, all of which make it difficult to turn a profit. High-quality inputs and other technologies that enter the country through formal channels are thus dependent on an educated consumer base willing to pay higher prices over those offered for similar (but lower quality) goods in the local markets—a challenge in an environment where farmers' access to credit and qualified advisory services are limited. The following subsections explore some of the more challenging constraints faced by technology suppliers in Tajikistan.

Finance

Bank credit for both farmers and agribusinesses is expensive. While inflation is less than 10%, loan rates are quoted at 24-26% per annum.[12] Repayment periods are also very short, often no more than 90 days. Bank savings rates are roughly 18% per annum. Such terms are prohibitive for both capital investment and operating loans. A new credit bureau has been established in Tajikistan, but its effect on lending practices is not yet apparent. Accordingly, most agribusinesses and farmers do not generally access commercial credit. As will be discussed in below in Farmer Adoption, the most significant source of funding for agriculture is through donors—either through grants, voucher programs, or credit guarantees. Some of these programs link farmers and agribusinesses to banks and MFIs. However, long-term relationships between banks and agribusinesses are unlikely to emerge until the base cost of commercial credit declines.

Taxation

Businesses in Tajikistan consider taxation to be a considerable burden. Recent reform of the tax code simplified the system, but high VAT taxes and customs duties continue to pose obstacles to the importation of agricultural technologies. The import of seed and fertilizers, for example, is subject to an 18% VAT tax and 5% duty. By contrast, inputs in the Krygyz Republic are subject to only 0.15% tax, which contributes to the high rate of illegal smuggling of these goods into Tajikistan. The GoTJ has instituted a VAT exemption for certain types of agricultural equipment, including tractors and chemical sprayers, but tax authorities expressed no intention to extend the exemption to other agricultural inputs, animal health products, or spare parts. Further, leasing arrangements and service contracts are also subject to a value-added tax (VAT), thus driving up the cost and reducing the commercial viability of lease-to-buy equipment agreements or services such as tillage. These taxes discourage the development of innovative business models for input supply at prices farmers can afford to pay.

Under the new tax code, small businesses (i.e., those with an annual turnover of less than 500,000 Tajikistani somoni (TJS), or 100,000 United States dollars (USD)) are exempt from VAT and subject to an income tax based on gross revenues at a rate of 5% on goods and 6% on services. While this approach should be simpler for the tax authorities and businesses from an administrative perspective, it does not allow for the deduction of expenses and encourages underreporting of income. For example, there are reports of importers bribing customs officials to reduce the official documented shipment value so as to avoid the VAT threshold.

[12] Inflation and interest rates quoted as of January 2014.

Larger businesses pay a graduated tax on net income, 18% VAT, and transportation and road taxes and are subject to significantly greater reporting requirements. Overall, the tax regime limits farmers' access to quality inputs and equipment by encouraging smuggling and disincentivizing the provision of spare parts, equipment leasing, and related services.[13]

In an attempt to spur investment and industry, the GoTJ has created 4 free economic zones (FEZs), two of which are located in Khatlon province (Dangara and Panj). FEZs offer trade, tax, and customs benefits to their members, and are open to all types of businesses regardless of industry. The FEZs in Khatlon are in the early stages of development. It remains to be seen what, if any, agro-processing will develop in these zones.

Intellectual Property Rights

Effective border controls are essential if innovative technologies and products are to flow into the country. For example, as there is minimal commercial plant breeding in the country, Tajikistan should be a major importer of plant varieties. It is essential that international seed companies, as well as suppliers of chemicals and their agents, have confidence that the country's customs system is enforcing efficiently and effectively applicable laws and regulations to minimize the movement of counterfeit and black-market goods, and assure that contracts are effectively enforceable.

Tajikistan is a signatory of the Patent Cooperation Treaty and a member of the World Intellectual Property Organization and the International Union for the Protection of New Varieties of Plants (UPOV). While these legislative frameworks are in place, the underlying capacity to manage the resulting obligations and provide for effective enforcement, particularly at the borders, remains a work in progress.

Electricity

Khatlon province faces power outages during much of the winter. Most businesses are afforded only 8 hours of electricity per day. Without reliable access to electricity, some agro-industries (such as poultry and milk processing, or storage facilities for perishable horticultural and livestock products) cannot viably operate year-round in Khatlon. Access to electricity is more reliable in the capital district, Dushanbe, and currently larger wholesale fresh fruit, dairy and meat producers are mostly located there. Larger businesses with political connections or sufficient capital and an advantageous geographic location can buy access to the "red line"—a dedicated power line directly to their business that affords them 24-hour access. However, such access is very expensive (business must pay all costs for the physical hardware and labor to connect the line) and is beyond the reach of small agribusinesses that must aggressively compete to survive.

Transportation and Cross-Border Trade

Uzbekistan, which borders Tajikistan to the North and West, provides both road and rail routes to important agricultural markets in Kazakhstan and Russia. Due to a dispute over Tajikistan's plans to build a dam (the Rogun Dam) over the Vakhsh River, Uzbekistan has actively impeded the flow of goods into and out of Tajikistan since the GoTJ expressed its renewed intent to pursue construction of the dam in 2008. Agricultural shipments, particularly those containing perishable goods, are frequently subject to undue delays and excess customs charges.[14]

A railroad line tying Khatlon (via Qurghonteppa) to Dushanbe has fallen into disrepair. Thus all agricultural goods are transported via trucks before being loaded in railway containers to travel to Sughd and beyond. Farmers can also access markets in China via the Pamir, although the mountainous terrain and poor road conditions, impassable in winter, make this route costly. The US funded construction of a bridge across the Panj River south of Dusti that facilitates the flow of goods south into Afghanistan and from there south to Pakistan and east into China. The Khatlon provincial government expects that much of future Khatlon vegetable production will be transported via this route to markets in Afghanistan and possibly on to China. The Asian Development Bank is also actively supporting improved links and border processes between China, Tajikistan, Kyrgyzstan, and Afghanistan.

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[13] The Consultative Council on Improvement of Investment Climate, an advisory group established in 2007 under the office of the President, has a working group dedicated to taxation issues that continues to evaluate and make recommendations for future reforms of the tax system in Tajikistan. Its members come from the public and private sectors as well as international organizations. For additional information on the work of the Council, see http://investmentcouncil.tj/en/.

[14] One stakeholder claimed that railway fees have jumped 40 percent in the past three years due to the dispute with Uzbekistan.

WTO Accession Issues

Sanitary and phytosanitary (SPS) protocols are crucially important to agricultural trade. Both China and Russia, important export markets for Tajik agricultural products, are signatories of the WTO. Tajikistan has commenced implementation of the required framework, for example by signing onto the International Plant Protection Convention (IPPC). Much remains to be done in regard to food safety and to assure that established technical standards are enforced on both agricultural imports and exports. Stakeholders expressed particular concern about an increase in the import and use of black and gray market agro-chemicals from China in recent years. The standards agency Tajikstandart is currently in charge of all technical barriers to trade (TBT) related activities—drafting and adoption of standards and technical regulations, conformity assessment, accreditation and metrology—as well as market inspection. This arrangement creates a conflict-of-interest that serves to impede effective monitoring of the quality and safety of goods. The agency also lacks the financial resources and equipment required for effective testing of goods, although it employs sufficient inspectors. Technical trade issues are sure to surface as Tajikistan implements WTO processes and seeks access to foreign markets for its agricultural goods.

Workforce Education and Business Skills

Tajikistan's need for more skilled workers transcends all economic sectors. Many of the agricultural advisors employed by donors and the Ministry of Agriculture are nearing retirement. Yet few new graduates enter the agricultural sector workforce. Approximately 125 students are accepted annually into the Horticulture and Agricultural Biotechnology Faculty at Tajik Agrarian University. Of these students, only 20% return to rural areas to work as farmers. New graduates of the agricultural universities face low salaries and often seek employment abroad, even in fields such as construction that are completely unrelated to the students' degrees. Salaries in Tajikistan, even for professional agronomists, cannot compete with income from employment in Russia.

Farmers uniformly stated that there is sufficient unskilled labor available, either through unpaid family labor or hired workers. Tajikistan has a very young population, including a large number of teenagers who are capable of farm work but not yet old enough to migrate to Russia. In addition, women play a significant role as hired laborers in many aspects of agricultural production. All of these workers by and large lack an understanding of agriculture as a business—not all farmers in Tajikistan have learned how to make decisions independently, how to be profitable, and how to manage their own expenses.

FARMER ADOPTION

The transition from large-scale collective farms to small private *dekhan* (or "peasant") farms has created numerous challenges for farmers in Tajikistan. The prevalence of small farms has repercussions for effective irrigation management, access to equipment, and the development of strong marketing channels. Government policies and messaging to farmers continue to favor cotton production over the more lucrative fruit and vegetable sectors. Long-term development of agriculture in Khatlon province will require overcoming these organizational barriers to improve farmer access to markets, technology, and high-quality advisory services.

Land

After independence, the large state-owned collective farms of the Soviet period were divided into shares and given to individual, families, or other collective groups. These *dekhan* farms range in size from less than one hectare to greater than 40 hectares with an average size of 10.[15] Families also retained control of their household gardens, small plots of land near the home that are typically used for household consumption rather than commercial agricultural production. Land reform began in 1992 and have taken place gradually. Most recently, reforms were enacted to enable the establishment of a market for land use rights and the use of land certificates as collateral.[16] Although some farmers have received formal land use certificates, all land remains the property of the state and can be confiscated for a broad range of reasons. Some of the more pernicious rationales, such as the "non-rational use" exception, were addressed in recent land reforms. Yet farmers remain uncertain of their long-term rights over their land. These concerns are reportedly stronger in Sughd province, where the population is denser and the land less plentiful, but some farmers in Khatlon voiced these fears as well.

[15] World Bank Rural Investment Climate Assessment (2013).

[16] USAID, *Property Rights and Resource Governance Profile: Tajikistan* (2010).

On collective *dekhan* farms, it is not uncommon for the elected head of the collective to have retained the formal land use certificate for all of the land, reducing individual members to paid laborers, similar to the structure under the large state-run farms of the Soviet era. New land allocations can be requested in some areas, and land can also be rented. In some cases, rental is preferred to allow for temporary expansion of farm land for annual crops such as onions without the hassle of land taxes, use requirements, and the threat of confiscation. According to farmers, rented land costs approximately $1,400/ha per year.

Farmers are nominally free to plant whatever crops they wish on their land, but in practice the MoA still exerts a large degree of influence, as evidenced by the fact that 100% of non-orchard farmers interviewed by the assessment team continue to grow exactly 70% cotton in accordance with the former national production plan. Freedom to farm does not extend to the establishment of orchards—for this, farmers must apply to and receive consent from the local government. In practice, however, all such applications have reportedly been accepted.

Water

While about 85 percent of Tajikistan's 830,000 hectares of arable land is irrigable, only about 515,000 ha are currently estimated to be irrigated.[17] The irrigation systems were established under the Soviet collective farm system that strove for large scale and highly mechanized cotton production. When land reform divided those farms into thousands of *dekhan* farms, management of the collective irrigation system was neglected.

Years of poor management have led to degradation of irrigation infrastructure, a rising water table, and widespread soil salinization. Salt build-up is visible on the surface of fields throughout much of Khatlon, threatening crops and rendering thousands of hectares of land unusable for agricultural production. For example, one farmer stated that of his seven hectares, only two were currently arable due to the high water table and salinization in the soil. This problem is especially detrimental to orchards, whose tree roots extend further into the soil.

The Ministry of Water Resources and Land Reclamation is nominally tasked with the development and maintenance of the country's irrigation infrastructure, including both supply and drainage channels. However, low institutional capacity and poor management led to its bankruptcy and restructuring in 2013 as part of the Ministry of Energy and Water Resources.[18] In the past 10-15 years, private water user associations, with funding from USAID, the World Bank, and other donors, have been established to remediate and manage the upkeep for irrigation supply canals. Yet little to no efforts have been addressed at improving the drainage channels, which remain the primary responsibility of the farmer.

Farmers are required to pay fees to both the national water agency and the local water user association, but many complained that they experience little benefit in return. The inability and/or unwillingness of farmers to pay water fees leads to the chronic underfunding of the system as a whole, limiting capital investment in long-term infrastructure maintenance and upgrades. The resulting soil salinization poses a serious risk to the long-term development and competitiveness of agriculture in Khatlon province.

Tax

Farmers are subject to comparatively favorable tax treatment. Under the new tax code, there is no income tax on farmers. Instead they are taxed based on the land area under production. Rates on land differ, in part based on whether or not the land has access to irrigation. This tax must be paid regardless of the farmer's yield and income, although in practice farmers stated that they could receive a reprieve in the event of drought or extreme cold through petitioning the local government.

Farmers also pay monthly a social protection tax equal to 10 TJS for each shareholder in the *dekhan* farm. Although no farmers discussed this issue directly, the tax seems to have the potential to encourage the consolidation of *dekhan* farm ownership in a single individual. This dynamic has particular implications for women, who are much less likely to be heads of households or the leaders of collective *dekhan* farms.[19]

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[17] World Bank, *Project Appraisal Document Report No. 72293-TJ* (October 25, 2012), available at: http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2012/11/08/000356161_20121108233950/Rendered/PDF/722930PAD0P1330Official0Use0Only090.pdf.

[18] See Asia Plus, "Deputy Ministers of Energy and Water Resources Appointed" (Nov. 23, 2013), available at http://news.tj/en/news/deputy-ministers-energy-and-water-resources-appointed.

[19] This issue is discussed in more detail in the next section, Women and Agricultural Technology in Tajikistan.

The preferential treatment for producers only extends to sales at farm gate or into the market. Sales to processing facilities, such as the sale of stone fruit to a jam producer, would be subject to the 6% tax on gross income for small businesses. This approach reflects the government view that processing is business and that only primary production should receive favorable treatment. However, it incentivizes the sale and export of raw goods and discourages the development of value-added processing.

Finance

Under the Soviet system, all support for agriculture derived from the government, and many farmers raised during this period continue to look to outside assistance for funding their activities. Given the limited resources of the Tajik government, most of the financial support to the sector today derives from or is subsidized by donors and NGOs, including both large-scale investments in infrastructure and small-scale support to farmers in the purchase of equipment and inputs. Accordingly, farmers have little incentive to seek out formal credit. As discussed above, banks and microfinance institutions offer loans to the agricultural sector, but the terms of these products put them out of the reach of most farmers. Farmers also lack the business skills necessary to put together a successful loan application.

A limited amount of value chain finance has emerged to cover short-term operating costs. Many of the input suppliers interviewed sell seeds, fertilizer, and pesticides to their clients on credit and are repaid when the crop is harvested and sold. It is important to note that these arrangements were most common with small-scale local input dealers who have developed trust through a long-term relationship with their farmer clients. Larger companies and equipment suppliers often insisted on cash at the time of sale, or accepted a more limited credit or lease-to-own arrangement if it was supported and guaranteed by donors.

By contrast, interviewees were unable to point to any examples of farmers receiving credit from the buyers of their agricultural products (i.e., the traders and exporters who come to the farms to purchase onions or stone fruits at harvest time). The use of formal contract farming arrangements would allow farmers to receive inputs and/or agricultural advisory services on the basis of advance purchase agreements for their production. The lack of this relationship is telling for the broader goals of technology distribution as it cuts off an important potential commercial pathway for farmers to access new technologies. This dynamic is particularly surprising for the onion and orchard sectors, which have the type of strong, high-price export market opportunity that should incentivize the development of long-term supply relationships with farmers. More research is needed to better understand these dynamics and what is needed to facilitate these market linkages.

Agricultural Advisory Services

Agricultural advisory services are critical to the successful dissemination and adoption of new agricultural technologies. "Technology" implies not only physical products but also new agronomic practices and techniques. For both products and processes, the proper use of these technologies must be taught to ensure farmers experience the type of return on investment that will encourage long-term adoption. Advisory services can be provided by both public and private sectors. The relative merits of each approach have been considered extensively by researchers and policymakers and will not be discussed here. However, both types of service have a role to play.

In Tajikistan, extension services were originally provided through agronomists employed by the state-owned collective farms. In the wake of independence, many of these agronomists have become government extension advisors employed at the district level or private agronomists employed by large *dekhan* farms or donor projects. The district-level government advisors are few in number and have little access to training. Accordingly, their reach is limited and the advice provided may not be up-to-date with the most modern production methods. The advice may also be skewed in support of government policy—without fail, the farmers interviewed whose chief advice came from government agents grow 70 percent cotton, in line with the government's agricultural production plan but not necessarily with the farmers' best interests.

NGOs and donor projects provide substantial assistance to farmers through agronomists employed directly as project staff. These advisors are highly qualified, but their tenures (tied to the project lifecycle) are necessarily short-term, creating gaps in service over time. Moreover, the duplication and contradiction between the advice provided by the government and donors can confuse farmers.

A small number of previously project-based extension providers have attempted to transition to a sustainable fee-for-service business model. As seen elsewhere in the developing world, this business model is difficult because farmers have a long tradition of getting these services for free or very low cost. Donor and NGO specialists often provide free or very low-cost services, and government advisors (if paid) are typically paid in kind or offered tea for their efforts. The most successful of these consultancy businesses have bundled their advisory services with other business branches, such as input shops, financial services, and exporting of agricultural goods. Yet all of these businesses readily admitted that their consultancy services are not yet financially sustainable, and they remain reliant on donor funding. These businesses also face competition for long-term staff from donors themselves, whose projects often hire agronomists directly as project staff rather than working by contract through existing consultancy groups. Donor projects can offer much higher salaries, and many of these businesses have struggled with losing staff, and the investment into the training of that staff, to donor projects. This cycle must be broken if a long-term sustainable extension system is to develop in Tajikistan.

Extension services can also be integrated into the purchase price of agricultural inputs and equipment. Many input suppliers in Tajikistan offer advice to farmers through demonstration plots and in-house lectures or simple assistance in selecting from among the products on sale. Larger, more established businesses with ties to international seed companies arguably provide the highest quality advice. However, farmers reportedly prefer and trust the advice of their local input dealers. These dealers have little formal training but do test their products in their own household plots. Larger input companies have responded to this market dynamic by licensing the local dealers to sell their products. By contrast, as discussed above, there is little to no provision of inputs or advisory services by the buyers of agricultural products. Long-term relationships between farmers and traders or exporters have not yet developed in Khatlon to allow for this type of knowledge transfer.

WOMEN AND AGRICULTURAL TECHNOLOGY IN TAJIKISTAN

The status of women and girls in Tajikistan has undergone significant changes over the last twenty years, and continues to change. Under Soviet rule, human development indicators on education, literacy, and life expectancy were high. Post-independence economic and social transitions have left women and girls more vulnerable.[20] Civil war, the rollback of social services (e.g., child care and medical coverage), and migration have increased the burden of care and household responsibilities onto women and girls. Significant gender inequalities persist, despite a legal framework that largely provides for equality between men and women.

The Constitution of Tajikistan, adopted in 1994, and later amended in 1999 and 2003, guarantees equal rights for women and men. It upholds international conventions on the advancement of women including the Convention on Elimination of All Forms of Discrimination Against Women (CEDAW, ratified in 1993), and the Platform for Action adopted at the Fourth World Conference on Women (1995). In 1991, the Government created the Committee on Women and the Family, which aims to promote the advancement of women and continues to operate today. Over the years, the Government has invested in harmonizing the legal framework with international conventions to protect and advance women's rights, adopting the Law on Reproductive Health and Reproductive Rights (2002), the Gender Equality Law (2005), and the Law Against Domestic Violence (2013).

The implementation and enforcement of these laws, however, is weak, and strong cultural notions that reinforce men's leadership and women's subordination interfere to reduce gender equality in practice.[21] For example, although the Constitution guarantees equal rights in family relations and in the dissolution of marriage equal shares in common property, divorced women are often left with little property and without the means to pursue their property rights in court. Furthermore, religious marriages (*nikokh*), which are not recognized by the state, are widespread and leave women with no legal rights to property or protection from the state.[22]

Article 17 of the Constitution of the Republic of Tajikistan

"Everyone is equal before the law and the courts. The State shall guaranteed individual rights and freedoms, irrespective of nationality, race, sex, language, faith, political beliefs, education, or social or material states. Men and women shall have equal rights."

WOMEN'S PARTICIPATION IN THE AGRICULTURAL SECTOR

Women make up an important share of agricultural labor force in Tajikistan. Estimates range from 31 percent[23] to 85.5 percent[24] of women are active in the sector. UN Women estimates women conduct 80 percent of farm work.[25] This "feminization of agriculture" results from men migrating out of Tajikistan or taking up non-farm occupations.[26] However, women's participation in the sector is characterized by seasonal, low-wage, and low-paid or unpaid positions. Women's tasks are largely restricted to field labor, such as weeding, sowing, transplanting, and harvesting, which do not require decision-making, whereas the selection of seeds, fertilizers, and plant protection materials is controlled by men. Women are often hired as day laborers, working together in informal groups, referred to as brigades. The term "brigades" refers to groups of workers who were organized to undertake specific agricultural tasks on kolkozes. The group is led by a brigadier. Today a brigadier, often a woman, will organize other women in the village for work when a farmer needs laborers. As a result, women's income earnings are concentrated during peak times when their labor is sought, such as during the cotton harvest, but during the winter months they are less active in the sector and have fewer income-generating opportunities. Most rural women also tend household plots that play an important role in smoothing income and consumption in the household.

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[20] USAID, *Gender Assessment USAID/Central Asian Republics* (2010).

[21] United Nations, *Consideration of reports submitted by States Parties under article 18 of the Convention on the Elimination of All Forms of Discrimination against Women: Tajikistan* (2005) (CEDAW 2005).

[22] Ibid.

[23] FAOStat (estimate as of 2010).

[24] Statistical Agency under President of the Republic of Tajikistan (TajStat) data as reported by Abdulloev, M. N.d., *Gender Aspects of Agriculture* (2013), available at: http://www.stat.tj/img/en/seling.pdf.

[25] Action Against Hunger, *Land Reform in Tajikistan: From the Capital to the Cotton Fields* (2003).

[26] The Migration Service of the GoTJ estimates that 877,335 people migrated in 2012 of which the majority was men. An increasing number of women, estimated in 2012 at 14 percent, are now also migrating. Kurbanov, S., *Gender shape of labor migration in the Republic of Tajikistan* (2013), available at http://www.stat.tj/img/en/Gender%20aspects%20in%20migration%281%29.pdf.

Fewer women than men are formal managers of *dekhan* farms: in 2012, only 7.8 percent of all *dekhan* farms were legally headed by women.[27] More women are managers of family *dekhan* farms than they are of collective or individual farms.[28] Within large *dekhan* farms, women hold a larger proportion of shares, estimated at 53 percent of shares, which is considered to be a more accurate reflection of their participation in the sector.[29] The low level of leadership suggests women face gender-based barriers to assuming the responsibility of *dekhan* farms. Although few women are legal heads of *dekhan* farms, women are assuming the de facto leadership on some *dekhan* farms because of male migration. Evidence suggests that a slightly higher proportion of privatized *dekhan* farms led by women relative to those led by men are able to support their families through income and production, suggesting women-led farms are at least as productive men-led farms.[30] This indicates that mechanisms to move women into leadership positions by addressing the real and perceived lack of leadership qualifications or gain access to their land shares would improve productivity.

A range of associations or groups exist in the agricultural space, from formal groups of *dekhan* farms, like the National Association of *Dekhan* Farms (NADF), to common interest or self-help groups. These serve as a vehicle to deliver extension and training, and in some cases credit. Women's participation in these different types of associations is generally low.[31] NADF estimates that of its 16,000 members, roughly 2,000 of them are women. NGOs and other services providers also organize farmers to deliver information and training into common interest groups or self-help groups. For example the National Agricultural Training Center (NATC) organized farmers into production groups for specific activities (e.g., beef fattening, poultry breeding, and vegetable production). Of the roughly 2000 farmers with whom it works, approximately 35 percent are women and their participation is sex-segmented by topic with more women participating in vegetable producer groups than beef fattening.

Underpinning the occupational and task segmentation are perceptions and social norms about men's and women's role in households and in the agriculture. Women are often described as lacking the appropriate skills and knowledge required, whether as farmers or farm managers, influencing their ability to take on these roles.[32] Their continued participation as informal, seasonal laborers reinforces the perception that women have no experience or knowledge of farming. This is further strengthened by the widespread belief that men, as breadwinners and heads of households, are farm managers regardless of whether or not they are active in the sector.

INPUTS INTO DECISION-MAKING

Women's independent decision-making role is limited, although it varies depending on the types of decisions under consideration. Women in male-headed households lack a role in decisions related to how much to save, whether to sell production, borrow money; and, decisions related to purchasing of large items, what to grow, and how to spend income. They are more involved in non-economic decisions related to children's marriage and school attendance.[33] Consultation among family members and joint decision-making is prevalent.[34] Furthermore decisions are influenced not only by spouses but other family members, for example mothers-in-law, particularly in rural areas where multiple households and generations often live together.

Younger women, and particularly daughters-in-law, have few assets and little power in the household. Among married women, those between the ages of 15 and 19 are least likely to participate in decisions about their own healthcare, major household purchases, and visits to family and friends. Young married men similarly have limited control over income; 43 percent of married women ages 15-29 years report that someone else in their households makes decisions about how to spend their husband's earnings.[35] Compared to women in other regions, women in Khatlon are the least likely to participate in decisions related to their own healthcare, major household purchases, and visits to family and friends.

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[27] Abdulloev, M. N.d., *Gender Aspects of Agriculture* (2013).

[28] Asian Development Bank (ADB), *Mainstreaming Gender in Poverty Reduction Strategies: Tajikistan Country Gender Assessment* (2006).

[29] Ibid.

[30] Ibid.

[31] The Women's Empowerment in Agriculture Index for Tajikistan found that women's access to group membership was one of the weakest areas of empowerment.

[32] CEDAW 2005.

[33] Shahriari, H., A.M. Danzer, R. Giovarelli, and A. Undeland, *Improving Women's Access to Land and Financial Resources in Tajikistan* (2009) (Shahriari et al. 2009), available at http://siteresources.worldbank.org/INTTAJIKISTAN/Resources/CombinedGenderESWreportENG.pdf 2009.

[34] South Asia Pro-Poor Livestock Policy Programme, *Small-Scale Poultry Farming and Poverty Reduction in South Asia* (2013).

[35] Ibid.

By contrast, older women are afforded greater decision-making power, have more assets, and exert greater control over their own income. Participation in decisions also increases with the number of children that a woman has, or with the level of cash earnings the woman contributes from her own employment.

Despite the high percentage of male migrants in Tajikistan, and particularly in Khatlon province, the absence of men does not necessarily lead to an increase in women's decision-making. The composition of rural households, often involving extended family, complicates women's ability to make agricultural-related decisions. Women's decision-making does not automatically increase when men in their households migrate. As an example, even with the high rate of migration, women manage only 51 percent of land owned by absent migrants. This is partly due to the high percentage of migrants who are sons of male heads of households and therefore not the primary decision maker in the household.[36] Additionally, where spouses are migrating, it is not uncommon for women to still seek input from their migrant spouses. If husbands migrate, sons will often assume management of the farm (although more often sons are migrating, leaving husbands in the decision-making role).

ACCESS TO AND CONTROL OVER PRODUCTIVE RESOURCES

Women's participation in agriculture and their ability to adopt new technologies is shaped by access to land and other productive resources.

Land

Access to land, and tenure security, remains a severe constraint for women. The land reform process was not equitable, and women continue to have access to less land than men and to face challenges in registering land in their name. It is estimated that women-led *dekhan* farms are smaller than men-led farms; on average 4.1 hectares of arable land for women-led farms compared to 5.8 hectares for men-led farms.

