The Agricultural Innovation System of Azerbaijan: An Assessment of Institutional Linkages

Tuğrul Temel
Willem Janssen
Fuad Karimov

ISNAR Country Report 64

International Service for National Agricultural Research

International Service for National Agricultural Research (ISNAR)

ISNAR, one of the 16 Future Harvest Centers supported by the Consultative Group on International Agricultural Research (CGIAR), seeks to contribute to the generation and use of knowledge that fosters sustainable and equitable agricultural development. ISNAR's mission is to help bring about innovation in agricultural research institutions to increase the contribution of research to agricultural development for the poor.

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ISNAR conducts its work on institutional innovation through the following six thematic areas of work:

- Policies for institutional innovation for agricultural research
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About the authors

Tuğrul Temel is a Research Fellow and ***Willem Janssen*** is the Director of the Research Program, at the International Service for National Agricultural Research (ISNAR). ***Fuad Karimov*** is a Researcher of the Agency for Support to the Development of the Agricultural Private Sector, under the Agricultural Research Board of Azerbaijan

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ABBREVIATIONS AND ACRONYMS

ASCA	Agrarian Science Center of Azerbaijan
ADB	Asian Development Bank
ADCP	Agricultural Development and Credit Project
ADPMA	Agricultural Development Project in Mountainous Areas
AFPU	"Azer-Forest" Production Unit
AIS	Agricultural Innovation System
ARB	Agricultural Research Board
AS	Academy of Sciences
ASDPAS	Agency for Support to the Development of the Private Agricultural Sector
AzAA	Azerbaijan Agricultural Academy
CGS	Competitive Grants System
CIMMYT	International Center for Maize and Wheat
EAF	"Euro-Asia" Fund
ERS	Economic Reform Center
FPP	Farm Privatization Project
FAO	Food and Agriculture Organization of the United Nations
HDSREPT	Head, Dept. of Scientific Research, Education, and Personnel Training
IARC	international agricultural research center
ICSC	Information and Consulting Services Center
IDA	International Development Association
IDU	Information Dissemination Unit
IFAD	International Fund for Agricultural Development
ISNAR	International Service for National Agricultural Research
GTZ	German Technical Support Society
MoA	Ministry of Agriculture
MoE	Ministry of Education
MoED	Ministry of Economic Development
MoF	Ministry of Finance
MoT	Ministry of Taxes
nAPC	non-agricultural private colleges
nASC	non-agricultural state colleges
NARS	national agricultural research systems
NGO	nongovernmental organization
NGOF	nongovernmental organization foundation
PACF	private agro-consulting firms
PrU	private universities
PVO	private voluntary organization
RES	regional experimental stations
RI	research institutes
SAC	state agricultural colleges
SCEN	State Committee for Ecology and Nature Use
PCSEC	Permanent Commission for Science, Education, and Culture
SCAR	State Commission for Agrarian Reforms
SCADPF	State Commission for Assistance to Development of Private Farms
SSF	state seed farms
SAIC	State Amelioration & Irrigation Committee
SLC	State Land Committee
SU	state universities
SCST	State Committee on Science and Technology
SCC	State Customs Committee
TACIS	Technical Assistance Committee for Independent States
UNDP	United Nations Development Program
USAID	United States Agency for International Development
WB	World Bank

EXECUTIVE SUMMARY

Since independence in 1991, Azerbaijan has had to contend with severe adverse developments including civil unrest, the dismantlement of inter-republic trade links, and economic blockade by its neighbors. Slow progress has been recorded with respect to the country's efforts to build institutions and establish markets with proper infrastructure, while it has received increasing attention for its rich oil reserves. Rural development in general, and agriculture in particular, have been neglected. New private-sector farmers have been oriented toward subsistence farming and have experienced declining productivity and incomes. In addition, poverty has become widespread. Promoting agricultural innovation should help the agricultural sector get out of this vicious circle. The following observations provide insights into the workings of the current agricultural innovation system (AIS), pinpoint its weaknesses, and identify areas that need to be strengthened.

Key observations

The components of the AIS – policy; research; education; credit; extension and information; input supply, processing, and marketing; farm organization; consultancy; and external assistance – are at an early stage of development.

The policy component is functioning poorly. Government bodies related to agricultural production, science, and technology need to establish national policies and priorities. This requires a vision for agricultural development and qualified human resources to implement it. Research is undergoing major structural, institutional, and organizational changes. Research priorities need to be established, funding mechanisms developed, and agricultural research organizations reduced in number. The research organizations need qualified human resources, financial sources, and access to knowledge and information on new technologies.

Two patterns are emerging in the education component. First, owing to the positive developments in the oil sector, students are leaning toward oil engineering, chemistry, geology, and similar fields. Second, private educational institutions are attracting quality teachers, inducing competition in the sector. Many teachers and professors work at both private and public universities. The reorganization of agricultural education needs to be supported with new regulations.

The extension and information component needs to be strengthened to provide an inventory of the agricultural knowledge and information that is in great demand at the policy level. The public sector should play a more active role in this, as the social benefits of such services outweigh their private benefits. International organizations and private-sector enterprises are the most dynamic units involved in information diffusion activities.

Private consultancy firms and public information dissemination units operate independently of each other. The private-sector firms are essentially motivated by externally funded projects. Significant progress is reported regarding their client linkages, procedures, financial resources, and program planning and output. The public units are established in the Ministry of Agriculture as extensions of the old information dissemination department.

Input supply, processing, and marketing firms are not specialized yet. Many of the about 20 input supply firms currently operating have grown out of pre-independence cooperatives. Most of these firms engage in producing seeds; importing seeds and plant protection materials; processing seeds; and marketing. They also provide training and extension services

to farmers on how to cultivate crops and use agricultural chemicals. In addition, many state-owned processing firms are awaiting privatization.

International companies dominate the cotton sector, engaging in production, processing, and marketing. These companies sign contracts with small landholders, providing them with inputs for cotton production in return for the output. They also provide extension services covering the use of chemicals, water, etc.

Private-sector input supply firms are gradually making their presence felt, specializing largely in supplying seeds and plant protection materials. In most cases large farms produce, process, and market the crop. Since cotton is mainly exported, cross-border problems and difficulties with monetary transactions are very pressing problems for these producers.

Large farms could play a considerable role in diffusing new technologies, as, being the only farms motivated by profits, they undertake production, processing, and marketing activities. They benefit from their structural suitability to the irrigation infrastructure and relatively easy access to other farm inputs and from their close connections with experiment stations of research institutes. This is in contrast to small farms, which lack everything, and, most important, do not produce enough for their owners to think about farming for markets.

Large farms obtain information on new varieties from experts in research institutes and international agencies. The role played by the extension and information unit in the Ministry of Agriculture is negligible. Inputs such as pesticides, agricultural chemicals, and fertilizers are obtained from private-sector suppliers, who often give field demonstrations of their use.

Large farms have contacts with researchers at experiment stations of research institutes, and together they engage in problem diagnosis and technology development. Personnel are also exchanged. The farms establish relations with input supply firms and enterprises, and in a few cases through project implementation they establish relations with international organizations that offer new seed varieties and new farming techniques.

Consultancy firms are like amoebae in the area of agricultural innovation. They have specialized and tacit knowledge, and with their skilled and energetic staff they are capable of quickly adapting to changing conditions. Therefore, they play a pivotal role, facilitating the effective operation of international organizations. But they lack a proactive approach to business, floating around in accordance with the needs of these organizations; hence, they strongly depend on subcontracts with international organizations.

Within the context of joint projects, these firms familiarize farmers with new regulations and procedures, help them prepare business plans, get involved in public awareness dialogues on the interactions between agriculture and the environment, and provide extension services covering new seed varieties. They supply knowledge that has until recently been confined to academies and research institutes. Furthermore, their constantly increasing number implies that the market for knowledge is growing.

These firms use a wide range of sources to learn about innovation-related developments in the country. They obtain information from policymakers, research institutes, universities, computer-based information sources, and professional meetings. They also learn about changes in the market through their connections with large private-sector processing and marketing firms.

