ZEF Bonn
Zentrum für Entwicklungsforschung
Center for Development Research
Universität Bonn

The Role of Knowledge in Developing a Local Agricultural Value Chain: The Story of "White Gold" from Uzbekistan

Farah Purwaningrum, ZEF a
Maksud Beckhanov, ZEF b
Alejandra Sepulveda, ZEF c

December, 2009
Interdisciplinary Term Paper
Bonn International Graduate School for Development Research (BIGS-DR)

Source of picture: Anonymous

Acknowledgments

We would like to thank:

Dr. Günther Manske
Dr. Anna-Katharina Hornidge
Dr. Ali Seid Nuru
Fiona McDonald

for academic assistance and helpful comments.

Table of Contents

1 Introduction 1

2 State of the Art of Value Chain and Knowledge 3

2.1 Towards an Agricultural-based Value Chain 4

2.2 Firms Upgrading in the Value Chain 6

3 The "White Gold" in Uzbekistan : A Value Chain Map 10

4 Exploring the Potential for a Cooperative Growth in the Cotton Industry Value Chain in Uzbekistan: a Game Theory Approach 16

4.1 Principles in Game Theory Model 17

4.2 Applying the Game Theory Model in Farmer's Adoption of Knowledge *vis a vis* Government Prices in Uzbekistan 18

5 Discussion 22

6 Conclusion 28

7 Appendix 31

6 References 32

1 Introduction

In an increasingly fragmented but cosmopolitan world, the means of production in international production networks has shifted. Firms break down the value chain into discrete functions and locate them wherever they can be carried out most effectively and where they are needed to facilitate the penetration of important markets (Ernst: 2005). Liberalization has cemented the ways for value chain to flourish. The proposition that economic growth requires innovation is held to be true for OECD countries and perhaps also for more advanced developing countries. One econometric analysis indicates that technological competitiveness is among the factor predominantly influencing differences in international competitiveness and growth among countries (Fageberg: 1990, Ernst: 2005).

Studies have been carried out to show how governance structure affects the value chain (Gereffi: 1999, Humphrey: 2004) or to explain the different trajectories of upgrading within the value chain (Kaplinsky, Morris: 2002). This includes the difficulties in transferring so-called tacit knowledge between firms (Saliola, Zanfei: 2009). Tacit knowledge is defined by Polanyi as "knowledge that is known but cannot be told." There are difficulties in articulating it because it has become internalized in the unconscious mind (Polanyi: 1967, Yue Wah Chay, et.al: 2005). However, current approaches in looking at knowledge in value chains are deficient. Notably, the assumption that by conceptualizing knowledge as tacit knowledge and by looking at embededness and/or bounded groups (Bair, Gereffi: 2001, Sengenberger, Pyke: 1991, Morrison, Rabellotti: 2005) one can at least deal with the issue of knowledge transfer. In fact it is much more complex than this (see, Engel: 1990, Long: 2001).

The question as to which and how the value chain relationships affect the process of learning, innovation and the acquisition of technological capabilities by firms remain unanswered (Fromm: 2007). This article will try to contribute in this area by focusing on first the role of knowledge for firms in the value chain, especially agriculture. Secondly it will identify the barriers in adopting knowledge. The term of knowledge will be referred to as 'intangible' resource and will be used, generated and transformed by multiple actors and firms at the local and global level. The process of transforming and adapting knowledge is a social process on which individuals or groups continuously alter and adapt their knowledge in response to changing intentions, opportunities and circumstances (Long: 2001). Included within is the changing of

ecological circumstances and economic situations. Firms will be defined as economic agents within the value chain, ranging from local enterprises to farmers.

This article will identify barriers of knowledge adaptation using a case study, in the title noted as a "story", relating to an agricultural value chain: namely the Uzbekistan cotton value chain. The Uzbekistan cotton is a "white gold" which refers historically as a chief cotton-growing region of the former Soviet Union. Moreover cotton has been the main source of hard currency from exporting. In the 1990s, cotton provided more than 70% of national export (Curtin: 1996). Uzbekistan is by far Central Asia's biggest cotton producer (International Crisis Group: 2005). Within the country internally, this cotton gained importance as state ordered norm as well as quota are in place (Veldwisch: 2008) to ensure the production of this agricultural product.

The reason of opting Uzbekistan is due to post-soviet history surrounding the political-economy system. It is a developing country that still enforces relatively strong norms on its economic and political aspects (Veldwisch: 2008, Hornidge et.al: 2009, Wall: 2006). By focusing on a case study of agricultural value chain namely cotton in Uzbekistan, hopefully one may grasp the problems and challenges of knowledge adoption for upgrading in local firms in developing countries. Agriculture still remains a vital sector for many developing countries (Pardey et.al: 2006). Indeed the protectionism measures taken in Uzbekistan show how problems within the local value chain originated from asymmetry of information, a lack of vertical coordination and the imbalanced bargaining power of the actors involved in the value chains (Rudenko: 2008).

This article contends that knowledge is important, as knowledge adoption and acquiring new technology by local firms would enable them to move up in the value chain. However, these processes of learning are complex and non linear (Roeling, Fliert: 1994), as such they require heterogeneity and diversity of learning processes, not only vertically but also horizontally. The thesis argued in this paper is that trade liberalization allows heterogeneity, diversity in the firm level to flourish both of which are push factors for knowledge exchange at the vertical and horizontal level. Moreover, trade and market liberalization increase incentives and push competitiveness of the firm. This does not mean that a blanket neoliberalism is proposed, this paper will show at the discussion part that that trade liberalization provides a continuum, and reaping the benefits may mean that a concerted effort is required at the national and local level (Humphrey: 2004).

The theoretical construct of the analysis will be carried out through mapping and game theoretic analysis. A mapping of the value chain will be conducted for the Uzbekistan case study of the cotton industry. The map will incorporate a technological and environmental element to describe the process of cotton production in Uzbekistan. Mapping is a useful tool to incorporate these technological and environmental elements and at the same time identifying the demand and supply side of the agricultural commodity. Then, game theory will be used to explore the possibilities of local firms in Uzbekistan adopting new knowledge to move up in the local value chain. Game theory is a mathematical model that is analytical to project the actor's strategic options, preferences as well as reactions (Turocy, Stengel: 2001). In this case, game theory will be utilized to observe what would occur if government of Uzbekistan undertook a liberalization measure specifically to relax the procurement prices of cotton and how this would affect farmer decision on innovation at the farm production level.

Thus this article will be divided into five main parts. The first part will explore the current debates relating to generally agricultural value chain and the upgrading process of firms including the barriers of knowledge adoption for firms in this process. The second part focuses on the case study namely the cotton industry in Uzbekistan. In this part a map of the agricultural local value chains will be introduced and the barriers confronting firms in respect of adapting knowledge will be identified. The third part will apply game theory analysis to assess the likelihood of farmers adopting knowledge and technology in Uzbekistan. The fourth part will concentrate in elaborating the argument of trade liberalization by taking the case study in Uzbekistan. It will then show that even liberalization does not always project the expected result, thus the process of liberalization should be regarded in a continuum with efforts at the local and national level. Finally, the last part will conclude that despite some limitations inherent, trade liberalization may be one of the alternatives to be pursued for firms in the local level to be able to upgrade in the value chain process.

2 State of the Art on Value Chain and Knowledge

Globalization produces diverse social processes, including the spread of certain means of production and patterns of consumption from specific geographic/political/national contexts to others (Snyder: 1999), although latecomers, i.e., small firms in developing countries, might have

less capacity to be able to move upwards within the value chain (Kaplinsky, Morris: 2002). Several decades ago proponents of dependency theory (Velasco: 2002) in globalization examined the negative implications of transnational companies for local development in Latin America to corroborate their theory (Bair, Gereffi: 2001). Genealogically, the term 'value chain' emanates from an extended version of dependency theory, combined with Braudelian history (Raikes: 2000). But value chain theory has distanced itself from dependency theory as studies within value chains shows that for firms to be able to rise up in the ladder of the value chain, the firm must ensure collective efficiency, not only vertically but also horizontally i.e., intra-firm. Collective efficiency calls for competitive advantage from local external economies as well as joint action vertically or horizontally. It is important to note that the effects of active cooperation have a bearing in the degree of collective efficiency for fostering small firms/small and medium enterprises to upgrade (Giulani et.al: 2005). Thus, the conceptualization of value chain such as collective efficiency has a bearing for firm to upgrade in the process of value adding amid globalization.

This state of the art will be divided into two subparts. The first subpart will discuss the significance of value chain analysis and discuss on the need to integrate environment for a more holistic agricultural value chain. Whilst the second subpart will focus on the importance of upgrading for firms in the value chain as well as the knowledge-related barrier faced by firms in upgrading.

2.1 Towards an Agricultural-based Value Chain

The significance of value chain analysis is elaborated by Kaplinsky and Morris. Value chain analysis is essential as it can assist with the estimation the value added to processed commodities, as well as to identify potential bottlenecks and options for further development. At the same time, the essentiality lies in the fact that the value chain can uncover power relations by agents/players in the value chain which often cannot be unmasked in developing countries due the prevalence of formal-informal work (Kaplinsky, Morris: 2002).

Value chain is described by various literatures in different ways, some defined it from an economic perspective, some more to a governance perspective. Kaplinsky and Morris (Kaplinsky, Morris: 2002) have described it as "a complete full range of activities which are

required to produce a product or service from conception, through the different stages of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use." Whilst according to Gereffi (1994), a value chain is defined in four different strands, first, as input-output structure with the flows of raw materials, intermediate goods and finished products as well as knowledge linked together in the process of value creation. Second, a map of the geographic concentration or dispersion of production and marketing networks comprised of a chain actors. Third, a governance structure, understood as authority and power relationships that determine how financial, material, and human resources are distributed within a chain. Last, is an institutional framework provisioning the national and international context for the interaction of chain segments.