Although the land reforms legally guaranteed equal rights to men and women to use land (and be conferred shares or certificates), several provisions of the code disadvantaged women more than men. For example, individual shares to the dismantled kolkhozes and sovkohzes were given only to full-time members of the collectives. Women on maternity leave or who were not members of collectives were excluded from accessing those land shares. Individuals were also required to have experience in farming and farm management. As women had initially fewer opportunities to manage farms, relative to men, fewer women were able to meet the criteria. Despite improvements in the legal code (see box), in practice women's names are often left off of land certificates, which are registered in one name only and generally in the name of the head of household. There are few stipulations for women who are married, divorced, or widowed, leaving them at a significant disadvantage upon change in their marital status. Furthermore, social protection taxes for *dekhan* farms are calculated based on the number of shareholders, reducing the incentives to register shareholders such as wives and daughters-in-law. Women also rarely claim their legal share of *dekhan* farmland. Evidence suggests this is because they are unaware of their rights or unable to withdraw the land to work. Age is strongly associated with land size for women, and more so relative to other characteristics such as education, indicating that older women are more likely than younger women to have land.[37] UN Women is advocating for additional reforms to the Law on *Dekhan* Farms that would increase women's access to land and tenure security, specifically by ensuring women's, and other family members', names are included on land use certificates and licenses.

Women largely gain access to land via household plots ranging in size from 0.02 ha to 0.8 ha. These lands, over which some women in the household are able to exercise greater control, produce food that is consumed in the household or sold to supplement household income. By some estimates, between 10 and 20 percent of the production from household plots in female-headed households is directed to the household for consumption.[38] However even in the case of these household plots, certificates, when they are issued, are in the name of the head of the household. Women utilize presidential lands less than household plots. The land is further from home and generally less irrigated, making it more difficult for women to improve the quality of the land.

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[36] An estimated 74.5 percent of migrants are sons of male heads of households (Shahriari et al. 2009).

[37] Shahriari et al. 2009.

[38] Ibid.

Key Amendments in Tajikistan's Land Code (as of 2008)

A number of changes to the Land Code were made with support from UN Women (formerly UNIFEM) to revise articles that were discriminatory or that allowed for discriminatory interpretations of the code.

- Article 17, clause A: This article states that all members of a family *dekhan* farm, including women, are eligible for a land use certificate (LUC), in addition to the general LUC, which is given to the head of the family, typically a man. Previously, if the head of the family received a general LUC, neither the women nor children in the family could obtain documents certifying their right to a land share.
- Articles 67-69: These articles have been repealed and no longer appear in the amended Land Code. Previously, these articles stated that kolkhozes (collective farms) were to be redistributed only to their permanent, full-time members. This meant that women on maternity leave or who were not full-time members were effectively excluded from the distribution process.
- Article 66: A modified article 66 now replaces articles 67-69, stating that all citizens living in rural areas of the country have equal rights to land shares. Previously, rural people who were not members of kolkhozes or who performed non-agricultural work were excluded from having land shares. Since many women did not work the land directly, and instead provided health or social services in their villages for example, this had a profound negative impact on them.

Source: UN Women, *Land in the Right Hands: Promoting women's rights to land* (2012).

Credit, Technologies, and Extension and Advisory Services

Women's use of new technologies is lower relative to men as is their access to productive resources and information. Households headed by women are less likely than men to own their assets. Instead they share available equipment with each other or rent. They also work their land less intensively (i.e., use smaller amounts of inputs such as fertilizer and improved seeds) than men.[39]

Both men and women are limited in their access to agricultural credit. Interest rates remain high (between 24 and 26 percent), and much of the available credit targets the cotton sector. Relative to men, women face more severe constraints in accessing credit, particularly where property-based collateral, such as a land use certificate or other assets, is required.[40] Research and interviews indicate that there is an attempt to expand agricultural lending and in ways that can improve women's access to credit. These include diversifying the types of collateral that can be accepted to include assets that women are likely to own, such as gold and jewelry, as well as developing group lending schemes.

Although largely used to meet basic needs, remittances from migrant workers are another potential source of capital for agricultural investments. Remittances account for almost 40 percent of GDP.[41] In Khatlon province, almost 40 percent of households have at least one migrant, but flows per capita are low, indicating that migrant workers are being hired in low wage and low skilled positions. Nonetheless their importance suggests that formal financial services use could increase if appropriate mechanisms are identified, for example by improving links between banks, remittance transfers, and other financial services.

With few farming households receiving public extension services, agricultural information is largely disseminated via donor-funded projects with different channels and means for delivering information. Women reported that when they need assistance or advice for household plots, they will call upon a local agronomist. They will also ask neighbors and other family members.

[39] Ibid.

[40] Results from the Women's Empowerment in Agriculture Index cite access to credit as one of the more severe constraints women face.

[41] World Bank, *Tajikistan: Reinvigorating Growth in the Khatlon Oblast* (Report No. 80022-TJ, 2013).

CONCLUSION

Gender dynamics in the agriculture sector are influenced by a complex set of intra-household dynamics, migration, the continued lack of clarity on legal reforms, and social norms that overlook and undervalue women's role in the sector. As discussed above, women's role in the sector is currently limited to low-skilled and low-paid tasks. As new technologies increase the productivity of the sector, women's role has the potential to evolve. Many of their activities can be targeted for labor-saving technologies. The trade-off between the savings in terms of unpaid labor needs to be weighed against the paid income that many women receive, for example for weeding. In either case however, the dissemination of new technologies should seek opportunities to upgrade women's skills into higher value activities.

For Tajik women, households are complicated units of multi-family dynamics in which their decision-making is influenced by husbands, both present and absent, and other women in the household, especially mothers-in-law. Women are infrequently the decision-makers on the farm, even with the husband is absent. This dynamic depresses innovation on the farm as the direct involvement of the farm's decision-maker in the operation of the farms is crucial for the acceptance and adoption of new technology. Moreover, women lack access to productive resources in their own right, from land and livestock to credit and inputs, further reducing their ability to adopt new technologies.

There is unlikely to be direct pathway however for improving women's participation and performance in the sector and strategies will have to engage multiple members of the household to support women. To the extent that men or other women (e.g., mothers-in-law) control income and decisions, targeting women exclusively to invest in the technology may not work. And technologies that could have an impact on women's income but require the use of resources under men's control will also require careful consideration. Conversely directing training and technology dissemination to men only ignores the fact that women are productive actors in the sector, and may use or be indirectly affected by new technologies. Moreover overlooking women's participation in the sector leads to missed opportunities for building women's skills, changing perceptions of women's role in the sector, and sustaining adoption. This suggests that approaches to enhancing women's role in the agriculture need to focus on both increasing women's access, control, and ownership of agricultural assets (e.g., land and livestock) as well as strengthening their ability to increase the returns from those assets via extension and credit.

Although not discussed at length in this report, women's role in managing household plots has important implications nutrition and dietary decisions. Women's involvement in managing the crops that get produced and harvested in household plots makes them key stakeholders for combined agricultural and nutrition messaging. This presents an alternate avenue for upgrading women's agricultural knowledge and skills, while at the same time (and under the guise of) improving nutrition outcomes. And while some income is being generated from these plots that women control, yet again, the pathways for reaching women would need to consider the intra-household dynamics (such as the influence of mothers-in-law) that mediate women's activities and influence the adoption of new technologies.

EARLY ONION

In Tajikistan, early onions are a relatively new post-Soviet crop that has emerged as a lucrative cash crop, replacing many of the hectares once under cotton production. In Khatlon province, onions are grown on *dekhan* farms and in smaller quantities in household plots. Most farmers use local seed varieties, which result in a low yield and poor quality product. The low germination rate of these seeds and the traditional method of broadcasting the seeds in open fields requires farmers to use a large amount of seeds per hectare (up to 20 kilograms/hectare (kg/ha)). Open field production also necessitates a heavy amount of weeding throughout the season. Fertilizers and plant protection materials of varying quality are readily available in the market. However, most farmers do not regularly use these materials and lack understanding of the right products for their soil and production methods.

Under current production practices, the soil and climate in Khatlon can generate yields of 25-40 metric tons (MTs) per hectare for early onions sown in autumn. According to an onion wholesaler in the Giprozem market in Dushanbe, onion yields in Sughd province are twice as high on average as yields in Khatlon province for the same variety. The introduction of improved inputs and more efficient agronomic practices, such as growing seedlings under low tunnels and transplanting them to open field later in the season, has the potential to increase income for smallholder farmers throughout Khatlon.

MARKET OPPORTUNITY

Production

Tajikistan has experienced a steady increase in onion production as the country's farmers transition away from cotton production and towards more profitable horticultural crops. From 2000 to 2012, Tajik onion production increased from 113,000 MTs to 371,200 MTs, or by 228%.[42] Khatlon province in particular has taken advantage of this change and today accounts for approximately 52% of Tajikistan's total onion production. From 2010 to 2013, Khatlon province experienced a 37% increase in the overall area under onion production from 6,691 ha to 9,166 ha.[43] Within Khatlon province, Qumsangir district in southern Khatlon is the province's top onion producer, with 1,014 ha of farmland under onion cultivation as of 2013. The districts of Yovon, Shaartuz, Farkhor Rumi, and Danghara have followed suit, each with at least 400 ha dedicated to onion production and recording at least a 48% increase in acreage under cultivation vis-à-vis 2010.

TABLE 1: KHATION PROVINCE, AREA OF ONION PRODUCTION (HA)

DISTRICTS	2010	2011	2012	2013
Qumsangir	986	905	977	1,014
Yovon	524	661	749	781
Shaartuz	426	446	573	757
Farkhor	365	462	540	596
Kulob	409	458	515	525
Others	3,981	4,527	5,079	5,493
Total	**6,691**	**7,459**	**8,433**	**9,166**

Source: Khation Department of Agriculture.

Early onions in Khatlon are typically sown from late September to early November and are harvested from May to June.[44] Accordingly, there is a surplus of early onions during the summer months, with a large share exported to wholesale markets in Russia and Kazakhstan. Onion production does not take place later in the summer owing to the hot climatic conditions of Khatlon. During the winter months, onions from Sughd province supply local markets in Khatlon. Although data was not yet available at the time of this report, it is expected that 2013 onion production figures will drop considerably due to nationwide crop losses from heavy snowfall that occurred in March 2013.

[42] FAOStat.

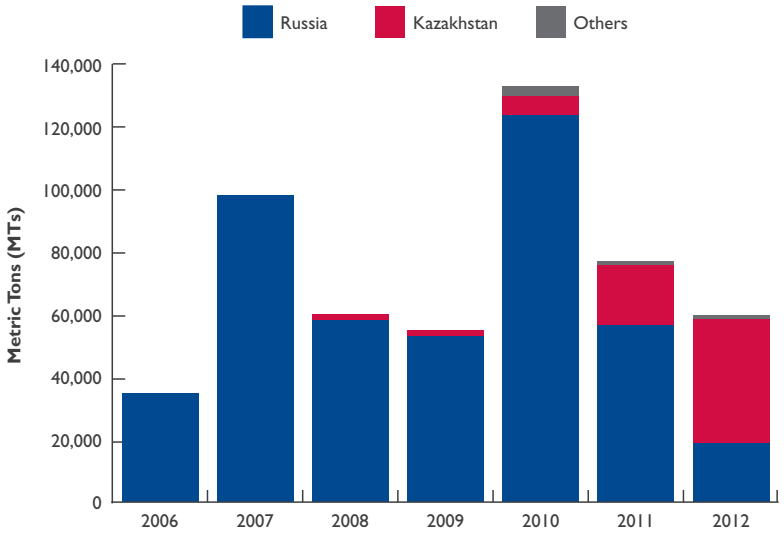
[43] Khatlon Department of Agriculture.

[44] Harvest dates vary by farm location and production method. Some of the southernmost districts are already harvesting in late April, when prices are highest. As will be discussed below, the introduction of improved practices could allow more farmers to access this favorable market window.

End Markets

Traditionally a significant portion of year-round production is exported to other countries as total onion production is nearly three times domestic onion consumption.[45] Russia in particular is the dominant importer of Tajik onions. From 2006 to 2010, Russia accounted for over 93% of Tajik's onion exports by volume, with Russian purchases peaking in 2010 at 123,465 MTs. From 2011 to 2012, Kazakhstan emerged as the top onion buyer, supplanting Russia's position. A similar trend was seen in fresh and dried fruit exports. This switch is likely due to the 2010 establishment of the customs union between Belarus, Kazakhstan, and Russia,[46] which eliminated all customs borders between member countries in mid-2011. Tajik onions are likely still being exported to Russia, but are being recorded as exports to Kazakhstan since member states are considered a single economic zone.

FIGURE 1: TAJIKISTAN: ONION AND SHALLOT EXPORTS



Source: UN Comtrade HS Code 70310.

China, India, and Pakistan remain unattractive markets for Tajik onions as each of these countries is self-sufficient in onion production. Taijk onion producers expressed interest in supplying the European market and could take advantage of the summer market window to supply northern European markets. However, due to strict phytosanitary requirements and logistical barriers, Tajik producers have had little success accessing these markets to date. Accordingly, the remainder of commercial production is sold in the urban markets of Dushanbe and Sughd province. Household garden production is largely consumed in the household, although some may be traded or sold to neighbors or in the market.

Price Trends

Onion prices are based on multitude of factors including size (medium vs. large), quality (dry vs. high moisture content), and market availability. In general, onions prices increase over the winter and early spring season and bottom out in the summer when supply is highest. In domestic and export markets, consumers pay more for larger onions. On the whole, domestic onion prices can range from 0.4 TJS/kg in Qurghonteppa in in the summer months to 1.5 TJS/kg in Dushanbe in winter. The price of early onions tops out at 2 TJS/kg in April and early May for onions destined for export markets in Russia and Kazakhstan.[47]

Distribution Channels

Farmers with marketable and high quality early onions will often sell to intermediaries as opposed to directly taking their crop to local markets. These traders will visit onion farms two to three weeks before the harvest and typically set the purchase price at that time. During the harvest, farmers (or laborers hired by the farmer) calibrate and do an initial sorting of the onions based on size. In some cases, the buyer brings in his or her own laborers to do the harvesting and sorting. Traders load the stock in trucks to transport to major wholesale markets (e.g. the new Qurghonteppa bazaar and Giprozem bazaar in Dushanbe). Onions destined for export markets are typically shipped north to Sughd province where they are unloaded, re-sorted and re-packaged, and loaded on to trains or trucks for export.

[45] Calculations based on data from the Tajik Statistics Agency on overall population, onion consumption, and annual onion production.

[46] Eurasian Economic Community customs union between Belarus, Kazakhstan, and Russia. Additional information available at http://www.eurasiancommission.org/ru/Pages/default.aspx.

[47] Price information based on statistics from the Tajikistan Agricultural Information Marketing System, stakeholder interviews, and spot prices in the Shohmansur and Giprozem markets of Dushanbe and regional Khatlon markets of Qurghonteppa and Qumsangir.

Currently, there is a de-facto trade embargo with Uzbekistan over the construction of the controversial Rogun Dam. Uzbekistan has subsequently hindered outbound Tajik train shipments and has even gone so far as to damage Tajik cargo. According to an official within the Ministry of Agriculture, when shipping onions, Uzbek customs agents will sometimes demand a fee of USD100-200 per container in order to guarantee safe passage. Otherwise, they will dump water into the consignment, causing the onions to rot before arriving at their destination. This additional fee and risk of spoilage constitutes a significant barrier to trade for onion traders.

Competition

As onions are produced throughout the Central Asian region, market advantage is largely dependent on climatic differences and the ability to produce a high number of large, uniformly sized bulbs. Producers in Sughd, Russia, and neighboring republics to the north have lower costs of production, better agronomic techniques, and greater access to improved inputs. However, Khatlon farmers have a distinct climatic advantage, enabling farmers who produce early onions during a narrow spring window from late April to early May to get a considerably higher value from their production than those who harvest later in the season.[48]

Overall, Tajikistan's onion exports to Russia and Kazakhstan occur from April to July, with exports tending to trail off at either side of this window. Beginning in July, onion production comes online in neighboring Kyrgyzstan and Uzbekistan, though the latter has instituted a ban on onion exports since 2011.[49] Harvests also occur around the Russian cities Krasnoyarsk and Volgograd at this time. In addition, Tajikistan must compete with the Netherlands and China, which have traditionally been the top two onion suppliers to the Russian market. In general, Russia imports onions from the Netherlands from January to June, with shipments peaking in March/April. It is highly likely that Dutch onions are shipped by boat (from Rotterdam) to ports in Western Russia (e.g. Saint Petersburg). Chinese onion shipments to Russia occur throughout the year, but spike in May/June. It is highly probable that Chinese onions are shipped by rail to Russia's Far East. Tajikistan is aptly situated to supply Central Russia and Siberia even though it shares a similar seasonal export spikes with China.

Outlook

Tajikistan's onion industry is at a crossroads. Russia, Tajikistan's primary export market, decreased its global onion purchases from 500,870 MTs in 2010 to 230,192 MTs in 2012 (a decrease of 54%). During the 2010/2011 season, Russia limited imports owing to high global onion prices, while the decline from 2011/2012 was due to increased onion production within Russian itself. The overall 2011-2012 import decline was reflected in Tajikistan's global onion exports, which fell by 56% (by volume). Fortunately, in 2013, Russian onion imports rebounded somewhat to 300,000 MTs, but the market remains turbulent. At the same time, Tajikistan is pivoting away from cotton production and boosting its acreage of horticultural crops such as onions. In Khatlon province, the heart of "white gold" or cotton cultivation, the acreage dedicated to onion production increased by 37% from 2010 to 2013. According to Khatlon producers, half of production is exported internationally while the other half is sold domestically. This increased production will have a dampening effect on domestic onion prices, therefore farmers must increasingly looks towards exports markets in order to maintain profitability. In the long term, onion farmers need to create better conditions for postharvest storage in order extend the market life of their product. In the short term, Khatlon farmers should focus on production techniques that allow them to harvest high-quality onions in the highest price early spring export market window (i.e., April).

[48] It should be noted that parts of Uzbekistan have similar climatic conditions. Before political tensions disrupted cross-border trade, Uzbek farmers dominated the market for early onions in Sughd. If the borders were to reopen, it is unknown if the Uzbek farmers would be able to win back their market share in Sughd.

[49] Microfinance Centre and Inter Church Organization for Development Cooperation, *Research on Agricultural Value Chains in Tajikistan* (2011). It should be noted that this ban has resulted in great amounts of onions being illegally imported to Tajikistan through the Uzbek border. These onions re-exported as Tajik onions, which positively affects export figures, despite distorting them.

IMPACT OF PROPOSED TECHNOLOGIES

Two technologies were proposed for early onions: the introduction of improved inputs, such as seeds, fertilizer, and pesticides; and the introduction of a method of growing onion seedlings under low tunnels and transplanting the seedlings to open fields later in the growing season. These two technologies are evaluated below.

Improved Inputs

Accessing quality certified vegetable seeds, fertilizers, and plant protection materials is problem for farmers in Tajikistan. From 2009-2011, the USAID Productive Agriculture in Tajikistan (ProApt) project implemented a voucher program to increase access to imported onion seed for small commercial *dekhan* farms. ProApt linked input dealers and lead farmers to launch demonstration plots at the farm level, demonstrating potential yields and returns resulting from agricultural best practices. To help overcome the risk involved in adopting new technologies, ProApt provided farmers with vouchers equal to 40 percent of the cost of the inputs, which were distributed through local input dealers. The remaining 60 percent of the cost was paid by the farmer. The voucher packages included high quality onion seeds, fertilizers, and plant protection materials. In addition, project agronomists provided trainings and support to the farmers within the project.

Based on preliminary findings from project agronomists and interviews with farmers throughout the province, the assessment team prepared the basic comparative crop budget found below to show the potential impact of the proposed technology on smallholder income. According to these findings, the introduction of improved imported varieties has the potential to increase early onion yields substantially, with estimates ranging from 50-100MT/ha. Improved inputs increase farmers' expenses by up to 50 percent, but have the potential to triple producer income when combined with modern agricultural production techniques.

Even under traditional production methods, onion production is a highly profitable endeavor for Tajik farmers, especially production of early onion. Accordingly, any technology that can increase the yield or decrease the losses per hectare can have a large effect on farmer income. Improved inputs do both. On average, farmers spend about 6,500 TJS ($1,352) on one hectare of grown vegetables in Sughd. Onion is the mostly costly vegetable crop to produce with farmers spending about $4,363 per hectare including harvesting and transportation costs.

When low quality seeds are used, three times more seed must be sown (up to 20 kg) over hybrid seed amounts. In addition, the germination rate of low quality seeds is low, requiring additional seeds to be sown to replenish the field (an additional 1.25 kg/ha). By contrast, high quality seeds, especially hybrids, increase the yield per hectare by up to 30-50 percent, increase the uniformity of the yield, and decrease the amount of pesticides required. Pesticides, including insecticides, fungicides, and herbicides, protect crops against losses due to pests and diseases, which can decrease the yield by up to 85 percent. Despite a significant increase in operational expenses, the use of improved inputs can quadruple farmers' income from onion production.

This technology can benefit all commercial onion producers, even those with small farms of less than 5 ha. The benefits to household gardens are much less clear, as the added expense will not be offset through sale of the product.

TABLE 2: COMPARATIVE CROP BUDGETS FOR EARLY ONION PRODUCTION WITH IMPROVED INPUTS[50]

DESCRIPTION	BASELINE CROP BUDGET LOW QUALITY INPUTS OR THEIR ABSENCE (WITHOUT TECHNOLOGY)				HYPOTHETICAL CROP BUDGET HIGH QUALITY INPUTS (WITH TECHNOLOGY)			
	Unit	Quantity	Unit Price USD	Total Revenue USD	Unit	Quantity	Unit Price USD	Total Revenue USD
REVENUE								
Sales of Onions	ton	25	$300	$7,500	Ton	60[51]	$300	$18,000
Total Revenue				**$7,500**				**$18,000**
EXPENSES								
Seeds	kg	20	$5	$100	kg	6	$300	$1,800
Additional seeds	kg	1.25	$5	$6.25				
Fungicides including spraying					kg	15	$19	$285
Insecticides including spraying					L	4	$55	$220
Herbicides including spraying					L	4	$25	$100
Weeding	person/day	200	$4	$800	person/day	40	$4	$160
Irrigation	times	8	$240	$1,920	times	8	$240	$1,920
NPK					package	1	$300	$300
Sowing	person/day	40	$4	$160	person/day	40	$4	$160
Additional weeding[53]	person/day	40	$4	$160				
Consultancy	person/day			$0	person/day	4	$10	$40
Land tax	year/ha	1	$24	$24	year/ha	1	$24	$24
Organic fertilizers	ton	20	$40	$800	ton	20	$40	$800
Plug	ha	1	$78	$78	ha	1	$78	$78
Loosen	ha	1	$22	$22	ha	1	$22	$22
Bed making	ha	1	$100	$100	ha	1	$100	$100
Urea	kg	100	$0.50	$50				
Superphosphate	kg	150	$0.50	$75				
Ammonium	kg	200	$0.50	$100				
Total Expenses				**$4,395**				**$6,019**
Net Income				**$3,105**				**$11,981**

[50] The data in this budget draws on estimates from farmer interviews and the expertise of the team's horticulture expert. It is based on a commercial *dekhan* farm of less than 5 hectares, with one hectare dedicated to early onion production, that uses irrigation by pump.

[51] Although some stakeholders gave estimates as high as 100MTs, this result is likely unreasonably optimistic. Based on farmer interviews and the expertise of the team's horticulture expert, a high yield of 60-65 MTs is more likely.

[52] Labor expense estimates assume that all labor is paid. In practice, farmers suggest that up to 70% is unpaid labor.

Transplanting Seedlings

Crops grown in outdoor farming suffer from the often suboptimal, and sometimes extreme, nature of geological and meteorological events such as undesirable temperatures or rainfall amounts, monsoons, hailstorms, tornadoes, flooding, wildfires, and severe droughts. The protection of crops from weather variability is increasingly important in the face of global climate change. Growing crops indoors or under cover can signficantly reduce weather-related losses. The main goals of indoor systems in agricultural production are (1) the intensification of agricultural production through optimization of natural resources (rational use of land, water, labor, fertilizers, plant protection material, etc.) and (2) the reduction of *force majeure* risks.

An indoor system of agro-production—onion production through seedling production under cover, followed by transplanting—increases productivity, improves quality of the product (yielding large, uniformly sized bulbs), and ensures the onion is harvested and available to buyers earlier (in April, approximately 15-20 days earlier than under traditional methods). This 20 day market window allows the farmer to capture the highest possible prices for their onions. It is also ecologically safer, requiring fewer pesticides, water, and fertilizer, and requires less labor in the form of weeding and sowing.

There are also strong land use benefits to this technology. Seedling production begins in a small area of land under low tunnels in November, and seedlings are not transplanted in open fields until February. The onions are harvested in late April, giving the farmer the opportunity to grow a second crop each year on the same plot of land, which is now unoccupied between April and February. The second crop (corn is used as an example in the crop budget below) increases farmer income and promotes improved soil quality through crop rotation. Because farmers have limited irrigated land, most do not use crop rotation, which increases the risk of diseases and pests accumulating in the soil.

This technology was piloted last year by the USAID ProApt project. Introduction of the technology increased partcipants' harvest and improved the quality of the onions harvested. However, the project beneficiaries started seedling production in January and transplanted in April. Accordingly, they harvested the onion in June, after the most profitable marketable period had closed. As a result, the pilot results were not as favorable as those that could be obtained through earlier planting as shown in the crop budgets below.

As shown in Table 3, the use of low tunnels to grow onion seedlings can increase farmer income by more than nine times through increased yield and earlier harvesting.

TABLE 3: COMPARATIVE CROP BUDGETS FOR EARLY ONION PRODUCTION USING SEEDLINGS GROWN UNDER LOW TUNNELS[53]

DESCRIPTION	BASELINE CROP BUDGET PLANTING IN OPEN FIELD (WITHOUT TECHNOLOGY)				HYPOTHETICAL CROP BUDGET TRANSPLANTING SEEDLINGS (WITH TECHNOLOGY)			
	Unit	Quantity	Unit Price USD	Total Revenue USD	Unit	Quantity	Unit Price USD	Total Revenue USD
REVENUE								
Sales of onions	ton	25	$300	$7,500	ton	75	$400	$30,000
Sales of corn leaves	ton				ton	12	$20	$240
Sales of corn seeds	ton				ton	10	$300	$3,000
Total Revenue				**$7,500**				**$33,240**
EXPENSES								
Seeds	kg	20	$5	$100	kg	2	$300	$600
Additional seeds	kg	1.25	$5	$6.25				
Plastic tunnel including installation					sq. meters	300	$3	$900
Fungicides including spraying					kg	10	$19	$190
Insecticides including spraying					L	3	$55	$165
Herbicides including spraying					L	3	$25	$75
Weeding	person/day	200	$4	$800	person/day	40	$4	$160
Irrigation	times	8	$240	$1,920	times	2	$240	$480
NPK					package	1	$300	$300
Sowing	person/day	40	$4	$160	person/day	2	$4	$8
Additional weeding	person/day	40	$4	$160				
Transplanting					person/day	40	$4	$160
Consultancy					person/day	4	$10	$40
Land tax	year/ha	1	$24	$24	year/ha	1	$24	$24
Organic fertilizers	ton	20	$40	$800	ton	20	$40	$800
Plug	ha	1	$78	$78	ha	1	$78	$78
Loosen	ha	1	$22	$22	ha	1	$22	$22
Bed making	ha	1	$100	$100	ha	1	$100	$100
Urea	kg	100	$0.50	$50				
Superphosphate	kg	150	$0.50	$75				
Ammonium	kg	200	$0.50	$100				
Plug for corn					ha	1	$78	$78
Loosen for corn					ha	1	$22	$22
Sowing for corn					person/day	40	$4	$160
Cultivation for corn					person/day	40	$4	$160
Irrigation for corn					times	2	$240	$480
Integrated Pest Management (IPM) treatment for corn					times	1	$300	$300
Total Expenses				**$4,395**				**$5,302**
Net Income				**$3,105**				**$27,938**

[53] This crop budget is based on the same assumptions and same farm as the budget for early onions with improved inputs. The increase in yield and price per MT reflects the assumption that farmers using this method will increase the overall number of onions produced and be able to harvest those onions in April, hitting the peak market price.