While extensive efforts are being made to restructure and reorganize the banking system, no strategic plan appears to have been implemented to finance the agricultural sector. Preparations are underway to merge the Agro-Industry and Security Banks to create a Universal Bank, but the new bank is unlikely to extend credits to private-sector farmers. Recently, the government of Azerbaijan established an oil fund to help mobilize resources for the rural sector in general and the agricultural sector in particular.

International organizations, which include a variety of international development agencies, donors, and nongovernmental organizations (NGOs), have been the key entry point for new or improved knowledge, processes, and practices. National bodies are exposed to international standards through joint project-based activities,. These activities usually involve private consultancy firms, as they have relatively better human and physical resources and flexible organizational structures. Public entities, however, have been slow in adapting to international standards due to organizational rigidities, continuing organizational changes, and lack of qualified human resources. Furthermore, international organizations expose the country to new processes. However, an incomplete and weak legal framework hinders their performance, and local conditions seem largely unfavorable to international organizations.

Conclusions

The essential components of the AIS are at an early stage of development, and policymaking, research and education, and credit institutions have yet to show significant achievements. In particular, to facilitate knowledge flow between the public and private components of the system, emphasis is needed on the formulation of public policy, science and technology institutions, and the development of intermediary institutions.

The public-sector components have to be strengthened with sectoral priorities, clear organizational mandates and objectives, qualified human resources, physical and financial resources, and motivation to initiate interactions with the private sector. On their part, the private-sector components should take a more proactive approach to participating in the process of technological change. Currently, private, public, and external organizations operate mostly as stand-alone units, and hence a framework to facilitate speedy interaction between them needs to be developed.

Intermediary institutions, such as marketing associations, farmers' organizations, trade and commerce organizations, and platforms for constructive dialogue, which are still in their infancy, deserve more attention for the integration of the AIS components.

An up-to-date agricultural knowledge and information system is required to set agricultural research priorities and to develop science and technology strategies. The private-sector components of the system also need such an information system to enable them to make informed decisions.

Financing mechanisms should be established and coupled with general guidelines provided for agricultural, science, and technology policies. In this regard, the allocation of resources that have started to accumulate in the newly established oil fund should be based on these guidelines.

I. INTRODUCTION

Much has been written about the transition from a command economy to a market economy in Azerbaijan. The underlying observation commonly stressed in policy dialogues is that Azerbaijan has experienced severe adverse developments after independence in 1991. Civil unrest, the dismantlement of inter-republic trade links, and the economic blockade by neighboring countries were the harsh realities faced during the 1991-95 period. After 1995, the situation improved gradually, both politically and economically, giving the government an opportunity to accelerate reforms that had been adopted in 1992. The land distribution process seems to have been completed, at least in the eyes of policymakers; a framework has been prepared for privatization of state-owned enterprises; and several important oil agreements have been signed with international companies. Most recently, to give an impetus to rural development, the government has established an oil fund to generate resources for the rural sector, reduced the number of rural taxes, and prepared a legal framework for enabling land transactions.

Currently, the focus is on building institutions.[1] Legal changes introduced only two years ago are now taking root in the economy. These changes have contributed considerably to the development of private enterprises such as input supply firms, processors, marketing agents, extension and information units, nongovernmental organizations (NGOs), consultancy firms, and farm organizations. Public-sector components of the economy, in particular government bodies responsible for the design and implementation of agricultural, science, and technology policies, are still undergoing changes in their organizational structure. The changes offer opportunities for external assistance organizations to participate in the process of institution building. As they introduce new technologies, organizational structures, and processes, these organizations are most likely to be key actors in shaping the future of the agricultural sector. Currently, private, public, and external organizations operate mostly as stand-alone units, and hence there is a need to prepare a framework to facilitate interaction between them. The effective implementation of such a framework would require further investment in enforcement of laws and regulations, and construction of infrastructure, especially in rural areas.

Although recent developments are favorable in general, policymakers are worried that the attention given to the oil sector is at the expense of agriculture. But, even with a growing oil sector, agriculture can contribute significantly to overall economic development if the inherited knowledge infrastructure of Azerbaijan can be adapted to the needs of emerging markets. At the moment, the most promising strategy for achieving this is investment in the development of agricultural knowledge generation, diffusion, and application processes (OECD 1999b; European Commission 2000), and design and implementation of policies for synergic interactions between agents involved in these processes.

Agricultural research, though an essential element of the system, is not enough to realize this interaction. Production requires more than mere generation of agricultural knowledge; it requires linkages to be established between market and nonmarket institutions; it requires channels to be established through which the existing knowledge can flow freely into areas where it can be used effectively. Therefore, this study seeks to examine the current status of such linkages and channels in the agricultural innovation system of Azerbaijan.

[1] Institutions are defined as formal rules and informal constraints that govern economic and social activities.

Objectives of this study

ISNAR started to work in Central Asia and the Caucasus (CAC) in 1997, and from early 2000 it conducted a series of studies to examine the agricultural innovation systems (AIS) of countries in the area. The current study aims to

1. describe and analyze the main components of the AIS of Azerbaijan;

2. identify the main priorities that the public-sector components of the AIS should address, in light of what the private-sector components of the AIS are expected to do, and

3. recommend changes in the functioning of the public-sector components to increase the effectiveness of the AIS.

More specifically, the study focuses on the following dimensions:

1. *Institutional dimension*: What are the key institutions in the AIS? What are their main activities in general, and in what aspect of innovation? How is their governance and oversight arranged? How are they financed and managed?

2. *User dimension*: How are agricultural producers and traders integrated into the overall innovation system?

3. *Organizational dimension*: How are the different institutions interacting with each other, and what types of coordination mechanisms are in place?

4. *Technological dimension*: On which type of innovation activity does each of the involved institutions concentrate?

5. *Socioeconomic dimension*: What implications do changes in economic activities and demography have for the necessary and expected types of innovations?

6. *Political and regulatory dimension*: How are the political system and legal framework changing, and what implications do they have for innovation activities?

Rationale and policy relevance

Knowledge, embodied in new technologies and in human beings, has always been central to economic development; therefore, theories of economic growth have concentrated on the determinants of knowledge accumulation. The new growth theory stresses the significance of knowledge accumulation from investment in new technologies and human capital (Romer 1986, 1990, 1994; Aghion and Howitt 1998). Evolutionary and industrial economics claims that this accumulation is path-dependent, nonlinear, and shaped by the interplay of market and nonmarket institutions (David 1975; Nelson and Winter 1982; Metcalfe 1995). And institutional economics emphasizes the role of institutional arrangements in enhancing the capability of organizations to deal with issues of specialization and competitiveness (North 1995).

These theories are all organized around two emerging trends in the world economy. First, technological innovations are becoming an ever more important contributor to economic growth, and countries with markedly different patterns of national technological specialization are experiencing persistent differences in their long-run growth (OECD 1999b). Second, national economies are becoming increasingly open and increasingly interdependent. The two

trends are not unrelated. Rapid communication and close contacts between innovators in different countries facilitate the process of innovation and the spread of new ideas. And rapid changes in technology intensify the motives for trade and the consequences of integration into the world trading system. It is not surprising, therefore, that increasing attention is being paid to issues of productivity and technology on the one hand, and to international competitiveness and the world trading system on the other.

Two convictions drive the current study. First, that innovation (new ideas, new knowledge) occurs almost everywhere in society. Second, that innovation is largely the result of a complex set of relationships between agents who produce, distribute, and apply various kinds of knowledge (European Commission 2000). As a result, bringing together the diffuse elements of a collective system of knowledge creation and use should significantly improve the innovation performance of a country.

The systems approach adopted in this study is rooted in the view that interactions between knowledge-generating and knowledge-using agents are as important as direct investment in R&D, and that science is necessary, but only part of the whole innovation process. This approach is a systemic method to present qualitative information about such interactions. With the systems approach, policymakers should be able to identify the existing cause-effect interactions between the interconnected agents in the agricultural sector, and hence, design effective science and technology policies to improve the capability of the main channels to transfer knowledge. Furthermore, an understanding of the agricultural innovation system would help policymakers identify leverage points for enhancing the innovation performance and overall competitiveness of the agricultural sector, detect mismatches within the system, and develop alternative scenarios or mechanisms to release the constraints on innovation in agriculture.