Current developments have attempted to integrate the environment in value chain analysis (Faße et.al: 2009), owing to the fact that economic activities, and particularly agricultural production, are largely based on natural resources. The environment provides the basis for most essential inputs and energy as well as the capacity to dispose of emissions and waste. Other reasons for incorporating the environmental perspective into a value chain analysis are that the environmental impact of products has become a major aspect of environmental policy programs (Boons: 2002). This is usually enforced through standardization norms that are often practiced transitionally. However, Rudenko (2008) and mainstream approaches (Asche et.al: 2002) of value chain neglect inter-dependencies of different crop production processes in describing a value chain for single crop. Even if environment is taken into account, it is recognized through hazard modeling (Klibi et.al: 2009). Irrigation systems are also an inseparable element of agricultural value chain which was not considered most cases. This paper provides a more consistent regional agricultural value chain, including all agricultural commodity production processes. In addition, the chain map allows the potential for technological improvement as well as knowledge adoption to be assessed. The map will provide a portray of knowledge exchange, and possible threats to the environmental system at every stage of the chain.

Governance in the value chain literature is constructed as being lead by producers or buyers. In producer-driven value chains, large, usually transnational, manufacturers play the central roles in coordinating production networks. Whilst on the other hand, buyer-driven value

chains are those in which large retailers, marketers and branded manufacturers play the key roles in setting up decentralized production networks in a range of exporting countries, typically located in developing countries. Leverage in this case is within the hands of marketers and merchandisers at the design and retail stages (Gereffi, Memedovic: 2003).

Thus in this part significance of value chain is explored, as well as the current economic and governance approach of value chain. This part also emphasizes the requisite for an environmental-agricultural value chain analysis. In the next paragraphs potentials of firms to upgrade as well as barriers of knowledge adoption will be explored.

2.2 Firms Upgrading in the Value Chain

Upgrading means linking up. Gereffi contends that national development requires, inter-alia, linking up with the most significant lead firms in an industry. Lead firms, such as fashion designers or private label retailers, can be located upstream or downstream from manufacturing, or they can be involved in the supply of critical components (Gereffi, Memedovic: 2003). Arguing along these lines, Humphrey suggests that developing countries firms' must be prepared to offer advantages of that are not flexible like Foreign Direct Investment (Humphrey: 2004). Gereffi contention of the need to link up with lead firms creates inherent problems not only because of ignorance of the historical context (Raikes et.al: 2000). But it goes further to take into account the role of knowledge in relation to the lead firm in the chain. Since lead firms exert a certain quality control procedure, this means that one needs to focus firstly on how do these lead firms control knowledge for purposes of upgrading other related firms in the value chain. Moreover, this linear thinking is problematic in that it fails to see the potentiality of government-state norms, the political system in place (Hornidge: 2007) in conceptualizing, mediating and encouraging knowledge sharing among firms in the downstream level.

Firms are described in transaction costs economics in organizational terms (as a governance structure) and not in technological terms (as a production function). Williamson suggested that differential adaptive capacity for firms are attributed to incentive intensity, administrative control, as well as the legal rule regimes (Williamson, O.E: 1999). By defining firm as a collection of knowledge assets, Nonaka and Toyama identifies that the existence of knowledge conversion rate will determine the existence of the firm. Knowledge conversion rate is prescribed by the

synthesizing capability of the firm. This synthesizing capability is embedded in: 'knowledge vision, creative routines, incentive systems as well as the domain of the firm' (Nonaka, Toyama: 2002). For the purposes of explaining the role, and barriers of knowledge in the agricultural value chain, firms will be defined as economic agents acting and influenced with the production processes. This includes agents from ginneries processing the cotton for example, to farmers collecting and harvesting the cotton.

Firms may be assisted to acquire new competencies, or new resource and take on activities or functions associated with being located elsewhere in the value chain. Governments can assist firms to upgrade their knowledge intensive process competencies. Upgrading can be the result of the diffusion of management/skilled worker skills as personnel migrate from firms located in sectors/value chains where supply chain learning has been strong to jobs in other sectors/value chains (Kaplinsky, Morris: 2002). Or, on the other hand, this upgrading process also should be regarded as an outcome of engagement, negotiation, construction of multi actor perspective (Norman Long: 2001) including farmers, entrepreneurs, and scientists as to the best means to approach upgrading. Upgrading in this regard should be constructed as a non linear process of moving up in the chain or whether it becomes a race to the bottom.

Humphrey and Schmitz discern the different types of upgrading that can occur in value chains (Humphrey, Schmitz: 2002): first is a process upgrading in which that firms can upgrade processes, transforming inputs into outputs more efficiently by re-organizing the production system or introducing superior technology. The second type is product upgrading. In this regard, firms can upgrade by producing products resulting in more value added per employee, although, this upgrading involves changing the firm's position in product markets. This change can be achieved by changing customers or through a repositioning of the value chain, shifting the whole chain to higher value products. In functional upgrading, firms could attain new functions within the chain, such as design or marketing. This involves altering the inter-firm division of labour within the chain or moving to another chain. Humphrey (in Humphrey, Schmitz: 2002) argues that there are several implications for upgrading agricultural and manufacturing capabilities in developing countries that cannot be overlooked. Learning and the acquisition of technological capabilities can be stimulated through involvement in global value chains. However, there is no guaranteed path to upgrading as a result of this involvement and complementary endeavours at

the local and national levels are needed to stimulate both (Humphrey: 2004).

This paper argues that for firms to upgrade they require to adopt a knowledge and technology processes. Though there exist barriers relating to knowledge adoption by firms, liberalization will to a certain extent help to overcome the barriers. Trade liberalization allows the heterogeneity and diversity at the firm level to flourish, both of which are the push factors for knowledge exchange among the vertical level actors or the horizontal level actors. Although there are those who argued that firms can compete and innovate better in a closed economy. Woodruff for example identifies that the institutional structure of the market in the closed economy provide the baseline of manufacturers the ability both to set the low quality standards for the industry and to assess whether those standards were met. This means reducing their incentives to produce innovation in product quality and to design a more sophisticated commercial strategy (Woodruff: 1997). This argument is difficult to sustain, as arguably, the exchange of ideas from the bottom up is difficult to institutionalize in a closed-state economy.

Studies have been carried out to observe how trade liberalization provides the conditions of cooperation, heterogeneity and diversity for the firms to flourish. These studies will be presented and evaluated in the subsequent paragraphs.

Rabellotti examined the impact of Mexico's economic liberalization in the context of one shoe cluster in Guadalajara. She identifies that trade liberalization geared greater cooperation and increased horizontal and vertical linkages, and thus enhanced cooperation, all of which had a positive effect on firm performance. In addition, she also found that liberalization increased the heterogeneity within the cluster, and that exporting firms were favored by local suppliers (Rabellotti: 2004). The contention of this paper is that liberalization would increase heterogeneity of firms and enhanced cooperation lends support from Rabelloti’s study of cluster in Guadalajara. However, she did not explore nor analyze the extent to which they linked to external actors within the cooperation framework to enable them to share and transfer knowledge.

Bair and Gereffi in their study of the commodity chain in Mexico showed two key tenets: first, that the typology of links that connect local firms to global chains shape development and second, how post- North American Free Trade Agreement Mexican firms are tapping into direct links to export markets (Bair, Gereffi: 2004). The full package firms are reaping the benefits through learning *maquila* (assembly factory) production and gaining the trust of foreign buyers.

They manage to upgrade by means of eliminating middlemen, such as brokers, within the chain. Nonetheless, the authors noted how these networks of full package firms in Torreon are predominantly benefiting the domestic elites. The fact that these elites have exercised a certain access to the buyers, which potentially might produce hierarchy within inter-firm, they can potentially be gatekeepers of knowledge. Gatekeepers according to Norman Long, have a strategic role in facilitating and blocking the flow of a certain modes of information (Long: 2001).

Thus liberalization is likely to produce two spectrums, on the one hand it creates conditions necessary for firms at the local level for an enhanced heterogeneity either in size markets and arguably perhaps in terms of exchange of ideas, but on the other hand this also gives room for additional hierarchies and asymmetries amongst the local firms themselves. Asymmetry does not mean that it produces an entirely negative result as such for firm to upgrade, because, as identified by Nick Henry and Steven Pinch, asymmetries in knowledge flows can lead to competitive advantage for both individuals and firm on a cluster basis (Henry, Pinch: 2006).

However, a lack of knowledge sharing or in base in the local level risk to create double conundrums, first it reduces the likelihood of the positive impact of knowledge clusters on socio-economic development (Evers, Bauer: 2009). Secondly, lack of a knowledge base, along with complex new technologies and practices, has been highlighted as a constraint to more sustainable management of soil (Ingram: 2008), which is an inseparable component of environment.

Bart Nooteboom has identified barriers in knowledge adoption. First is relating to cognitive distance, combined with lack of absorptive and communicative capacity, yields obstacles for knowledge transfer (Nooteboom: 2003). Second is that transmission of tacit knowledge requires intensive interaction, which can be time consuming and laborious. As identified by Nooteboom knowledge transfer is not a matter of simple linear transfer. Rather it requires an ongoing process of interaction, as shown in the model of Kline and Rosenberg (Kline, Rosenberg: 1986). This cognitive distance as well as the time consuming and labourious process in transmitting tacit knowledge are not the only barriers in adopting/transferring knowledge. In addition to this, state and historical forces as argued by Caleb Wall could hamper transfer as well as development of agricultural knowledge (Wall: 2006).

Morrison and Rabellotti in a study of knowledge diffusion and exchange among actors in a local production system in the *Colline Novaresi* local wine system in Italy shows relatively high degree of heterogeneity, and diversity in learning among large firms located in the periphery (Morrison; Rabellotti: 2005). They conducted an analysis of the characteristics in a knowledge network, concluding among others that firms in the periphery are more open to external market and have more tendency to innovate (Morrison; Rabellotti: 2005). There are different capabilities of large and small firms indeed to actively

participate to informal exchanges, in particular those concerning knowledge. Despite the difference, it is important to note that these heterogeneity and diversity are difficult to be expected in a closed economy system. The trade liberalization thus will enable heterogeneity, more interactions in different levels of value chains, diversity in learning for the local firms and at the same time will provide an economic incentive for government to adopt measures to gain competitiveness.

In the case of study in the following section, these barriers will be re-explored in light of the argument on trade liberalization. The agricultural value chain map of cotton will be presented as well as a game theory will be utilized to project the possibility of adopting innovation by the farmers.

3 The "White Gold" of Uzbekistan: A Value Chain Map

Agricultural production in the Khorezm region contributes with more than 50% of the regional domestic product (Rudenko: 2008). It fully depends on irrigation water. Due to a low degree of technology improvement and modernization, there is a hazardous impact on the environment that together with the production in all the country, especially cotton. This is evidenced by the Aral Sea desiccation. Therefore, the agricultural value chain in the region needs to take into account the irrigation system as well as technologies in each step of production, environment and all the agricultural commodity production processes (including other crops), that differs from single crop production value chains (Figure 1).