The following table provides an comparison of the relative impact of the two proposed technologies:

TABLE 4: COMPARATIVE ANALYSIS OF EARLY ONION PRODUCTION TECHNOLOGIES

CRITERIA	ONION PRODUCTION (EXISTING TECHNOLOGY)	ONION PRODUCTION BY USING OF IMPROVED INPUTS: SEEDS, FERTILIZERS, PESTICIDES (IMPROVED TECHNOLOGY)	ONION PRODUCTION THROUGH SEEDLING PRODUCTION UNDER LOW TUNNELS (IMPROVED TECHNOLOGY)
Productivity	Low, 25 MT/ha	High, 50–60 MT/ha	High, 65 MT/ha
Product price	0.15 USD/kg	0.5 USD/kg	0.5 USD/kg
Bulbs' quality	Poor, 75% different size	Better, 50-60% different size	High, uniform yield
Bulbs' quality control	---	60%	100%, during all vegetation period
Harvest losses	65%	30-35%	0-5%
Prevention of agro and force majeure risks	---	35%	50%
Quantity control and management	No	No	Yes
Prime cost of the product	0.17 USD/kg	0.11 USD/kg	0.06 USD/kg
Seeds expenses, kg	20	6	2
Energy expense	High	Low, 20–30% less than traditional methods	Low, 80–90% less than traditional methods
Consumption of water	Same	Same	Four times less than traditional methods
Requirement in area/ land	800,000 plants/ha	800,000 plants/ha	800,000 plants/300 sq.m.
Care	Required for all land during entire vegetation period: August–May	Required for all land during entire vegetation period: August–May	Required for only 1/3 of land for half vegetation period: November–February
Additional crop production in year	No	No	Yes

Technology Impact on Women

The gendered division of labor for onion production is similar to other horticultural products. Women plant, weed, harvest, and are responsible for the post-harvest handling of the product. Men will prepare the land, water the crops, and apply pesticides (if available). Men and women work together to apply fertilizer. Many of these tasks can be outsourced to day laborers or individuals with time-saving equipment such as seeders. Informal groups of women, referred to as brigades, are often hired for weeding and harvesting.[54] These women are paid between 15-25 TJS depending on the task and are offered one or two hot meals.[55] The size of the farm and availability of family labor will determine the extent to which hired labor is used over family labor.

The adoption of improved inputs will not have a significant impact on women's labor or access to income. The use of improved inputs, such as high quality seeds, fertilizer, or pesticides is not likely to alter women's tasks significantly. Women are involved in, but not primarily responsible for, fertilizer application and generally do not apply pesticides.

Adopting transplanting techniques for overwinter onion will reduce the time women spend weeding. Although transplanting for onions is not widespread, men and women report that for other crops, such as tomatoes, where transplanting techniques are used, women are often involved in those activities. Women may therefore assume the responsibility of transplanting onions. The impact of the new activities is going to be different for different women. For women who work as unpaid laborers on family farms, the reduced time spent weeding will be positive, or at least neutral if they add transplanting to their activities. However women are often hired as day laborers to weed. Reducing weeding will have a positive impact on farm production costs, but it will reduce the income for women who are hired to weed on farms unless they are also hired to transplant seedlings.

Men and women reported that income from onion sales is used for larger purchases, for example weddings, health emergencies, expanding the house, or reinvesting in the farm. There was some variation in how men and women reported decision-making over income use. Onion sales create a large, bulk sum, which some men and women reported was treated similarly to fruit income; that is, men had greater control over use of the income. Others reported that both men and women make joint decisions about how to use the income from the sale of onions.

CONSTRAINTS TO TECHNOLOGY COMMERCIALIZATION AND ADOPTION

Improved Inputs

Incentives and Constraints to Smallholder Adoption

One of the biggest challenges to farmer adoption of improved agricultural inputs is the need to adopt not only the inputs themselves but to use them in the context of a modern integrated production system. This requires an understanding of production calendars, growing schemes, norms and standards for fertilizers and plant protection materials, and awareness of soil fertility needs. The farmer is required to reliably follow the system step by step to get the expected results. It is impossible to disregard of even one component of this system and still achieve the expected results. Thus access to the products is not enough. Farmers need to acquire the knowledge and skills to understand how to properly use them. As discussed below and elsewhere in this report, extension services for smallholder farmers in Tajikistan are limited. Onion producers, like other agricultural producers in Tajikistan, are not accustomed to testing their soil before applying fertilizers and need more information about the importance of soil testing. Farmers also need to understand that hybrid seeds lose beneficial characteristics in subsequent generations and should not be re-used as seed. These and many other complexities of the improved input production system increase the risk of farmers failing to achieve the expected results and being discouraged from ongoing adoption of the new technologies.

[54] The term "brigades" refers to groups of workers who were organized to undertake specific agricultural tasks on *kolkozes*. The group is led by a brigadier. Today a brigadier, often a woman, will organize other women in the village for work when a farmer needs laborers.

[55] For cotton, women who harvest may also be paid in-kind with cotton stalks, which are used for fuel.

For onions grown on *dekhan* farms, decision-making power is held by the head of the *dekhan* farm and men household members. While men maintain control over decisions regarding which inputs to use, women predominately apply the inputs. On household plots, women reported having greater input into decisions, although individual women in the same household do not all exert the same amount of influence over what is planted or how it is planted on household plots. Strategies to encourage adoption of improved inputs must identify the chief decision-maker as well as the individual who will apply the inputs in practice to ensure a high rate of adoption.

Pathways to Technology Commercialization

Accessing high-quality seed material and other agricultural inputs is a big problem for farmers in Tajikistan. Access requires the availability of high-quality inputs on the market, access to agricultural advisory services to ensure proper application, and access to credit to finance the purchase.

There is no shortage of seed, fertilizer, and crop protection materials available local markets. However, farmers have little assurance of the quality of these products. Illegal imports are common, and the expiration dates on the products are often tampered with. Input dealers interviewed expressed a willingness to provide any product or package of inputs requested by farmers, but said they provide what the market wants—in this case cheap imported seeds from China. Given the lax regulatory structure and the willingness of government officials to accept small bribes for speedy processing, the procedure for importing inputs is not a barrier to their availability. However, taxes are high (up to 24 percent on the value of the import), making it very difficult to compete against informal imports and fraudulent goods, which can be sold at a fraction of the price. One input dealer estimated that up to 80% of the products available on the market are illegal or adulterated.

Farmers also lack knowledge of the type and quantity of inputs suitable for their farms. Small-scale local input suppliers provide some explanation but often have little formal training. Many of those interviewed stated that they occasionally test seeds on their own plots to be able to provide more informed advice to farmers. Agro-shops that are supported by NGOs and other donor organizations tend to be more organized, offering demonstration plots and in-house trainings with multinational seed company representatives. But their products also come with a higher price tag, and these companies also report a marked preference by the community to work with locals. Some companies have tried to hire local input suppliers to work as licensed dealers to take advantage of their personal connections and standings in the community. Results have been mixed—one company reported experiencing a huge problem monitoring and auditing the activities of these dealers, who were underreporting sales prices and pocketing the extra cash. Farmers rely on advisory services provided by NGO and donor project agronomists and local government extension agents to fill in the gaps.

Finance is one of the largest barriers to the successful commercialization of improved inputs. In light of the high interest rates on short-term loans offered by commercial banks and MFIs, farmers must seek other sources of credit. At present, the chief source of this credit is from donors, NGOs, and input suppliers. Many, although certainly not all, of the input suppliers interviewed offered to sell inputs on credit to trusted farmers. This arrangement was far more common with input suppliers who were closer to the community—trusted local dealers as opposed to branches of larger foreign or Sughd-based companies. Some suppliers condition the credit on a commitment from the farmer to advertise the product to his or her neighbors. By contrast, onion buyers usually do not engage with the farmer until just before harvest.[56]

[56] Several farmers suggested that onion buyers have offered them high-quality seeds in the past but have insisted on cash payment upfront. Any discussion of purchase of the final harvest is always oral and never includes a firm commitment on price. Accordingly, these discussions cannot be considered true agreements on which a farmer could base his or her investment decisions.

Transplanting Seedlings

Incentives and Constraints to Smallholder Adoption

The transplanting of seedlings is not a new technology for Tajik farmers—it is already being used for tomato seedlings. Thus adapting its use for onion production should not pose a great degree of difficulty for farmers. Similarly the cost of investment in the low tunnels is not a significant barrier to adoption. While an upfront investment is required, and most plastic films will have to be replaced annually, the cost of these materials is affordable for most smallholders and can be recouped within one production cycle. With such low barriers, farmers should have a strong incentive to adopt this technology, particularly in light of the potential land efficiency gains (i.e., the ability to grow a second crop on the same plot of land each year).

Moreover, the impact of the technology on the overall labor burden on the farm may be negligent—time previously spent weeding will now be spent transplanting seedlings, but the time frame in which the activities must take place will shift. More research is needed to see how this shift would impact other activities for which labor is required on the farm, but in theory the seedling production and transplanting will occur during months when there is less agricultural activity. It is also unclear at this point if the technology poses a net positive, negative, or neutral impact on women. As men are the primary decision-makers on the farm, however, the impact on women may have little bearing on the likelihood of adoption.

The benefits of the technology, however, are largely tied to timing. To achieve maximize income gains, the seedlings must be planted and transplanted in time to allow for harvest within the 15-20 day peak market window in April.

Pathways to Commercialization of the Technology

Some farmers suggested that the quality of the plastic films available on the market is low and requires replacement each year, this cost is not an overarching concern. By and large, the suppliers will provide what the farmers will buy—in this case cheaper plastic sheeting from China. Higher quality permanent greenhouses are also available from a subset of dealers, but the added cost may not be justified by farmer production methods. Onions may be rotated with other crops in the same year or from year to year, and the flexibility to easily remove or replace these tunnels is important to the farmer. In addition, some farmers claimed that the low tunnels are unnecessary in warm years or in certain southern regions of Khatlon where the climate does not pose a risk to young seedlings grown outdoors.

There is no clear commercial pathway for the extension advice farmers need to learn how to grow onion seedlings to their maximum advantage. Unlike the suppliers of seeds and fertilizers, sellers of low tunnel building materials (by and large simply vendors of a roll of plastic sheeting along with other construction materials in the bazaar) have no expertise and little commercial incentive to provide extension advice to farmers on how to build and use a low tunnel for onion seedling production. Similarly, as discussed above, onion buyers currently invest little in the farmers they buy from and often very late in the season, including at times even harvesting the bulbs themselves. While there is a clear market benefit to ensuring farmers have a more uniform, high-quality harvest, the practice of engaging farmers at the start of the growing season is not reflected in the current structure of the market. Thus there is a strong argument that this is an area for donor investment, particularly since farmers already use tunnels for other crops and may feel they do not need assistance to learn similar best practices for onion.

CONCLUSION AND RECOMMENDATIONS

The use of improved inputs (including high-quality seed, fertilizer, and pesticides) makes up a complex system that, while highly effective, requires a high degree of sophistication, know-how, risk, and capital on the part of the farmer. Similarly, the introduction of high-impact onion seedling production methods requires finance and training for farmers in order to be successfully adopted. In Tajikistan, access to inputs and advisory services still predominantly come from donors and NGOs in the form of short-term assistance programs. Commercialization pathways are needed to supply finance, extension, and access to output markets to sustainably reduce the risks associated with adopting these higher-cost, higher-reward production methods. To enable the rapid scaling of these technologies, the focus should be on reinforcing what works—e.g., leveraging the influence of early adopters and trusted input dealers to demonstrate the impact of the technologies to new farmers.

Work with the GoTJ and private sector to reduce the illegal import of agricultural inputs. In the long term, improved market regulation and a decrease in the cost of importing high quality inputs will be required to establish profitable marketing channels for input dealers in Khatlon province. This will require strengthening the capacity of the GoTJ to crack down on the import and sale of illegal or low-quality inputs through streamlining customs and market inspection procedures and reducing the discretion of individual agents. In addition, support should be provided to facilitate discussions between the Consultative Council on Improvement of Investment Climate, the Tax Committee, and broader private sector stakeholders to reduce the high rate of tax (both VAT and import duties) on legally imported inputs.

Leverage horizontal and vertical linkages in the value chain to facilitate farmer adoption. Short-term increases in farmer adoption of these technologies will depend on farmer willingness to invest in more expensive production methods. An assessment should be conducted to determine and address the chief obstacles to the provision of inputs, finance, and advisory services by onion buyers. These vertical linkages within the value chain will be an important resource to facilitate long-term adoption of these and other agricultural technologies. The AgTCA team found no initial evidence that this pathway exists, but this possibility should be further examined through facilitated discussions between farmers and onion buyers. Strong existing market dynamics, such as trusted relationships among farmers or between farmers and local input dealers, should also be leveraged to increase the impact of outreach activities.

Invest in training initiatives that target women. Although men largely control decisions over agricultural inputs and production methods, women supply the labor—including sowing seed, applying fertilizer, and weeding. Improving women's comprehension of the role and use of improved inputs and production methods should significantly increase short-term success rates and long-term adoption. It is also an opportunity to create better employment opportunities for women. To offset the potentially negative impact of the technology on women who work as day laborers weeding, training efforts should build the capacity of these women to grow and market onion seedlings from their household plots.

Investigate supplemental technologies to augment the impact of the proposed technologies. Additional technologies have been shown to increase the effectiveness of onion production systems in similar settings. For example, the use of drip irrigation in low tunnels could significantly decrease the expenses for water, fertilizer, and pesticides by decreasing the amount of each required for production.[57] Onion seeders and planters would also decrease the required labor time and cost for sowing onion seed and transplanting seedlings.[58]

[57] See, for example, studies from India and the US, available at http://ageconsearch.umn.edu/bitstream/97154/2/7-D-Suresh.pdf, http://agsyst.wsu.edu/IrrigationSystems.html, and http://www.ksre.ksu.edu/irrigate/OOW/P97/OBrienetal_IrrigSysEconFieldSize.pdf.

[58] Some efforts have been made by the USAID ProApt project to import and distribute pneumatic planters to farmers. However, the planter chosen for the initial pilot for this technology turned out to be inappropriate for onion seeds. With a different product, this technology could be very effective as a time and labor saving device, particularly for women.

ORCHARD PRODUCTION

Historically, Tajikistan was one of the largest producers of fruits inside the former Soviet Union. Exports of fruits reached up to 100,000MT per year in the period from 1965 to 1990.[59] Production decreased from 1985 to 2000 due to the collapse of the Soviet Union and the civil war. The break-up of collective farms after the dissolution of the Soviet Union and the subsequent civil war created numerous challenges for farmers in Khatlon province. Marketing channels collapsed, and many fruit farmers cut down their orchards for firewood, often replacing them with cotton for which organized state marketing still persisted.

After reaching bottom in 1999, production began to recover. Over recent years, the GoTJ has made a systematic effort to diversify the agricultural sector, including encouraging the allocation of greater amounts of farm land to orchard production. Stone fruits such as apricots, plums, peaches, and cherries represent 92% of all fruit trees in Tajikistan and are among the top products in the region.[60] However, to make this sector more profitable and export-oriented, production of seedlings and saplings of high quality is key, along with long-term access to land, plant protection, and extension. Access to irrigation water and alternative technologies, both for production and processing, storage, and similar facilities will be other prerequisites.

According to World Bank calculations, fruit and horticulture require on average five times more workforce per hectare than wheat.[61] Thus modern fruit production may also be a suitable way to generate the jobs badly needed to maintain the stability of the Tajik social sector. In addition, modern fruit production will generate complementary jobs in fruit processing, as land-locked Tajikistan will always face high transportation costs to Russia favoring the export of higher value dried or processed agricultural products rather than that of bulk raw material.

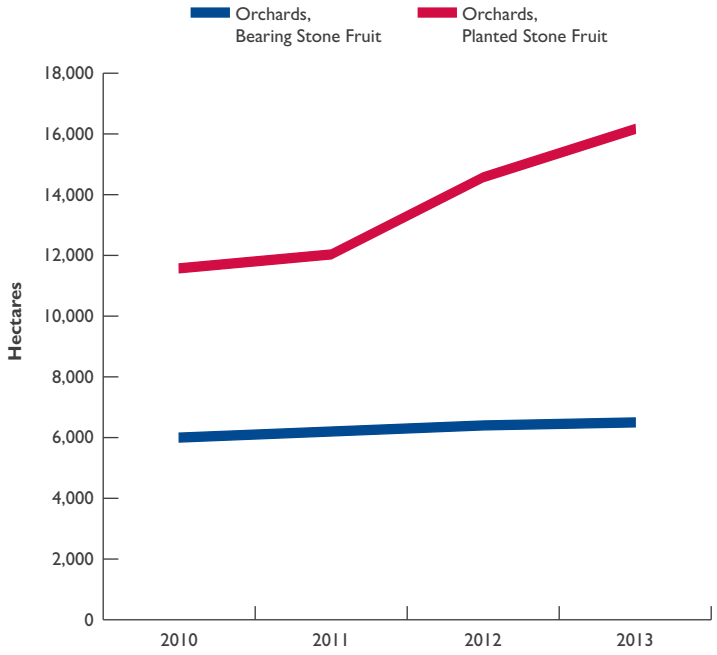
MARKET OPPORTUNITY

Production

Orchard production has long been part of Tajikistan's agricultural landscape. The country is particularly known for its production of sweet (e.g. high sugar content) and flavorful apricots. There are over 180 different apricot cultivars in Tajikistan, with the majority of farmers planting multiple varieties. Despite the numerous varieties, production can be broken down into early apricot varieties that are generally sold fresh in markets, and later varieties that are processed and dried. Plum, peach, and cherry production in Tajikistan is not as diverse or ubiquitous as apricot production, but it is significant in that orchard farmers generally cultivate all three stone fruits in conjunction with apricots.

Stone fruit production is centered in Sughd province, which has a well-established practice of production and drying, particularly of apricots, among family farms. Khatlon province is not well known for its production of dried fruit and primarily focuses on production of early varieties of stone fruits that are sold fresh. Apricot production in Khatlon is still in its infancy, but is slated to develop as farmers familiarize themselves with cultivation and processing techniques.

FIGURE 2: KHATLON PROVINCE: STONE FRUIT PRODUCTION (HA)



Source: Khation Department of Agriculture

[59] European Union (EU)/European Bank for Reconstruction and Development (EBRD) Tajik Agricultural Finance Framework (TAFF) and Goskominvest, *Agribusiness Investment in Tajikistan* 2011-2012 (2012).

[60] Ibid.

61 World Bank, *Development Report 2008*, p.208 (2007).

Khatlon is known to actively cultivate five to seven varieties of apricots including *Subhani, Mirsandjali, Khurmu*, and *Kandak*, while seven to eight peach varieties are cultivated including *Alberta, Alexander, Mayflower, Sumboli,* and *Zoti*. Unlike the numerous varieties of apricots and peaches, Khatlon only produces primarily two varieties of plums and cherries. For plums, the Soviet era *Pobeda* or "Victory" is by far the dominant variety, while the imported *Vengerka*, a late variety plum from Turkey and Italy, is far less common. Cherry varieties include *Gelos,* a sweet deep red cherry, and *Oluch,* a sour bright red cherry that is smaller in size than its sweeter cousin. Due to the fragile nature of cherries, production primarily occurs in the milder climatic areas around Dashti-Jum and Khovaling in eastern Khatlon.

TABLE 5: KHATION PROVINCE, AREA OF STONE FRUIT PRODUCTION (HA)

DISTRICTS	2010	2011	2012	2013
Danghara	858	858	1,177	1,377
Kolkhozobod	1,168	1,107	1,205	1,277
Qubodiyon	949	1,144	1,232	1,227
Panj	1,028	808	948	1,018
Shahritus	919	870	888	987
Others	8,855	7,247	9,125	10,280
Total	**11,574**	**12,032**	**14,572**	**16,163**

Source: Khation Department of Agriculture.

Stone fruit production in Khatlon province has steadily risen primarily due to a government initiative to boost orchard production nationwide by 47,000 ha as part of a four year horticultural development policy.[62] Accordingly, from 2010 to 2013, Khatlon province saw its stone fruit acreage increase from 11,574 ha to 16,163, or by 40%. The surge in orchard production has yet to bear fruit, as only 6,440 ha of orchards yielded fruit in 2013, only a 7% rise from 2010 (vs. the 40% rise in total acreage under production).[63] However, this is likely to change by 2016/2017 when these orchards start hitting their peak fruiting period.[64]

Stone fruit production in Tajikistan is highly seasonal, with harvests typically occurring in late spring/early summer and ending by late summer. In Khatlon, plums are the first stone fruits to be harvested (early May). Those destined for export markets are harvested before they ripen (e.g. green skin coloration) so that they maintain their freshness during their journey. Apricots follow plums and are harvested starting in mid/late May and ending in June. Peach harvest season occurs from late May to June, while cherries enjoy a later harvest from early June to July.

Stone fruit production in Tajikistan suffers from a lack of an adequate cold storage network. Every summer, during the harvest season, a glut of fresh fruits flood rural and urban markets throughout the country. Demand is high, but not high enough to absorb all volumes that are put to market. Farmers are unable to store excess fruit and sell at later date, and, absent sufficient processing capacity, a substantial share of this production simply goes to waste. In Sughd province, this overabundance has been mitigated somewhat by drying fruit and storing them for sale at a later date. For farmers in Khatlon province, this process of preserving one's crop through drying is not widely practiced, which necessitates that farmers sell their harvest as soon as possible before it rots.

End Markets

Exports of fresh stone fruits are often sporadic and vary year-to-year depending on domestic yields and demand in Russia and Kazakhstan. Apricots and plums comprised the bulk of exports, with Sughd province as primary exporter of fresh apricots and a minor supplier of plums, while Khatlon province and the areas around Dushanbe supply the remaining plums. From 2006 to 2012, Tajik stone fruit exports topped 2,300 MTs twice in 2008 and 2012, and hit a low of just over 1,000 MTs in 2007. In 2011, apricots comprised a 44% share of exports (by volume), while plums had a 40% share. Cherries almost made up the difference (15% share) as peaches only added up to 1% of exports.

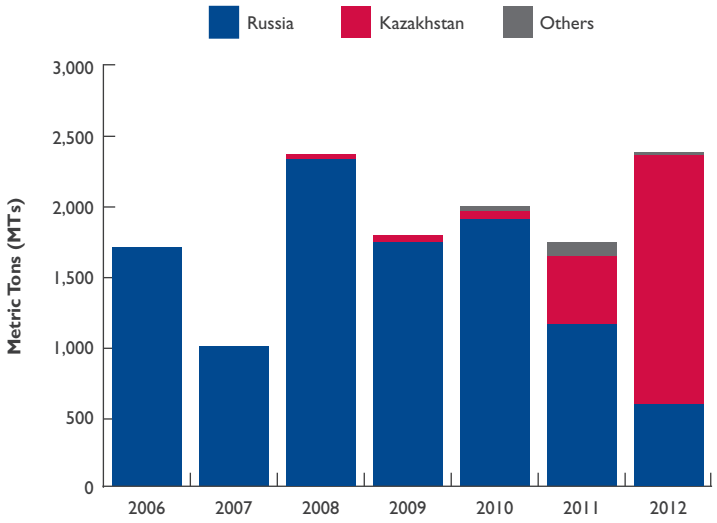
62 GoTJ, Decree of the President No. 683, *Further Development of Horticulture and Viniculture in the Republic of Tajikistan for the Period 2010-2014* (June 27, 2009).

63 Khatlon Department of Agriculture.

64 According to one NGO familiar with orchards in the area, stone fruit orchards in Khatlon hit their peak fruiting period between years five and seven, with limited fruit production initially beginning in year three of the tree's life.

The primary export markets are cities in central Russia including Chelyabinsk, Ufa, Krasnoyarsk, Perm and Novosibirsk. However, trade figures recorded that Kazakhstan was major purchaser in 2011 and the top destination market in 2012. A similar trend was noted in onion and dried fruit exports. This switch is likely due to the 2010 establishment of the Eurasian Economic Community customs union between Belarus, Kazakhstan, and Russia.[65] In mid-2011, the customs union eliminated all customs borders between member countries. In essence, Tajik fresh fruit exports are still being shipped to Russia, but are being recorded as exports to Kazakhstan since member states are considered a single economic zone. Regardless, pending favorable climatic conditions, Tajikistan should experience a significant increase its fresh stone production by 2016/2017. Whether this translates into rising exports is questionable due the country's inadequate cold storage network and the annual glut that already hits local markets.

FIGURE 3: TAJIKISTAN: STONE FRUIT (FRESH) EXPORTS

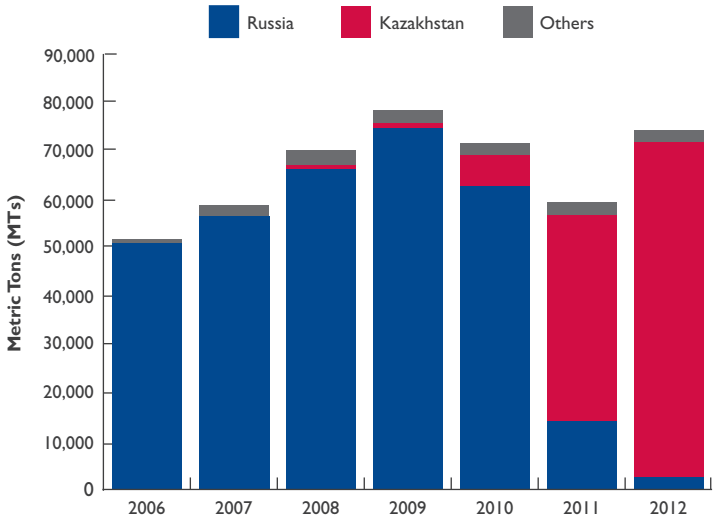


Source: UN Comtrade MS Codes 0809.10/.20/.30/.40

On account of logistical issues and the lower quality reputation of Khatlon fruits vis-à-vis those from Sughd among consumers, local provincial markets are the primary destination for Khatlon's apricots, peaches, plums, and cherries. Apricots and peaches are more readily sold in Khatlon's *Jamoat* or municipal level, while cherries are chiefly sold to the higher income consumer markets of Dushanbe and Qurghonteppa. In terms of international trade, only plums are exported in any meaningful quantities from Khatlon.

Tajik dried fruit exports are relatively more stable and larger in volume/value than their fresh counterparts. Russia and Kazakhstan are the top destination markets, with dried apricots and mixtures of dried apricots and seeds comprising nearly 90% of dried fruit exports by volume (as of 2012). Dried plums, apples, and other fruits made up the remainder. From 2006 to 2009, exports of dried fruit progressively increased from 51,594 MTs to 78,347 MTs, or by 52%. In 2010, exports dropped and continued to do so in 2011. In May 2010, Russia temporarily banned Tajik dried fruit from entering its market over concerns of polio contamination. The ban, largely considered politically motivated and designed to disrupt the construction of the Rogun Dam, halted exports for months, as well as eroded trust between buyers and sellers. By 2012, exports recovered somewhat totaling 74,072 MTs, but remain wholly reliant on Russian and Kazakh demand, prompting the need to diversify export markets.

FIGURE 4: TAJIKISTAN: DRIED FRUIT EXPORTS

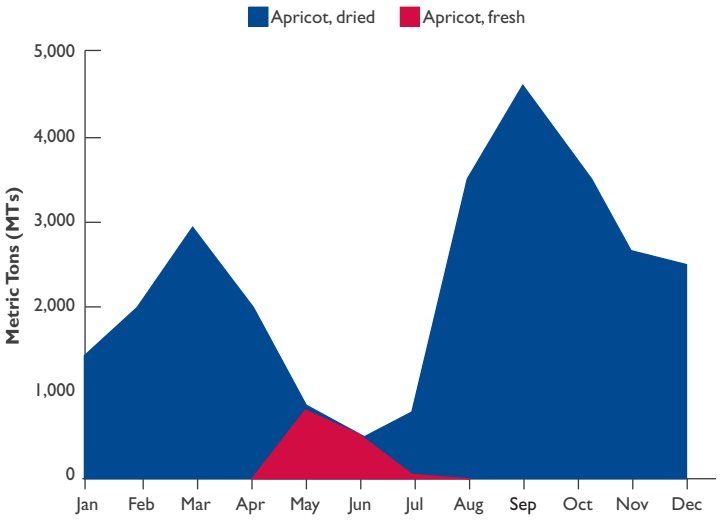


Source: UN Comtrade MS Codes 0813.10/.20/.30/.40/.50

[65] Eurasian Economic Community customs union between Belarus, Kazakhstan, and Russia. Additional information available at http://www.eurasiancommission.org/ru/Pages/default.aspx.