This report is divided into eight sections. Section 2 discusses recent developments in the agricultural sector. Section 3 describes the questionnaire used for data collection and notes several limitations faced during the interviews. Section 4 introduces a conceptual framework and explains graph-theoretic concepts used in analyzing the structure of linkages between actors. On the basis of the information collected, Section 5 describes the roles of organizations in each component of the innovation system, analyzes the emergent linkages, and pinpoints the key constraints faced by organizations. Section 6 uses graph-theoretic concepts to analyze the structure of linkages. Section 7 makes suggestions on how to improve the innovation system. Finally, Section 8 presents the conclusions.

II. DEVELOPMENTS IN THE AGRICULTURAL SECTOR[2]

Azerbaijan today presents a mixed picture. Although progress is being made in the area of institution building, the economic situation is not altogether favorable. First, Gross Domestic Product (GDP) doubled between 1990 and 2000, but agriculture's share of GDP declined from 34 percent to about 18 percent during that period. Second, while exports of oil and oil products have markedly increased, accounting for almost 80 percent of total exports, traditional export markets for cash crops (processed cotton, grapes, and tobacco) have been lost and imports of food and agricultural products (mostly wheat, wheat flour, sugar, and meat products) have increased significantly. Furthermore, war with Armenia has resulted in one million internally displaced people who need food, shelter, and employment.

[2] The data in this section were obtained from ARKTN (2000) and SSCRA (2000).

These adverse developments might be the outcomes of more serious difficulties at the sectoral and farm levels. At the sectoral level, 66 percent of total farm land is still held by the state and municipalities, and this has hindered the efficient operation of the agricultural sector. Furthermore, investment in agriculture has been decreasing continuously, reaching zero in 2000.[3] At the farm level, excessive land fragmentation,[4] together with the nature of the irrigation infrastructure, which addresses the needs of large farms, has made agriculture unattractive for small and medium farmers. In addition, widespread malfunctioning of the irrigation channels has exposed large tracts of land to serious salinity. Since more than 80 percent of production is carried out on irrigated land, the significant decline in agricultural production should not come as a surprise. Moreover, most farm equipment is unusable and rural credit has dwindled to nothing.

Fortunately, the options for agricultural development have not yet been exhausted. One possibility is to concentrate on the agroprocessing sector, which promises spin-offs in other spheres of economic activity. Further privatization of state agroprocessing enterprises will increase market transparency and strengthen the demand at farm level.[5] Another option is to promote regional cooperation and to invest in establishing an enabling environment to attract foreign direct investment. Peace with neighboring countries,[6] construction of an effective legal framework for contractual arrangements, a private property rights system to ensure the growth of private enterprises, and investment in market infrastructure are all essential to achieve that. Once these elements are established, it should not be difficult for a marketing and service sector to develop quickly. These two options are not unrelated. They both demand a careful study of characteristics of national and regional markets and a thorough analysis of constraints on and potential for specialization in products that can compete abroad. And again, both demand a restructuring and reorganization of the agricultural research system as they entail implications for the development of new research programs.

III. DATA COLLECTION

It should be stated from the outset that a 20-day mission to Baku, Azerbaijan is not enough to fully characterize the agricultural innovation system; however, it should be enough to obtain an overview. Therefore, this report should be seen as an attempt to identify weak linkages in the innovation system so that they can be strengthened. Given the number and the nature of the interviews conducted for this study, the results cannot be used to design specific policies for individual components of the system.

The questionnaire in the Appendix was used to interview 63 persons. It is divided into five sections.[7] Section 1 builds up an organizational profile, including information on the respondent, classification of his/her organization, and internal and external factors that influence organizational performance. Section 2 characterizes innovation activities, asking for information on types and goals of activities, sources of knowledge about innovations, funding mechanisms, and factors that constrain the activities. Section 3 focuses on linkages that

[3] This is in contrast to investment in industry, which has steadily increased, reaching US$ 314 million (65 percent of gross investment) in 2000.

[4] The average farm size is 7 hectares (ARKTN 2000).

[5] ARKTN (2000) reports that, of 53,780 registered enterprises, 75 percent and 25 percent are in the private and public sectors, respectively. Some large enterprises (in communications, construction, and light industry, as well as some social complexes) have been privatized, but the majority are still awaiting privatization. While these numbers suggest significant achievement in privatization, it is not clear who owns these enterprises now.

[6] With the recent elimination of customs duties, trade with the Russian Federation is expected to increase.

[7] The English version of the complete questionnaire is given in the Appendix. The Russian version is available on request.

organizations develop during the innovation process, with special emphasis on the strength of the linkages, linkage mechanisms used, and constraining factors. Section 4 characterizes the most recent innovation(s) developed diffused or used by the respondent's organization. Section 5 seeks information on the science and technology policy in place. It should be noted that the questions in Sections 1, 2, and 3 were asked to all interviewees, while those in Sections 4 and 5 were asked only when relevant. In analyzing the questionnaires, the authors have utilized national statistics from the literature in order to place the respondents' answers in a broader framework.

Having reviewed the literature on innovation systems, the authors first compiled a general list of actors that are likely to take part in an agricultural innovation system. This list was revised in Azerbaijan after consultations with the director and deputy director of the Azerbaijan Agrarian Science Center. The authors interviewed 7 policymakers, 12 directors of agricultural research institutes, 5 professors and graduate students, 1 credit institution director, 4 extension and information specialists, 8 directors of private-sector input supply, processing, and marketing enterprises, 10 farmers from large and small farm organizations, 11 directors of private consultancy firms, and 5 project managers of international development agencies. Because of inconsistencies in some of the questionnaires, only 63 questionnaires were used for the analysis.

Three limitations considerably changed the nature of the study. The original intention was to investigate agricultural innovation, but in some cases the interviewees did not understand the concept of an innovation system. Therefore, the focus could only be on overall changes in the components of the innovation system instead of on specific innovation activities. Thus, no conclusions can be drawn about specific innovations or innovation activities. A second problem was that, when asked about their innovation-related linkages with other actors and the constraints that hindered their innovation activities, the respondents simply tended to report all their linkages and all the constraints faced, irrespective of their nature. Finally, several respondents were not at liberty to talk, although they held relevant offices. Therefore, their questionnaires are not included in the final report.

IV. A CONCEPTUAL FRAMEWORK

There is no single definition of a national innovation system (NIS). But there is a commonality in the existing definitions, which is the premise that a NIS constitutes the market and nonmarket institutions in a country that influence the direction and speed of innovation and technology diffusion (OECD 1999b). In the literature on innovation systems, some definitions are referred to more often than others. For example, Freeman (1987) defines a NIS as the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify, and diffuse new technologies. Nelson (1993) defines a NIS as a set of institutions whose interactions determine the innovative performance of firms. Metcalfe (1995) defines it as a set of distinct institutions that jointly and individually contribute to the development and diffusion of new technologies, and which provides the framework within which governments form and implement policies to influence the innovation process. As such, it is a system of interconnected institutions to create, store, and transfer the knowledge, skills, and artefacts that define new technologies. Smith (1996) stresses that the innovative performance of an economy depends not only on how the individual institutions perform in isolation, but also on how they interact with each other as elements of a collective system of knowledge creation and use, and on their interplay with such social institutions as values, norms, and the legal framework.

While the above definitions seem to be quite similar, there are some differences in the meaning, emphasis, and use of the concept. The key difference is that some view the concept as a simple aggregation of institutions, while others point to the synergies that originate from their joint operation. Our point of departure is the view that the innovation system is not a simple aggregation of organizations but a group of agents who operate like an *invisible orchestra*. The members of the orchestra play different parts of the score with an underlying harmony linking them. This orchestra can be characterized by coherence, harmony, and synergy: coherence brings different pieces together with the same melody; harmony creates a tune that keeps the orchestra members playing with the same spirit; and synergy ties the members more strongly around the common goal.