The local value chain map presented in the Figure 1 shows how agricultural production involves the processes beginning from the irrigation system through farm production and processing industry, ending at domestic or external consumption. The technology sub systems at the right side of the chart provide possible options of modernization in each level of the chain. While the environmental sub systems the left side of the chart show the environmental impacts that each stage. The chart allows the identification of economic, financial, legal, social, and business problems in each part of the chain that hinder development of the agricultural and processing sectors in the Khorezm region. A good start in this case would be to analyze statistically the main relationships between various variables on agricultural production and processing. In addition, combining this with quantitative data would allow an estimation of the parameters of various models of agricultural production and processing.

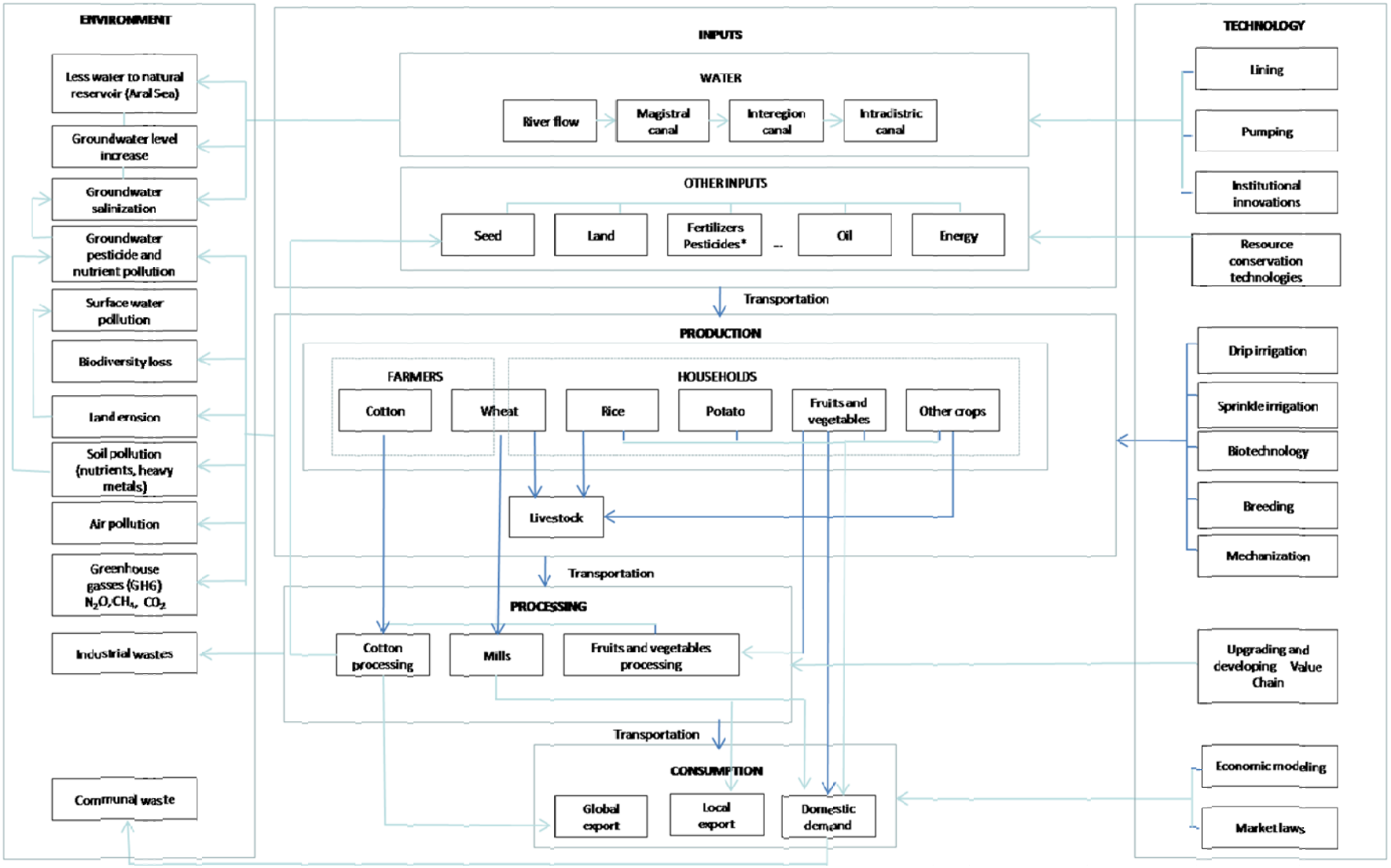


Fig. 1. The agricultural value chain of the Khorezm region and its relationship with technology and environment subsystems, Uzbekistan. Source: own presentation.

A system dynamics analysis can also be a medium to analyze this value chain as shown below in Figure 2. As reflected in the figure, innovation systems positively influence to agricultural production performance allowing more output per input. In turn, increased productivity could provide increased R&D expenditure.

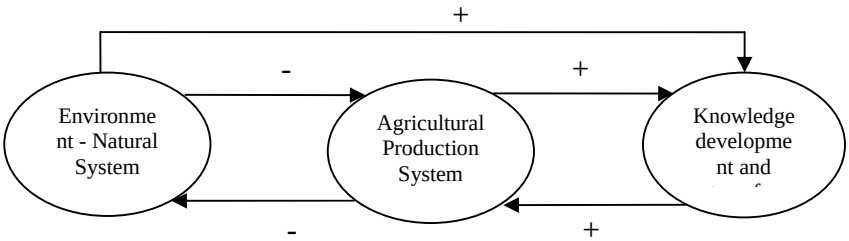


Fig. 2. System analysis approach. Source: Own presentation

Regression analysis on the basis of World Bank data across some countries also shows, even though slightly, a positive relationship between Research and Development (R&D) and agricultural productivity (r^2=0.43, Figure 3). For example, 1% increase in R&D expenditure would provide 1.3 % growth of agricultural productivity.

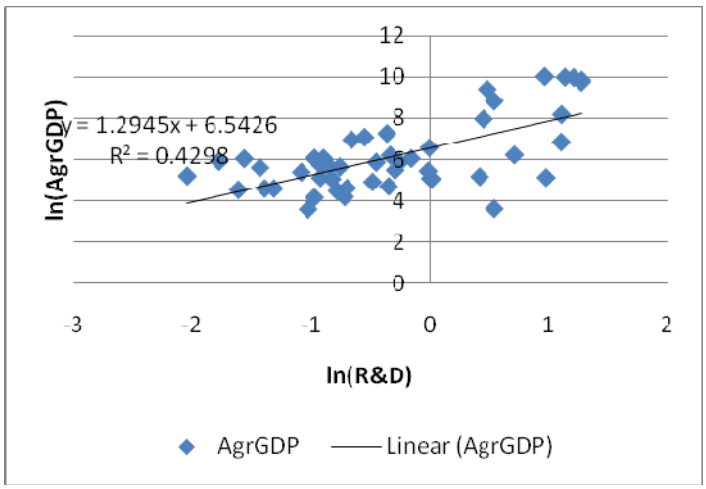


Fig. 3. Relationship between agricultural R&D expenditure and agricultural productivity. Source: own results on the basis of data from the World Bank (2007).

However, an inefficient use of water for crop production, and the excessive use of pesticides and fertilizers due to increased production levels also generate impacts in the environment, causing for example surface and ground-water pollution, soil degradation and

erosion. Consequently, water salinization, and abandonment of irrigated lands, and high groundwater level decreases productivity in agriculture without considerable technological improvements.

The case of Khorezm shows a rather bleak scenario due to relatively low expenditures on technological modernization in agricultural production in spite of government efforts to adopt new resource efficient technologies. It can be explained as on the one hand by lack of public and private funds to modernization. On the other hand, there is dependency upon the importation of foreign technology which is likely to be more expensive due to transportation and transaction costs hinder modernization. As it is seen from the value chain analysis beforehand, production needs technical, social, and institutional modernization. Production also requires sound irrigation and drainage technologies in all water conveyance, distribution and application levels, efficient biotechnologies and machinery in farm production, as well as development of agro-processing industries instead of exporting raw cotton. In addition, low spending on environmental improvement potentially threatens food security and rural livelihoods in the region. The overuse of water as the main input for cotton production in Uzbekistan (around 90% of the total water budget to irrigation, UNEP: 2005) and the associated draining infrastructure witness the severe and irreversible environmental impacts of the former soviet irrigation-intensive scheme focused on the production of so called “white gold”. The most disastrous consequence of “putting water under stress as an available resource (Kuzmits: 2006)” with this production scheme has been, as described before, the progressive and irreversible desiccation of the Aral Sea, by many accounts the worst environmental tragedy of the twentieth century (Baffes: 2005), and which triggered a number of problems crossing environmental (e.g. loss of biodiversity and the saline environment created in several countries, Salukvadze: 2008) and human spheres.

The water context gives then the starting point to consider the cotton value chain in Uzbekistan, but factors other than the intensive irrigation and the draining infrastructure, like the massively overuse of agrochemicals in the area (UNEP: 2005) must be considered as well due to its environmental and human health impacts. By 2005, up to 66% of irrigated fields in Uzbekistan were reported as polluted and some chemical concentrations exceeded standards twenty or forty-fold (Strickman, Porkka: 2008). Much of the drainage effluent from fields, along with sewage and industrial wastes, is returned directly to waterways, and these waters are used

for drinking, washing, and further irrigation (Strickman, Porkka: 2008). Both, over irrigation and pollution side-effects are directly related to the production practices, but the processing sector impacts are also important in terms of the value chain. In the industrial stage, there are two major impacts on water: abstraction of process water from surface or groundwater, and pollution of water as a result of the waste flows from the cotton processing industries (Chapagain et.al: 2006). In most developing countries, wastewater treatment remains below 5% (Eurostat: 2005, Hoekstra, Hung: 2005).

Without technological improvement, economy and environment could be negatively impacted as depicted by the lines *Economy-* and *Environment-* in the perspective scenario as shown in the figure below (Figure 4). Thus, technological improvement and a strong knowledge base would provide a realistic sustainable economy and environment for firms to upgrade.