China would appear to be an attractive market for Tajik fresh and dried exports since the two countries share a border and Xinjiang Region is home to an expatriate ethnic Tajik population. However, China has remained a marginal trading partner for multiple reasons. First, although technically neighbors, Tajikistan's Pamir Mountains and China's Taklamakan Desert represent major geographical obstacles for rail and truck shipments. Transporting by air is prohibitively expensive, while flights from Tajikistan to Russia and Kazakhstan occur at much more frequent basis.[66] Second, China is able to produce apricots, plums, and peach in great quantities. Only cherries represent a market opportunity, but they have to be shipped by air, minimalizing profit margins. It should be noted that in July 2013, Tajikistan exported over 2 MTs of *Gelos* (dark red coloration) cherries to Urumqi, Xinjiang Region, western China, as a first-time trial shipment. Improved rail and/or road access through Afghanistan could improve access to Chinese markets in the future.

FIGURE 5: TAJIKISTAN: MONTHLY APRICOT (FRESH AND DRIED) EXPORTS, 2012



Source: UN Comtrade MS Codes 080910, 081310

In May 2012, fresh apricot exports (primarily to Kazakhstan) peaked at 845 MTs and dropped off to 554 MTS and 74 MTs during June and July, respectively. Once the harvest ends and fresh exports are exhausted, dried apricot exports come online. During 2012, dried apricot export hit twin peaks in in March (2,978 MTs) and September (4,627 MTs). The first peak in winter is due to high seasonal prices while the second peak coincides when freshly harvested apricots are initially processed and dried. Like dried plums, dried apricot exports are lowest during the summer harvest season (under 1,000 MTs per month from May-July).

Price Trends

Price trends in Tajikistan for fresh and dried stone fruits are intimately linked with the climatic seasons due to the lack of a cold storage network and perennial winter road closures. During the summer harvest, prices plummet as an oversupply of fruit hits local markets. As autumn arrives and progresses into winter, local fresh apricots, plums, peaches and cherries vanish from the marketplace or are replaced with expensive imports. During the team's visit (January 2014) to various markets in Dushanbe and Khatlon province, fresh apricots, plums, peaches, and cherries were nowhere to be found. Instead only dried stone fruits were available and sold at a premium price of at least 20% when compared to summer prices. In addition to seasonal demand and price spikes, sales often peak during the high holidays of Islam, specifically during the month of Ramadan and the two to three day holiday of Eid al-Adha, known locally as Idi Qurbon.

Dried stone fruits vary in price depending on the type of fruit, taste, coloration, origin, type of processing, and the physical location of the market. Dried apricots from Sughd are significantly higher priced (up to 40 TJS/kg) than those from Khatlon (8 TJS/kg) due to the drying process used. In Sughd, processors use all-natural solar drying, while in Khatlon fruit is dried using additives (e.g., sulphur). Dried plums and cherries range from 10-15 TJS/kg.

Distribution Channels

The logistics of shipping fresh and dried fruits from Khatlon province is not a straight forward task. Due to poor relations with Uzbekistan, it is not uncommon for Uzbek Customs officials to illegally delay, hold, and even damage cargo of Tajik outbound trains. This trade obstacle, particularly for Tajik fresh fruit exporters, constitutes a hefty economic risk that few are willing to take. The rail network, which dates back to the Russian Empire era, runs from Khatlon into Uzbekistan, meaning Khatlon traders must transport their goods by truck to Sughd province in order to safeguard their export to Russia. During the winter, particularly from December-January, these roads to become too dangerous and are closed.

[66] According to a representative from Nuri Khatlon, there are six international flights that depart Qurghonteppa weekly, all destined for Russian and Central Asian cities.

Despite the road and rail difficulties, fresh plum traders are able to navigate the obstacles and export as far as Russia during the summer harvest season. A manager of a fruit trucking company in Khatlon stated he sources plums from late April to early May from farmers in the districts of Boktor and Qumsangir. The plums, still green and unripe, are packed into 20 MT refrigerated trucks and transported to his distributor in Perm, Russia. A day prior to their arrival, the transporter shuts off the cooling system and allows the plums to ripe so that they arrive fresh at the market. From Perm, the plums are either sold locally or distributed onward to other wholesale markets within Russia. The manager noted that only fresh plums are exported since Khatlon does not produce other high quality fresh or even dried fruit. A manager of a cold storage facility (not operational as of January 2014) added that fresh cherry exports from Khatlon spoil rapidly (within one day if not properly stored), while apricots have a slightly longer shelf life (three days if not stored).

Competition

Tajikistan's fresh stone fruit exports to Russia and Kazakhstan are limited not by having a narrow market window, but rather by a lack of adequate cold storage network and other logistical issues (e.g. lack of refrigerated trucks, non-transparent customs clearance procedures, etc.). Exports of fresh fruit occur on the heels of their harvest, which generally runs from May to July. Fresh apricots and plums are the top commodities, with cherries and peaches traded in much smaller amounts. Russia and Kazakhstan are the primary destination markets, with Russia taking the vast majority of imports as the country is limited in its production capacity.

In general, Tajik apricots have a positive reputation in Russia and are considered a medicinal fruit that prevents heart disease and boosts the brain's cognitive abilities. Despite these advantages, Khatlon province exports nearly no fresh apricots owing to their poor quality. If the quality is raised, apricots from Khatlon, which are generally harvested 10 days before those from Sughd, should be able to compete for export markets. Apricots are also grown in the Republic of Dagestan, southern Russia, but only large varieties which are not as flavorful as Tajik varieties. In addition, Russia grows wild varieties of apricots but these fruits are of low quality and not marketable.

As stated above, only fresh plum are exported in any significant quantities from Khatlon province (in particular from the Boktar and Qumsangir districts). These plums successfully compete with those from Sughd in terms of quality.

Russia is also the top market for Tajik dried fruit exports, and Sughd province is the primary supplier as Khatlon cannot compete on quality. In general, the market window for dried fruit exports runs from September to April and comes to a standstill during the summer harvest months. For the Russian and Kazakh markets, Tajikistan is the dominant supplier of dried apricots followed by Turkey and Uzbekistan. These three countries have an import market share of approximately 98%. From 2008 to 2012, Tajikistan's market share remained steady at around 57%, while Turkey's and Uzbekistan's share hovered around 30% and 11%, respectively. It remains to be seen if Khatlon apricot producers can improve their drying techniques to the level required to compete with Sughd exports for the Russian and Kazakh markets.

Within the domestic market, Khatlon dried apricots do not directly compete with Sughd apricots due to the former's poor quality and accompanying low price (8 TJS per kg for Khatlon dried apricots vs. 40 TJS per kg for dried apricots from Sughd). In the short term, Khatlon may be better suited to export dried cherries and dried plums, two crops whose varieties and drying techniques are more familiar to local farmers than apricot production/processing.

Outlook

The 2010 government initiative to increase orchard production by 47,000 ha by 2014 has entered its final year. Thousands of farmers from Khatlon province have responded, resulting in a 40% increase orchard area over the 2010-2013 period. For many Khatlon farmers, stone fruit cultivation (e.g. apricots, peaches, plums, cherries) is a relatively new endeavor. Processing and drying apricots, a common and well known practice in Sughd province, has yet to be fully adopted in Khatlon. Additionally, the province lacks an adequate cold storage network and its railways remain obstructed owing to poor relations with neighboring Uzbekistan. The environment as a whole is not a favorable one for the newly planted orchards. By 2016/2017, these orchards will begin to hit their peak production period. Investments are needed to not only train farmers on cultivation and postharvest handling methods, but also to facilitate their connection to domestic and international markets.

IMPACT OF PROPOSED TECHNOLOGY

Improved Pruning Techniques

Fruit trees in Khatlon province are cultivated by three types of producers: (1) large agricultural farms (state and collective farms), (2) smaller private *dekhan* farms, and (3) in household plots.[67] Despite favorable conditions for the growing of orchards, under current production methods, the yield per hectare in Khatlon province is quite low.[68] Current orchards are characterized by large distance between trees and low use of fertilizers and pesticides. Many farmers in Tajikistan (estimates range from 90-98 percent) do not train their fruit trees after planting and neglect to annually prune the trees during the winter. In addition, many of the orchards were established more than 15 years ago and contain older, aging trees with poor yield rates. Tree replacement is costly, and farmer lack access to high quality planting material and advisory services.

Production technology, including the use of improved pruning techniques, is a crucial factor in fruit tree production. Pruning provides a variety of benefits for fruit trees, including 1) to obtain maximum light exposure for both leaves and fruit; 2) provide uniform distribution of fruiting wood along the scaffold branches; 3) control the size and vigor of the tree; 4) reduce limb breakage due to excessively heavy fruit loads; and 5) produce high quality fruit of good size. Although it may decrease crop yields during the first several years after establishment of the orchard, over the long-run effective pruning increases overall quality, size, and color of fruit. However, the use of pruning alone will not yield the maximum return on investment but rather should be combined with the introduction of an integrated pest management (IPM) system. When used alone, pruning can generate up to a 40% increase in crop value compared to that of unpruned orchards, a significant economic return on investment for fruit growers. When combined with other technologies, such as the introduction of an integrated pest management system, the increase in income ranges from two to ten times the current income for Khatlon farmers who do not employ these methods.[69]

Technology Impact on Smallholder Income

The impact of improved pruning techniques in Khatlon would vary by fruit type and the age of the orchard. The USAID ProApt project has introduced improved pruning techniques, along with the distribution of high quality fertilizers and plant protection materials, to 200 farmers with existing orchards (2-3 years of age) in Khatlon province. As these activities began only 1-2 years ago, data on the impact of these activities on smallholder income is not yet available. However, data from other contexts suggests that plum, peach, and cherry trees in Khatlon are significantly underperforming their potential yield when compared to apricot yields. As shown in the crop budgets below, the use of modern orchard techniques (including improved pruning techniques and the introduction of a modern IPM system) over a four-year period would likely double farmer income from existing apricot orchards and increase income from existing plum orchards tenfold.

The introduction of modern orchard techniques requires additional expenses for labor and inputs, but these expenses are not significant and can be compensated in existing orchards by revenue from fruit production even in the first 1-3 years of adoption. For new orchards that have not yet begun fruiting, the expenses must be carried forward.[70]

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[67] Lerman, Z., *Agrarian Reform of the Republic of Tajikistan: Farm Reform and Restructuring Cooperative Development*, pp. 1- 38 (2012).

[68] Farmers estimated the yield of orchards by crop at approximately 20-25 MT/ha (apricot), 3-4 MT/ha (cherry), 6 MT/ha (plum), 2-3 MT/ha (peach). Farmers reported that the fruit tree yield is on average three times higher on household plots than on large dehkan farms. This difference can be explained, first, by the lower labor intensity and, second, by the fact that household plots usually have a smaller number of trees that can be treated with organic fertilizer (i.e., cow manure) on a small scale much more easily than the labor and cost required for a larger farm. This has implications for household consumption and nutrition but would not be easily scaled to a commercial operation.

[69] Pesticides play a critical role in orchard production. The MoA estimates that up to 50 percent of fruit production is lost to pests and diseases each year.

[70] Crop budgets were prepared based on the expected results from established (fruiting) orchards as these orchards were the subject of USAID's current efforts to introduce pruning technology. For new orchards, the annual expenses would be similar but revenue would not begin to accrue for a minimum of four years, as all flowers and fruit should be removed in the first three years of growth. The hypothetical orchard is 1 hectare in size and irrigated by pump. All fieldwork is assumed to be paid labor.

TABLE 6: COMPARATIVE CROP BUDGETS FOR APRICOT PRODUCTION USING MODERN PRUNING TECHNIQUES AND IPM

DESCRIPTION	WITHOUT PRUNING OR IPM	YEAR 1 WITH PRUNING AND IPM	YEAR 2 WITH PRUNING AND IPM	YEAR 3 WITH PRUNING AND IPM	YEAR 4 WITH PRUNING AND IPM	YEAR 5 WITH PRUNING AND IPM
	USD	USD	USD	USD	USD	USD
REVENUE						
Sales of apricot	$20,000	$20,000	$25,000	$30,000	$40,000	$40,000
Total Revenue	**$20,000**	**$20,000**	**$25,000**	**$30,000**	**$40,000**	**$40,000**
EXPENSES						
Personnel						
Field work	$300	$1,340	$1,340	$1,340	$1,340	$1,340
Subtotal Personnel	**$300**	**$1,340**	**$1,340**	**$1,340**	**$1,340**	**$1,340**
OPERATIONAL EXPENSES						
Fungicides including spraying		$150	$150	$150	$150	$150
Insecticides including spraying		$300	$300	$300	$300	$300
Insecticides including spraying after flowering		$52	$52	$52	$52	$52
Insecticides including spraying in summer		$52	$52	$52	$52	$52
Irrigation	$420	$60	$60	$60	$60	$60
NPK		$200	$200	$200	$200	$200
Fertilizer, P		$40	$40	$40	$40	$40
Consultancy		$40	$40	$40	$40	$40
Land tax	$24	$24	$24	$24	$24	$24
Organic fertilizers	$200	$200	$200	$200	$200	$200
Urea, superphosphate, and ammonium	$225					
Subtotal Operational Expenses	**$869**	**$1,118**	**$1,118**	**$1,118**	**$1,118**	**$1,118**
Total Expenses	**$1,169**	**$2,458**	**$2,458**	**$2,458**	**$2,458**	**$2,458**
Net Income	**$18,831**	**$17,542**	**$22,542**	**$27,542**	**$37,542**	**$37,542**

TABLE 7: COMPARATIVE CROP BUDGETS FOR PLUM PRODUCTION USING MODERN PRUNING TECHNIQUES AND IPM

DESCRIPTION	WITHOUT PRUNING OR IPM	YEAR 1 WITH PRUNING AND IPM	YEAR 2 WITH PRUNING AND IPM	YEAR 3 WITH PRUNING AND IPM	YEAR 4 WITH PRUNING AND IPM	YEAR 5 WITH PRUNING AND IPM
	USD	USD	USD	USD	USD	USD
REVENUE						
Sales of plums	$1,500	$1,500	$3,000	$5,000	$7,500	$7,500
Total Revenue	**$1,500**	**$1,500**	**$3,000**	**$5,000**	**$7,500**	**$7,500**
EXPENSES						
Personnel						
Field work	$300	$1,340	$1,340	$1,340	$1,340	$1,340
Subtotal Personnel	**$300**	**$1,340**	**$1,340**	**$1,340**	**$1,340**	**$1,340**
OPERATIONAL EXPENSES						
Fungicides including spraying		$150	$150	$150	$150	$150
Insecticides including spraying		$300	$300	$300	$300	$300
insecticides including spraying after flowering		$52	$52	$52	$52	$52
insecticides including spraying in summer		$52	$52	$52	$52	$52
Irrigation	$420	$60	$60	$60	$60	$60
NPK		$200	$200	$200	$200	$200
Fertilizer, P		$40	$40	$40	$40	$40
Consultancy		$40	$40	$40	$40	$40
Land tax	$24	$24	$24	$24	$24	$24
Organic fertilizers	$200	$200	$200	$200	$200	$200
Urea, superphosphate, and ammonium	$225					
Subtotal Operational Expenses	**$869**	**$1,118**	**$1,118**	**$1,118**	**$1,118**	**$1,118**
Total Expenses	**$1,169**	**$2,458**	**$2,458**	**$2,458**	**$2,458**	**$2,458**
Net Income	**$331**	**($958)**	**$542**	**$2,542**	**$5,042**	**$5,042**

TABLE 8: COMPARATIVE ANALYSIS OF ORCHARD PRODUCTION TECHNOLOGIES

CRITERIA	FRUIT ORCHARDS (EXISTING TECHNOLOGY)	FRUIT ORCHARDS (USING PRUNING/IPM TECHNOLOGIES)
Productivity	Low	Increased, up to 40% more
Fruit quality	Low	High
Percent of marketable fruits	Low, 25–40%	High, 70–80%
Harvest losses	45%, sometimes up to 80%	5-10%
Quantity control and management	No	Yes
Prime cost of the product	0.29 USD/kg	0.17 USD/kg
Care, operation in orchard	Difficult	Easy

Technology Impact on Women

Women provide less labor to orchards. They harvest and also clean the tree beds. Men are responsible for watering and irrigation, pruning and marketing. Farmers with orchards may use household labor or hire individuals and women's brigades for specific tasks. On farms that can afford to hire labor for harvesting and pruning, this is preferred.

Pruning is almost exclusively a task undertaken by men. There are no restrictions or beliefs that would limit women from undertaking the task, except the perception that it is a "heavy" task and therefore something that men should do. Men are hired to prune and receive about 5 TJS per tree. They would be the obvious target for training on improved pruning techniques.

Women are hired for harvesting at 25 TJS per day and additional in-kind payments and are hired in brigades. When labor is hired for agricultural tasks, women in the household are responsible for cooking meals for these workers. Improved pruning techniques are therefore not likely to have a direct impact on women's labor, based on the current division of activities on orchards.

With respect to income, farmers who have marketed fruits in previous years report that the income is used for large household expenses and reinvestment into the farm. Decision-making around the use of the income appears to rest more with men than with women, although both men and women reported a certain degree of consultation between spouses.

CONSTRAINTS TO TECHNOLOGY COMMERCIALIZATION AND ADOPTION

Incentives and Constraints to Smallholder Adoption

Despite the long-term advantages of investment in improved pruning and IPM technology, the likelihood of farmer adoption of these techniques is somewhat low. The large upfront investment in pruning puts financial pressure on the farmer by increasing the labor cost (whether paid or unpaid) without a clear immediate benefit.

Only with a clear understanding of the techniques and the benefits will farmers be willing to invest. Yet farmers lack access to finance to front the labor cost, particularly if the benefits may not be felt within the first year. Banks and MFIs view orchards as a high-risk business and typically do not provide the types of long-term financial products needed for capital investment in the orchard. In addition, farmers receive conflicting and possibly incorrect advice from various sources regarding what constitutes proper pruning techniques. For example, one farmer had been told by the local MoA extension agent that pruning is not required before the tree reaches three years of age. It may be difficult to convince farmers to pay for better advice or to learn and adopt a new practice.

Orchard production is by its nature a high-risk endeavor in Khatlon province. Salinization of the soil and a rising water table threaten tree roots, and there is no guarantee that the trees will survive to fruiting age. In addition, farmers take big risks in the purchase of seedlings as there is no mechanism to identify the quality of the planting materials until the tree begins to produce fruit in the third or fourth year. There are no nursery farms, and farmers typically buy seedlings that have been produced or imported without any quality control. Thus the farmer may lose three to four years if low-quality seedlings were planted. Without a way to control these risks, farmers may be reluctant to invest additional amounts of capital into caring for their orchards until they determine whether the trees will indeed bear fruit.

Another high risk factor for Khatlon's orchard sector is the lack of established marketing channels, storage, and processing facilities. The government plan to increase the number of hectares under orchards was sold to farmers with the promise of government assistance in reaching output markets and developing the capacity to store and/or process fruit that could not be sold fresh. To date, this support has not materialized. Many new orchard farmers are within one year of harvesting their first crop of fruit and yet have no plan for how that fruit will be sold. Investment in expensive technologies that increase yield and quality will only be beneficial if farmers can access the markets that enable them to receive a return on that investment.

Pathways to Technology Commercialization

The introduction of improve pruning techniques and IPM practices is at base a transfer of knowledge, which, if to be sustainable, must come at a price. The key to successful commercialization of improved pruning techniques rests in determining which actor or actors in the system are best positioned or have the greatest incentive to absorb that cost.

Absent substantial government investment in extension, the long-term vision for sustainable advisory services will necessarily involve farmer compensation to private service providers, either through direct fee-for-service extension, investment in farmer training by the fruit buyer, or through the hiring of qualified pruners. To be successful, pruning must be applied and monitored consistently over the lifetime of the tree, including particular attention over the initial four to six years after planting.

For reasons discussed is the section above, smallholder farmers have little incentive and frequently lack the funds to front the money for agricultural advisory services and the increased labor to learn and apply modern production techniques. Only the largest farms (above the 5 ha or less farm size targeted by USAID's Feed the Future strategy) hire their own agronomists. For smallholders, pruning is currently taught for little to no cost by government extension advisors, NGOs, and donor projects. The advice provided by these varied sources may be inconsistent and is available to only a small subset of farmers.[71]

Fruit buyers currently lack the incentive to invest in training farmers. Most buyers of fresh fruits for export do not even rely on the farmer to do the harvesting, preferring to "buy the tree" and bring in their own labor, packaging, and transportation directly to the farm. While buyers may return to the same farmers year after year, they do not make advance agreements that could enable the transfer of knowledge and/or inputs to improve production. Further research should be determine if a plausible marketing arrangement exists that would incentivize greater investment by buyers in farmer education and access to inputs.

Pruning for commercial *dekhan* farmers is largely done through hired labor. Perhaps the most promising pathway to improved pruning throughout Khatlon province is to focus on the service provider. Currently, most farmers hire individuals (often teenage boys) and train them to prune their orchards using techniques learned from government advisors or NGO/donor agronomists. The establishment of highly qualified pruning brigades, at a slightly higher labor cost to farmers, would save the farmer time and effort while ensuring the job is done correctly.

[71] For example, the USAID ProApt project can target only 200 or so farmers in a project cycle. The reach of the government advisors is similarly limited; one farmer estimated that out of 10,000-12,000 hectares in a district, the government advisor can visit only 300 per year.

Integrated Pest Management requires the use of high-quality plant protection materials following specialized application methods. These inputs, including both the required pesticides and equipment, are available from some higher cost input suppliers in Dushanbe and Khatlon province. Input suppliers by and large express no difficulty in sourcing high-quality products if the demand exists in the market. In addition, chemical sprayers are included in the VAT exemption list for imported agricultural equipment, which helps to keep the cost lower. Input providers offer training and/or demonstrations to foster demand for the products that they sell, but report that farmers are more likely to trust the advice of the local input dealer or a fellow farmer over an outside input supply company. Farmers also rely on donors and NGOs to provide these products and services for free, undercutting the consumer base for high-quality, but high-cost, agricultural inputs. This dynamic is discussed in more detail in the Early Onion chapter above.

CONCLUSION AND RECOMMENDATIONS

Pruning is one part of a successful modern fruit production system that can substantially boost the quality and quantity of fruit production over the lifetime of an orchard. However, marketing channels in Khatlon are insufficient to absorb all of the fresh fruit currently produced, and the province lacks the processing and cold storage facilities necessary to keep excess production from going to waste. These output market challenges outweigh interests in investing in pruning and remove potential commercial pathways to the dissemination of pruning techniques through private advisory services or buyer support. There is an urgent need to upgrade the capacities of Tajik fruit producers to compete in domestic markets and abroad. This can only be achieved through facilitating better aggregation of supply, market linkages, and post-harvest storage and processing. A strong focus on improved pruning without the simultaneous investment in upgrading the value chain will not yield the type of broad-based impact on smallholder income desired by farmers, donors, and government alike.

Facilitate better integrated marketing channels to increase access to agricultural inputs and advisory services. There is currently very little organized aggregation of stone fruit supply in Khatlon. Encouraging stronger market linkages through farmers' associations and value chain partners would increase access to finance, inputs, and advisory services.

Focus on the direct training of pruners to improve the long-term transfer of knowledge. It is important to improve farmer awareness of the differences between traditional and improved pruning methods, yet scaling strategies should target the direct training of pruners, so that the knowledge transfers from farm to farm through hired labor rather than being dependent on second-hand training from the farmer. Special efforts should be made to train women, who are currently employed on orchards for other tasks, perhaps through the creation of specialized all-women pruning brigades similar to those that current exist to provide weeding services.[72] In addition to providing an additional source of income for women, this approach would ensure the long-term impact of the training, as the teenage boys currently hired for pruning are likely to migrate to Russia within a few years.

Involve key public and private stakeholders in outreach activities. To maximize impact, strategies must involve the buy-in of the local government extension advisors. These agents are heavily involved in orchard promotion and currently provide pruning advice—advocating for different practices would only serve to confuse farmers and reduce the impact of the new trainings. Strategies must also take into account the incentives of male household members, who currently have primary responsibility for decisions regarding production and marketing in relation to orchards.

Investigate additional technologies to maximize the benefits from the proposed technology. Further research should also be conducted into options for the introduction and scaling of drip irrigation for orchards. Farmers currently use flow irrigation for fruit orchards in Tajikistan. This trench-based saturation of the soil is inefficient and risks damage to the roots of the tree. By contrast, drip irrigation could significantly decrease the expenses for water, fertilizer, and pesticides by decreasing the amount of each required for production.[73] Additional research is need to determine evaluate access to drip irrigation technology and the potential to bring this technology to scale.

[72] Women's weeding brigades are currently informally organized. Further research would be required to determine whether these groups could be formalized into agricultural business development enterprises. Elsewhere (e.g., Kenya) there has been some success in organizing agricultural business development services in this way.

[73] See recommendations in the Early Onion chapter for additional information.

BEEF PRODUCTION

Ninety-two percent of cows in Tajikistan are owned by household farms; with most households owning between 1 and 3 lactating cows for domestic consumption or local sales of milk. Women-headed households in Khatlon have slightly fewer livestock holdings than men: 56.3 percent of female-headed households have cattle compared to 65.5 percent of male-headed households.[74] Bull calves born to the family milk cows are kept and grown until the household needs cash or the animal is ready to sell as a feeder animal.

Cattle fattening involves identifying the potential of feeder calves based on frame and condition, providing appropriate feed rations to maximize the weight gain to feed cost ratio and to reach slaughter weight as resource efficiently as possible. Feeder calves in Tajikistan are typically purchased for fattening, also known as finishing, around the age of 3 years old or more. They will have spent most of their time to that point owned by the same household, but grazed with the community herd, where possible. The varied genetics as well as the inadequate grazing available translates into more time to reach a feeder weight of about 400kg for finishing. Fattening or finishing in Tajikistan typically involves confining the animal to a shed, often tied and providing feed for an additional 100-150kg of weight, between 6 months and a year (though some buy slightly larger animals and feed only 3 to 4 months). Animals are finished at a weight between 500 and 600 kg, depending on their frame. The average finished beef animal is a bull that is 4-6 years old when slaughtered.[75]

The majority of beef in Tajikistan is produced from bulls born to mixed breed cattle emphasizing dairy traits. There are some specific beef breeds present in the country,[76] but most animals are local landrace animals mixed with dual-purpose (dairy and meat) breeds such as Brown Swiss or Brown Carpathian.[77] While crossbred animals are typical of developed economy fattening due to vigor and health, the significant variations among feeder calves in Tajikistan makes it more challenging to achieve consistent feed performance desired during beef finishing. Increased animal populations in some locations have added pressure on poorly managed public grazing. Since the growth stage for calves after weaning often relies on this pasture and grazing on other marginal areas, this contributes to the poor condition and growth of feeder calves.

While there are a few large private feedlots, the majority of fattening happens in much smaller operations. Households with the capital, may finish as few as 3 or 4 animals, while others may have up to 20 or 25 animals at any one time. Many butchers also fatten animals themselves. It is extremely difficult to get an accurate number of how many households are engaged in finishing beef animals. Capital cost and experience are the two real barriers to entry, and the relatively quick turnaround (typically 6 months to 1 year to finish an animal) may result in households entering and exiting the activity as resources allow.

MARKET OPPORTUNITY

Production

Overall meat production, including beef, has been steadily increasing in recent years. In 2012, a total of 81,000 MT of meat was produced in Tajikistan; a 25% overall increase in meat production over the previous 5 years. Beef represents 45% of the total meat produced; about 37,000 MT.[78] Even with this recent growth, levels remain below production levels at the end of Soviet era; while the country's population has subsequently increased by 45%.[79] Tajikistan produced 40,000 MTs of beef in 1992. Tajikistan hasn't imported any meaningful quantities of beef since 2004. Beef imports were significant prior to that year, peaking in 2000 at 26,000MT.