Innovation systems also exist at the sectoral level. On the basis of the above definitions, the authors have adopted the following definition of the agricultural innovation system in this report:

An agricultural innovation system is a set of agents (i.e., farm organizations; input supply, processing and marketing enterprises; research and education institutions; credit institutions, extension and information units, private consultancy firms, international development agencies, and the government) that contribute, jointly and/or individually, to the development, diffusion, and use of new agricultural technologies, and that influence, directly and/or indirectly, the process of technological change in agriculture.

Graph-theoretic concepts

This study adopts the systems approach as a conceptual framework to characterize patterns of innovation activities of different organizations (e.g., firms, banks, universities, and public and private research institutes, NGOs), patterns of interactions between them, and factors constraining their interactions. This approach assumes that learning takes place in many parts of the system, and that knowledge generated in one place can be diffused to other places through active linkages between the organizations and between people.

Graph-theoretic techniques (Hudson 1992; Richardson 1999) are used to investigate the key features of the AIS of Azerbaijan. First, the links between the nine components of the AIS, as implied by the data collected through the questionnaires, are identified. Then, using these links, a cause-effect structure is established and possible clusters (or subsystems) and interaction pathways (Cormen, Leiserson, and Rivest 1990; Pearl 1995; Spirtes, Glymour, and Scheines 1996) are detected. Finally, suggestions are made to enhance the workings of the AIS.

Concept 1 (An Interaction Matrix)[8]
Suppose that the AIS under investigation is organized around the objective of developing, diffusing, and applying new or improved technologies. And suppose further that it consists of five actors: policymakers (P), research and education institutions (R), extension and information units (E), farm organizations (F), and external assistance organizations (A). Interactions between the five actors are described following the clockwise convention. First, the actors are located in the diagonal and binary (or one-to-one) interactions between them in the off-diagonal cells of the matrix AIS[o]. The term PR placed in the cell corresponding to the first row–second column of AIS[o] denotes that actor P interacts with actor R, and that P is the initiator of this interaction. Likewise, the term RP in the cell of the second row–first

[8] The key advantage of representing complicated graphs in matrix form is that matrix algebra lets us examine the underlying characteristics of the system. The controllability, solvability, and decomposability of the system can all be studied once the graph is converted to matrixes.

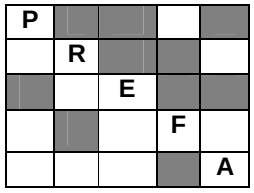
column denotes that R interacts with P, and that R is the initiator of the interaction. Binary interactions in AIS[o] represent one-edge paths since these interactions take place between two actors only and do not involve any intermediate actor(s). The notation PR, for example, represents a one-edge path denoted by P→R since P directly influences R.

$$\text{AIS[o]} = \begin{bmatrix} P & PR & PE & PF & PA \\ RP & R & RE & RF & RA \\ EP & ER & E & EF & EA \\ FP & FR & FE & F & FA \\ AP & AR & AE & AF & A \end{bmatrix}$$

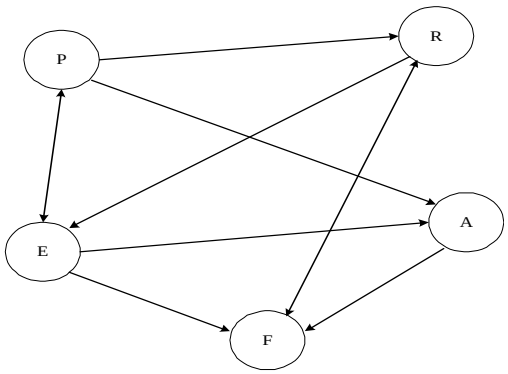
Concept 2 (A Coded Interaction Matrix)
The binary interactions in AIS[o] are coded with 1 if the interaction exists and is important to the investigation, and with 0 if either the interaction does not exist or the investigator is unable to identify it, or if it exists at a negligible level. Let us fill the matrix AIS[c] with arbitrarily chosen codes:

$$\text{AIS[c]} = \begin{bmatrix} P & 1 & 1 & 0 & 1 \\ 0 & R & 1 & 1 & 0 \\ 1 & 0 & E & 1 & 1 \\ 0 & 1 & 0 & F & 0 \\ 0 & 0 & 0 & 1 & A \end{bmatrix}$$

or



According to the codes in AIS[c], P influences (R, E, A); R influences (E, F); E influences (P, F, A); F influences R only; and finally, A influences F only. Note that P influences R but not the other way around. This is manifested by 1 in the first row–second column and by 0 in the second row-first column. Similarly, F does not influence A but A influences F, which is manifested by 0 in the fourth row–fifth column and by 1 in the fifth row–fourth column. What is implied by this coding convention is that interactions in AIS[c] are directional and not necessarily symmetric. The following *directed graph* (or *digraph*) is another way of representing the same information as in AIS[c], but then it is very difficult to see the underlying patterns. The digraph consists of five vertices (or actors) (P, R, E, F, A), and assumes an implicit function that translates the interactions into real values: 1 or 0.



Concept 3 (Qualitative Coding)
Binary interactions are assigned (+) or (-) signs depending on the nature of one actor's influence on another. For example, RF in AIS[q] takes 1, indicating that the activities of R influence F positively. In contrast, the code -1 in the cell FR indicates that the activities of F influence R negatively. Such situations might easily arise in real life. For example, research and education activities might target improved living conditions for farmers, but farmers' irresponsiveness to research would hamper research capacity. Such asymmetry is not always the case. In some cases, agents show consistent behavior. Such consistencies occur especially in systems where relations between agents are controlled by some kind of authority.

$$\text{AIS[q]} = \begin{bmatrix} P & 1 & -1 & 0 & 1 \\ 0 & R & 1 & 1 & 0 \\ 1 & 0 & E & 1 & -1 \\ 0 & -1 & 0 & F & 0 \\ 0 & 0 & 0 & 1 & A \end{bmatrix}$$

Concept 4 (Binary Interactions versus Pathways of Interactions)
P→R is a binary interaction but P→E→F→R is a pathway of interactions between P and R. Within the context of AIS[c], the former one-edge interaction represents a direct contact between P and R, while the latter three-edge interaction represents a pathway of contacts between P and R. According to this pathway, P influences E, which then influences F, which then influences R. The choice between one-edge and three-edge interactions depends on the values assigned to each edge in AIS[c]. Let us suppose that we have AIS[v]:

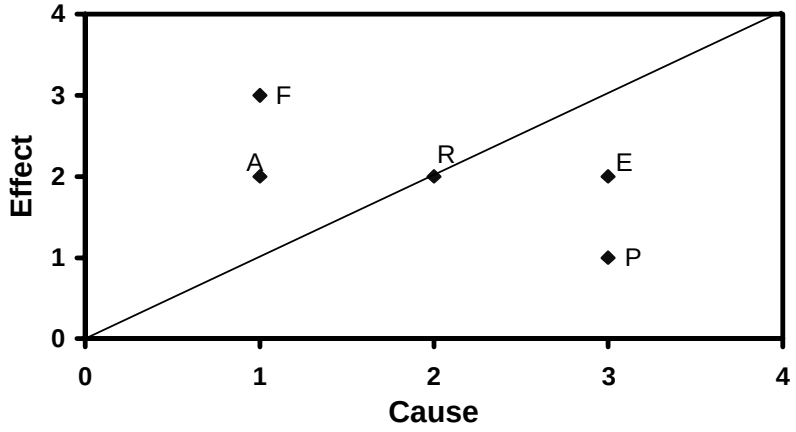
$$\text{AIS[v]} = \begin{bmatrix} P & 3 & 1 & 0 & 1 \\ 0 & R & 1 & 2 & 0 \\ 2 & 0 & E & 3 & 4 \\ 0 & 5 & 0 & F & 0 \\ 0 & 0 & 0 & 1 & A \end{bmatrix}$$

Implicit in the coding of AIS[v] is the assumption that each component has an objective function and a set of constraints, and that a common decision made by a component influences other components' performance. We further assume that these cross-component influences (i.e., binary influences) can be quantified by an implicit function. Once these assumptions are satisfied, analysis of the interactions can be conducted as follows. In AIS[v], the binary relation P→R has a value 3, and P→E→F→R has a value 9, which is the sum of values assigned to each edge: that is, 1 is assigned to P→E, 3 to E→F, and 5 to F→R. If the objective is to maximize (minimize) the influence, then the pathway P→E→F→R (the binary relation P→R) will be the optimal choice. It should also be noted that AIS[c] can have at most four-edge paths since the system has only five actors.