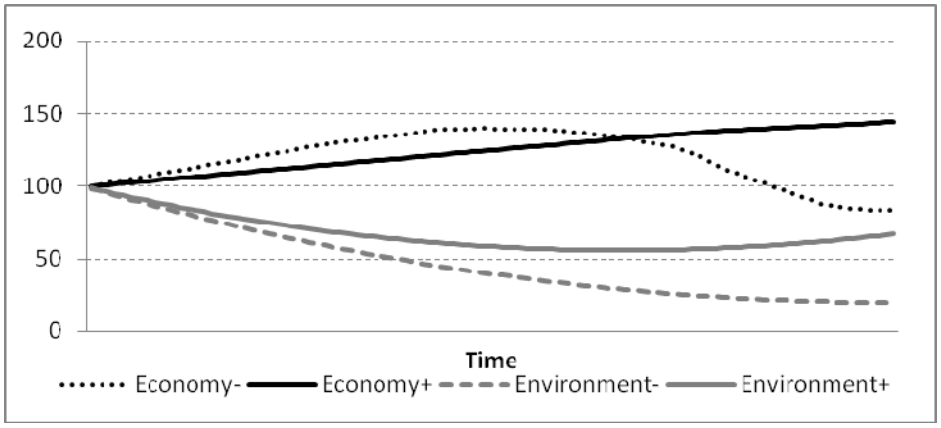


Figure 4. Economic and environmental state with and without technological improvement. Source: own presentation.

Despite attempts to liberalize or privatize markets in Uzbekistan, in reality little change has really occurred. The actors in the Cotton Value Chain are identified as follows: the private farms which are mostly independent enterprises taking part in the agricultural production on leased lands, the ginneries which are the industries or factories assigned for processing raw cotton, the oil extracting companies as well as textile companies (Rudenko: 2008)–. Cotton production and processing heavily rely on farmers for production and firms for processing (Rudenko: 2008). They are considered here as firms in the local level in Uzbekistan.

As in the previous centralized system, newly formed farmers still have to follow government orders on main crops (cotton and wheat), which occupy almost 70% of the total irrigated area (Figure 5). Since procurement prices for cotton and wheat are set much lower than alternative market prices there is no incentive for farmers to invest in land and water conservation technologies. The domination of administrative methods of regulation does not permit the world-experienced technologies and progress in agricultural research to make its way to the farmers fields (Westminister: 2009) nor it permits the usage of farmers knowledge (Hornidge et.al: 2009). Moreover, controlled cotton and wheat land allocation restrict farmers from switching to other cash or environmentally tolerant crops such as potato, indigo, and soybean, limiting crop biodiversity (Babajanov et.al: forthcoming).

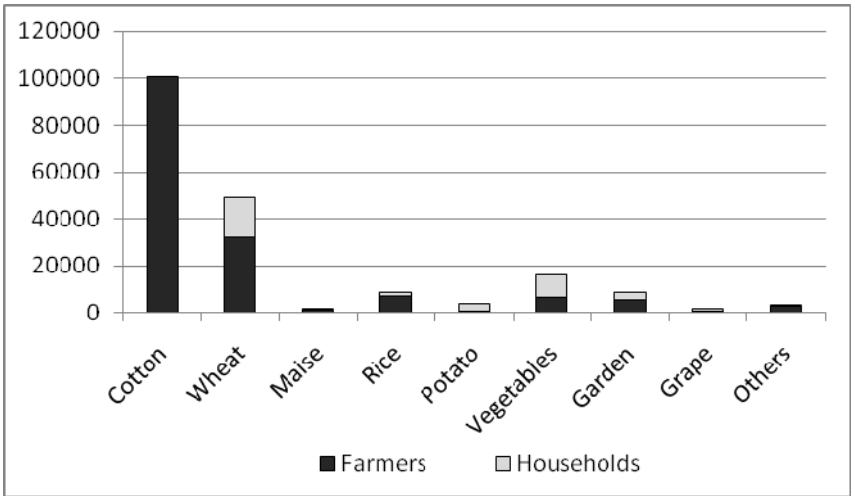


Fig. 5. Source: Data obtained from OblStat (2008).

Main barriers of knowledge and innovation transfer in Uzbekistan are as follows: inappropriate management structure, lack of technical specialists, influence of local authorities, and implementation of strict state orders and norms. Although knowledge system development promises sustainable welfare growth, World Bank (1998) states that there are significant risks related to political levers performance.

4. Exploring the Potential for a Cooperative Growth in the Cotton Industry Value Chain in Uzbekistan: a Game Theory Approach

Previous discussions on government regulation systems show how particularly lower price to cotton and wheat and full dependence of farmers on government crop land allocation, are basic restrictions which are causing a number of negative consequences. In addition, production quotas for these crops and financial punishment proportional to deviation from the quotas are considered by government as a motivation tool for farmers to keep production levels more stable and close to the plan. In reality, this system makes farmers think out different ways of increasing their own profit and reduces their trust in the system. In other words, there appears space for a *principal-agent dilemma* because of low procurement prices and the quota system.

Principal-agent problems are also very common in the economies with high government intervention. For example, in the case of Uzbekistan farmers are encouraged to follow government plan which determines the area of cotton planting however in reality farmers find different ways to run away cropping cotton. Producing other cash crops, such as rice in some part of the fields, not informing state organizations or purposefully flooding the cotton field before cropping, thus missing cropping deadline and making the field available for only some specific marketable crops are just few examples. Possibilities of such kind of hidden incomes in reality motivate farmers to require land use rights again, in spite of many restrictions as well as frequently changeable policy reforms.

Sometimes, even government expenditures to modernize the system are made without considering the interests of farmers can cause the purposeful breakdown of the system by its users. For example, canal lining is believed to technically improve water conveyance efficiency, thus contributing water conservation, preventing huge loss of water to drainage system, providing more water to tail end users and contributing more equal water distribution. However, upper end water users have incentives to break some parts of the canal thus obtaining more water for irrigation (personal communication) rather than equal and fair water distribution. These kinds of problems cause economic and technical inefficiency of technologies and make technological development less efficacious.

Moreover, the government price and quota system strongly influences farmers' attitudes and consequently cotton production levels. In addition, public investments to modernize the

system without considering social relationships and the economic interests of producers decrease financial and technical feasibility of technologic development projects.

Thus, it would be interesting to see what would occur if government relaxed procurement prices and how this would affect farmer decisions on innovation adoption at the farm production and processing levels. Game theory modeling is best suited to analyze the impact of different farmer/government strategy combinations on total value chain income and income distribution.

4.1 Principles in Game Theory Model

During the last decades, as a result of the development of computer technologies the mathematical modeling approach in economics is widened. At first linear and non-linear optimization models were common, but subsequently more scholarly attention was paid to game theory models. Optimization models were mainly based on many assumptions about customer and producer behavior as well as the institutional framework, while game theory approaches allows improved analysis of the relationships of actors and the condition of institutional frameworks.

Games describe situations where there is a potential for conflict and for cooperation (Thun: 2005). Many business situations and social interactions have both of these features. Game theory consists of decision making between two or more parties competing against one another for maximizing their own utility. Consequently, the decisions of each of the parties may depend on the other, whether in the form of a cooperative model or non cooperative model. Game theory was first defined by French mathematician Emil Borel in 1921 and the famed mathematician John von Neumann provided an analysis of games in 1921 (Kogan, Tapiero: 2007). Applications of game theory became widespread after the Nobel Prize was awarded to Nash in 1993 (Kogan, Tapiero: 2007).

Although basically game theory was applied to analyze relationships between competitive groups, later game theory augmented equilibrium models to analyze the coordination of information and the allocation of profit between actors in value chain (Fasse et.al: 2009). Radhakrishnan and Srinidhi (2005) analyzed information exchange in a value chain arguing that information exchange improves resource coordination. Their non-cooperative model involves a bilateral monopoly with a manufacturer and a retailer, where retailers are aware of private

demand information, which allows the manufacturers to improve resource decisions. The results showed that the manufacturer took advantage of both improved resource coordination and reduced payment for information rent, while the retailer has no incentive to adopt information exchange only by a resource-based costing and pricing system. Nagarajan and Sosic (2006) applied a cooperative game theory model to analyze profit allocation and its stability constructing the set of feasible outcomes in commonly seen supply chain models. Thun (2005) assumed that different actors collectively maximize the global benefit, for that reason cooperative game theory is more appropriate than non-cooperative. He argued that the stability of cooperation depends mainly on the payoff for each player eliminating incentives that leads value chain partners to abandon cooperation. Kogan and Tapiero (2007) discussed briefly applications of different game theory models from static to dynamic and from deterministic to stochastic in supply chain analysis.

4.2 Applying the Game Theory Model in Farmers Adoption of Knowledge *vis a vis* Government Prices in Uzbekistan

In this section of the paper a simple game theory model will be employed between the cotton producer and processing industry in Uzbekistan. As previously mentioned, the price for raw cotton set by the government in Uzbekistan lowered incentives for farmers to increase productivity by adopting resource conservation technology, which is also one of the main reasons of gradual environmental degradation in the area. Thus, higher prices for raw cotton would contribute to adoption of environmental friendly technologies and higher yield. However, to receive higher prices farmers have two options: to invest added income to technology investments and get increased yields with less damage to environment or to spend it for consumption which in turn do not support technological development.

Considering the case study discussed above, it is possible now to construct game theory model of cotton value chain that imitate the relationships between farmer producers and processing industry. In the model farmers try to increase their own benefit (π_{farm}) which depends on cotton procurement price (P_{gov}), yield with and without technology (y^+, y^-), technology adoption rate (r), deviation of farmers from planned cotton crop area (s) which

matches to the area share of marketable crop, additional income – *opportunity cost* (IN_{alt}) and yield (y_{alt}) of alternative marketable crop, variable production costs with and without technology (VC^{+},VC^{-}):

$$\pi_{farm} = P_{gov}(y^{+}rX + y^{-}(1-r-s)X) + IN_{alt}y_{alt}sX - VC^{+}rX - VC^{-}(1-r-s)\,X$$

where X is total cotton area planned,

or

$$\pi_{farm} = (P_{gov}y^{+} - VC^{+})rX + (P_{gov}y^{-} - VC^{-})(1-r-s)X + IN_{alt}y_{alt}sX$$

and

$$obj \rightarrow \max_{r,s} \pi_{farm}(P_{gov}, r, s)$$

Processing industry planners also try to maximize their benefit (π_{pr}) which is determined by world price of cotton fiber (P_{world}), raw cotton amount required to produce one unit of cotton fiber (η), procurement price paid to farmers (P_{gov}), variable costs of processing (VC_{pr}), value added by other processing industries such as cotton oil production (VA_{oth}) and amount of raw cotton delivered by farmers ($y^{+}rX + y^{-}(1-r-s)X$):

$$\pi_{pr} = (P_{world}/\eta - VC_{pr} - P_{gov} + VA_{oth})(y^{+}rX + y^{-}(1-r-s)X)$$

and

$$obj \rightarrow \max_{P_{gov}} \pi_{farm}(P_{gov}, r, s)$$

Neglecting the *principal-agent* problem may cause declined levels of potential cotton production and irrational expectations of farmer's adoption of technologies. This would keep prices low in practice and create conditions for non-cooperative game that increases the load to environment gradually making chances of economic and environmental threat more possible.