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[74] Shahriari et al. 2009.

[75] By comparison, in the US, beef calves are weaned at about 6-8 months, and are grazed until they are 12 to 16 months. These feeder calves are purchased by cattle feeders (feedlots) for fattening before slaughter. Animals are fattened for roughly 4 to 6 months before attaining a finished weight of 550 to 650kg and approximately 18-22 months of age.

[76] Aberdeen Angus was the most frequently mentioned beef breed.

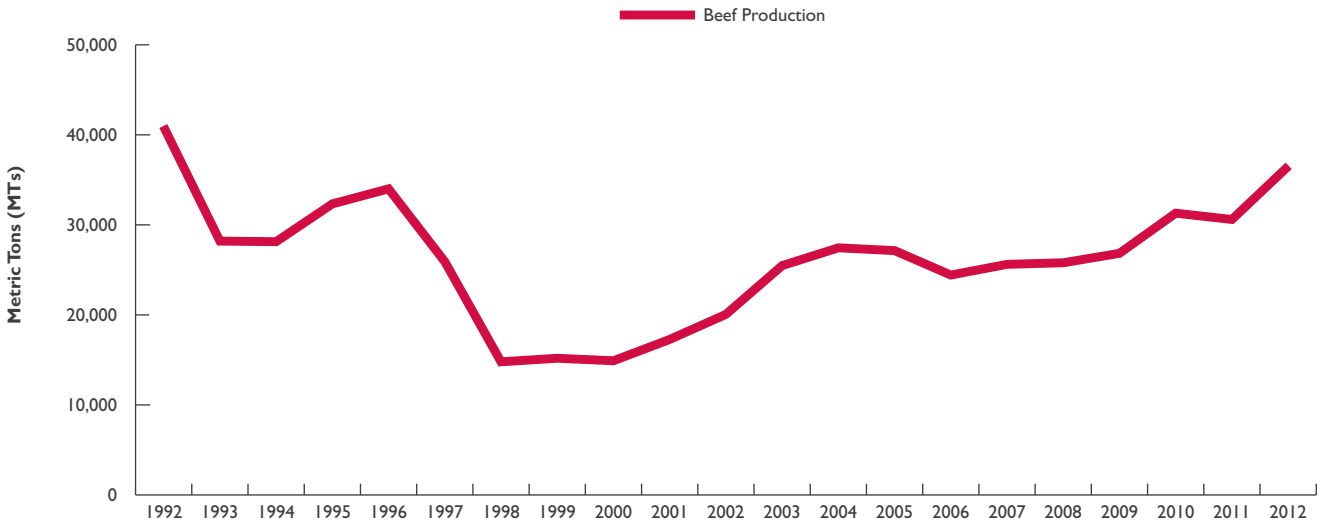
[77] Brown Swiss is a high yielding dairy breed with a larger frame suitable for beef, calving ease, milk with higher average butterfat, and considerable heat tolerance. Brown Carpathian is a Ukrainian dual-purpose breed of cattle with origins including Brown Swiss.

[78] Data obtained from the Food Security and Poverty Quarterly Bulletins published by Tajikistan's statistical agency (TajStat) between the 2nd quarter of 2010 and the 3rd quarter of 2013, TajStat data, and interviews.

[79] FAOStat.

In 2012 Khatlon had 770,000 head of cattle, about 40% of Tajikistan's total. While the general dairy production practices in Khatlon prioritize late winter/early spring calving to take advantage of early spring grass growth, the beef fattening does not experience any significant seasonality.

FIGURE 6: ANNUAL BEEF PRODUCTION (MTs)



Source: FAOStat and TajStat

End Markets

With no significant imports or exports, Tajikistan's beef production is for local consumption.[80] As noted above, production has been increasing in recent years. Regardless of this steady increase in supply, prices have risen an astounding 90% over the past 4 to 5 years. In comparison, chicken meat prices have only increased 12% over the same period.[81]

TABLE 9: PER CAPITA BEEF CONSUMPTION AND % CHANGE (KG/CAPITA/YR)

DISTRICTS	1992	2000	2009	PERCENT CHANGE IN CONSUMPTION (1992-2009)
Russian Federation	28.7	15.1	17.5	-39%
Kazakhstan	27.1	17.8	21.2	-22%
Turkmenistan	20.6	16.2	26.9	31%
Kyrgyzstan	19.6	20.3	15.3	-22%
Uzbekistan	16.4	15.9	23	40%
Tajikistan	8.9	6.6	4	-55%

Source: FAOStat

Khatlon produces approximately 45% of beef production and has 35% percent of Tajikistan's population. In 2012, urban consumers ate on average a total of 14.4kg/year of meat, while rural residents consumed an average of less than 10kg total. A number of Khatlon districts are geographically close to Dushanbe, where about 9% of the population resides, making it an important destination market. Overall per capita beef consumption has been decreasing as the population and prices have increased. Tajikistan already had the lowest per capita consumption of beef in Central Asia, and it has decreased more than 50% since 1992.

[80] Globally, less than 3% of beef ever crosses a border, so the lack of significant imports or exports is not surprising. However, until Tajikistan completes implementation of legal reforms in line with its commitments to the WTO, exports of meat and cattle and other livestock are not likely.

[81] Data obtained from the Food Security and Poverty Quarterly Bulletins published by TajStat between the 2nd quarter of 2010 and the 3rd quarter of 2013. While beef production is entirely domestic, chicken meat is almost entirely imported from the lowest cost global producers. The poultry product market will be discussed in a subsequent section.

Distribution Channels

Cattle are sold through weekly district markets. This includes fattened animals ready for slaughter as well as the feeder calves sold to livestock entrepreneurs specializing in fattening. While each district has a weekly livestock auction, there are larger markets which draw animals from surrounding districts and which have become the dominant markets for the areas. The animals are individually handled by the owners and related men. The buyers will meander through the crowd inspecting the animals individually and conducting direct negotiations. A market veterinarian is available for consultation, but this is rarely requested.

Since more than 90% of the cattle are owned by households, the cattle market participants are drawn from the general rural population. At the same time, because the households only have an animal to sell one or two times a year, the individuals specializing in cattle fattening and the abbatoirs, who frequent the markets, have significantly more breadth and depth of cattle experience. Ninety-nine percent of the market participants are men.

Cattle of all ages and condition are available. Often the seller has brought only one animal. Not all animals will be successfully sold, and the seller will return home with their animal. Many of the small abbatoirs will also finish their own animals. They attend the weekly market to purchase high potential feeder animals for finishing at home.

There are five large slaughtering facilities in Dushanbe. Multiple independently owned small slaughtering operations are located in the smaller towns and districts.[82] Typically these facilities serve multiple purposes. The abbatoir owners will slaughter their own animals purchased and/or fattened directly. Some of the abbatoir owners will even own some beef retail. The abbatoirs also provide their inspected slaughtering facilities to cattle owners and their customers as a service. The beef retailers will purchase a live animal from a small animal finisher and together they will take the animal to the slaughter facility. The animal is inspected, slaughtered, and the dressed carcass is weighed and the attending veterinarian issues a certificate. The fattened animal seller will at that point be paid based on the final carcass weight and the retailer has the required documentation for retail customer sales. The small beef retailers (or buyers from the retailers) are likely to be present at the abattoir for the slaughter.

Consumers purchase their meat from specialized local retailers. Beef retailers also sell mutton, though few will carry chicken meat, which is largely imported.

Competition

There are no significant beef imports into Tajikistan. Competition to beef within the market comes from substitute meat sources. Mutton, also traditionally consumed in Tajikistan, costs between 5-10% more than beef, but per capita consumption has increased by 50%. The sheep and goat are also locally produced, and have similar distribution channels. The biggest dietary shift and animal protein substitution has come from increasing consumption of chicken meat. Compared to 1992, per capita consumption has increased by over 360%.[83]

This analysis indicates that while poultry consumption is gaining ground due to price, there remains an opportunity to increase per capita consumption of beef. The market will absorb more beef, if it becomes available, particularly if the cost to finish beef is reduced.

TABLE 10: TAJIKISTAN PER CAPITA CONSUMPTION (KG/CAPITA/YR)

DISTRICTS	1992	2000	2009	PERCENT CHANGE IN CONSUMPTION (1992-2009)
Bovine Meat	8.9	6.6	4	-55%
Mutton and Goat Meat	3.6	2.1	5.4	50%
Poultry Meat	0.9	0.1	4.2	367%

Source: FAOStat

[82] Abbatoirs visited ranged in size between 7 head/week to 25-30 head/day.

[83] Poultry products are looked at in more depth in a subsequent chapter.

Outlook

Beef is losing share of domestic consumption patterns due to its low availability and high price vis-à-vis other meat products, but it remains an important component of the diet (45% of all meat produced and consumed at roughly the same per capita rate as imported chicken meat). While the increasing prices for beef are attractive to those fattening cattle, there exists an opportunity to expand the overall size of the domestic market through increased per capita consumption, particularly through a focus on increasing supply and reducing the cost to finish beef.

IMPACT OF PROPOSED TECHNOLOGY

Improved Livestock Feed, Including Supplements and Alfalfa

Improved cattle fattening requires improved cattle ration development and understanding to produce a balanced cost-effective ration for fattening the animal. Ration components available in the market (or produced by the family and used for cattle feeding) include wheat straw, grass hay, alfalfa, corn or other grain stover, cotton seed cake,[84] wheat, wheat bran, corn, barley, and in some markets brewer's mash and corn silage.

Animals also need a combination of macronutrients and micronutrients for optimal health and performance, in this case efficient and cost-effective weight gain in preparation for slaughter. Mineral supplements are used to assist in providing these necessary macro- and micro-nutrients. However, high quality feed often provides the majority of macronutrient and micronutrient requirements. Feed ration macro- and micronutrient deficiencies are a reflection of local mineral deficiencies in the soil; feed components grown in the soil will also have those deficiencies. Mineral supplements should be specifically chosen to address these natural, local deficiencies. Interviews did not suggest any acute mineral deficiencies in the soil which would translate into severe micronutrient deficiencies in locally produced feed ingredients. This may also be influenced by the mixed breed animals which are producing at only average levels.[85] While there appear to be no acute deficiencies dramatically affecting animal health and performance, experts recommend adding small amounts of Bentonite to cattle feed. Bentonite is a locally mined clay that is sometimes available in the market and fed as a mineral supplement along with locally mined natural rock salt.

In the US, technology has allowed for feed ration calculators. These are spreadsheets or computer applications where animal weight and frame type can be input along with feed component prices to formulate a feed ration. These are meant as a starting point for the producer as animal observation and actual performance will indicate additional ration development. But the calculators have greatly assisted in offering alternative rations based on cost shifts of underlying ingredients. For example, cotton seed cake sells for about 1.6 TJS/kg in October, at the height of cotton harvest season, but increases to 2-2.5 TJS/kg in January. This is a 25-60% increase in the price of the energy component of the fattening ration. There is a strong tradition of use and availability of cotton seed cake in Tajikistan, but balanced rations developed with alternatives, particularly for fattening outside of cotton harvest,[86] could strongly improve the economics of beef fattening.

Technology Impact on Smallholder Income

A base cattle fattening ration today often includes mixed alfalfa with grass, harvested from the farmer's own production, wheat straw and other crop residues collected largely for free, and wheat bran and cotton seed cake, both purchased from the market. The market price for alfalfa is included since some producers do purchase from the market or neighbors.[87] Based on this ration, a medium frame bull should gain about 360 grams/day and require over 400 days to add the desired 150kg (starting weight of 400kg.) The total cost of that gain would cost a total of 1,986TJS in feed.

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[84] The cotton seed cake available on the market in Tajikistan includes both expeller-processed (i.e., high oil content) cake and solvent-processed (i.e., low oil content) cake, although solvent-processed cake processed by old Soviet-era solvent factories appears to be more readily available.

[85] The largest and most professional cattle fattening and dairy farm operation visited in Khatlon does not utilize any complementary mineral supplements. They are also utilizing Brown Swiss and Brown Swiss mixed breed animals, as are the smallholder producers. They have a professional nutritionist who is confident in the locally produced feeds to meet the macro- and micronutrient needs of the animals.

[86] While cotton production has a strong and continuing base in Tajikistan, cotton production is steadily decreasing each year. Availability of cotton seed cake is expected to diminish in future years, though a dramatic decline in the immediate future is not likely.

[87] The Oklahoma State University Cattle Ration Calculator was utilized to determine the average gain expected for medium frame bulls. The ration calculator is available at http://beefextension.com/new%20site%202/sccalc.html.

As noted in the previous section, cottonseed cake prices go up from the fall during cotton harvest. The prices in the base budget above indicate a cottonseed cake price of 2.5 TJS/kg, the price in the market during the assessment. Anecdotally, it was reported that during October the price of cottonseed cake in the market was 1.6 TJS/kg. This difference in price doesn't reduce the overall days to maturing, but does reduce the cost of achieving that gain utilizing the same ration. The difference in the cottonseed meal price reduces the overall cost of the feeding through the 400 days by 440 TJS, about 20%. The time to maturity though at this basic ration remains well over a year.

TABLE 11: CATTLE FEEDING RATION ANALYSIS – COMPARING OVERALL COST TO FINISH AND DAYS TO FINISH; BY ANIMAL

DESCRIPTION	BASE CATTLE FEEDING RATION (JANUARY 2014 PRICES)		CATTLE FEEDING RATION WITH OCTOBER 2013 COTTONSEED CAKE PRICE		CATTLE FEEDING RATION WITH ADDITIONAL ALFALFA	
Feed Component	**% of Ration**	**TJS/kg**	**% of Ration**	**TJS/kg**	**% of Ration**	**TJS/kg**
Alfalfa hay	13%	0.21	13%	0.21	34%	0.21
Grass hay	32%	largely free, mixed with alfalfa or other crop residues	32%	largely free, mixed with alfalfa or other crop residues	34%	largely free. mixed with alfalfa or other crop residues
Wheat straw	48%	largely free from wheat production	48%	largely free from wheat production	23%	largely free from wheat production
Wheat bran	3%	1	3%	1	4%	1
Cottonseed meal	3%	2.5	3%	1.6	4%	1.6
REVENUE						
Sales of plums	$1,500	$1,500	$3,000	$5,000	$7,500	$7,500
Sales price	**7,000**	**TJS/animal**	**7,000**	**TJS/animal**	**7,000**	**TJS/animal**
EXPENSES						
Personnel						
Price of feed animal	5,000	TJS/animal	5,000	TJS/animal	5,000	TJS/animal
Feed expenses						
cost of feed/kg	0.69	TJS/kg	0.55	TJS/kg	0.86	TJS/kg
kg of feed/day	7	kgs	7	kgs	7.4	kgs
cost of feed/day	4.86	TJS/day	3.86	TJS/day	6.36	TJS/day
average gain/day	367	grams	367	grams	594	grams
days to achieve gain	408	days	408	days	252	days
total cost for gain	1,986	TJS total feed cost	1,575	TJS total feed cost	1,607	TJS total feed cost
Total expenses	**6,986**	**TJS**	**6,575**	**TJS**	**6,607**	**TJS**
NET INCOME						
Gross margin	**14**	**TJS/animal**	**425**	**TJS/animal**	**393**	**TJS/animal**
Total days to finish	**408**	**days**	**408**	**days**	**252**	**days**

Leaving the cottonseed meal price at the harvest levels, but increasing the share of alfalfa, which has more protein that straw or grass hay dramatically reduces the number of days required for the animal to add the desired 150kg. This shift to more alfalfa improves the average daily gain to nearly 600 grams/day. This reduces the number of days required to 250 days. Even though alfalfa is included at the market price as compared to the 'free' straw and grass hay, this ration delivers the same margin in 40% less time, an opportunity to re-invest in additional cattle.

TABLE 12: COMPARATIVE ANALYSIS OF CATTLE FEED RATIONS

DESCRIPTION	BASE RATION	HARVEST PRICE OF COTTONSEED MEAL	INCREASED ALFALFA COMPONENT
Price of feed animal	5,000	5,000	5,000
Total cost of feed	1,986	1,575	1,607
Sales price	7,000	7,000	7,000
Gross margin	14	425	393
Days to finish	408	408	252
Return on cash investment[88]	0%	6%	6%

With the purchase price of the feeder animal and the selling price of the finished bull staying the same, simply by adjusting the feed ration based on component price and availability, as indicated in the previous ration examples, can have a dramatic impact on margin and turnover rate (days). This type of technology can facilitate adjustments to rations and performance analysis for better decision-making by cattle fattening operations, large or small.

Technology Impact on Women

Women are largely responsible for cows and calving on Tajik farms.[89] Although women and children participate in the daily feeding and animal care, purchasing and sales are handled by men. Men also take primary responsibility for growing and cutting alfalfa, especially when it is grown on the land between and around orchard trees. Women may be marginally involved to the extent that they are involved in cleaning the orchards beds but this is not directly linked to alfalfa. This dynamic is consistent with practices in other developing countries, although in some countries, such as Ethiopia, women have been more successfully integrated into beef fattening chains.[90] For this reason, the introduction of improved livestock feed is unlikely to have significant impacts on women's labor or income. A more cost-effective feed ration may have little impact on the overall labor required, and feed decisions and income from the sale of fattened cattle are controlled by men and provide only a tangential benefit to women.

CONSTRAINTS TO TECHNOLOGY COMMERCIALIZATION AND ADOPTION

Incentives and Constraints to Smallholder Adoption

Cattle fattening is a capital-intensive activity requiring the upfront purchase of the animal to fatten and the majority of the feed. Animals for fattening are often 3 years old before final feeding begins. Because of this, very few of the families with milk cows that produce the underlying bull calves for the final beef market can afford to fatten and finish the animals themselves. Given the average beef animal is between 4 and 6 years old before reaching finished weight, a household producer simply cannot keep a beef animal long enough to finish it, particularly considering that a productive cow should produce another calf each year. Since the target adopters of the technology (i.e., small scale cattle fattening and feeding operations) are already investing in purchasing feed and fattening animals, capital is less of a new constraint. The technology is more focused on improving the cost-effectiveness of the capital already being invested. That said, there is likely limited scope for many additional smallholders to enter beef fattening as a result because it will remain a reasonably capital-intensive activity.

The feed components are largely available. Alfalfa production is fairly common, with many people involved in small-scale dairy production or cattle fattening producing some alfalfa for their own use. Most cattle producers are small enough that 1/3 to 1/2 of their alfalfa production will be sold to nearby dairy or fattening households. With the increased encouragement to produce

[88] These budgets are indicating the market price for alfalfa; but in reality many of these cattle fatteners will be growing their own alfalfa (and selling a cutting or two to neighbors, most likely who own a household dairy cow or two and need the milk for their household consumption).

[89] Lindahl et al., *Enhanced surveillance and control of zoonoses in peri-urban dairy farming in Tajikistan,* joint presentation between the Swedish University of Agricultural Sciences and the Tajik Agrarian University (2013).

[90] Rubin, D., *Gender and Community Development: Experiences of GL CRSP projects in Ethiopia, Ghana, Kazakhstan, Kenya, and Kyrgyzstan* (Global Livestock CRSP, 2010).

orchards, alfalfa is one of the crops being widely intercropped under the trees. Often those with cattle who do not have alfalfa will approach a neighbor with alfalfa and make an arrangement to purchase a cutting or two directly. Laborers in orchards or horticulture may also be paid in access to cutting the alfalfa under the trees or planted in nearby strips.

For farmers wishing to produce alfalfa, low-cost alfalfa seed is widely available. In addition to imported seed, the National Livestock Institute has 100 hectares of alfalfa seed under production for the local market. For the most part, alfalfa is not managed to optimize production, with little to no fertilizer applied, although some organic fertilization may occur if one cutting is grazed off by the farmer's herd. Alfalfa bales are typically 15-20kg each and sell for roughly 3.5 TJS/bale. Because of the opportunity cost for irrigated land (compared with the profit potential of early onions, for example), it is unlikely that specific forage operations separate from livestock operations will emerge. Since alfalfa is a legume, it is an attractive crop to grow in rotation with crops requiring significant nitrogen such as cotton and/or corn. As a perennial, however, it often requires a multi-year investment in establishing alfalfa and thus it is generally found under orchards (also perennial in nature) and in more marginal strips alongside roads or without consistent irrigation access.

Pathways to Technology Commercialization

With the various feed components readily available at the household or neighborhood level or in the local market,[91] the key to improving efficiency in livestock fattening is through the development of cost-effective livestock rations. Because ruminant diets are dominated by fiber, even the finishing of beef on grain, which are grown by the producers or are by-products of cereal production, it is unlikely that a prepared feed concentrate would be more cost-effective for the producer. Component costs change, and the ration should be modified based on component cost and animal performance on the feed. Thus the chief obstacle to the commercialization of improved livestock feed is farmer education.

Feed ration development is focused on providing the most cost-effective balanced ration for the production. Ration development expertise does exist in the National Livestock Institute and the Tajik Agrarian University, but households fattening a few animals have little to no means of accessing this knowledge. There is no connection or linkage with information and communications technology (ICT), which could broaden access and adoption. While smart phones are not ubiquitous yet, even some rural households now have smartphones sent by working relations in Russia. Most of the technical expertise is employed by the public sector, including public sector veterinarians and to a lesser extent the livestock departments at the regional level. The veterinarians have responsibility for animal health surveillance and work with the larger livestock operations on vaccinations and animal health management. They have limited capacity to work with a broader constituency of smaller operations on animal husbandry topics, including feed. The livestock departments are responsible for the public access pasture management, which represents a significant challenge due to overgrazing and degradation. The National Livestock Institute and the Tajik Agrarian University target the limited personnel within the livestock departments for their training workshops related to feed research and feeding recommendations. Feed ration technology applications could be used by these local technicians in responding to feed related inquiries.

[91] Qurghonteppa has two markets with feed component sections. These areas are on the outskirts of the main markets, with multiple vendors selling from small warehouse spaces. The established markets in smaller towns also have these fixed feed component retailers. They sell corn, barley, wheat, wheat bran, and cottonseed cake. The heavy mined rocksalt is sold by only one or two vendors in each area as it is very bulky and requires additional space for stockpiling a few tons at a time. Not all of these vendors also carry mineral supplements, including Bentonite, though most know where to source if they get requests.

CONCLUSION AND RECOMMENDATIONS

It is unlikely that separate feed concentrate businesses will emerge due to the availability of the feed components and relative ease in mixing the small volumes fed. Ruminant feed is dominated by fiber and the fiber components (wheat straw and alfalfa) are often produced by the cattle fattener or purchased from neighboring producers. The feed rations are in part determined by availability and price, as well as experience and tradition. The opportunity cost for land for irrigated horticulture versus forage also make it unlikely that specialized forage-only businesses will emerge. Alfalfa will be grown by those with land and livestock, while neighbors without access to the land required will buy from those neighbors or work where labor is compensated in forage. No acute macro- or micronutrient deficiencies were identified which would require significant mineral supplementation to address. The lack of mineral supplementation was not identified as a major constraining factor to improved effective and cost efficient cattle fattening.

Develop a technology-based feed ration calculation tool for use through smart phones. Improving fattening margins will likely come by developing technology-based feed ration development tools for use through smartphones. These would need to be specifically developed for the local context (frame size, weight gain potential, available feed components). A strategic cell phone partner may have a commercial interest, the expertise largely exists within the country, though experience in smallholder-focused technology-linked knowledge-based innovations would need to be brought in. Complimentary feed component production (such as alfalfa) and sourcing information could be provided alongside. Tracking individual animal performance using such technology could assist the producer in analyzing return on investment by animal as well. This type of analysis assists in matching animal selection with feeding regimes for maximizing returns.

The International Rice Research Institute (IRRI) has developed an easy to use technology-based Nutrient Management calculator which is used by lead farmers and other moderately trained extension agents.[92] There does not appear to be a similar experience with the International Livestock Research Institute (ILRI), though there may have been discussions related to dairy feed ration development. A simple multiple-choice questionnaire results in a specific recommendation. A cell phone-based application could be complemented with periodic requests for performance updates which could collect additional data points and provide modified recommendations.

Men and women reported that men are largely responsible for feed decisions. Women are, however, familiar with the mix of materials for feeding cows and, along with their children, handle the bulk of feeding responsibilities. Use of some interactive ICT platform for feed ration development would not increase the standard labor related to cattle fattening, but it would require training and familiarization. Accordingly, attention should be paid to solutions that target or are at a minimum accessible to women in the household and not just the men who purchase the feed. Because of the high rates of male migration, many women appear to have access to a mobile phone (although sex-disaggregated data on mobile penetration rates is not available), and the overall mobile phone penetration rate reach about 90% by the end of 2012. More research should be conducted to determine the level of women's access to mobile phones and their role in mixing feed rations at the household level to ensure that the proposed feed ration calculator can have the maximum adoption and impact.

[92] The web-accessible demonstration can be visited here: http://webapps.irri.org/ph/rcm/.

MILK PRODUCTION

Dairy production in Tajikistan has changed dramatically since 1992. Previously the bulk of the milk and dairy production occurred on larger commercial dairy farms and milk processors located across each region. Even then there was a culture of households owning backyard milk cows, but today there are very few large dairy farms, while household milk cow ownership has become a fixture.

Family milk cows provide milk for the households, some milk for trade into to the neighborhood and nearby markets, and produce bull calves for fattening and beef. The average household has between 1 and 3 head lactating cows. They often keep the calves for at least a year (weaning between 6 and 10 months) and up to two years depending on cash needs and feed availability.[93] For operations so small, it is easy to use family labor. Women manage the milking, and children often help with limited cattle care chores.

While the milk cows overnight within the household garden plot, they are often staked out or grazed along field edges, on alfalfa and grasses under fruit trees, or on other nearby crop residues depending on the season. Where possible, the milk cows (and definitely the dry cows and weaned calves) are sent in neighborhood herds to public pasture lands where distance is not an issue as the cows must be milked twice a day.

With nearly 400,000 cows owned by Khatlon households, there could be between 150,000 - 200,000 households with some milk production.[94] Excess household milk production may also be turned into artisanal dairy products including yogurts and other cultured items and sold to women with retail stalls within the markets.

MARKET OPPORTUNITY

Production

As noted in the previous Beef chapter, 92% of all cattle in Tajikistan are owned by the households, with household dairy cows driving overall cattle production. In 2012, the country produced 780,000 MTs of milk with about 50% of that produced in Khatlon and about 30% in Sughd. This volume is a nearly 30% increase over 2008 production of 600,000 MTs.[95] The overall cattle population increased 25% over the same period, so the volume increase is largely from overall herd size and not from a dramatic increase in productivity.[96]

The cattle are mixed breed local animals with some dual-purpose cattle genetics, including Brown Swiss and Brown Carpathian.[97] Average milk yields per cow are also reported in the TajStat Quarterly Food Security and Poverty Bulletins. They report an average annual yield of 1,500 kg/cow (a 10% improvement in productivity over 2008 levels). This may be compared with the breed potential of purebred Brown Swiss selected for dairy production in Europe of approximately 9,000 kg/cow annually. These yields reported by TajStat are average and actual productivity varies widely between households and animals.

In Khatlon most lactating cows are kept within the household garden plot. There are a handful of old Soviet dairy farms still in some level of production as private operations and *dekhan* farms. These farms are milking on average between 25 and 60 cows a day (although a couple of large dairies milking up to 300 cows a day exist closer to Dushanbe.) These private and *dekhan* farms are largely under-capitalized; on average not producing at any significantly higher yield than the national average.

Small-scale dairy farms are the same households milking 2 to 3 lactating cows housed in their household plot. The difference between the family milk cow and the small-scale dairy farm is production and marketing. The household feeding the animal for milk production[98] (here considered a small-scale dairy farm) reported on average 9-12 liters/day production instead of the average 4 liters/day from the households managing their animals largely for household consumption only.

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[93] See the Beef chapter for additional information.

[94] TajStat, Feed the Future Strategy, and interviews with consultant calculations.

[95] Data obtained from the Food Security and Poverty Quarterly Bulletins published by TajStat between the 2nd quarter of 2010 and the 3rd quarter of 2013, TajStat data, and interviews.