Concept 5 (A Cause-effect Structure)
What is the underlying cause-effect structure embedded in AIS[c]? Put simply, which agents in the system are sources of influence and which ones are sinks? To answer this question, we need to define the terms "cause" (C) and "effect" (E). The cause of an agent is defined as the sum of codes in the relevant row of AIS[c], and the effect of others on an agent is defined as the sum of codes in the relevant column of AIS[c]. The following cause-effect coordinates (C, E) are calculated: (3, 1) for P, (2, 2) for R, (3,2) for E, (1, 3) for F, and (1, 2) for A. Figure 1

shows the underlying cause-effect structure, where P is the key source, while F is the key sink in the system. This means that the management of AIS[c] can to a large extent be handled by focusing only on P and F.

Figure 1. A cause-effect structure of AIS[c]



Concept 6 (Density of the Cause-Effect Structure)
The density, d, of the cause-effect structure is calculated as $d=b/[n(n-1)]$ with $1 \geq d \geq 0$, where b denotes the total number of existing binary interactions, and n is the number of dimensions of AIS[c]. Given this definition, the density of AIS[c] is 0.5, where b=10 and n=5. Fully identified structures will have d=1, implying that all the agents are connected to each other.

Concept 7 (A Cluster)
A cluster is a subset of actors that have close cause-effect coordinates. The cause-effect diagram is a useful tool for detecting clusters in the system. This concept, especially useful in a system with a large number of actors, helps us identify subsystems and examine their characteristics.

Weaknesses of the methodology

This approach has two main weaknesses. First, it is not a theoretical construct and needs to be extended to examine the relationships between actors within a component in order to provide insights into the dynamics of inter-component interactions. Second, at present, the interactions are all qualitative, which does not let us measure the effects of a specific policy (or strategy). Establishing quantitative measures of policies (or strategies) and testing specific hypotheses might be possible with the theoretical formulation of objectives and constraints of each component in the system. This implies that the systems approach needs to be reformulated as a mathematical model if the effectiveness of policies (or strategies) is questioned. The need for quantitative measures of interaction is obvious, especially when rare but influential interactions take place between the components in the AIS. An interaction may only be infrequent and yet of crucial importance, while some, such as committee meetings, may occur frequently but be of low importance.

V. THE KEY COMPONENTS OF THE AIS IN AZERBAIJAN

Drawing on the interview results, this section gives an overview of the nine components of the AIS in Azerbaijan: policy; research; education; credit; extension and information; input supply, processing, and marketing; farm organization; consultancy; and external assistance. More specifically, it describes organizations' profiles, their system linkages, and their constraints. The interview results are also blended with data from official documents.

Component 1. Policy

The policy component of Azerbaijan's AIS comprises five key units: (i) the State Committee for Science and Technology (SCST), (ii) the Ministry of Agriculture (MoA), (iii) the Ministry of Education (MoE), (iv) the Ministry of Finance (MoF), and (v) the Ministry of Economic Development (MoED). In addition, each of these units has several operational committees and commissions that perform specific tasks to support the formulation of agricultural policy in general and agricultural research policy in particular. For example, the State Land Committee and State Amelioration Committee also play a role in agricultural policy formulation.

Organizational profiles

The SCST, which was established in 1993, supports formulation of science and technology policy. It performs several functions: coordinating all the science- and technology-related activities of ministries, committees, and state joint-stock companies; preparing priority research themes; organizing teams to conduct research; managing the information system, and supervising patent-license activities. Depending on the national priorities set, it can approve research programs and projects prepared by research institutes and academies. The Committee approves all budgets for these activities, while the MoF provides the funds.

The MoA is not alone in supporting the Cabinet's formulation of national agricultural policy. The task is performed by several other committees or commissions as well. This is not surprising, given that all the units within the policy component are constantly undergoing structural change. The result is that mandates and tasks within and across units often overlap, causing managerial and organizational inefficiencies and slowing down the decision-making process. The MoE not only provides support in formulating national educational policy, but also coordinates all educational entities and governs all educational activities. The MoF supports the Cabinet in the formulation of national budgetary policy. And the MoEc supports the Cabinet in the formulation of economic policies.

As noted above, several commissions and agricultural units also contribute to the formulation of agricultural policy. Some work directly under the Cabinet, while others communicate directly with the Parliament. For example, the State Commission for Agricultural Reforms, the State Commission for Assistance to Agricultural Private Farm Sector Development, and the Agro-Industry Unit are responsible to the Cabinet, while the Commission for Agricultural Policy works in cooperation with the Parliament.

Key observations

The science and technology infrastructure is not functioning effectively. The main reason for this is the absence of clear direction at the national level, with a corresponding absence of national priorities. A second reason is the frequent changes in science- and technology-related entities, which are mostly motivated by short-term survival needs. In such an environment, it

is unrealistic to expect institutions to effectively utilize their existing resources (especially human resources).

Institutions involved in policy are currently going through major reorganization and are therefore excessively fragmented. New tasks and new organizational linkages are assigned to the departments and/or units in the ministries, in some cases creating overlapping mandates and slowing down day-to-day operations. The SCST is currently paralyzed by the absence of science and technology priorities at the national level and lack of qualified human resources at the organizational level. The MoA and MoE are also undergoing major reorganization related to the coordination of agricultural research and education institutes, and management of information dissemination activities.

Public organizations are in serious need of more and better-quality human, physical, and financial resources. Human resources and infrastructural facilities, such as buildings, computers, and office appliances, are lacking. Joint use of facilities by the public organizations is impracticable because they all lack resources.

Component 2. Research

Organizational profiles

The research component of the agricultural innovation system consists of 26 research institutes. Of these, 15 come under the Agrarian Science Center (ASC) of the MoA, six under the Academy of Sciences, three under the Committee for Water Economy, one under the Committee for State Land, and one under the "Azer-Forest" industrial amalgamation.

The ASC was established in 1999 and coordinates the research programs and activities carried out by its 15 institutes. Research is carried out on the MoA's 20,000 hectares of land, at its experiment stations, base stations, and subsidiary experiment farms. The dissemination of the institutes' research outputs is coordinated by the MoA's Information Dissemination Unit.

The other 11 research institutes do not yet have clearly defined relations with the ASC. Although the SCST is supposed to coordinate research programs of all research institutes in the country, no initiative is taken to address the problem of a two-headed agricultural research system.

Project-based research programs and funding

The Agency for Support to the Development of the Private Agricultural Sector (ASDPAS) was established in late 1996 to manage projects initiated by donors and international development agencies. The ASDPAS is directly responsible to the State Commission for Assistance to Agricultural Private Farm Sector Development. Currently, ASDPAS manages three projects. The Farm Privatization Project (FPP), which started in 1996 and was co-financed by IFAD and the WB (US$ 30 million), has three components: land registration, irrigation, and credit. The Agricultural Development and Credit Project (ADCP), which started in 2000 and is scheduled to go on till 2010, is funded by the WB and the government of Azerbaijan (at US$ 133 million) and has five components: land registration, information and consulting services, credit, veterinary services, and rural policy. Reform of the competitive grants system and knowledge system is a subcomponent of information and consulting services. Finally, the Development of Mountains and Highlands Project (DMHP), fully funded by IFAD, will start in 2001 and operate for 10 years in seven regions of Azerbaijan.