In spite of complicated regulation and quota system, dependence of technology adoption rate on procurement price should be considered for more favorable performance of the production system:

$$r = f(P_{gov})$$

Moreover, the relationship between diversion rate of farmers from planned cotton crop area and

marketable crop and procurement price difference ($\Delta(P_{alt}, P_{gov})$) is also important to determine optimal procurement price:

$$s = f(\Delta(P_{alt}, P_{gov}))$$

In practice, quantification of the last two relationships requires cross-sectional data on farmers' technology adoption rates and deviation from a planned area which may be undesirable to be responded by farmers. Thus, here we simplify our calculations applying discrete model. The response of farmers to price change was not considered in these calculations due to lack of data. However, without this data still we can build game theory model which shows benefits/losses of farmer and government under different strategies of these players. Approximate values of exogenous variables of the model are estimated based on previous survey results at ZEF/UNESCO (Khorezm) project.

Table 1. Estimated input data

Variable	Amount	Unit	Description
P_{world}	2500	\$/ton	World price
η	2.5		Raw cotton amount required to produce one unit of cotton fiber
VC^-	400	\$/ton	Variable cost of cotton production without technology
VC^+	500	\$/ton	Variable cost of cotton production with technology
VC_{pr}	300	\$/ton	Variable cost of cotton processing
$\Delta\%$	20	%	Yield increase under technology adoption
α	{0,1}	Binary	1, if farmer adopts innovation, otherwise 0

Source: Own compilation

Farmers benefit is simplistically calculated as a difference between (P_{gov}) government procurement price and variable costs of cotton production:

$$\pi_{farm} = P_{gov} - (1 - \alpha) \cdot VC^- - \alpha \cdot VC^+$$

Processing benefit is estimated as a difference between cotton fiber world price (P_{world}) and government procurement price plus variable costs of cotton processing:

$$\pi_{gov} = (P_{world}/\eta - P_{gov} - VC_{pr}) \cdot (100\% + \alpha\Delta\%)$$

Obtained results are given in Table 2 a) and b).

Table 2. Income of farmers and processing industry under different strategy scenarios

a) Farmer:

		Government		
		300	450	600
Farmer	innovation-	-100	50	200
	innovation+	-140	40	220

b) Government:

		Government		
		300	450	600
Farmer	innovation-	400	250	100
	innovation+	480	300	120

Source: Own results

As it is seen from Table above the scenarios are as follows, a) Farmer loses under low procurement prices if he or she adopts innovation and only high prices were paid by processing industry can make innovation advantageous. If the farmer expects lower prices, like in the case of Khorezm region, he or she will never implement the technology. Or, in contrast, according to table b) government prefers low procurement prices since it can gain the highest profit, even at the cost of its overall socio-economic inefficiency. It is defined in the literature as the prisoner's dilemma, which is one of the main reasons for innovation adoption failures in the region, consequently increasing distrust between value chain agents and lowering sustainability of agricultural production system.

Thus, it is emphasized that determining and setting optimal value of procurement price under cooperation which provides optimum social income and optimal technology adoption rates plus sustainable development is one of the prior problems of agricultural value chain

development. Hence, game theory has shown that knowledge can be successful only if necessary conditions such as market liberalization, good market infrastructure, and favorable government policy are provided and appropriate way of technology adoption is chosen.

The next part will discuss the outcome of the mapping and game theory and also show through series of mini-case studies how trade liberalization argument may have unfolded in non-linear ways.

5 Discussion

The Agricultural-environmental Cotton Value Chain map in Uzbekistan highlights that the development of agricultural production and processing sector are hampered by lack of support services, legal, social and market infrastructure. Firms at the local level face the following barriers of adopting knowledge and new technology: inappropriate-bureaucratic management structure, lack of technical specialist, influence of local authority, as well as implementation of state norms, the nature of knowledge is monopolistic and reinforces the state authority (Wall: 2006).

Rudenko (2007) systematized main barriers of local value chain development in Khorezm region in Uzbekistan by relying on a mini survey of 121 farmers (out of 13621), 10 ginneries (out of 10), textile companies (out of 26), 4 state wheat mills (out of 4) (see table below). She identified the barriers to growth and upgrading of the cotton value chain in Uzbekistan, presented in the next page.

Table 3. Barriers to growth and upgrading in the cotton value chain.

Issue area	Agricultural sector	Ginning sector	Textile sector
Inputs / Equipment	• lack of the main inputs • delayed and limited delivery • high prices • poor quality • lack of agricultural machinery • lack of pre treatment (for pre drying of raw cotton) and storing facilities	• lack of inputs (raw cotton) • high prices (energy inputs and spare parts) • low quality • warn ginning and other equipment • low efficiency • lack of spare parts	• lack of inputs (fibre and chemicals) • poor quality of inputs (best fibre is exported) • warn equipment and tools • lack of spare parts
Financial problems	• lack of circulating assets • delayed payment for the output • no cash payments/no access to bank accounts • unfair assignment of quality (lower profits to farmers) • many unforeseen expenditures • cumbersome taxation	• lack of circulating assets • delayed transfers/payment for the output • high tax burden • terminal fees • poor management (inventories) • low-liquid assets (accounts receivable) • control over currency	• credit pay off (high interest rates) • 100% prepayment for cotton fibre • high transportation expenses • lack of circulating assets • terminal fees
Marketing	• no alternative marketing channels for the output • lack of alternative input sources	• lack of freedom • full control of activities by the governing ginning branch	• weak marketing chain
Legislation / Regulations	• contradictions among legislation / regulations • lack of law enforcement	• contradictions among legislation / regulations • lack of law enforcement	• contradictions among legislation / regulations • lack of law enforcement • inconsistent legislation

Source: Rudenko (2007)

The above table indicates that main hindrances are high prices and late delivery of inputs, underdevelopment of mechanization, high energy input use, imperfect bank and legislation/regulation system, and lack links and infrastructure to global value chains. It suggests there is a huge need for social-economic, technological and institutional environmental friendly technologies to develop and upgrade the agro-industrial value chain in the region. Despite the attempts to liberalize and opening up shown above, the state in Uzbekistan still retain a certain level of knowledge control which is deemed central to control the agricultural production process (Wall: 2006).

The game theoretic analysis shown above also shows that knowledge adoption would be successful only if necessary conditions are fulfilled. These conditions include market liberalizations, as well as solid market infrastructure. The economic mathematical modeling and any cost-benefit analysis related to cotton production should consider economic efficiency of the

entire cotton production value chain from input provision to global market export. These models are very important since government procurement prices may cause underestimated incomes from cotton production when only production chain is taken into account.

Thus the different parts of this paper -the literature reviews, the map of value chain as well as the game theoretic analysis- all pointed out that liberalization, opening up and reducing a monolithic state control will allow firms the diversity-heterogeneity in learning, as well as providing an economic incentives for state to invest more in productive capitals such as social capitals to stimulate economic competitiveness.

Releasing the control of knowledge, as argued by Caleb Wall, means reducing the power of the state. This is important as state should reorientate itself in governing the knowledge in the interest of the society rather than vice versa. This means an "expert" system is no longer controlled by state (Wall: 2006), but local firms as well as farmers are the "experts" capable of observation, delibaration and decision-making (Roeling, Fliert: 1994). The likelihood of farmers adopting technology is also influenced by state norms in Uzbekistan, specifically in this case the state recommendations about production norms (Hornidge et.al: 2009).

Ayenor, G.K et.al, in their study of organic cocoa production at Brong-Densuso and surrounding communities in the Suhum-Kraboa-Coaltar District of Ghana highlighted how the approach of cocoa as a public crop requires broad techno-social innovations (Ayenor et.al: 2004). It is interesting to emphasize that in this study farmers set diverse criteria for choosing the 'best' pest management strategies for their cocoa production. The strategies they opted are among others cost-effectiveness, increasing yields as well as the fact that the technology should not affect taboos of cultural beliefs (Ayenor et.al: 2004). Thus, it is essential to release the state control of knowledge and of socio-economic infrastructure in the sense to focus more on the society and on the farmers as experts, as well as to 'bridge' the different views of scientist versus farmers as to the best means to proceed to adopt new technology and knowledge.

However this does not mean that the argument of trade liberalization pursued by means of adopting a blanket neoliberalism or advocating the idea of neoliberalism. Neoliberalism is the belief that open, competitive and unregulated markets, liberated from all forms of state interference will represent the optimal mechanism for economic development (Brenner: 2002). This path of liberalization may go in a non-linear trajectory, showing that it is not always

fulfilling its expected aims as shown in the next paragraphs.

In this part a Mexico Coffee Value Chain will be taken up from a different account. Privatisation of the coffee sector has been the driving vision of policy-making in Mexico since 1992 with certain negative consequences especially for the upgrading of the firms at the coffee value chain. Mexico is the world's fifth largest coffee producer (5%) after Brazil (27%), Colombia (14%), Indonesia (7%) and Vietnam (6%). Coffee is the most important agricultural source of foreign exchange in Mexico, accounting ca. 25% of the total export values (the country exports coffee to 58 countries ca. three quarters going to the United States), though it is fifth in terms of area cultivated (after corn, beans, wheat and sorghum); it is produced in 761, 161 ha in 12 states of the country; is cultivated by 282, 593 farmers with an average of 2.7 ha/producer; and it is estimated that some 3,000,000 persons are employed in activities related to production, processing and sales – which is approximately 6% of the economically-active population of Mexico – and close to a quarter of the economically-active rural population. Thus, coffee represents one of the most important activities in the agricultural sector of Mexico (Guerra and Moss: 2004, Porter: 2000, Pérez-Grovas: 1998, Instituto Maya: 1999).