[96] FAOStat.

[97] Dual-purpose breeds are breeds selected and maintained to balance dairy and meat production, instead of favoring one product over another. Brown Swiss is not only a dual-purpose animal, but is also a good choice for Khatlon due to its heat tolerance, calving ease, and high butterfat.

[98] Small-scale dairy farms feed some combination of whole grain, wheat bran, fodder beet, pumpkin, or other available higher energy feed, including brewer's mash.

The production size and complexity is the same between household milk cows and the small-scale dairies. The difference is the intention of the producer. In the small-scale dairy, they prioritize better dairy genetics (where possible) for the animals and feed a higher quality and higher energy feed for greater milk production. On larger farms that hire labor for specific tasks, women are hired to milk the cows.

The production culture appears to favor late winter/early spring calving to coincide with new grass. Spring freshening of cows is reflected in lower summer milk prices when the cows are in peak production, grass and grazing are available, and more milk is available in the market. December, January, and February were reported to be typical dry periods prior to calving, though many households reported continuing to milk small volumes, without completing drying the animal prior to calving. The higher dairy prices over this period reflect the lower availability of milk in the market.

End Markets

Not only are there negligible dairy imports or exports, the dairy trade is very decentralized with most production, trade, processing, and consumption occurring in neighborhoods and villages, with the exception of Dushanbe. Dushanbe as the exception will continue to develop as the recent ban on peri-urban dairies will push those household dairy animals out of the city limits and offer an opportunity for dairy farm development in the surrounding districts to meet the city's dairy needs. A couple of Khatlon districts are near enough to Dushanbe to develop to serve that market along with the other neighboring districts.

Another factor influencing the decentralized dairy market is the fact that the rural population consumes significantly more milk and dairy products than the urban resident; in 2012, rural per capita consumption was 5.36 kg/month versus 3.38 kg/month respectively.[99] Due to the decentralized household production and the decentralized rural consumption, it is difficult to quantify how much of the milk produced is actually traded versus consumed directly. Some percentage of household dairy cows are being milked only for the immediate household's consumption while others are producing extra liters daily for selling to neighbors or into the nearby neighborhood. Quantification of the numbers of households in each category are not available. The FAOStat milk production numbers vary dramatically from TajStat which may reflect these data challenges.

Currently in Khatlon, milk processors produce yogurts, fresh cheese, and other soured and cultured milk products. The milk processors are largely old Soviet era facilities operating significantly below capacity. The processors do not compete with the informal trade of fluid milk from household cows except in Dushanbe. There is limited hard cheese production today. According to FAOStat, Tajikistan produced nearly 3,500MTs of cheese in 1992 and only 210MTs in 2012, with most of that production having collapsed by 1996 due to the civil war and never recovering. While struggling dairy processors mentioned cheap cheese imports from a more competitive Russian dairy industry, trade data does not indicate any significant cheese imports.

Price Trends

Milk prices vary by as much as 50% at any time across the country. Given the importance of milk in the daily diet, there is good quarterly data on prices in various strategic markets across the regions.[100] Overall milk prices have risen by about 75% since 2008 across the markets. Dushanbe is the consistent high price milk market and Sughd one of the lowest price markets. Khatlon is a middle price market. Sughd's lower prices are surprising as they produce about 30% of the milk and have about 30% of the population while Khatlon produces roughly 50% of the country's milk with only 35% of the population. This may be accounted for by the relative proximity of some of the districts to the Dushanbe market. While not dramatic, prices do tend to fall by about 5% between the winter quarters and the summer quarters, when milk volumes should be higher due to summer pasture and calving cycles.

While milk is consumed year round, anecdotally milk consumption is reported to be higher in the summer months due to increased consumption of certain traditional yogurts and other cultured products, along with ice cream.

[99] Data obtained from the Food Security and Poverty Quarterly Bulletins published by TajStat between the 2nd quarter of 2010 and the 3rd quarter of 2013.

[100] Ibid.

Distribution Channels

Household produced milk is sold directly within the neighborhoods surrounding the production. After the morning milking, women take milk in reused soda bottles and other repurposed small liter plastic bottles to be sold door to door within their neighborhoods or to sidewalks outside of market entries. Some women will process their own milk or aggregate neighborhood milk to process into traditional cultured milk products such as chaka, a firm yogurt product. These are sold to retailers with physical stalls within the markets, who must have it tested by the market labs prior to being sold. The fluid milk sold on sidewalks in front of the markets in the early mornings is not tested by the market labs.

As noted previously, there are also some milk processors in the larger towns. These processors absorb the limited milk production from the private and *dekhan* dairy farms as well as some household produced milk. One larger Khatlon processor reported receiving 50% of their total milk from *dekhan* farms and the other 50% from household milk producers.[101] The processor sends transport to identified collection points where households bring the milk to sell. Some processors pay based on butterfat content, while others pay based on volume.

A lack of refrigerated transport limits the geographical range for milk collection and sales. Processors without refrigerated tank trucks pick up in the evenings during the hot summer months and after the morning milking during the winter months. They collect at a distance up to 70-80 kilometers from their facility. There is limited household milk sold into the processors though due to processor capacity and competitiveness. The processors are operating significantly under capacity due to capitalization issues, unreliable electricity access, old technology, and fractured dairy demand. Where a milk processor has market access into Dushanbe or a secondary city, household milk could be organized to augment supply from the still emerging larger dairy farms. There are no decentralized milk collection and cooling facilities. The cost to develop a larger scale household milk collection model would likely be cost prohibitive to a milk processor already struggling with their own competitiveness and operations, though the additional reliable volume of milk would be a welcome diversification from the unpredictable and undercapitalized *dekhan* dairy farms.

Competition

Anecdotal reports of cheap imported cheeses were not confirmed through any of the available trade data. Cheese production can be an attractive value added product for large volumes of high quality milk, as one may assume 10kg of milk is used to produce 1kg of cheese. There is no significant trade in milk at all which offers any interesting import substitution opportunities. The large dairies that are developing in the industry represent the largest threat to household production, but only those properly capitalized dairies directly on the outskirts of Dushanbe. It is unlikely that even the medium size *dekhan* farms or private operations represent any significant opportunity due to the lack of investment and cost of capital.

Outlook

There isn't likely significant rural market incentive to dramatically increase the decentralized milk production at the household level, particularly at any significant distance from a larger milk processor. But underutilized processor capacity along with targeted business support to improve processor operations and competitiveness could offer a market outlet for a household milk collection and purchase model for thousands of producers within 75-80 kilometers (up to 100 kilometers or more possibly with refrigerated tank trucks) of a progressive processor. Isolated support for expanded milk production without addressing the capitalization, management, and market linkage (both upstream and downstream) challenges at the processor level would leave the milk producers without a reliable market outlet. Dushanbe will be a difficult market to target as there are larger dairy farms developing within easy access, though again progressive processors in nearby districts could welcome additional milk volumes from organized household collection and bulking.

[101] Currently purchasing an average of 3MT of milk a day during the low production season, that could be more than 500 household producers selling an average of 3 liters of extra milk a day to the processor.

IMPACT OF PROPOSED TECHNOLOGY

Improved Livestock Feed, Including Fodder Beets

As with all livestock, the animal converts feed and care into the final product; in this case milk. Feeding cattle to maximize margins and milk production is a balance between the genetic potential of the dairy animal, the cost and availability of the feed, and balancing the ratio for animal performance and health. Cattle are ruminants; requiring balanced fiber, energy (carbohydrates), different types of protein for fermentation within the rumen, the cow's specialized stomach.[102] There are also different feed rations and regimes needed at different stages of cattle development and production. For milk cows this can be simplified into two types of ration: the maintenance ration (for the dry period and used as the base during milk production) and the maintenance plus ration for lactation (additional ration above maintenance depending on desired milk production and genetic potential of the animal). This is a simplification as there are many variables related to balancing the components of the ration for rumen performance and productivity. The initial cost of feeding the animal per unit of milk produced will decrease as the maintenance component is spread over a longer period of production, though only until the genetic potential of the animal is maximized.

As described in the beef feeding section, it reasonably common in the US for dairy nutritionists and producers to utilize feed ration calculators for feed ration development. These spreadsheets and computer applications can assist in developing a maintenance ration for the dairy animal and provide additional balancing as higher levels of milk production are desired (up to the genetic potential and cost/benefit is achieved.) These calculators are useful as the cost of feed components change, but are meant to be used alongside animal observation and evaluation of animal performance.

The cattle owned by rural households in Khatlon are not the most efficient at converting feed into milk. The dual-purpose nature of the genetics (balancing beef and dairy productivity) make these breeds a good choice for the farmer who supplies both industries on a small-scale basis, but it limits the overall genetic capacity of the cattle to produce milk. Generally speaking, the producers and experts visited indicated 12-15 liters/day could be considered the upper limit of the genetic potential of the cattle at the household scale.

The feed components available to dairy producers mirror those already discussed in the previous beef section, including wheat straw, grass hay, alfalfa, corn or other grain stover, cotton seed cake, wheat, wheat bran, corn, and barley. In addition, fodder beets are grown by some households as supplemental feed for their lactating cows. Fodder beets are a highly productive use of land (commercial production may yield an average of 50 MT/ha or more) and are most often used to replace grains as a source of energy in the cow's diet. They were used extensively in the 1800's in Europe, particularly as a winter feed for cattle and dairy cows. Fodder beets are grown as a row crop that can be harvested as needed for feeding throughout the fall. They are not frost hardy, however, and should be harvested before the first hard frost.

Many households visited were not producing much milk beyond what was needed by the household, with occasional extra liters sold to neighbors. These families reported understanding that more fodder beets would result in more milk production, but were choosing to not provide the additional feed. The handful of small-scale dairies visited were milking at least two cows and all had some experience with fodder beets, while also feeding supplemental wheat bran, barley, and cottonseed cake. The salt provided was a naturally mined local block salt, widely available in the markets. No one fed any mineral supplements.[103] However, since the lactating cows are dual-purpose and mixed breed and not producing the overly high volumes of purebred dairy breeds such as Holstein, they are less likely to suffer from acute mineral deficiencies such as milk fever; a shortage of calcium in the diet.

[102] Mineral supplements to address any local macro- and micronutrient deficiencies are described in more detail in the discussion of feeding beef cattle. Dairy cattle are also ruminants and have similar requirements, though in different relative amounts.

[103] See discussion of mineral supplements in the previous section related to beef production.

Technology Impact on Smallholder Income

Fodder beets are fed by some small-scale dairy farms, but there is limited published data on rations for fodder beets. Maize silage is fed in all of the large dairy farms in Tajikistan, but can be difficult at the smallest scale and isn't available in the market.[104] Many of the available prepared rations include maize silage. The following analysis shows the average ration being fed by household producers. This ration includes some alfalfa hay (typically with heavy grass component), some wheat straw or corn stover, and some cotton seed cake and wheat bran for energy. This is producing on average 4 liters/day (3-5 range). Even if they do try to sell a couple of extra liters per day, it makes little impact on feed costs.

TABLE 13: COMPARATIVE ANALYSIS OF CATTLE FEED RATIONS

DESCRIPTION	BASE RATION 4 LITERS/DAY		8 LITERS/DAY		10 LITERS/DAY		15 LITERS/DAY	
	kg	TJS/kg	kg	TJS/kg	kg	TJS/kg	kg	TJS/kg
EXPENSES								
alfalfa hay (kg)	15	0.21	18	0.21	20	0.21	20	0.21
wheat straw (kg)	5	0	2	0	3	0	3	0
fodder beets (kg)	0	0	5	0	8	0	10	0
cottonseed cake (kg)	0.5	2.5	0	2.5	0	2.5	0	2.5
wheat bran (kg)	0.5	1	1.7	1	3	1	5	1
Total cost of feed per day		**4.9**		**5.5**		**7.2**		**9.2**
REVENUE								
milk for household (liters)		3		3		3		3
milk for sale (liters)		1		5		7		12
milk price/liter (TJS)		2		2		2		2
Gross receipts milk sold per day (TJS)[105]		**2**		**10**		**14**		**24**
Net Income (TJS)		**-2.9**		**4.5**		**6.8**		**14.8**
Net Income/year (USD)[106]		**($185.43)**		**$287.74**		**$434.80**		**$946.33**

The ration for increasing the same animal's production to 8 liters a day increases the alfalfa quantity and adds fodder beets. Cottonseed cake is eliminated at this production level. The extra liters/day for sale may start to cover the opportunity costs/internal labor costs associated with fodder beet production, but there is also a risk in having to establish reliable market linkages for still relatively small volumes of milk out of the household (5 liters/day). It becomes more straight-forward at the 10-12liter/day level. With 7-10 liters of milk to sell/day the volume and possible income make the investment in establishing regular linkages more interesting. The feeding labor and milking labor remains largely the same across all of the production levels and thus the return on labor becomes more attractive only at the higher milk volumes.

[104] Rations developed based on interviews with households, commercial dairies, Tajik Agrarian University, and National Livestock Institute. Feed recommendations within the country for a Brown Swiss mixed breed lactating cow generally maize silage with fodder beets. Maize silage is not common, nor practical, for small-scale households, so this ration calculation does not include it.

[105] It should be noted that the total gross receipts for milk does not include the potential cash value of the milk for household consumption. This format was chosen to accurately reflect the cash outlay required for milk production and thus the impact of these costs on farmers' incentives to invest in improved feed. Where milk is retained for household consumption alone, the cost of production is a net negative to household income. While the household no doubt values this milk for nutrition purposes, it does not provide the farmer with the additional cash needed to invest in better feed to produce more milk. The budget above accurately reflects the cash challenges of investing in cattle at lower production levels as well as the economies of scale and income benefits of using improved feed rations and engaging in commercial milk production.

[106] This budget assumes 305 days of milking per year, allowing two months to dry the animal prior to calving.

Technology Impact on Women

The household dairy cow is the primary responsibility and interest of the women of the household. As noted in the dairy market section, rural dairy consumption is higher than urban consumption and the family cow is an important dietary asset. The women manage the daily care and milking, managing the children who often contribute to the minimal feeding and cleaning chores required. Within the household milk production, any extra milk sold to neighbors or into nearby markets is the domain of the women. The women will likely make the determination of whether there is excess milk for sale and would make the arrangements to sell the milk to neighbors or into the market or to give it away to neighbors in exchange for help on their farms or other products. That decision may be somewhat influenced by the need for petty cash for other purposes. The women would also develop any artisanal dairy products to be sold as well. In the small-scale dairy, the man may also get involved in milk sales. In both cases, the men are more involved in feed production and feeding decisions, as grazing, feed production and purchase occur outside of the household garden plot.

The positive impact of fodder beets on milk production may increase the time women spend milking cows. As a result it may reduce their ability to attend to other household activities, which then are shifted to other women and young girls in the household.[107] For adult women, this increase is not necessarily negative if there is an accompanying increase in income under women's control from the sale of milk. Both men and women reported that women control the income from milk sales (approximately 2-3 TJS/liter), when it is sold. In other countries, women's roles have been known to evolve as milk processing commercializes and formalizes, but there have also been cases where women's participation has decreased as this occurs.[108]

CONSTRAINTS TO TECHNOLOGY COMMERCIALIZATION AND ADOPTION

Incentives and Constraints to Smallholder Adoption

While the household cow is already consuming some purchased cottonseed cake and wheat bran, it is likely that fodder beets would fit well for the household dairy operation as a feed they would easily be able to produce themselves. Fodder beets can be harvested on a weekly, as needed, basis over a 6-12 week period of the fall. This dramatically reduces the need for purchased grain or grain meals. However, the use of fodder beets in the dairy cow diet would slightly increase the daily labor requirement for feeding the animal, as they need to be chopped. It would also require a family decision to allocate some irrigated agricultural land to the cultivation, as the household garden is unlikely to accommodate the required area.

The decisions about what to plant on individual and family farms are largely made by men in the household, yet it is women who would likely benefit from the increased milk sales. Women may have a greater interest in adopting fodder beets for feed but will likely require the consent of men in their household to use land for its production. As the relative income gain to men farmers is not very high, this reduces their incentive to divert land to fodder beets over another more profitable crop. This may explain why, even though most household dairy producers recognized the role of fodder beets in increasing milk production, few had adopted this practice.

The current production of 4-5 liters/cow/day typically leaves the family with only a couple of liters per day to sell to neighbors. One neighborhood visited had 5 cows across 40 households, so selling into the neighborhood did not pose a significant problem, even at a daily milking of 12 liters/cow. But additional milk by a large number of household milk cows would produce a significant increase in overall milk availability.[109] Market linkages may be required beyond the immediate neighborhood, where some women with the 1-3 liter/day marketable production are selling. This would likely require women to travel beyond their immediate areas which may have cultural limitations in some families. Village-level bulking and cooling facilities could assist in aggregating household level production into volumes economical to move into milk processing facilities. *Dekhan* dairy farms are currently only providing 400-700liters/day each to milk processors. That would be the equivalent of about 100 households each bringing 4-7 liters of extra milk to a bulking plant a day (or fewer households with just a bit more milk.) Milk is a highly perishable commodity and producing excess milk without a reliable outlet is high risk.

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[107] Quisumbing, A., S. Roy, J. Mjuki, K. Tanvin, and E. Waithanji, "Can Dairy Value Chain Projects Change Gender Norms in Rural Bangladesh? Impacts on Assets, Gender Norms, and Time Use" in Quisumbing, et al (eds) *Learning from Eight Agricultural Development Interventions in Africa and South Asia* (Washington, DC: International Food Policy Research Institute 2013).

[108] For example in East Africa, women control over evening milk and income from sales to local markets and traders. Women have lost this control as milk is sold to formal markets via member-based collection centers to which they do not belong. In Sudan, women's participation as suppliers of milk for cheese factories facilitated their ability to maintain control and diversify into other milk products as demand, particularly urban, increased. Kristjanson, P., A. Waters-Bayer, N. Johnson, A. Tipalda, J. Njuki, I. Baltenweck, D. Grace, and S. MacMillan, *Livestock and Women's Livelihoods: A Review of the Recent Evidence* (Discussion Paper No. 20, 2010) (Kristjanson et al. 2010).

[109] As noted above, 56.3 percent of female-headed households have cattle and 65.5 percent of male-headed households.

Pathways to Technology Commercialization

Fodder beet seed is not as widely available in the market as other seeds, probably because of low demand by producers. Any promotion of improved feeding for higher milk yields would need a complementary outreach to input suppliers to stock the seed as demand is driven. If market demand and linkages for the aggregation of household milk increased, fodder beet seed could have strong market potential for the input supplier. Even if the seeds are open-pollinated, fodder beet seed will be purchased on an annual basis because seed production is a biennial process, requiring two seasons to produce seed. Farmers will not tie up their land to save the cost of annual seed purchase.

As noted in the beef section, feed ration development is a knowledge-based technology. Ration development expertise does exist in the National Livestock Institute and the Tajik Agrarian University, but the women managing the household dairy cows have little access to those expert resources. Successful partnership with milk processors could facilitate feed ration information and adoption. Yet the milk processors are struggling from undercapitalization, unreliable electricity, and strong competition from imported cheese. These firms need support to improve their management and capacity to absorb additional milk and build out a village-level bulking and cooling model. Until these investments are made, there will be little incentive for the commercialization or adoption of any technology that increases milk production.

CONCLUSION AND RECOMMENDATIONS

The potential scale of this technology is high since most households have at least one cow. However, given the land and labor requirements to grow fodder beets, the income benefits from adoption of the technology in isolation may not be suitable for households with few cows in the context of the entire production system. Ultimately, the incentives to produce will depend on the development of a reliable output market for increased milk production through increasing the capacity and market linkages of Khatlon-based milk processors.

Develop capacity of local processors to absorb a greater percentage of household milk production. Improved feeding for dairy production will need to be combined with improved market linkages and support for dairy processors. Particular attention will be needed to facilitate women's ability to sell their excess milk on a daily basis. It is unlikely that the market could absorb a doubling of household milk production, so the potential scale is not as significant as it may appear. Also market linkages could prioritize village centers within which a significant quantity could be consistently bulked to ship to successful milk processors. The milk processors do not today have the management capacity or efficiency to absorb more milk without additional assistance, but some do appear to be interested in exploring household milk production as a reliable source of high quality milk for their businesses.

Introduce an ICT-based feed ration development tool. The use of an ICT platform for feed ration development could be linked with dairy cow management in general, allowing the tracking individual cow performance and management over a productive lifetime. These types of information platforms are in early stage market penetration and rollout among small-scale dairy farmers in East Africa. iCow is one private company providing an ICT platform which tracks the performance and management for each dairy animal, including tracking estrus cycles, calving, and milk production and sending prompts and information updates tailored to the dairy cow's cycle. While the information will be very familiar to cattle producers, use of the information in this medium would require training and familiarization. This would be most relevant to the women who interact with the family cow(s) on a daily basis, yet men and women reported that men are largely responsible for feed decisions. Thus an approach that incorporates men and women would be important for the success of any scaling strategy.

Promote the pooling of land and labor for the production of fodder beets for the community. Work with village leaders to identify land on which groups of women could grow fodder beets together and distribute (or sell) among households. This approach would pool the land and labor requirements of the individuals with the greatest incentives (i.e., women) to adopt fodder beets for dairy cow feed. By designating specific land for women to use, it would not require competition for land on family farms.

Support GoTJ and other donors in investments to improve electricity infrastructure. Long-term increases in commercial milk production will require investment in more reliable electricity infrastructure throughout Khatlon. Milk processing requires continuous cold facilities, which are impossible under the current restrictions on commercial businesses to only 8 hours of electricity per day. Those who do operate in Khatlon must pay to access the "red line" for 24-hour access, a significant expense. Upgrading this infrastructure is long-term endeavor for which the GoTJ is currently receiving support from the ADB and EBRD. USAID should work with these and other donors to support these reforms.

POULTRY: BROILERS AND EGGS

By the end of the Soviet period, poultry production—both broilers, which are grown for chicken meat, and layers, grown for egg production—had developed as a small but growing industry in Tajikistan. This production vanished during the civil war and did not begin to re-emerge until 2008. Today there are just over 40 poultry operations in the country, approximately 25 of which are small-scale (i.e., averaging up to 1,000 layers or 5,000 broilers each).[110]

Many rural households also maintain a dozen or fewer backyard chickens within their household plots for domestic egg consumption and occasional meat consumption. These operations are unsophisticated and of little value to the household beyond family consumption and the occasional sale or barter of eggs. Accordingly, most households do not invest in vaccines or even feed for their chickens, allowing them to simply scavenge within the garden plot. This approach has risks—in one district in Khatlon, 80-90 percent of the household chickens had been wiped out by Newcastle disease. With training and finance for the initial investment, these households could be upgraded to small-scale poultry operations with little increase in labor.

Demand for eggs and chicken meat has grown steadily in recent years, a substantial portion of which is satisfied through imports. Upgrading the existing household production into a large number of small-scale poultry operations has the potential to displace these imports in the domestic market. Yet the cost of feed, particularly the protein component, poses a significant barrier to competitive poultry production in Tajikistan. Without the development of an affordable domestic protein source, the poultry industry will continue to struggle and present few opportunities for small-scale producers and rural households.

MARKET OPPORTUNITY

Production

Chicken meat has become increasingly important in world diets over the past 20 years. Globally, chicken meat production has increased by 140% since 1992, from a total of less than 40 million tons to over 92 million tons in 2012. Given the emerging nature of broiler production 20 years ago, it is not surprising that while there were some integrated broiler farms in Tajikistan at the end of the Soviet era, the total consumption of chicken meat was significantly lower than today.

TABLE 14: POULTRY PRODUCTION (TONS) FOR THE PAST 5 YEARS

DESCRIPTION	2008	2009	2010	2011	2012
Chicken meat (tons)	700	1,000	1,600	4,400	1,000

Source: TajStat Quarterly Food Security and Poverty Bulletins

What broiler operations did exist in 1992 almost completely disappeared in the intervening years. The industry has attempted a recovery in the past 5-6 years, but annual chicken meat production continues to lag behind the 5,200 MT mark achieved in 1992 and what few operations exist are not commercially viable. Farms continue to enter and exit broiler production with limited to no success.[111] There is only one large broiler operation in Tajikistan today. It is a relatively new Iranian financed venture in Khatlon that also produces layers, but it has already gone into bankruptcy.[112] Tajikistan's production over the past 5 years reflects this dynamic with significant variation in annual quantities.

[110] These estimates are based on stakeholder interviews, as concrete data on poultry producers in the country was not available.

[111] Broiler production occurs in a very short cycle, with day old chicks grown to slaughter within 40-45 days. While up to 8 cycles can occur within a year, often developing market operations enter and exit broiler production as capital and production economics allow.

[112] The farm was started in 2010 in Muminabad. The venture was still operating at the time of the assessment, but was reported to be going through financial restructuring via bankruptcy.

The layer industry collapsed just as quickly, dropping from nearly 300 million eggs in 1992 to less than 6 million only four years later in 1996, about 2% of the previous levels.[113] The industry began recovering soon after the civil war ended, reaching over 12 million eggs/year in 1998 and continued growth thereafter. By 2012, domestic production had reached 290 million eggs. Unlike the short, 40-45 day production cycle for broilers, layers are typically kept for 18-month cycles before culling. This longer time horizon decreases the easy entry and exit in the business. This is reflected in more consistent industry growth over time.

TABLE 15: EGG PRODUCTION (MILLIONS)

DESCRIPTION	2008	2009	2010	2011	2012
Eggs (millions)	151.0	188.4	232.0	255.0	291.6

Source: TajStat Quarterly Food Security and Poverty Bulletins

The vast majority, over 90%, of Tajikistan's roughly 40 poultry operations produce layers. The cost of feed, specifically the protein component, and not the market potential explains the heavy production bias for layers over broilers. Layers require a lower protein feed, thus slightly improving the underlying economic viability for layers versus broilers.

Khatlon production accounts for less than 20% of total domestic egg production, while Sughd produces about 30%. Most operations are located in the immediate districts around Dushanbe. While egg production typically reduces during the short daylight hours of winter, commercial production utilizes artificial light to ensure consistent production. Thus there should be no significant seasonality in egg production and none was noted. A very limited amount of egg production from household poultry reaches the market.

End Markets

Domestic poultry production is exclusively consumed domestically but, as described above, production levels are unstable and insufficient to meet domestic demand. As noted in the previous section on beef, chicken meat prices per kilo have only risen by 12% over the past 5 years while beef prices have risen by over 90%. This may account for the more than 350% increase in per capita chicken consumption. Across Central Asia poultry consumption has been steadily rising over the past decade and, with the exception of Uzbekistan, is entirely reliant on imports.[114] In Tajikistan, imports have only been significant since 2003, when they rose above 1,000MT for the first time. From 3,600MTs in 2003, imports reached 24,000MTs in 2008 and have largely stabilized at that level over the past 5 years.[115]

TABLE 16: PER CAPITA CHICKEN MEAT CONSUMPTION IN CENTRAL ASIA

DISTRICT	1992	2000	2009	PERCENT CHANGE IN CONSUMPTION (1992-2009)
Russian Federation	10	9.8	22.8	128%
Iran (Islamic Republic of)	9.8	12.7	22.2	127%
Kazakhstan	6.4	3.6	11.8	84%
Kyrgyzstan	5	1.3	6.4	28%
Uzbekistan	3.2	1	1.1	-66%
Turkmenistan	1.7	2.3	4.9	188%
Tajikistan	0.9	0.1	4.2	367%

Source: FAOStat

[113] FAOStat.