The Agricultural Research Board (ARB) was formed in March 2000 to coordinate the reform of the competitive grants system and knowledge system. The Board is directly responsible to the State Commission for Assistance to Agricultural Private Farm Sector Development. What is important is that, on the basis of the agricultural priorities set, grants will soon be available for research on a competitive basis, that the research institutes of the ASC and other public institutes are supposed to submit research proposals, and that the Secretariat of the ARB is to monitor the funded projects.

Existing linkages

After 1991, research institutes lost their clients and entered a period of financial difficulty. As a result, they were forced to use their resources to generate income for operations. Typically, experiment stations that belong to the institutes are used to produce, process, and then market seed. With these market-oriented activities, the institutes have developed relations with private seed supply and plant protection companies. They have also maintained close ties with large private farms and state farms. In addition, experts at the experiment stations have, from time to time, developed relations with international organizations within the context of joint projects.

Constraints and opportunities

The problems identified in this study remain essentially the same as those documented in ISNAR (1997). Let us take the external problems first since they are the most important. To begin with, research priorities have not yet been set at the NARS level. Second, although recognized by the government, funding mechanisms to support rural development and hence agricultural research, are not clear. Third, parallel to the excessive fragmentation at the policy level, the agricultural research component is overly divided into separate bodies and this makes it very difficult to manage and coordinate the institutes. Fourth, the excessively labor-intensive institutes have become pockets of hidden unemployment. There are more external problems that could be added to this list.

The internal problems of the research institutes are equally serious. Just about everything is inadequate for production of useful research outputs. The institutes need a mandate, qualified personnel, sources of finance, and access to knowledge and information about new technologies. With limited financial resources and too many (and most of the time unqualified) personnel, it is unrealistic to expect new programs to be initiated. In the past, even when financial resources were available, around 70–75 percent were allocated to staff salaries and only around 9 percent to research activities.

Yet, there is still some scope for improvement at the individual institute level. With the competitive grants that will be available soon, research institutes will have the chance to show their research capacity, but this capacity cannot be used effectively if the institutes are viewed only as employment centers. The Government expects reform of agricultural research to focus on the amount and quality of research work done. Its analysis has identified a need for research institutes in the areas of sericulture, viticulture, and fruit and vegetable farming to be reorganized according to the needs of the country. Finally, given the problems mentioned earlier, the research institutes can use existing resources (experiment stations, breeding farms, land, and farm equipment) more efficiently.

Component 3. Education

There are 42 universities (25 public, 17 private) and 77 colleges (73 public, 4 private) in Azerbaijan. All educational institutions are under the supervision of the MoE. Public universities are financed from the budget, and in 1999 their share was 24.6 percent. Two patterns are emerging in the education sector. First, owing to the positive developments in the oil sector, students are leaning toward oil engineering, chemistry, geology, and similar fields. Second, private educational institutions are attracting quality teachers, inducing competition in the sector. Many teachers and professors work at both the private and public universities.

Recent developments and organizational profiles

Prior to independence, the Head Department of Scientific Research, Education, and Personnel Training (HDSREPT) of the MoA was responsible for the administrative coordination of all educational institutions and for the management of all education programs. Currently, the HDSREPT is undergoing heavy reorganization. By presidential decree, the MoE is expected to assume full responsibility for all educational institutions, including 21 agricultural colleges and one agricultural academy that used to be under the control of the MoA. According to its mandate, the agricultural academy should engage in both teaching and research (mostly theoretical). The colleges are expected to engage in both teaching and applied research. The MoA will still supervise postgraduate education through the HDSREPT. Every year, a total of 8-10 postgraduate students are accepted by the 15 research institutes of the ASC. In addition, Azerbaijan State University and other engineering and technical universities have several agriculture-related faculties.

Established in 2001, the Agricultural Education Department of the MoE is responsible for administratively coordinating the agricultural education institutions and preparing their curriculum. The HDSREPT provides administrative coordination of education and training programs, and advises the MoA on the formulation of agrarian science strategy and administrative coordination of research programs. For example, the Agrarian Science Center was created at the suggestion of this Department.

Key observations

Several adverse developments are likely to occur in the future. First, the quality of education in the agricultural colleges will probably be jeopardized because experiment stations, pilot farms, and other applied research facilities are still under the control of the research institutes of the ASC of the MoA, depriving the colleges of the facilities to conduct field studies. Second, the reorganization of agricultural education needs to be supported with new procedures, regulations, and system linkages, but continual change at the policy level signals limited support in the future. Finally, the education component has developed relations with international organizations.

Constraints

Given that the entire education component is under reconstruction, constraints are abundant. At the ministerial level, linkages are not well defined, creating communication problems between the MoE and the MoA. Unclear roles and tasks at the departmental level slow down daily operations. In addition, these departments are organizationally very rigid. Lack of qualified personnel, low mobility of experts among related departments, lack of appropriate sources of finance, and inadequate access to information are among the other problems in education. Externally, the education component of the agricultural component is adversely

influenced by an unclear agricultural education policy. The lack of priorities in the area of education only increases the already existing frustration.

Component 4. Extension and information services

Organizational profiles.

The Information and Consulting Services Center (ICSC) was established in 2000 within the framework of the ADCP managed by the ASDPAS. Its task is to coordinate information and extension services specified in the ADCP, and its main activities are carried out at its regional branches. These branches provide extension services to people with land but without farming skills, and to those without knowledge of how to prepare business plans, which are needed to apply for credits or loans. Another activity of the Center, again through its branches, is to disseminate research results of projects implemented within the context of the competitive grants program. The Center has recorded progress, especially in the area of organizational structure, human and physical resources, information flows, program planning, and output. Recent changes in the legal system, promoting private consultancy services, are also regarded as forward-looking.

The Information Dissemination Unit (IDU) of the MoA was established in 1998 to coordinate the flow of agricultural knowledge at the national level. The IDU supports the introduction of new techniques or methods for gathering information about the current status of farming activities, provides extension services to farmers, and disseminates information about new techniques. In recent years, progress has been made regarding its objectives, procedures, client linkages, resources, and program. Improved external conditions that are likely to strengthen organizational performance in the near future are also reported.

Private enterprises are also active in the information and extension services sector. They are promoted indirectly by the ADCP and the FPP activities managed by the ASDPAS. Several water-user associations, agribusiness firms, and agro-consulting centers have emerged around the pilot study areas of the ADCP and the FPP. Two examples of these enterprises are the Farm Progress Center for International Scientific and Technical Co-operation; and the Ganja Business Group. According to representatives of these enterprises, significant progress has been made in the areas of their client linkages, procedures, financial resources, and program planning and output.

Key observations

There is a need to analyze current and emergent trends in the agricultural sector, but the existing agricultural knowledge and information is ineffective. Also, users and decision makers need a systematic approach to managing the knowledge and information, but financial support is lacking.

Until now, project-based extension activities have been used to meet current needs and demand. International organizations have given impetus to the growth of extension and information services through project-based activities. These activities have quickly attracted private companies. Equally important are informal extension services provided by seed and plant protection companies aiming to increase market opportunities. A final actor in this area is the IDU of the MoA. Its services have been relatively slow in developing due to long administrative procedures and financial difficulties. These diverse and independently initiated efforts indicate the importance of extension services to the agricultural sector, while at the same time pointing to the need for organizing the services around common ground. Since

such services currently promise much higher social than private benefits, the public sector should play a more active role in providing them.

The funding sources for information and extension services are diverse. The activities of the IDU are financed from the government budget, those of private companies through client contracts, subcontracts with international organizations, and sometimes through their own resources. Project-based activities are funded by international development agencies.

The actors and/or tools involved directly or indirectly in the diffusion of information and knowledge are also diverse. Experts in research and education institutions, professional meetings, international networks, computer-based information services, and mass communication media (TV, press, and radio) are commonly utilized for knowledge distribution.

Growing linkages

The first and foremost channel is the one that brings together extension experts and farmers around project-based activities. Private consultancy firms have been established as a spin-off from these activities. International organizations are the major players in this channel, bypassing the policy component, private consultancies, farmers, and several research institutes. Typically, they engage in activities such as planning and review, technology diffusion, exchange of personnel, and sharing of information. The second channel, which is kept partly active, is the old one between the IDU of the MoA and large farms (which were cooperatives before independence). Problem diagnosis, program planning and review, and joint resource use are among the most commonly practiced linkage mechanisms by the players in this channel.