Production, processing and exportation activities in the Coffee value Chain in Mexico together with further processing and retailing activities in the consumer countries are mapped with a set of relationships among actors in Appendix 1 which are based on the criteria set of Sinclair (2005) and Ponte (2001).

Within the coffee value chain, farmers involved either in the picking and processing coffee cherries by the dry or wet process, receive a farm-gate price. The cherries are then processed by local industries receiving a factory gate price for the obtained "green coffee", which is the main form of coffee for exportation. The beans then go to an intermediary for export (fob prices) and they are shipped to importing countries (cif prices -costs of insurance and fright). Importers then sell the beans at wholesale prices; and roasters process the beans and sell them at factory gate prices to retailers, whom sell the coffee to the public (retail prices) for domestic or out-of-home consumption (restaurants, caterers and Cafés). This value chain analytically is dominated by intermediaries between producers, processors and exporters in the local context, and between national exporters and industrial companies for secondary processing outside the

country. Producers have limited capacity in expanding their markets as power is exercised and leveraged by intermediaries.

While the previous parts (Rabellotti: 2004, Bair, Gereffi: 2001) showed how trade liberalisation has positively affected the linkages and cooperation in the value chain in Mexico, there are certain perhaps unintended consequences due to privatisation. To name a few for this case, coffee is being sold for less than its production costs, the market is the in hands of buyers, negative impacts to small-scale producers attributable by international low prices, increased risk of lost market share to large producers. Internationally, Mexico lost market share to Vietnam and other producer countries, and between 1989 and 1995 production declined by 6.6%. Migration from coffee producing areas is one of the social effects resulting since then (Celis et.al: 1991, Renard: 1999).

In relation with organic coffee production, a demand was created due to opening up to world market. It seems that the main knowledge as well as technological related barriers are the lack of information about certification processes and how to approach certification agencies; the lack of technical and financial assistance in the transition; high costs associated with the switch from conventional to organic production; the time issue, as it generally takes two to three years to gain the certification and to begin receiving a premium price; and corruption in national certification bodies that carry out the majority of inspections (Bray et.al: 2002, Rice: 2001, Calo, Wise: 2005). However, there are potentialities of this coffee industry to use the local knowledge of farmers in harvesting, cultivating as well as making complex decision-making. More than three-quarters of the coffee in Mexico is grown in the shade of woody perennials (either the existing forest or managed tree cover, Perfecto et.al: 1996, Rice, Ward: 1996). There are some locations where they are planted within the hotspots of biodiversity (Moguel, Toledo: 1999). In some areas of Latin America, coffee plantations are among the few remaining forested areas, especially in the mid-to high elevation ranges (Perfecto et.al: 2005). Due to these aspects, coffee production, especially under traditional management is gaining recognition in conservation issues (Moguel, Toledo: 1999). The traditional cropping systems in Mexico have gained attention due to their ecological, technological and productive advantages in comparison to monocultures (Alvarez-Buylla et.al: 1989). The importance of the coffee traditional systems, which can be recognized as agroforestry systems as well as the related knowledge system, are such, that they

have being considered as a technological alternative for reducing deforestation rates in tropical zones (de Jong et.al: 1995). Thus, the case of Mexico has shown how liberalisation could have some consequences for the farmers, and warrants reconsideration as how to one proceed with the argument of liberalisation. It is important to note that post NAFTA and liberalisation in Mexico, there exist windows of possibility of the firms to take advantage of the linkage with firms and could provide to be resourceful (Bair, Gereffi: 2001). A stark difference with Uzbekistan where the state ordered norms of production and the implementation of quota limit the possibility of innovation (Veldwisch: 2008, Hornidge: 2009, Wall: 2006).

Another case is the Cotton reforms which taken place in Tanzania since 1984 (Gibbon: 2001). Reforms in the cotton sector were introduced as a response of failing state monopoly system from the year 1970 onward. The consequences of liberalizing the sector were quite widespread ranging from the fell of cotton seed production from an average of 71,200 tons/year in 1971±75 to 46,200 tons/year during the 1980s. When initial more cautious proposals to liberalize cotton marketing were proven to be all abortive, this leads to widespread donor insistence by 1994 on a reform in which all levels of trade and processing were opened unconditionally to private operators, prior to a new regulative apparatus being organized. The reform was taken with corresponding commercialization cooperatives, which soon was to lead to their fragmentation. Indeed liberalization has its fruits especially in succeeding to create a high level of competition in primary marketing, ginning (lint production) and exporting. However, the quality of crop was clearly in decreasing due to reductions in input use and the ending of grading at point of sale. The crops were refused in increasing volumes of claims by international traders. This problem was aggravated with poor weather conditions. The inability to procure cotton in sufficient quantity and quality, some less capitalized private ginners went bankrupt and others closed their operations. This “narration” according to Gibbon may well be posed as one concerning regulative failure, exacerbated by policymakers' failure to comprehend accurately the workings of commodity chains, locally and globally.

The Mexico coffee value chain as well as the cotton liberalization case in Tanzania shows that liberalization does not always follow the expected trajectories, there could be some negative consequences. However, trade and market liberalization allow the heterogeneity, diversity, linkages outside as well as provide economic incentives for competitiveness. Liberalization as

argued beforehand is likely to have the two perhaps contradictory spectrums, on the one hand it forges conditions necessary for firms at the local level for an enhanced heterogeneity either in size markets and arguably perhaps in terms of exchange of ideas, but on the other hand this also gives room for additional hierarchies and asymmetries amongst the local firms themselves. In relation with the case study of Uzbekistan as well as the mini case study series presented above trade liberalization here is not a panacea, but more like a continuum. Firms in the local level within the continuum could afford to the learning experience in heterogeneity as well as in diversity. However concerted efforts at the local and national level are required to secure that technological capability, knowledge adoption and market access will provide upgrading for firms (Humphrey: 2004). The role of government is vital in the continuum to ensure that firms reap the benefits. Locally this continuum provide possibility small firms to link outside to access information and resources beyond those available within the social circle, i.e., strength of weak ties (Grannovetter: 1983). Thus, possible research in the future could focus on the role of the efforts at the national level to ensure technological capability, knowledge adoption and market firms for firms to upgrade as well as locally how the linkages well as the ties as used to secure resources for local firms to upgrade.

6 Conclusion

Knowledge in here is constructed as an outcome of a social process on which individuals or groups continuously alter and adapt their knowledge in response to changing intentions, opportunities and circumstances, including ecological circumstances and economic situations. This paper concludes that adopting knowledge would allow local firms to upgrade themselves in the value chain. Regression analysis shows that 1% increase in R&D expenditure would contribute 1.3% agricultural productivity growth. Trade and market liberalization will allow heterogeneity, foster cooperation, as well as diversity, in learning. Interaction with other actors/firms and a more favorable policy framework would create better conditions for knowledge adoption and utilization.

In order to describe social, institutional and economic relations among different players of the economy, value chain mapping is a very suitable tool. In addition, including environmental and innovation sub-systems into the value chain increases strength of the research rather than

being restricted on a single crop production process. Environment has an unquestionable importance for cotton production in Uzbekistan in terms of its consequent linkage with the livelihoods and upgrading opportunities of farmers. Degradation of environment pose more challenges for the “white gold” producers. It is also important to note that there are technical, social, and institutional needs relating to water conveyance for among others cotton production. Efficient production also calls for efficient biotechnologies and machinery, as well as development of agro-processing industries instead of exporting raw cotton. Thus, the agricultural value chain map shows that the barriers of knowledge adoption are due to inappropriate structure, lack of technical specialists, influence of local authorities as well as implementation of state orders-norms.

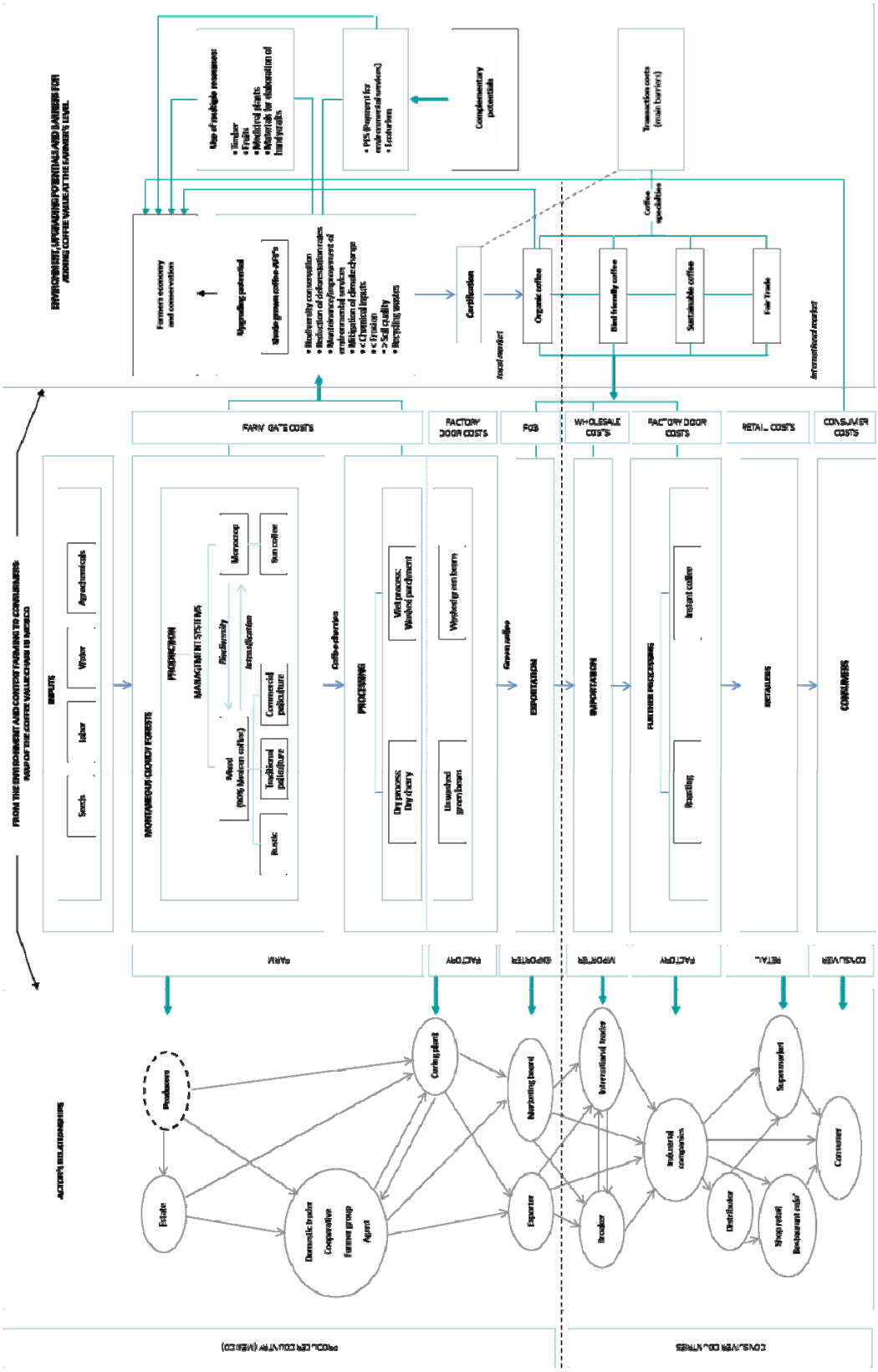
Game theory modeling allows to strategically analyze prize distribution among the players in competitive and cooperative scenarios and thus more practical to simulate social, economic relations of value chain actors quantitatively. The game theoretic analysis demonstrates *prisoners dilemma* in cotton value chain. Although state procurement price and quota system was thought as a powerful measure by government officials, in reality, it creates *principal-agent problem* which is favour of neither processing manufacturers nor raw cotton producers. Due to the model knowledge adoption would not likely to be successful unless necessary conditions in this case taking a more liberalized stance by increasing cotton procurement price. In general, investments in market infrastructure as well as trade liberalization will provide better incentives for farmers and firms at the local level to adopt innovation.