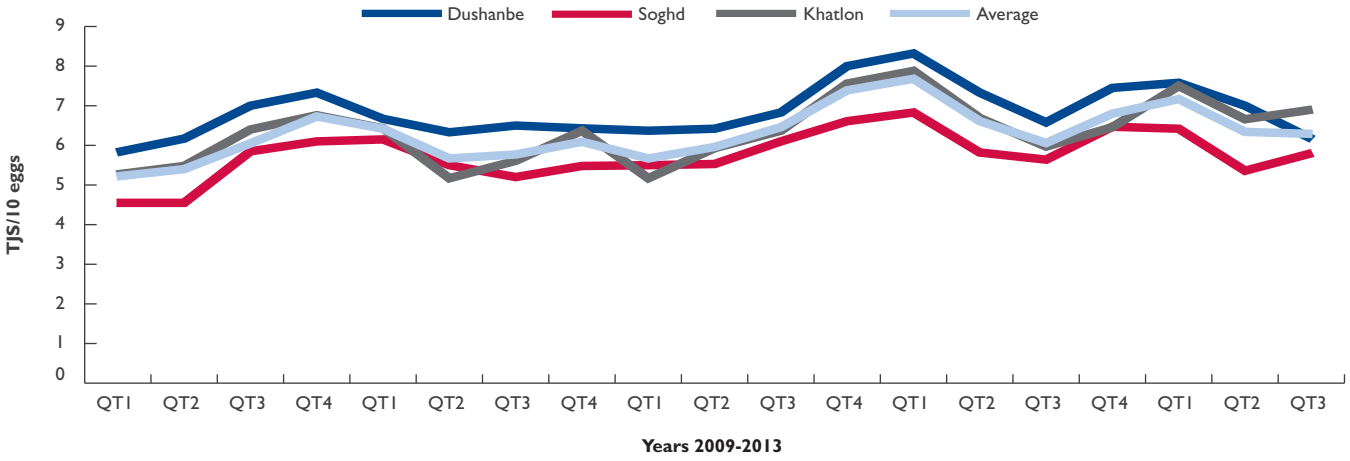
[114] Kyrgyzstan has been investing in domestic poultry production, including USAID support for soybean and feed production. The Government has been looking to increase import duties given the continued share of the domestic market imports represent and difficulties in achieving competitive domestic production while the soybean industry develops.

[115] 24,000MTs is equal to roughly 26,000,000 birds; or 3,250,000 birds each of 8 cycles a year.

Worldwide, table eggs are not extensively traded; production is usually for domestic consumption. Less than 3% of total global egg production ever crosses borders, unlike chicken meat where about 14% of global production is traded. In 2012, Tajiks consumed an average of 60 eggs/person/year. Multiplied by the total population, this is a total demand of roughly 500 million eggs annually.[116] Tajikistan's domestic production satisfies approximately 60% of the market, with another 20% (or 100 million eggs) imported annually, mostly from Iran.[117] The remaining 20% of current consumption is filled by household egg production, most of which never reaches the market.

Rural consumption of eggs is reported to be slightly lower than urban consumption, probably because fewer eggs are purchased and what domestic production from backyard chickens is available is relied upon. Egg prices show variability quarter to quarter. Dushanbe egg prices are consistently about 10% above the national average with Sughd prices running about 10% below national average. An estimated 5% of total traded demand (eggs actually sold) come from household eggs[118] and command a price premium of about 10% over commercially produced eggs. However, there is limited opportunity to expand the number of these "free-range" household eggs sold into the market as the consumer base for these eggs is very small and the average Tajik consumer is price sensitive. Thus the more inexpensive commercial eggs will continue to dominate the larger market.

FIGURE 7: QUARTERLY EGG PRICES (TJS/10 EGGS) BETWEEN 2009 AND 2013



Source: TajStat Quarterly Food Security and Poverty Bulletin

Distribution Channels

Poultry meat is largely imported frozen via different overland routes, including overland through Karachi port in Pakistan via Afghanistan, through Iran, and through the Baltic States. Butcher retail shops in markets typically do not sell this imported chicken meat alongside their beef and lamb. Frozen chicken is more often stocked by the small mostly dry goods retail market stalls that also stock imported canned food items and condiments.

As noted above, there aren't any regularly operating and profitable broiler farms. Domestic broiler operations that enter and exit the market sporadically lack access to formal abbatoir facilities. Smaller broiler operations slaughter by hand in informal processes that lack the oversight and inspection found in beef and lamb. Small tub-style electric pluckers are available and used. Slaughter occurs by order, often from food service, in small lots of up to 50-150 birds. There are also smaller poultry-specific periodic markets where live birds are sold. A few animals may pass through these markets, but their ability to absorb larger lots is limited as there isn't a dedicated butcher industry to purchase larger lots. This represents a significant risk for new broiler ventures, and is discussed further in the technology adoption section below. Birds sold through those live bird markets go to households or the smaller size food service for self-processing. Culled layers also find their way to the local market, often to institutional and food service buyers such as restaurants.

[116] Data obtained from the Food Security and Poverty Quarterly Bulletins published by the TajStat between the 2nd quarter of 2010 and the 3rd quarter of 2013, TajStat data, and interviews.

[117] The 100 million imported from Iran represent approximately 20% of total demand but about 30% of the eggs that reach the market and are traded.

[118] There is no data available; interviews suggested 5% without sufficient validation.

Table eggs are sold in all of the major markets by retailers, often alongside other products. One Dushanbe egg producer has branded retail kiosks in the larger markets, but mostly the eggs are sold retail stalls selling shelf stable food products such as canned foods and other dry goods. The eggs from some of the larger producers are individually stamped with the company name, such as Porcion, an egg producer in Khatlon. Eggs are often purchased by wholesalers from the layer farm. There are a few farms that send small trucks with eggs for wholesale to the markets. The same market egg retailers will often have a few dozen household eggs available for sale alongside the commercially produced eggs. They buy these from different wholesalers who have purchased them and aggregated a few dozen directly from women with household flocks, and who reliably have sold a few eggs to them at a time. The volume of eggs for sale from household production is relatively insignificant and inconsistent as noted in the end market section above. The market for a higher priced egg isn't sufficiently elastic to absorb a significant expansion of 'free-range' production. Even if the market were there to absorb additional production, fragmentation of the distribution channel would prevent the achievement of sufficient cost efficiencies, even with a doubling or tripling of volumes.

Competition

Broiler production is highly competitive globally. The best genetics require low cost high protein diets, and it is difficult to compete against Brazil and the US where soybean culture has facilitated low-cost chicken meat. Similarly in Africa, the development of the poultry industry is being underpinned by expansion of domestic and regional soybean production, which also provides additional domestic vegetable oil production, a complementary import substitution opportunity. As will be discussed in more detail in the Technology section below, Tajikistan lacks a similar low-cost protein source for poultry feed. Accordingly, the Tajik chicken meat market is dominated by frozen imports from the US and Russia (among others). The frozen chicken reaching Tajikistan markets are often the leg quarters and drumsticks not as in demand by the US consumer.

Imported eggs from Iran are priced the same as the equivalently sized domestically produced eggs. The retailers know the origin of the eggs and are very open to origin questions. Anecdotally, however, there was some concern expressed that the imported eggs from Iran may be older and not as reliably edible (i.e., they may be spoiled). Presumably if that were a common problem and risk, it would be reflected in a standard price discount, which wasn't present in the market. One interviewee noted that while on vacation in Iran he observed that the price of eggs was 50% of the retail price in Dushanbe. Iran has a vibrant oilseed industry, which provides a cheaper cost of production (feed cost). The growth of the domestic layer industry within Tajikistan indicates that domestically produced eggs can compete with imported eggs once transport and handling costs are taken into account. There were no reports of eggs moving across borders without paying the required 18% VAT, which also assists with a level playing field.

Outlook

The market opportunity for both chicken meat and table eggs is significant. The market for chicken meat is almost 500% larger than it was in 1992. This is partly driven by the low cost of imported frozen chicken meat in comparison with domestically produced animal protein alternatives, such as beef. However, the chicken meat market will not be a near-term opportunity for anyone in the industry, large or small, without addressing the underlying feed challenge as discussed further in the following technology section.

In the table egg industry, despite substantial increases in domestic production, the domestic industry has continued to cede roughly 30% of market share to Iranian imports. Thus domestic producers have the strong opportunity to displace imported products if the costs of production can be decreased. Adoption of best practices for intensive poultry production represents an opportunity for households and individuals to enter the poultry sector to meet this market opportunity. By contrast, the backyard scavenger poultry flock is not a cost-effective or competitive production model to assist the household to meet the market demand as it presently exists; even household free-range eggs, which receive a price premium, represent a very minor part of a market largely made up of price-sensitive consumers prioritizing affordable animal protein.

IMPACT OF PROPOSED TECHNOLOGY

Tajik poultry operations are integrated intensive production systems with birds housed in a poultry shed. While there are some cage type layer operations, these smaller-scale operations operate on a deep liter bedding method, where the birds roam freely within the poultry house and nest in boxes located alongside the inside walls. For the most part it appears that the poultry sheds are either built to purpose remnants from the Soviet era or repurposed buildings originally built and used for some other

purpose. This includes many of the larger as well as smaller operations. Labor is required to prepare the feed (most producers blend their own rations), and to feed and water on a twice daily basis, as well as for layers, to gather, wash, and pack the eggs. Deep litter systems require more labor than cage systems but are better adapted to small-scale operations. Small-scale operations of 200-1,000 layers are easily managed by family labor as the labor requirement is not full-time.[119]

Layers arrive as day-old chicks (DOCs). The DOCs require brooding (i.e., care with extra heat for the first few weeks of life). They should be vaccinated early, particularly from Newcastle, as it is a particular risk in Tajikistan. There are three stages of growth; chicks, which require a higher protein feed for the first 6 weeks, pullet, growth stage which is a lower protein feed until they start laying, and finally layers, which requires approximately 18% protein feed.[120] The same hybrid layer poultry stocked by commercial layer operations of all sizes start laying at approximately 18-20 weeks of age. They are kept laying until 18 months of age. After 18 months of age, productivity starts to reduce and birds are often culled, with replacement layers assuming production. While productivity does go down, there is some flexibility offered with layers and operations may choose to produce through to the next molt[121] or utilize the flexibility and cull over a period of months, as the market will absorb.

Broiler production varies from layers in the infrastructure needed, the feed, the timeline, and the risks. DOCs are brooded the same way as the layer DOCs. Broilers are then put on a growing ration until slaughter. They are always kept in a deep litter, open shed system. They are kept until market weight. In some African countries they are slaughtered as early as 30 days, with the market preferring a slightly smaller bird. In Tajikistan, birds are typically slaughtered by 45 days. Birds must be fully harvested by 50 days at the very latest as any birds not harvested on time continue to consume feed without providing additional weight gain for market.

Lower-Cost Poultry Feed

Small-scale poultry technology includes the genetics (high quality, reliable breed day old chicks), affordable feed components and rations for the stages of growth and production, and proper animal management and health practices. In Tajikistan, day old chicks, vaccines, and other poultry inputs are largely available and affordable for a small-scale poultry operation. High quality DOCs are produced by one licensed poultry hatchery in the North and imported as well through licensed dealers based in Dushanbe (hybrid poultry genetics are managed by international license owners). There are also unlicensed DOC producers around Dushanbe that have the same genetics, though are subject to less oversight of their quality control. Animal health products are available from specialized importers serving the broader poultry industry located in Dushanbe and through veterinary retail outlets located in towns throughout the country (19 in Khatlon) and operated by the Veterinarian Association or privately.[122] Animal health management is critical to proper poultry business execution, but availability of the required products is not a constraint.

More than any other component of production costs, feed is the most significant barrier to competitive poultry production. Feed costs should be about 50% of the cost of egg production (though in certain markets the share is larger) and may be as high as 70-80% of the cost of finished chicken meat production. This differential reflects the lower protein content of layer feed (~15% protein for layers versus ~22% protein for broilers). By contrast, in Tajikistan feed costs amount to over 90% of the variable cost of commercial egg production and 98% of the variable cost of broiler production.[123] Solvent-processed low-fat soybean meal has become the industry standard globally for poultry feed. Other oilseed cakes such as cottonseed cake and sunflower cake can be fed, though must be controlled in overall quantities in the feed due to fiber content and some variable toxic components which can limit animal performance.[124]

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[119] European egg production has been increasingly shifting from cage egg systems to deep litter systems resulting in significant best practices and understanding of maximizing productivity and efficiency.

[120] There are three phases of layer production with slight differences in feed possible to maximize productivity. While there are research and best practices available for these three stages as well, it must be combined with actual tracking of chicken productivity and adapted based on management experience. It has been simplified for this activity.

[121] Molting is when the chickens lose their old feathers and grow new ones. They reduce significantly or stop laying eggs at this time while their energy is spent on feather growth.

[122] The number of animal health product retail outlets was provided by the National Association of Veterinarians, which receives financial and technical support from the FAO.

[123] For household backyard poultry operations, the cost of production is nearly zero - farmers simply allow the chickens to roam freely and scavenge for food within the household plot and rarely invest in vaccinations. While inexpensive, this lack of investment is reflected in the low levels of production and frequent disease-related death of the household chickens. The investment required to increase productivity within such an extensive system would not produce competitive products to respond to the major market opportunities.

[124] Specifically for cottonseed meal, the presence of gossypol and cyclopropenic acids inhibit poultry performance. Also there is significant variation in protein levels and fiber levels (high fiber inhibits digestibility in poultry) with cottonseed meal depending on the processing method and the cottonseed itself.

There is no current soybean production within Tajikistan, and farmers must instead rely on imports.[125] Large poultry farms are importing soybean meal directly themselves and blending in internal feed mills with imported vitamin pre-mixes and local corn and wheat bran. The smaller poultry operations are buying prepared compound feeds from the handful of feed businesses and large poultry farms as well as imported feed concentrates (soybean meal with vitamin and mineral pre-mix already combined) from specialized poultry input companies (who also sell animal health products and DOCs) to blend themselves with local corn. Some of the smaller companies will also include limited quantities of cottonseed cake and sunflower cake to reduce the overall cost of feed, though productivity often suffers. Argentinean soybean meal was quoted by one direct importer at 950 USD/MT (compare with Mozambique import parity for the same soybean meal at about 650-700 USD/MT.) But soybean meal was available for purchase in the market by larger poultry farms for 1,250 USD/MT.[126]

Technology Impact on Smallholder Income

Presently, small-scale layer operations have two main feed options: purchase prepared compound feed from a feed business or larger poultry operation, or purchase imported feed concentrates and blend themselves with locally procured corn. The comparative budget below presents the stark reality for those that are purchasing the fully prepared compound feed.

It is likely that the operations that are purchasing the already prepared compound feed are not keeping adequate records to fully appreciate the losses they are incurring. The layer farms that purchase the imported concentrate (still relatively expensive compared to global benchmarks) are able to dramatically improve their business by blending with locally procured corn themselves for the layer ration. As illustrated in the budget below, all else being equal, they net variable costs of over 8,000 TJS over the life of the operation.

TABLE 17: ILLUSTRATIVE BUDGET FOR SMALL LAYER OPERATION (200 LAYERS) OVER THE 18 MONTH PRODUCTIVE LIFE OF ONE CYCLE OF LAYERS

DESCRIPTION			BASE FEED RATION (USING COMPLETE FEEDS CURRENTLY AVAILABLE ON THE MARKET)		BASE FEED RATION (USING IMPORTED CONCENTRATE WITH LOCALLY PROCURED CORN – OWNER-BLENDED)		LOWER-COST SOY RATION (ASSUMING COMPETITIVELY GROWN LOCAL SOY BLENDED WITH LOCALLY PROCURED CORN)	
	Quantity	Unit	Price (TJS)	Total (TJS)	Price (TJS)	Total (TJS)	Price (TJS)	Total (TJS)
REVENUE								
Egg revenue				58,442		58,442		58,442
Culled layers	182	bird	10	1,820	10	1,820	10	1,820
Total revenue				**60,262**		**60,262**		**60,262**
EXPENSES								
DOC	200	bird	5	1,000	5	1,000	5	1,000
Vaccines	800	doses	1.2	960	1.2	960	1.2	960
Grower feed	3,275	kg	2.88	9,432	2.88	9,432	2.88	9,432
Layer feed	10,400	kg	7.2	74,880	3.9	40,560	2.1	21,840
Total variable costs				**86,272**		**51,952**		**33,232**
Net Income								
Margin over variable costs				**-26,010**		**8,310**		**27,030**

[125] There has been interest in soybean production and it is anticipated that some soy will be planted in 2014 to respond to the increasing investment in layer farms.

[126] Kazakhstan is has over 80,000 hectares of soybeans. The soybean price in 2011 was about 350 USD/MT which would equate to about 300 USD/MT soybean meal, if they utilize globally competitive crushing margins. This is noted here as a comparison (though they utilize all of their soybean meal domestically.) This value will be used as a proxy in the budget analysis for the potential competitiveness should Tajikistan fully develop a domestic soybean industry.

With excellent execution, this type of small-scale layer operation would be able to be successful. If a vibrant domestic industry soybean was developed and able to reduce the price of soybean meal to roughly the same price as nearby Kazakhstan (see footnote 124), then the profitability for layers dramatically improves to 27,000 TJS over the 18 months of the layer cycle, a more than 200% improvement.

This budget assumes 200 DOCs are purchased and the producer experiences a 9% mortality. These birds will receive each receive 4 vaccinations and consume a chick grower ration for approximately the first 6 months. The poultry will begin laying at approximately 5 months (18-20 weeks of age). They are fed both a ready to feed chick grower feed and a ready-to-feed, prepared compound layer feed. The layers have a productivity rate of 85% and lay 154.7 eggs per day, which are sold at a price of 0.69 TJS/egg. The layers are culled at 18 months and that revenue is added to the egg revenue to show an overall operational revenue for the 18 month cycle of 58,442 TJS.

By contrast, at current feed costs, broilers are unprofitable even when the small-scale producers blend the ration themselves using local corn. Poultry farms continue to attempt to enter broiler production, at times utilizing some cottonseed cake and sunflower meal, but productivity drops and results are similarly unprofitable. Utilizing the same hypothetical soybean price as the previous example, where the domestic soybean industry in Kazakhstan is used as proxy for the anticipated result of a vibrant soybean industry in Tajikistan, a broiler cycle improves in profitability by 300%. Broiler operations would anticipate investing in 7 or 8 cycles a year, for a total annual turnover of more than 50,000 TJS/year.

TABLE 18: ILLUSTRATIVE BUDGET FOR SMALL BROILER OPERATION (1,000 BROILERS)

DESCRIPTION			BASE FEED RATION (USING IMPORTED CONCENTRATE WITH LOCALLY PROCURED CORN – OWNER-BLENDED)		LOWER-COST SOY RATION (ASSUMING COMPETITIVELY GROWN LOCAL SOY BLENDED WITH LOCALLY PROCURED CORN)	
	Quantity	Unit	Price (TJS)	Total (TJS)	Price (TJS)	Total (TJS)
REVENUE						
Broilers	1616	kg dressed weight	15	24,239	15	24,239
Total revenue				**24,239**		**24,239**
EXPENSES						
DOC	1000	bird	4	4,000	4	4,000
Vaccines	2000	doses	1.2	2,400	1.2	2,400
Broiler feed	4848	kg	4.4	21,330	2.2	10,665
Total variable costs				**27,730**		**17,065**
Net Income						
Margin over variable costs				**-3,491**		**7,174**

The introduction of a domestic soybean industry has the potential to reduce feed costs thus increasing smallholder income from small-scale poultry production by 200% for layers and 300% for broilers. By contrast, under current feed costs, broiler operations are completely unviable today.

Technology Impact on Women

As in the case of cattle, women play a prominent role in managing backyard poultry farming. USAID estimates that roughly one third of all households in Khatlon province keep poultry and an estimated one-third of households headed by women also have poultry.[127] The scale of these household operations is small—often fewer than 20 birds and with few that are laying regularly. This backyard scavenger production system is largely irrelevant to the consideration of moving these households into small-scale poultry production. The development of a small-scale poultry sector would likely impact women's labor as the care of chickens increases and additional supporting activities evolve (e.g., training). However, the marginal increase in labor to expand household production from fewer than 20 birds to a small-scale commercial venture with 200 or more birds is not significant. It is likely that those families with small-scale poultry operations would abandon the backyard scavenger system around their household garden completely and benefit from direct access to the production of the small-scale operation.

At the moment, backyard egg production is largely used to satisfy household needs, although some may be traded or sold to neighbors or in local markets at about 1 TJS per egg. As in many countries, income from eggs and poultry meat operations at the household level is currently controlled by women.[128] Yet women's role could be jeopardized as the scale of operations increases and formalizes.[129] Care should be taken to ensure that women's participation can evolve with the sector, either as the operators of small-scale poultry production operations or as community animal health workers to deliver animal health products and other supplies.[130]

CONSTRAINTS TO TECHNOLOGY COMMERCIALIZATION AND ADOPTION

Incentives and Constraints to Smallholder Adoption

The main barrier to adoption will be developing a domestic soybean industry to improve the economics of all poultry production, including small scale poultry operations. This is addressed in more depth in the subsequent section. But experience elsewhere has proven that small scale poultry production can successfully compete with larger scale operations. While poultry production is technical, it is not difficult.[131]

Poultry production takes relatively small areas, and houses for a few hundred layers could easily fit alongside or in the back of household gardens. The challenge is that some of that land has already been planted in fruit trees. Other than feed, the critical inputs are available within the market. As noted, high quality day old chicks are imported by authorized dealers of specialized hybrid layer breeds from Russia and elsewhere in Europe, in addition to a few hatcheries in Sughd and near Dushanbe hatching DOCs from imported fertilized eggs and locally managed parent stock. Animal health products are available and the FAO supported Association of Veterinarians operates animal health product retail outlets in addition to the private outlets in the main urban centers of the regions.

As indicated in the budget analysis, currently small scale layer operations can be successful by purchasing the available imported feed concentrates and blending with locally procured corn themselves. Some small producers have purchased small Chinese-made extruder equipment to process their feed themselves. There is a risk though that some of these smaller producers are not as experienced in feed ration development and blending and may suffer some productivity by pursuing this cost savings.

Technical expertise within the country is very limited. Because proper implementation is so important, additional technical support will be needed to develop production models and mentor new small-scale producers over the first few cycles of production. Also, biosecurity is very important in poultry production, but in deep litter systems there is more frequent physical contact between people and the bird living environment (through shoes and clothing). Biosecurity is extremely uneven in practice within the domestic industry. Adequate technical expertise will provide advice on all aspects of poultry management and operation execution, which would include the basic biosecurity protocols easily established at even the smallest of intensive poultry operations.

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[127] Shariari et al. 2009.

[128] Kristjanson et al. 2010; Doss, C., *The role of women in agriculture* (ESA Working Paper No. 11-02, 2011).

[129] Kristjanson et al. 2010.

[130] In South Asia, women, some with limited literacy, have been successfully trained as animal health service providers. Kristjanson et al. 2010; South Asia Pro-Poor Livestock Policy Programme, *Small Scale Poultry Farming and Poverty Reduction in South Asia: From Good Practices to Good Policies in Bangladesh, Bhutan, and India* (2010), available at: http://sapplpp.org/lessonslearnt/small-holder-poultry/smallscale-poultry-farming-and-poverty-reduction-in-south-asia#.UwjWlf4o7IU. It is unknown how many of the small number of existing Tajik small-scale commercial poultry operations are currently headed by women.

[131] Brazilian experience has proven that while grain production (fundamental foundation for livestock feed) benefits from large economies of scale, livestock production can occur with small scale outgrower models very competitively. Mozambique has launched a domestic poultry industry based on both large scale and integrated large scale with smallholder outgrowers (underpinned by domestic soybean production and processing).

Capital represents the largest constraint for households entering poultry for the first time. For layers the payback comes after a period of initial poultry growth, prior to the onset of lay, and then comes consistently, but slowly, over the subsequent 52 weeks. The financing of the upfront variable cost prior to the beginning of cash flow represents a hurdle for the average household. The DOCs, animal health products, and grower feed, equaling 11,400 TJS (about USD 2,400) must be paid for prior to any cash flow. Once the birds begin to lay, 155 eggs may be expected each day, for 107 TJS revenue per day.[132] On top of this, equipment costs would be approximately 500 TJS to include waterers, feeders, nest boxes, and such. Buildings are thus far largely being repurposed, but new construction would represent a significant upfront expense though it would be depreciated over a very long time horizon.[133]

For broilers, the turnover of financing is a shorter time horizon, with upfront capital investment completely cycled every 45-50 days. Financial institutions would find the broiler time horizon more attractive in a market where feed costs did not prohibit profitability. However, egg production provides a regular income stream over a longer period of time once the birds come into production. A significant risk with broiler production is market linkage. There is currently no domestic slaughtering or distribution developed to absorb a significant increase in domestic production. Broilers must be harvested by 45 days and no later than 50 days because return of weight gain to feed reduces dramatically after that point (additional feed is consumed, but with no additional value added). Market linkages would need to be secure and predictable. Other economies have linked small scale broiler producers to larger integrated broiler slaughter and marketing operations as outgrowers to minimize this investment risk. This also facilitates confidence for potential financiers.

The operating capital considerations and commitment to mastering poultry production will limit the numbers of households who enter poultry production. The full potential is possibly in the low hundreds of households and unlikely to reach thousands. Initial start-up capital will be a barrier for women especially. The constraint is not insurmountable but would need some consideration. Some banks accept alternatives to land for collateral, such as jewelry and gold, which are assets to which women have access. Self-help or savings groups are also increasingly being used to organize women and improve access to larger sums of money. Additionally local government funds are available to support women entrepreneurs and self-help groups with no-interest loans.

Pathways to Technology Commercialization

With poultry production, feed ration formulation and proper blending to create a consistent feed product are critical. The development of feed specific companies is still emerging. Currently there are a handful of companies which specialize in the import of a range of poultry related inputs including feed concentrates (soybean meal with vitamin and mineral pre-mix.) One new feed company, Nutristar, will begin operations in 2014 with substantial investment from its parent company in France. Although the company would like to target the small-scale poultry operation market, it expects to rely on one large poultry company for 85 percent of its feed sales for at least the first year. A Kazakh feed company reportedly had also explored the poultry feed market a year previous. These companies are serving the layer industry due to the reliance on imported soybean meal concentrates and the underlying economics, as laid out in the technology analysis section above. New investment and growth will likely come from these companies. One of the input importers is raising capital now to build a slaughter offal processing factory to produce animal protein meal as a domestic alternative to soybean meal.[134]

These specialized poultry industry product and service providers work with both the larger producers and the smaller producers. Building from these linkages within the industry, a nascent National Poultry Industry Association was launched and has been operating for a year. The association has prioritized an advocacy platform to assist in reducing the import tax burden on critical inputs into the industry, such as feed concentrates. The physical equipment is already subject to the import tax exemption on agricultural equipment, but this represents a very small part of the overall production cost.

[132] See illustrative layer budgets from the previous section; based on a 200 layer small operation.

[133] African experiences with smaller scale layer and broiler operations have little to no building costs utilizing basic local pole construction and limited chicken wire. The winter climate in Tajikistan is such that a more substantial building (though recognizing the need for good ventilation) is necessary. Kyrgyzstan has experienced some smaller scale poultry operations starting within extra rooms in personal residences until enough cycles are completed to gain financing for purpose built construction.

[134] Feed animal based protein meal produced from ruminants should not pose specific health concerns if fed to poultry, but oversight and regulation should monitor to ensure this is not fed back to ruminants; one source of BSE problems (a.k.a., "mad cow" disease) in the United Kingdom and other markets.

Feed blending is often integrated into larger poultry farms. This is the case with the largest poultry farms in Tajikistan. Those poultry farms are importing the soybean meal directly themselves and blending their own feed. In many places the larger farms will sell a compound, complete feed to the smaller size poultry operations along with other necessary inputs including day old chicks, animal health products such as vaccines, and often also offer technical advice. However, the economics of this are not favorable; as analyzed in the previous section.

With the high prices of imported soy products, domestic soy production should be an attractive proposition for Tajik farmers, even if production challenges discussed elsewhere in this report (relating to access to improved inputs, water, etc.) would limit farmers' ability to achieve globally competitive yields. Currently soybean meal is being imported for 925 USD/MT (over 1000 USD/MT soybean equivalent). Compare this with nearby Kazakh prices of 346 USD/MT, where approximately 80,000 hectares are under soybean production.[135] The 24,000MTs of chicken meat imported is equivalent to about 23,000MTs of soybeans and 44,000MTs of corn needed for feed. Tajikistan already produces about 150,000MTs of corn. Soybeans would be a natural rotation with corn or complement cotton in rotation. Maize prices were 208 USD/MT at harvest in 2013 (375 USD/MT at the time of the assessment).[136]

Soybeans must be processed prior to being utilized as feed. Processing capacity for soybeans does exist, both in solvent facilities (Sughd and Yovon) as well as the previously mentioned small capacity extruders.[137] The processors would produce soybean meal for the poultry industry as well as refined soybean vegetable oil for the local vegetable oil market. From the 23,000MTs of soybeans needed to allow domestic broiler operations to completely replace the imported broilers, just over 4,000MTs of vegetable oil would be produced, which would go towards replacing the nearly 6,000MTs of imported soybean oil.