Constraints

International organizations and private enterprises are the most dynamic units actively involved in all kinds of information diffusion activities. The obstacles most commonly faced by these units include the organizational rigidities and long administrative procedures in government offices. Weak cooperation between private and international organizations and farmers' lack of interest in extension services are the second most common obstacles. Equally important are internal problems such as poor quality of personnel, inadequate access to market information, and inadequate sources of finance.

Component 5. Private-sector input supply, processing, and marketing

Market structure

In Azerbaijan, firms do not yet specialize in input supply, processing, or marketing. Typically, a firm engages in all three activities. As many as 20 input supply firms currently operate in the market. Some of the firms grew out of the pre-independence cooperatives, while others are newly established, and their increasing number should bring about specialization in the near future.

With a total of 1,759 agricultural enterprises presently under the Ministry of State Property for Privatization, the processing sector is waiting for further initiatives to accelerate the privatization, consolidation, and reform processes. Currently, 1,121 of the enterprises are involved in the following activities: food processing (114 in grapes, 40 in canneries, 33 in meat and dairy products, 19 in cotton, and 14 in tea), weaving (540), and leather processing

(98). A total of 42 canneries are to be privatized. The food industry currently accounts for 12.9 percent of the total labor force. A relatively speedy privatization has occurred in the cotton sector with all 19 cotton-processing plants now in private hands. These private companies provide farmers with everything they need to cultivate cotton: seeds, plant protection means, fertilizer, gas, etc.

Meat and milk products are important in the diet of the Azeri people. Forty percent of total household food spending goes on milk and dairy products, and 26 percent on meat and meat products. Recent developments in this sector are not as significant as its vital role would suggest, although the market for dairy products shows some progress. Joint ventures are the dominant form of business, initiated especially by multinational companies.

Market developments

Examples of firms that have grown out of pre-independence cooperatives include a joint-venture seed marketing firm and two plant protection material supply firms. They all engage in producing seeds, importing seeds and plant protection materials, processing seeds, and marketing activities. They also provide training and extension services to farmers on how to cultivate crops and use agricultural chemicals.

The story is different in the cotton sector. Two international companies keep full control over cotton production, processing, and marketing. They engage in contractual arrangements with farmers, supply all the required inputs for cotton production, and buy the raw cotton. They also provide extension services since cotton demands continuous attention from farmers in terms of chemical use, watering, etc. After the harvest, the raw cotton is processed in their processing plants and the final product is exported through their marketing connections.

Trends

Five trends are apparent in the private input supply and marketing sector. First, private input supply firms are gradually making themselves known, specializing largely in the supply of seeds and plant protection materials. This trend is consistent with the general orientation of the agricultural sector, where many farmers concentrate on wheat and vegetable growing for their own consumption. Second, in most cases large farms operate like firms. They perform as producers, processors, and middlemen. Third, monopolistic cotton companies engage in the complete chain of cotton production. The chain starts from contractual arrangements with farmers: inputs are provided to cotton farmers, in rare cases irrigation channels are rehabilitated, raw cotton is harvested and processed and then sold in the world market. Fourth, international companies transmit new varieties of seeds (grains, vegetables, cotton) and of chemicals, pesticides, and herbicides. Finally, all of the firms, in one way or another, engage in extension services such as field demonstrations of input use.

Growing linkages

The passage of a law on the privatization of state-owned enterprises has led to the emergence of private firms. Their linkages with other entities around them depend on the way the firms have emerged and on the type of product they are interested in. For example, firms that grew out of the pre-independence cooperatives continue to have relations with research institutes of the MoA. Their only new relations are with international input supply companies. In this connection, these firms have developed “intimate” relations with the Seed Quality Control Unit of the MoA, owing mostly to the importation of seeds from abroad.

These firms' dominant pattern of relations includes linkages with research institutes, operational offices at the Ministry (like the Quality Control Unit), international seed supply firms, and farmers. They engage in joint problem diagnosis activities with experts from the research institutes, field demonstrations and training sessions with customers, and the preparation of TV programs and of information booklets for farmers.

Constraints

Two types of factors constrain the activities of the firms. One relates to their internal environment. Interestingly, none of the firms' representatives interviewed acknowledged any internal weaknesses, although they suffer from a severe lack of qualified personnel and physical resources (e.g., computer-based information sources and storage facilities), information on market developments, and up-to-date managerial skills. The second group of constraining factors is external. Among the commonly voiced complaints are (i) high customs duties and cross-border difficulties with Russia and Armenia, (ii) long procedures for seed quality control, (iii) farmers' lack of interest in and poor capacity to utilize new seed varieties, (iv) lack of mechanisms (e.g., workshops and seminars) to obtain information on international markets, and (v) a weak legal framework for contractual arrangements, land ownership, and monetary transactions.

Cotton producers face a somewhat different situation, since they are all international firms. The cross-border problems and difficulties in monetary transactions are more pressing for them owing to the fact that they can only sell their products in the world market. Executives of the firms have direct relations only with top-level bureaucrats, international input supply firms, and farmers.

Component 6. Farm organizations

Farm structure

There are two types of land ownership in Azerbaijan: private and public. Private ownership comprises six groups: households, farmers' holdings, collective enterprises, leased enterprises, production cooperatives, and small enterprises. Only 32 percent of total agricultural land (4,469,345 ha) has been allocated for private use, while 68 percent belongs to the state and municipalities (table 1). Of the 4,469,345 ha, the land allocated for crop production is approximately 1,782,994 ha, of which only 950 ha is actively used at present: 70 percent by households, 12 percent by farmers, 7.4 percent by collective enterprises, 6.3 percent by state agricultural enterprises, 2.6 percent by production cooperatives, 1.1 percent by small enterprises, and 0.9 percent by leased enterprises (ARKTN, 2000; SSCRA, 2000).

Table 1. Breakdown of Land Tenure and Use in Azerbaijan

	Total land		Agricultural land		Arable land	
	ha	%	ha	%	ha	%
Private sector	1,654,647	19.0	1,442,643	32.3	1,218,306	75.7
State	4,840,191	56.0	1,885,044	42.2	293,227	18.2
Municipalities	2,146,668	25.0	1,141,658	25.5	97,891	6.1
Total	8,641,506	100	4,469,345	100	1,609,424	100

Average farm size at the national level is 7.2 ha, excluding farmland allocated to households. The average size of state farms is 449 ha, of nongovernment agricultural enterprises 42 ha

(the figure is 37 ha for collective farms, 98 ha for leased enterprises, 95 ha for production cooperatives, and 21 ha for small enterprises), and of private farms only 4 ha. A large majority of private farms and information and consultation centers are clustered around three pilot districts (Zagatala, Masalli, and Khizi).

The composition of overall agricultural production (61 percent crops, 39 percent livestock) remained unchanged after independence, but a remarkable shift has been observed within these subsectors recently. Cereal production rose from 8 percent of all crops in 1990 to 43 percent in 1999, while the production of cotton, grapes, and tobacco decreased considerably. In the livestock subsector, the share of milk production in total animal products increased from 29 percent in 1990 to 51 percent in 1999, while production of meat, which declined by 50 percent over the period, accounted for 40 percent of total animal products in 1999 (ARKTN, 2000; SSCRA, 2000).

Patterns

Large farms can play a considerable role in the diffusion of new technologies as they undertake production, processing, and marketing activities simultaneously. They benefit from their structural suitability to the irrigation infrastructure and relatively easy access to other farm inputs on the one hand, and their close connections with experiment stations of research institutes on the other. Such connections, a legacy from the past, strengthen their close links with policy units of the government. Several of the owners interviewed identified positive changes in their client linkages. This is only a reflection of the subsistence orientation in farming. In contrast to large farms, small farms lack everything and, most important, do not produce enough for their owners to think about farming for markets. They also lack the knowledge and skills required for market-oriented farm production. Under these circumstances, they can only grow crops and livestock for own consumption.