The qualitative and quantitative approach employed in the paper have shown that despite the existing barriers, trade liberalization and reducing state control are key determinants of new technology and knowledge adoption in developing countries. The cotton case in Uzbekistan have shown that due to high government intervention farmers do not have enough platform of possibilities to change their role of primary producers of cotton for the state. It is sometimes the case that the farmers are not being perceived capable of utilizing agricultural knowledge as well as to collaborate with other actors of the chain due to the so called state quota and procurement price system.

However, it is also concluded that neo-liberalism is probably not the best pathway to describe the trajectories of trade liberalization. Instead trade liberalization should be seen as a

continuum, forged and formed by measures and efforts taken by governments at the national level as well as firms at the local level.

Appendix I.



Coffee value chain in Mexico and importer countries. Context of production and relations with processing, exportation, importation, further processing and retail activities are mapped in the central part of the diagram. Series of costs from the farm to the consumer level are considered (central part), as well as the relationships among actors in the chain (left), and upgrading potentials and barriers for adding coffee value at the farmer's level (right part). Relationships between actors and the costs from the farm to the consumer's level were taken from Poole (2001) and Sinclair (2005).

References

Alvarez-Buylla M. E., E. Lazos and J. R. García-Barrios. 1989. Home gardens of a humid tropical region in Southeast Mexico: an example o an agroforestry cropping system in a recently established community. Agroforestry Systems 8: 133-156.

Audebrand, L. K. and T. C. Pauchant. 2009. Can the Fair Trade Movement Enrich Traditional Business Ethics? An Historical Study of Its Founders in Mexico. Journal of Business Ethics 87: 343–353.

Asche, F., O. Flaaten, J. R. Isaksen and T. Vassdal. 2002. Derived Demand and Relationships between Prices at Different Levels in the Value Chain: A Note. Journal of Agricultural Economics 53(1): 101-107.

Ávalos-Sartorio, B. and A. Blackman. 2009. Agroforestry price supports as a conservation tool: Mexican shade coffee. Agroforestry Systems DOI 10.1007/s10457-009-9248-4

Ayenor, G. K, et.al. 2004. Converging Farmers scientist perspective on research constraintson organic cocoa prodction in Ghana: results of a diagnostic study, NJAS: 52-2/4.

Baffes, J. 2005. The "cotton problem". Oxford University Press on behalf of the International Bank for Reconstruction and Development. The World Bank 20: 109-144.

Bair, J. and G. Gereffi. 2001. Local Clusters in Global Chains: The Causes and Consequences of Export Dynamism in Torreon's Blue Jeans Industry. World Development 29(11): 1885-1903.

Boons, F. 2002. Greening products: A Framework for Product Chain Management. Journal of Cleaner Production 10: 495-505.

Brenner, T. 2002. Cities and the Geographies of "Actually Existing Neoliberalism". In: Brenner, Neil, Theodore, Nikolas (eds.). Spaces of Neoliberalism: Urban Restructuring in North America and Western Europe, Oxford. Blackwell Publishers.

Bray, D. B., J. L. Plaza Sanchez and E. C. Murphy. 2002. Social Dimensions of Organic Coffee Production in Mexico: Lessons for Eco-Labeling Initiatives. Society and Natural Resources 15: 429-446.

Celis, F. 1999. Análisis sobre las importaciones de café. En: Revista "Cafés de México" 123: 11-16.

Chapagain, A. K., A. Y. Hoekstra, H. H. G. Savenije and R. Gautam. 2006. The water footprint of cotton consumption: An assessment of the impact of worldwide consumption of cotton products on the water resources in the cotton producing countries. Ecological Economics 60: 186-203.

Calo, M. and T. A. Wise. 2005. Revaluing Peasant Coffee Production: Organic and Fair Trade Markets in Mexico. Global Development and Environment Institute. Tufts University. Medford, USA. 57 p.

Curtis, Glenn, 1996, Uzbekistan A Country Study, Washington : GPO for the Library of Congress, http://countrzstudies.us/Uzbekistan/38.htm (downloaded on 15th of November 2009).

Decree no. 476 of Cabinet of Ministers, 2003 30 October, Appendix-7: Regulations of long term land renting of farmers.

Djanibekov, N. 2008. A Micro-Economic Analysis of Farm Restructuring in the Khorezm Region, Uzbekistan.

Ernst, D. et.al. 2005. Technological Capabilities and export growth. In: Technological capabilities and export success in Asia. Routledge: London.

Engel, P.G.H. 1990. Knowledge Management in Agriculture: Building upon Diversity, Knowledge in Society, The International Journal for Knowledge Transfer, 3,3: 28-35.

Eurostat, 2005. EU Statistical Office, Luxembourg. http://epp.eurostat.cec.eu.int, (downloaded on 20th of November 2009).

Evers H-D., T. Bauer. 2009. Emerging Epistemic Landscapes, K-Clusters in Ho Chi Minh City and the Mekong Delta. ZEF-Working Paper Series No.48, Bonn.

Fageberg, P. 1990. International competitiveness. The Economic Journal 98: 370-371.

Faße, A., U. Grote, E. Winter. 2009. Value Chain Analysis: Methodologies in the Context of Environment

and Trade Research. Discussion Paper No. 429. Gottfried Leibniz University of Hannover, Institute for Environmental Economics and World Trade.
FLO (Fairtrade Labelling Organizations International). 2007. Sales volume of Fairtrade-certified coffee per country 2004/2005. http://www.fairtrade.net
Fromm, I. 2009. Upgraing in Agricultural Value Chains: The Case of Small Producers in Honduras. GIGA Working paper No. 64 December 2007. GIGA German Institute of Global and Area Studies, (downloaded in www.giga-hamburg.de/workingpapers on 17th of November 2009).
Ganeshan, R. E., M. J. Magazine and P. Stephens. 1998. A taxonomic review of supply chain management research. In: Quantitative models for supply chain management, Tayur, S. R (ed.).
Gereffi, G. 1994. Capitalism, Development, and Global Commodity Chains. In: Sklair, L.(ed.). Capitalism & Development.
Gereffi, G. and O. Memedovic. 2003. The Global Apparel Value Chain: What Prospects for Upgrading by Developing Countries? UNIDO, Vienna.
Gereffi, G. 1999. International Trade and Industrial Ugrading in the Apparel Commodity Chain, Journal of International Economics, 48, 37-70.
Giulani, E., C. Pietrobelli, and R. Rabellotti. 2005. Upgrading in Global Value Chains, lessons from Latin American Cluster. World Development 33(4): 549-573.
Gibbon, P. 2001. Upgrading Primary Production: A Global Commodity Chain Approach. World Development 29(2): 345- 363.
González Jácome, A. 2004. Dealing with risk: small-scale coffee production systems in Mexico. Perspectivas Latinoamericanas 1: 1-39.
Grannovetter, M. 1983. The Strength of Weak ties: A Network Theory Revisited. Sociological theory 1: 201-233.
Guerra, G. and C. B. Moss. 2004. Mathematical model for Mexican coffee market. Revista Brasileira de Gestao de Negócios. FECAP 15: 27-33.
Henry, N. and S. Pinch. 2006 Knowledge and Clusters, in Christos Pitelis, et.al (eds.). Clusters and Globalisation. The Development of Urban and Regional Economies, Edward Elgar Publishing Massachusetts.
Hoekstra, A.Y. and P. Q. Hung. 2005. Globalisation of water resources: international virtual water flows in relation to crop trade. Glob.Environ. Change 15 (1): 45–56.
Hornidge, A. 2007. Re-Inventing Society - State Concepts of Knowledge in Germany and Singapore. Sojourn. Journal of Social Issues in Southeast Asia 22(2).
Hornidge A., Ul-Hassan M., Mollinga P.P., 2009. 'Follow the Innovation' - A joint experimentation and learning approach to transdisciplinary innovation research. ZEF-Working Paper Series No.39, www.zef.de/fileadmin/webfiles/downloads/zef_wp/WP39_Hornidge-et-al.pdf (Downloaded on 1st of November 2009).
Humphrey, J. and H. Schmitz. 2002. "How does insertion in global value chains affect upgrading in industrial clusters?" In: Regional Studies 36(9): 1017-1027.
Humphrey, John, Upgrading in global value chain, May 2004, Working paper No. 2of the Policy Integration Department , International labor Office Geneva, www.ilo.org/publns (Downloaded on 10th of November 2009).
Implications for Pricing and Profitability. Review of Quantitative Finance and Accounting 24: 23-45.
Ingram, J. 2008. Are Farmers in England equipped to meet the Knowledge Challenge of Sustainable Soil Management? An Analysis of Farmer and Advisor Views. Journal of Environmental Management 86: 214-228.
International Crisis Group. 2005. The Curse of Cotton: Central Asia's Destructive Monoculture. Asia Report No. 93. http://www.crisisgroup.org/home/index.cfm?id=3294&l=1 (downloaded on: 1st November 2009)
Instituto Maya, A.C. 1999."Estudio de Gran Visión: Café". Commissioned by Fondo Social Banamex.