Soybean production requires high quality adapted seed. All soybean seed is open pollinated and can be kept and replanted by producers for about 3 years before needing to be genetically refreshed. Soybean seed does need to be produced on an annual basis (unlike corn seed which can be produced and carried over from one season to the next) and has some sensitivity to temperature and storage conditions on seed viability. Soybeans are most often grown as a rainfed crop, though would most likely require some irrigation in Khatlon's dry summer. As a legume, it should have an adapted inoculant for maximum yield and nitrogen fixation (which will also benefit the rotational crop). A specific fertilization program would be required as it will not need nitrogen but may benefit from specific additions of phosphate or potassium.

There has been recent discussions by investors with vegetable oil processing facility to plant some soy and some production is expected in 2014. Anecdotally, it was noted that some of the specialized feed concentrate importers may be politically positioned and resistant to a soybean production promotion program. It is more likely though that the nascent Poultry Association would support soybean production promotion and that they would be a strong ally to initiating production. Unlike Africa, where soybean production is expanding to support growing domestic vegetable oil and chicken meat consumption and requires building processing facilities from scratch; any soybean production in Tajikistan could be processed by existing plants, with processing expansion and updating occurring once production volumes grow. Soybean production will not be directly linked to the poultry operations and producers. It represents an attractive rotational crop for other row crop producers, such as corn or cotton producers.

[135] FAOStat data for 2011, the most recent prices and production available.

[136] It should be noted that there have been numerous failed soybean initiatives over the years globally. However, since 2008, vegetable oil and oilseed prices are at all-time highs, and animal protein demand continues to rise. Failed soybean initiatives have largely focused on production of soybean protein for direct human consumption. Recent successes in building soybean industries have specifically focused on vegetable oil import substitution and underpinning growing domestic and regional poultry industries.

[137] For broilers, solvent extraction of soybean oil produces the highest quality protein meal, where the extruder produces a full-fat/low protein meal which needs to be subsequently pressed for a medium protein/medium fat product. Extruder produced soybeans can be used in layer feeds, where protein requirements are lower.

CONCLUSION AND RECOMMENDATIONS

Feed is the pivotal constraint to poultry industry development. Fundamentally, soy production investment will be needed for long term growth and competitiveness of the sector (layers as well as broilers). While the broiler market offers the largest import substitution opportunity, the broiler industry is unprofitable without lower cost soy, and the layer industry will remain on the edge, depending only on excellent production execution for its thin margins.

Develop a domestic soybean industry including local production and processing. There are at least two varieties of soybean seeds available in limited quantities form the National Farming Institute. The development of a local soybean industry will require support for the production and availability of high quality soybean seed, the development and dissemination of production protocols, and linkages with soybean processors. As a legume, soybeans are an attractive rotational crop for cotton and irrigated grains such as wheat and corn. In Africa cotton companies have become strategic partners in the promotion of soybean production given the attractive return for the producers and the complementary soil benefits from rotation with cotton. Soy will most likely reduce overall cotton acres, but could facilitate higher cotton margins by reducing overall nitrogen fertilizer requirements. While soybeans do not have high fertilizer requirements themselves, the development of an inoculant supply chain for use in soybean planting should be pursued from the beginning to ensure productivity and yield (and nitrogen fixation for subsequent rotational crop). Cottonseed oil processors and vegetable oil processors may need some additional investment to add soybean processing capacity, but the addition of soybeans to the industry will assist them to better utilize their installed capacity given overall declining trend of cotton production.[138]

Encourage small-scale poultry operations to improve household livelihoods. It is important to note that smallholders can be as competitive as larger producers in meeting the market opportunity. The Tajik poultry industry could develop with only large scale poultry producers and a handful of small entrepreneurial small scale operations. The alternative is a specific effort to support the entry of and participation by a larger number of small scale poultry operations to thrive and benefit. In Brazil and in the US, while grain production is exclusively large-scale production, livestock is often a combination of integrated operations along with outgrowers. Brazil has many smaller scale outgrowers in their poultry industry, leveraging the economies of scale of feed production, meat processing (production aggregation), and market linkages. As the underlying cost of production issue is addressed for the industry through the development of a domestic soy industry, small-scale production can be developed to serve the market alongside larger scale investment. Small-scale poultry operations will need assistance accessing initial capital due to high establishment and operating costs as well as technical assistance for the first few production cycles while they learn to execute the business successfully.

Target women and women's groups for small-scale egg operations. Women's involvement in small-scale poultry has been successful in part of South Asia. One of the more successful models, from BRAC (the Bangladesh Rural Advancement Committee) in Bangladesh, has successfully reached resource poor women in small-scale poultry businesses.[139] The BRAC relies on ensuring that some of the key pieces, described throughout this section are in place: affordable feed and vaccinations, as well as credit and extension. The model uses women's groups to support credit and savings and organize women to provide different services (breeders, chicken rearers, animal health workers). It also brings men into the chain to support feed distribution, marketing, and egg collection. It should be noted that this model has not been successfully translated in the African context, where population and market density are similar to the conditions in Tajikistan. Similar attempts to promote small-scale poultry operations by women in Tajikistan have to date been unsuccessful.[140] Greater research would be necessary to understand how this model could be replicated in Khatlon.

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[138] For reference, a Southern Africa Soybean Industry Roadmap outlined status of development across 7 countries along with specific industry determined activities and investments for industry development. http://www.technoserve.org/files/downloads/technoserve-bmgf-regional-presentation.pdf.

[139] For details, see http://www.lrrd.org/lrrd13/5/dolb135.htm.

[140] The *Groupe Energies Renouvelables, Environnement et Solidarités* (GERES), a French NGO specializing in the introduction of environmental and energy conscious methods of development, has had very limited success in the promotion of solar poultry farms in Sughd due to the high investment cost, geographic isolation, and lack of business skills of the target clients. More information can be found at http://www.geres.eu/en/our-actions/location/local-offices/geres-tajikistan.

SUMMARY OF RECOMMENDATIONS

The USAID Mission in Tajikistan (USAID/Tajikistan) seeks to invest in scaling strategies that have the maximum potential for broad-based impact within the next two years. To achieve this goal, the AgTCA team evaluated three aspects of each proposed technology: (1) the output market potential for the affected commodity (including the existence of established marketing channels), (2) the potential impact of the technology on smallholder income and women, and (3) the potential of scaling the technology within two years, based on the potential number of target farmers impacted and the enabling environment for commercialization and adoption of the technology. The results of the assessment are summarized in the table below.

TABLE 19: AgTCA TEAM ASSESSMENT SUMMARY

VALUE CHAIN	TECHNOLOGY	MARKET OPPORTUNITY	TECHNOLOGY IMPACT		POTENTIAL FOR SCALE IN TWO YEARS		
			Smallholder income	*Women*	*Potential # of farmers impacted*	*Adoption potential*	*Commercial potential*
Early Onion	Improved inputs	High	High	Low	High	Medium	Medium
Early Onion	Transplanting seedlings	High	High	Medium	High	High	Low
Orchards	Improved pruning techniques	Low	High	Low	High	Low	Low
Beef	Improved feed rations with alfalfa and mineral supplements	Medium	Medium	Low	Medium	High	Low
Milk	Improved feed rations with fodder beets	Low	Medium	High	High	Low	Low
Poultry	Lower-cost poultry feed	High	High	Medium	Low	Low	Medium

Balancing the investment criteria and the scaling potential delineated in the chart above, the team recommends that scaling strategies focus on support for the technologies that can have the greatest impact within two years as well as on laying the groundwork for longer-term scaling of technologies through developing market linkages and pressing for needed reforms within the agribusiness enabling environment.

Near-Term Impact (Two Years)

Two years is a very ambitious timeframe for technology distribution and will require focusing on commodities with strong market potential for which the enabling environment constraints to adoption and commercialization are low. Within the two-year timeframe targeted by USAID/Tajikistan, the strongest potential for broad-based scaling of new agricultural technologies rests in early onions. Early onions are widely cultivated by USAID's target group of farmers (i.e., *dekhan* farms of five hectares or less and household gardens). Through the adoption of USAID's proposed technologies, farmers will be able to harvest their onions during the peak market window in April. Moreover, growing onion seedlings in a small area under low tunnels and transplanting them in open field much later in the season allows farmers to use the open field for a second crop during the same season—generating a substantial boost to farmer income.

As can be seen from the table above, commercial pathways for technology distribution are almost universally lacking in Tajikistan. This reflects the strong knowledge transfer component inherent in most, if not all, of the proposed technologies. Although the domestic extension system is still nascent in Tajikistan, the team encountered highly entrepreneurial, commercially focused consultancy services that could be strengthened in the next two years. Strengthening market linkages between farmers, input suppliers, and commodity buyers could also open commercial pathways for knowledge transfer. USAID/Tajikistan is well-poised to harness this potential through the existing USAID Farmer Advisory Services Tajikistan (FAST) project and its follow-on project that is expected to commence next year. With improved access to qualified advisory services, many of the "low" classifications for Commercial Potential in the table above could be shifted to medium or even high.

The dissemination of feed rationing information to farmers engaged in beef fattening could also generate results within the two-year timeframe. The technology uses feed components that are readily available in the current market; only it ensures the farmer can make the most cost-effective decisions to achieve a finished animal in a much shorter time period. However, from a scale perspective, this technology is less interesting—it impacts fewer farmers than onion and has only a moderate impact on income.[141] Beef also continues to face strong competition from other types of meat in the domestic market (e.g., mutton, goat, and chicken).

Medium-Term Opportunities

The opportunity for import substitution in the poultry industry through the introduction of a domestically produced soy-based poultry feed industry is incredibly strong. Imported chicken meat and eggs are considered by many consumers to be lower quality than that produced domestically. Yet Tajik producers simply cannot compete on price until a lower-cost domestically produced feed source becomes available. The high cost of imported soy makes it an attractive investment for Tajik farmers. In addition, existing cotton seed oil processing facilities have the requisite technology to process soy into poultry feed. With some support for the development of marketing channels, the domestic soy industry could develop rapidly. However, this is at best a medium-term investment. Early soy production would go to supply existing industry; small-scale expansion would follow in later years.

Long-Term Investments

Although market opportunity is strong for stone fruit, the lack of established marketing channels will limit the commercialization and adoption potential of any new technologies. Pruning and integrated pest management practices require an upfront labor and materials cost that farmers may be reluctant to spend without a guaranteed market for the product. In addition, farmers in many parts of Khatlon province face the added risk of losing their trees due to salinization of the soil and a rising water table. Accordingly, a commercial pathway for technology dissemination is unlikely to develop until the more immediate concerns regarding irrigation, cold storage, and processing infrastructure have been addressed. An argument could be made for immediate donor investment in this technology in light of the importance of early pruning for long-term orchard development. If pursued, the investment strategy should incorporate potential long-term commercial relationships as the vehicle for technology dissemination (i.e., through training pruners). This technology also has the potential to generate income for thousands of women if training activities can successfully overcome cultural barriers to women's employment as pruners.

The milk market is highly decentralized. The rural population consumes more milk than the urban population, but demand is largely met through domestic production or bartering with neighbors. Supplying the urban market with milk sourced from Khatlon province requires aggregation, electricity, processing, and transportation resources that add up to a high cost of production. However, if the market was stronger, milk presents one of the strongest commercial pathways for technology distribution as there is daily interaction between the milk processors and the small-scale milk producers. Milk collection centers in Africa have proven to be dynamic sources for knowledge transfer, microfinance, and other services for the rural poor, particularly women. Until market potential improves, there is little incentive for farmers to expend the time and land resources needed to regularly incorporate fodder beets into the household dairy cow's diet.

[141] As discussed in the Beef chapter, the exact number of households engaged in beef fattening is unknown but is estimated to be in the thousands, not the tens of thousands as for early onions.

Areas for Further Research

While it was outside of the scope of the assessment, the team met with a number of individuals and organizations, including the NGO Nuri Khatlon, that have had success with greenhouse production of high-value horticultural crops such as tomatoes. The technology, which consists of a much larger greenhouse structure than the low tunnel row covers proposed for early onions, can reportedly be constructed for an average price of USD 700. In some cases, a collection of greenhouses is owned and operated by a group of families who purchase inputs, pay taxes, and provide labor collectively. A portion of the greenhouse space is heated and used to grow tomato seedlings as early as January, which are either sold or transplanted to other greenhouses later in the season.

Several producers who had received assistance in constructing one greenhouse through Nuri Khatlon (with funding from FIDA and the USAID ProApt project) stated that they had invested in an additional one to three greenhouses with their own money, suggesting ample unmet market demand and the potential for widespread farmer adoption. Furthermore, the higher return on investment for these crops has encouraged at least one bank to provide loans to producers to finance the construction of these greenhouses. High-value horticultural crops have strong potential as a revenue generator and as a source of nutrition for Khatlon farmers and their families. Additional research should be conducted to determine the level of market demand and the strength of the marketing channels for these crops, as well as any obstacles within the enabling environment for the commercialization of greenhouse technology that might limit the scalability of this technology in the next two years.

In addition, the team recommended additional research be conducted into the potential for development of the fruit drying industry in Khatlon province. As noted throughout the report, the increase in orchard production anticipated in the next few years lack sufficient market outlets for the fresh fruit and very little technology currently exists in Khatlon for storage and/or processing of this fruit. The fruit drying industry is very well established in the North, and firms in the North may have an interest in investing in the South. More research is needed to understand the enabling environment constraints that have inhibited this investment to date.

The following sections compile recommendations found throughout the report. Please refer to individual chapters for more information and context for the recommendations given.

ENABLING ENVIRONMENT REFORMS

- **Facilitate the development of stronger market linkages within the value chain.** The lack of a relationship between farmers and traders in Tajikistan has negative implications for the distribution of advisory services, finance, and agricultural inputs. Input suppliers and commodity buyers can and should be key sources of technology transfer to farmers. Facilitating these established, long-term relationships between buyer and seller is essential to strengthening farmer access to output markets and encouraging investments in technology.
- **Support the development of commercial pathways for agricultural advisory services.** To become financially sustainable, independent for-profit advisory services must build up a client base, name recognition, and earn the respect of farmers. Donors should ensure that extension activities support these service providers by investing through these services to encourage long-term continuity of service to clients.
- **Work with other donors and the GoTJ to upgrade production and marketing infrastructure.** The potential for scaling technologies depends not only on the benefits of the technology itself but on whether those benefits can be translated into concrete returns for farmers. Decaying irrigation infrastructure, low electricity resources, poor roads, and limited rail service limit production potential, hinder access to markets, and inhibit private sector incentives to invest in new technologies. These infrastructure investments are necessarily long-term in nature, but can build the conditions in which technology commercialization can thrive organically.
- **Promote dialogue between the GoTJ and the Government of Uzbekistan.** Trade barriers between Tajikistan and Uzbekistan due to the dispute over the Rogun Dam threaten market access and product quality for all Tajik agricultural exports. The instability of trade policy and unpredictability of treatment by border officials contribute to the short-term spot sale agreements that characterize the onion and stone fruit export markets in Tajikistan. The donor community should promote dialogue to broker a long-term solution and normalize trade relations.

GENDER

- **Explore the use of audio and visual methods for delivering extension and advisory services.** Digital Green in India has been successful with engaging women farmers as actors and producers in short, locally produced, extension videos that are also targeted to women's self-help groups.[142] These would be useful not only for women, but for men as well to increase overall access to knowledge and information.
- **Explore the use of mobile phones for connecting men and women to agricultural information.** Because of the high rate of migration, many women have phones that are used to contact husbands and relatives. Mobile phone access creates an opportunity for delivering agricultural information to women, for example on how to improve production in their household plots. Mobile phones can be used either to connect directly with an agricultural specialist or to receive text messages (SMS).
- **Identify different messages and pathways for different members of the household.** The complex composition of Tajik households which include multiple families, generations, and migrants, will require a multi-pronged approach to delivering extension and advisory services. Efforts might consider targeting mothers-in-law separately or jointly with daughters-in-law, as well as men separately or jointly with women in the same household. See additional recommendations that follow.
- **Focus on existing pathways that have had success in other sectors.** Adapt successful practices from health efforts working with mothers-in-law and community action groups to agricultural extension systems. Several NGOs[143] are delivering healthcare advice to young mothers by engaging other individuals who influence women's lives.
- **Identify and work with influential leaders in villages and households to support expansion of women's roles in agriculture.** Village leaders, mother-in-laws, and husbands have varying degrees of influence over women's lives. Efforts to increase women's agricultural knowledge and capacity need to engage these individuals as supportive partners.

EARLY ONION

- **Work with the GoTJ and private sector to reduce the illegal import of agricultural inputs.** In the long term, improved market regulation and a decrease in the cost of importing high quality inputs will be required to establish profitable marketing channels for input dealers in Khatlon province. This will require strengthening the capacity of the GoTJ to crack down on the import and sale of illegal or low-quality inputs through streamlining customs and market inspection procedures and reducing the discretion of individual agents. In addition, support should be provided to facilitate discussions between the Consultative Council on Improvement of Investment Climate, the Tax Committee, and broader private sector stakeholders to reduce the high rate of tax (both VAT and import duties) on legally imported inputs.
- **Leverage horizontal and vertical linkages in the value chain to facilitate farmer adoption.** Short-term increases in farmer adoption of these technologies will depend on farmer willingness to invest in more expensive production methods. An assessment should be conducted to determine and address the chief obstacles to the provision of inputs, finance, and advisory services by onion buyers. These vertical linkages within the value chain will be an important resource to facilitate long-term adoption of these and other agricultural technologies. The AgTCA team found no initial evidence that this pathway exists, but this possibility should be further examined through facilitated discussions between farmers and onion buyers. Strong existing market dynamics, such as trusted relationships among farmers or between farmers and local input dealers, should also be leveraged to increase the impact of outreach activities.
- **Invest in training initiatives that target women.** Although men largely control decisions over agricultural inputs and production methods, women supply the labor—including sowing seed, applying fertilizer, and weeding. Improving women's comprehension of the role and use of improved inputs and production methods should significantly increase short-term success rates and long-term adoption. It is also an opportunity to create better employment opportunities for women. To offset the potentially negative impact of the technology on women who work as day laborers weeding, training efforts should build the capacity of these women to grow and market onion seedlings from their household plots.

[142] See http://www.digitalgreen.org/.

[143] See, for example, the work of Save the Children and Mercy Corps in Tajikistan.

» **Investigate supplemental technologies to augment the impact of the proposed technologies.** Additional technologies have been shown to increase the effectiveness of onion production systems in similar settings. For example, the use of drip irrigation in low tunnels could significantly decrease the expenses for water, fertilizer, and pesticides by decreasing the amount of each required for production.[144] Onion seeders and planters would also decrease the required labor time and cost for sowing onion seed and transplanting seedlings.[145]

ORCHARDS

» **Facilitate better integrated marketing channels to increase access to agricultural inputs and advisory services.** There is currently very little organized aggregation of stone fruit supply in Khatlon. Encouraging stronger market linkages through farmers' associations and value chain partners would increase access to finance, inputs, and advisory services.

» **Focus on the direct training of pruners to improve the long-term transfer of knowledge**. It is important to improve farmer awareness of the differences between traditional and improved pruning methods, yet scaling strategies should target the direct training of pruners, so that the knowledge transfers from farm to farm through hired labor rather than being dependent on second-hand training from the farmer. Special efforts should be made to train women, who are currently employed on orchards for other tasks, perhaps through the creation of specialized all-women pruning brigades similar to those that current exist to provide weeding services.[146] In addition to providing an additional source of income for women, this approach would ensure the long-term impact of the training, as the teenage boys currently hired for pruning are likely to migrate to Russia within a few years.

» **Involve key public and private stakeholders in outreach activities.** To maximize impact, strategies must involve the buy-in of the local government extension advisors. These agents are heavily involved in orchard promotion and currently provide pruning advice—advocating for different practices would only serve to confuse farmers and reduce the impact of the new trainings. Strategies must also take into account the incentives of male household members, who currently have primary responsibility for decisions regarding production and marketing in relation to orchards.

» **Investigate additional technologies to maximize the benefits from the proposed technology.** Further research should also be conducted into options for the introduction and scaling of drip irrigation for orchards. Farmers currently use flow irrigation for fruit orchards in Tajikistan. This trench-based saturation of the soil is inefficient and risks damage to the roots of the tree. By contrast, drip irrigation could significantly decrease the expenses for water, fertilizer, and pesticides by decreasing the amount of each required for production.[147] Additional research is need to determine evaluate access to drip irrigation technology and the potential to bring this technology to scale.

BEEF

» **Develop a technology-based feed ration calculation tool for use through smart phones.** Improving fattening margins will likely come by developing technology-based feed ration development tools for use through smartphones. These would need to be specifically developed for the local context (frame size, weight gain potential, available feed components). A strategic cell phone partner may have a commercial interest, the expertise largely exists within the country, though experience in smallholder-focused technology-linked knowledge-based innovations would need to be brought in. Complimentary feed component production (such as alfalfa) and sourcing information could be provided alongside. Tracking individual animal performance using such technology could assist the producer in analyzing return on investment by animal as well. This type of analysis assists in matching animal selection with feeding regimes for maximizing returns.

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[144] See, for example, studies from India and the US, available at http://ageconsearch.umn.edu/bitstream/97154/2/7-D-Suresh.pdf, http://agsyst.wsu.edu/IrrigationSystems.html, and http://www.ksre.ksu.edu/irrigate/OOW/P97/OBrienetal_IrrigSysEconFieldSize.pdf.

[145] Some efforts have been made by the USAID ProApt project to import and distribute pneumatic planters to farmers. However, the planter chosen for the initial pilot for this technology turned out to be inappropriate for onion seeds. With a different product, this technology could be very effective as a time and labor saving device, particularly for women.

[146] Women's weeding brigades are currently informally organized. Further research would be required to determine whether these groups could be formalized into agricultural business development enterprises. Elsewhere (e.g., Kenya) there has been some success in organizing agricultural business development services in this way.

[147] See recommendations in the Early Onion chapter for additional information.

MILK

- **Develop capacity of local processors to absorb a greater percentage of household milk production.** Improved feeding for dairy production will need to be combined with improved market linkages and support for dairy processors. Particular attention will be needed to facilitate women's ability to sell their excess milk on a daily basis. It is unlikely that the market could absorb a doubling of household milk production, so the potential scale is not as significant as it may appear. Also market linkages could prioritize village centers within which a significant quantity could be consistently bulked to ship to successful milk processors. The milk processors do not today have the management capacity or efficiency to absorb more milk without additional assistance, but some do appear to be interested in exploring household milk production as a reliable source of high quality milk for their businesses.
- **Introduce an ICT-based feed ration development tool.** The use of an ICT platform for feed ration development could be linked with dairy cow management in general, allowing the tracking individual cow performance and management over a productive lifetime. These types of information platforms are in early stage market penetration and rollout among small-scale dairy farmers in East Africa. iCow is one private company providing an ICT platform which tracks the performance and management for each dairy animal, including tracking estrus cycles, calving, and milk production and sending prompts and information updates tailored to the dairy cow's cycle. While the information will be very familiar to cattle producers, use of the information in this medium would require training and familiarization. This would be most relevant to the women who interact with the family cow(s) on a daily basis, yet men and women reported that men are largely responsible for feed decisions. Thus an approach that incorporates men and women would be important for the success of any scaling strategy.
- **Promote the pooling of land and labor for the production of fodder beets for the community.** Work with village leaders to identify land on which groups of women could grow fodder beets together and distribute (or sell) among households. This approach would pool the land and labor requirements of the individuals with the greatest incentives (i.e., women) to adopt fodder beets for dairy cow feed. By designating specific land for women to use, it would not require competition for land on family farms.
- **Support GoTJ and other donors in investments to improve electricity infrastructure.** Long-term increases in commercial milk production will require investment in more reliable electricity infrastructure throughout Khatlon. Milk processing requires continuous cold facilities, which are impossible under the current restrictions on commercial businesses to only 8 hours of electricity per day. Those who do operate in Khatlon must pay to access the "red line" for 24-hour access, a significant expense. Upgrading this infrastructure is long-term endeavor for which the GoTJ is currently receiving support from the ADB and EBRD. USAID should work with these and other donors to support these reforms.

POULTRY

- **Develop a domestic soybean industry including local production and processing.** There are at least two varieties of soybean seeds available in limited quantities form the National Farming Institute. The development of a local soybean industry will require support for the production and availability of high quality soybean seed, the development and dissemination of production protocols, and linkages with soybean processors. As a legume, soybeans are an attractive rotational crop for cotton and irrigated grains such as wheat and corn. In Africa cotton companies have become strategic partners in the promotion of soybean production given the attractive return for the producers and the complementary soil benefits from rotation with cotton. Soy will most likely reduce overall cotton acres, but could facilitate higher cotton margins by reducing overall nitrogen fertilizer requirements. While soybeans do not have high fertilizer requirements themselves, the development of an inoculant supply chain for use in soybean planting should be pursued from the beginning to ensure productivity and yield (and nitrogen fixation for subsequent rotational crop). Cottonseed oil processors and vegetable oil processors may need some additional investment to add soybean processing capacity, but the addition of soybeans to the industry will assist them to better utilize their installed capacity given overall declining trend of cotton production.[148]

[148] For reference, a Southern Africa Soybean Industry Roadmap outlined status of development across 7 countries along with specific industry determined activities and investments for industry development. http://www.technoserve.org/files/downloads/technoserve-bmgf-regional-presentation.pdf.

» **Encourage small-scale poultry operations to improve household livelihoods.** It is important to note that smallholders can be as competitive as larger producers in meeting the market opportunity. The Tajik poultry industry could develop with only large scale poultry producers and a handful of small entrepreneurial small scale operations. The alternative is a specific effort to support the entry of and participation by a larger number of small scale poultry operations to thrive and benefit. In Brazil and in the US, while grain production is exclusively large-scale production, livestock is often a combination of integrated operations along with outgrowers. Brazil has many smaller scale outgrowers in their poultry industry, leveraging the economies of scale of feed production, meat processing (production aggregation), and market linkages. As the underlying cost of production issue is addressed for the industry through the development of a domestic soy industry, small-scale production can be developed to serve the market alongside larger scale investment. Small-scale poultry operations will need assistance accessing initial capital due to high establishment and operating costs as well as technical assistance for the first few production cycles while they learn to execute the business successfully.

» **Target women and women's groups for small-scale egg operations.** Women's involvement in small-scale poultry has been successful in part of South Asia. One of the more successful models, from BRAC (the Bangladesh Rural Advancement Committee) in Bangladesh, has successfully reached resource poor women in small-scale poultry businesses.[149] The BRAC relies on ensuring that some of the key pieces, described throughout this section are in place: affordable feed and vaccinations, as well as credit and extension. The model uses women's groups to support credit and savings and organize women to provide different services (breeders, chicken rearers, animal health workers). It also brings men into the chain to support feed distribution, marketing, and egg collection. It should be noted that this model has not been successfully translated in the African context, where population and market density are similar to the conditions in Tajikistan. Similar attempts to promote small-scale poultry operations by women in Tajikistan have to date been unsuccessful.[150] Greater research would be necessary to understand how this model could be replicated in Khatlon.

[149] For details, see http://www.lrrd.org/lrrd13/5/dolb135.htm.

[150] The *Groupe Energies Renouvelables, Environnement et Solidarités* (GERES), a French NGO specializing in the introduction of environmental and energy conscious methods of development, has had very limited success in the promotion of solar poultry farms in Sughd due to the high investment cost, geographic isolation, and lack of business skills of the target clients. More information can be found at http://www.geres.eu/en/our-actions/location/local-offices/geres-tajikistan.

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