Kaplinsky, R. and M. Morris. 2002. A Handbook for Value Chain research. http://www.ids.ac.uk/ids/global/pdfs/VchNov01.pdf (Downloaded on 1st of November 2009)

Klibi, W., et.al. 2009. The design of robust value-creating supply chain networks: A critical review. European Journal of Operational Research, doi:10.1016/j.ejor.2009.06.011

Kline, S. J. and N. Rosenberg. 1986. An overview of innovation. In: Landau, R. and N. Rosenberg (eds.). The Positive Sum Strategy: Harnessing Technology for Economic Growth. Washington, D.C. National Academy Press, pp. 275–305.

Kogan, K. and C. S. Tapiero. 2007. Supply Chain Games: Operations Management and Risk Valuation. Springer Science+Business media. LLC, New York.

Kotzab, H., S. Seuring, M. Müller and G. Reiner. 2005. Research Methodologies.

Kuzmits, B. 2006. Cross-bordering Water Management in Central Asia. Conflict Constellations and Ways to a Sustainable Resource Use. ZEF-Center for Development Research, Univeristy of Bonn. Amu Darya Series Paper No 2: 23 p.

Lewis, J. and D. Runsten. 2005. Does Fair Trade Coffee Have a Future in Mexico? The Impact of Migration in a Oaxacan Community. Paper presented at 'Trading Morsels' Conference, Princeton University 3/21/05. 42 p.

Long, N. 2001. Development Sociology, Actors perspective. London: Routledge.

Masera, O., A. D. Cerón and A. Ordóñez. 2001. Forestry mitigation options for Mexico: finding synergies between national sustainable development priorities and global concerns. Mitigation and Adaptation Strategies for Global Change 6: 291-312.

Méndez, V. E. 2008. Farmers' livelihoods and biodiversity conservation in a coffee landscape of El Salvador. In: Bacon, C. M., V. E. Méndez, S. R. Gliessman, D. Goodman and J. A. Fox (eds.). Confronting the coffee crisis: Fair Trade, sustainable livelihoods and ecosystems in Mexico and Central America. MIT Press: Cambridge, U. S. A. pp. 207-236.

Moguel, P. and V. Toledo. 1999. Biodiversity conservation in traditional coffee systems of Mexico. Conserv Biol 13(1): 1-21.

Morrison, A., and R. Rabellotti. 2005. Knowledge and Information networks, evidence from an Italian Wine Local System. Working paper No. 174, downloaded in http://www.cespri.unibocconi.it, Centro di Ricerca sui Processi di Innovazione e Internazionalizzazione, Università Commerciale "Luigi Bocconi".

Nagarajan, M. and G. Sosic. 2006. Game-theoretic analysis of cooperation among supply chain agents: Review and extensions. European Journal of Operational Research 187: 719-745.

Nonaka, Ikujiro, Toyama, Ryoko, 2002. A Firm as a Dialectical Being, Towards a Dynamic Theory of a Firm, Industrial and Corporate Change, Volume 11, No.5, 995-1009.

Nooteboom, B. 2003. Problems and Solutions in Knowledge Transfer. In: Fornahl, D. and T. Brenner (eds.). Cooperation, Networks and Institutions in regional Innovations Systems. Edward Elgar Publishing Ltd, UK.

Pardey, P.G, et.al., 2006, Agricultural Research and development in the Developing World : Too Little Too Late, Washington DC : International Food Policy research Institute

Pérez-Grovas, G, V. 1998. Evaluación de la sustentabilidad del sistema de producción de café orgánico en la Unión Majomut en la región de los Altos de Chiapas. Universidad Autónoma Chapingo. Chapingo, Estado de México. 96 p.

Perfecto, I., J. Vandermeer, A. Mas and L. Soto-Pinto. 2005. Biodiversity, yield, and shade coffee certification. Ecol. Econ. 54: 435-446.

Perfecto, I., R. A. Rice, R. Greenberg and M. E. Van der Voort. 1996. Shade coffee: a disappearing refuge for biodiversity. BioScience 46: 598–608.

Polanyi, M. 1967. The Tacit Dimension. London: Routledge and Kegan Paul.

Ponte, S. 2001. The 'Latte Revolution'? Winners and Losers in the Restructuring of the Global Coffee Marketing Chain*. Centre for Development Research. Working Paper 01.3, Copenhagen. 35 p.

Porter, R. 2000. Politico-Economic Restructuring and Mexico's Small Coffee Farmers. In: Tardanico and Rosenberg (eds.). Poverty or Development: Global Restructuring and Regional Transformations in the U.S. South and the Mexican South. New York, NY: Routledge.

Radhakrishnan, S. and B. Srinidhi. 2005. Sharing Demand Information in a Value Chain.

Raikes, P., M. F. Jensen and S. Ponte. 2000. Global commodity chain analysis and the French filiere approach: comparison and critique. Economy and Society 29: 390-417.

Renard, M-C. 1999. Los intersticios de la globalización. Un label (Max Havelaar) para los pequeños productores de café. Centre Français d'Etudes Mexicaines et Centroaméricaines (CEMCA). México, D. F. 340 p.

Rice, R. A. 2001. Noble goals and challenging terrain: organic and fair trade movements in the global marketplace. Journal of Agricultural and Environmental Ethics 14: 39–66.

Rice, R. A. and J. R. Ward. 1996. Coffee, Conservation, and Commerce in the Western Hemisphere. Washington D.C.: Smithsonian Migratory Bird Center & Natural Resources Defense Council.

Rudenko, I. 2008. Value Chains for Rural and regional development, the Case of Cotton, Wheat, Fruit and vegetable Value Chains in the Lower reaches of the Amu Darya River, Uzbekistan., Ph.D Dissertation, University of Hannover.

Rabellotti, R. 2004. Recovery of a Mexican Cluster: Devaluation Bonanza or Collective Efficiency. Working Paper 71.

Roeling, Niels, Fliert, Elske, 1994, Transforming Extension for Sustainable Agriculture : The Case of Integrated Pest Management in Rice in Indonesia, Agriculture and Human Values.

Saliola, F. and A. Zanfei. Multinational Firms, global value chains and the organisation of knowledge transfer. Research Policy 38: 369-381.

Salukvadze, J. 2008. Good governance and natural resources tenure in Eastern Europe and CIS Region. Tbilisi State University, Georgia. FAO Land Tenure Working Paper 3. 66 p.

Sengenberger, W. and F. Pyke. 1991. Small firms, industrial districts and local economic regeneration. Labour and Society 16(1): 1-25.

Simpson, C. R. and A. Rapone. 2000. Community Development From The Ground Up: Social-Justice Coffee. Human Ecology Review 7(1): 46-57.

Sinclair, K. 2005. To Make a Living out of Coffee. Conventional versus Sustainable Coffee. Master Thesis. School of Business Economics and Law. Göteborg University. 49 p.

Snyder, F. 1999. Governing Economic Globalisation: Global Legal Pluralism and European Law. European law journal 5(4): 334-374.

Strickman, R. and M. Porkka. 2008. Water and social changes in central Asia: problems related to cotton production in Uzbekistan. In: Rahaman, M. M. and O. Varis (eds.). Central Asian Waters. Water & Development Publications - Helsinki University of Technology. pp. 105-115.

UNEP. 2005. Aral Sea. GIWA Regional Assessment 24. University of Kalmar, Kalmar, Sweden.

Turocy, Stengel, 2001, Game Theory, CDAM Research report, LSE/CDAM/2001/09, http://www.cdam.lse.ac.uk/Reports/Files/cdam-2001-09.pdf (downloaded in 1st of November 2009).

Thun, J.H., 2005. The Potential of Cooperative Game Theory for Supply Chain Management. In: Research Methodologies in Supply Chain Management. Kotzab H., Seuring S., Mueller M., G. Reiner (Eds.), Physica-Verlag, Heidelberg, pp. 477-491.

Valkila, J. and A. Nygren. 2009. Impacts of Fair Trade certification on coffee farmers, cooperatives, and laborers in Nicaragua. Agric Hum Values DOI 10.1007/s10460-009-9208-7.

Van der Hoff, F. 2009. The Urgency and Necessity of a Different Type of Market: The Perspective of Producers Organized Within the Fair Trade Market. Journal of Business Ethics 86: 51–61.

Velasco, A. 2002. The Dustbin of History: Dependency Theory. ForeignPolicy.com http://www.foreignpolicy.com/Ning/archive/archive/133/dustbin.pdf), (Downloaded on 1st of November 2009)

Veldwisch, Geert Jan Albert, 2008, Cotton, Rice & Water: The Transformation of Agrarian Relations, Irrigation Technology and Water Distribution in Khorezm, Uzbekistan, Ph.D Dissertation University of Bonn.

Vorley, B. and T. Fox. 2004. Global food chains—Constraints and opportunities for smallholders. IIED Draft Prepared for the OECD DAC POVNET Agriculture and Pro-Poor Growth Task Team, Helsinki Workshop 17-18 June 2004. 33 p.

Woodruff, C., 1997, Trade Associations and Coalition Bargaining with Incomplete Contracts, mimeo, San Diego: University of California.

Wall, C. 2006. Knowledge Management in Rural Uzbekistan: Peasant, Project and Post-Socialist perspectives in Khorezm. Ph.D Dissertation in University of Bonn.

Williamson, O.E., 1999. Strategy research: Governance and Competence Perspective, Strategic Management Journal 20:1087-1108.

World Bank, 2007. Agriculture for Development: World Development Report. The World Bank, Washington DC.

World Bank, 1998. World Development Report 1998. Washington, DC: World Bank. Available from: www.worldbank.org [Accessed in 15 April 2009].

Yue Wah Chay, et.al. 2005. What Makes Knowledge Sharing in Organisation Tick- an Empirical Study. In: Evers, H-D (ed.). Governing and Managing Knowledge in Asia.