Small private farmers in the cotton sector obtain two benefits from being exposed to new imported machines: exposure to new technologies and learning new business procedures (such as leasing, formal relations with financial organizations, and contracts with producers) that govern transactions in competitive markets.

Growing linkages

Large and small farms have different linkages and problems. A majority of farms privatized in 1993 were large, since they were the first wave to break away from the old kolkhozes (state-owned farms). The managers of these kolkhozes often bought the farms that they had been operating for years. Naturally, their pre-existing ties with the policy; research and education; input supply, processing, and marketing components were maintained. Furthermore, with independence they developed links with international organizations. In contrast, small farms are a simple expansion of garden plots in most cases, and so their relations are often with large farm operators. The existing regional farm associations are not active. Even if they were active, they would be likely to address the needs of large farms, because the associations are controlled by large-farm operators. In fact, very often these operators initiate such associations.

Large farms obtain information about new varieties from experts in research institutes and international agencies. The role that the extension and information unit in the MoA plays is negligible. Such inputs as pesticides, agricultural chemicals, and fertilizers are obtained from private input suppliers, and very often these firms demonstrate the ways to use these inputs optimally.

Large farms have contacts with researchers at experiment stations of research institutes, and together with them are engaging in problem diagnosis, technology development, and exchange of personnel. On the education side, they have informal contacts with graduate students and professors. They develop relations with input supply firms and input supply enterprises, and in rare cases through project implementation they develop relations with international organizations that offer new seed varieties and new farming techniques. With such organizations, these farms are involved in joint program development, problem diagnosis, technology demonstration, training, and information sharing.

Constraints

External difficulties are playing a major role. Large farms complain about the cross-border difficulties in importing seeds and about the lengthy seed quality control process. Marketing is also difficult due to customers' lack of knowledge about the imported new seed varieties. Further problems are caused by the underdeveloped market infrastructure (roads, transport, communications, etc.) and the excessive economic risk involved. The weaknesses of large farms identified by interviewees include inadequate farm management skills and lack of access to information sources.

A different picture is found in the cotton sector. Cotton processing and marketing firms complain that the infrastructural conditions are not suitable for cotton farming, that cotton farmers do not comply with the terms of contracts, and that the banking sector is not efficient in monetary transactions relating to the payment of wages and the transfer of money abroad. These farmers, for their part, complain that they are trapped into cotton farming, and that the legal system is too weak to protect them from producers.

Component 7. Private consultancy services

Market developments

A law allowing private consultancy firms was passed in 1998. As many as 35 firms have been established since then, many of which employ academics, researchers, and postgraduate students. Their activities are growing through opportunities offered by international development agencies and donors, and the areas of focus include agriculture, ecology, and agribusiness.

Most of these firms are spin-offs growing around the "Information and Consulting Services" component of the ADCP, which is jointly executed by the International Development Association and the Government of Azerbaijan. This component seeks to help farmers find appropriate sources of credit and to prepare business plans, but these activities cannot be conducted without knowledge of farmers' problems and possible solutions. This is the entry point for the consultancy firms. They aim to provide all kinds of services to farmers, ranging from preparing business plans to problem diagnosis.

Emerging trends

Several trends are emerging in this sector. First, the majority of consultancy firms have already developed project-based relations with international development agencies and donors. Second, the majority have one foot in the private sector and the other in the public sector. Third, they do not engage in joint activities with public organizations, although for some such relations are unavoidable since their investigative focus is the environment. Fourth, they are all relatively new and, therefore, still formulating their objectives and activities.

Typically, a consultancy firm develops relations with international organizations and the ASDPAS. The firms rarely consider jointly executing projects themselves, even though there is a need for it. This is mainly due to their lack of knowledge and expertise in preparing research proposals as well as their inadequate international and national linkages.

The firms are like amoebae in the field of agricultural innovation. They have specialized and have tacit knowledge. With skilled and energetic staff, they are capable of quickly adapting to changing conditions. Under the circumstances, they play a pivotal role, facilitating effective operation by international organizations. But they lack a proactive approach to business and float around in accordance with the needs of these organizations; hence, they strongly depend on subcontracts with international organizations.

Within the context of joint projects, they familiarize farmers with new regulations and procedures, help them prepare business plans, involve themselves in public awareness dialogues on the interactions between agriculture and the environment, and provide extension services covering new seed varieties. They supply knowledge that has until recently been locked in academies and research institutes. Furthermore, their constantly increasing number implies that the market for knowledge is developing.

Growing linkages

These firms have developed linkages with five types of organizations. Their immediate linkage is with the ASDPAS, characterized by joint program development, review, and evaluation. The second is with international organizations, characterized by joint program development, joint technology diffusion, and information and financial resource sharing. The third is with agricultural research institutes, characterized by joint program development, technology diffusion, and joint use of facilities and staff rotation. The fourth is with farmers, characterized by joint problem diagnosis, priority setting, and technology demonstration and diffusion. And finally, through their relations with farmers, they also develop linkages with private input suppliers, processors, and marketing agents.

These firms utilize a wide range of sources to learn about innovation-related developments in the country. They obtain information from policymakers, research institutes, universities, computer-based information sources, and professional meetings. They also learn about changes in the market through their connections with large private processing and marketing firms.

Constraints

External factors are regarded as the main constraining factors. These include a lack of clear agricultural priorities, farmers' weak response to developments in the market, low public awareness of environmental problems, and long administrative procedures. Among internal factors constraining their performance are inadequate access to market information, inadequate international linkages, weak client linkages, and the lack of proactive research. It is important to note that their weakening client linkages are related to the lack of a proactive approach to business. Currently, the consultancy sector is attracting a significant number of people, lowering the chances of headhunting. It is likely that, in the near future, market pressures will induce better quality consultancy services, which will be proactive and invest in the development of their organizational capacity.

Component 8. Agricultural credit

Recent developments

Extensive efforts are made to restructure and reorganize the banking system. By the end of 1999, this system comprised 70 banks, down from 180 in 1995. Four state-owned banks dominate the system, basically extending loans to public enterprises. For the last two years, no credit has been provided to the agricultural sector. The remaining state-owned banks continue to suffer from low and even negative equity, reflecting their deteriorating loan portfolios. The 66 private banks also continue to be in a precarious state (IMF 2000).

At present, it appears that no strategic plan has been implemented to finance the agricultural sector. While preparations are underway to merge the Agro-Industry and Security banks to create a Universal Bank, the new bank is unlikely to extend credit to private farmers. Most credits and/or loans are expected to flow to the industrial sector. Recently, the government of Azerbaijan established an oil fund to help mobilize resources for the rural sector in general, and to the agricultural sector in particular. It also reduced the number of taxes to one (land tax), which ranges between US$5 and 25 per year. The expenditures by international agencies such as TACIS (US$ 16 million) and the WB (US$ 28 million) are mostly project-oriented and limited in scope.[9]

Farmers normally have the "effective right" to use land as collateral, land titles, access to credit (if there is any), and a rural insurance scheme. The law allows land to be used as collateral, but land parcels under private farming are too small for this purpose. Land seems to be the only asset with which poor farmers can secure a small amount of credit, but they need the skills to prepare business plans before they can get credit. The rural insurance system is very useful in securing investment in farming.

Component 9. External assistance

International organizations, which include a variety of international development agencies, donors, and nongovernmental organizations (NGOs), have been the key entry point for new or improved knowledge, processes, and practices. Through joint project-based activities, national bodies are exposed to international standards. These activities usually involve private consultancy firms, as they have relatively better human and physical resources and have flexible organizational structures. Public entities, however, have been slow in adapting to international standards due to organizational rigidities, continuing organizational changes, and lack of qualified human resources.

International organizations very often engage in project-based capacity-building activities. Together with national counterparts, they carry out activities such as the optimal application of agricultural chemicals, preparation of official documents (such as land registration documents), provision of advisory services (such as the preparation of business plans, which are required to apply for credit), and (rarely) the testing of new varieties of seeds. The capacities acquired by new farmers are expected to place them in an advantageous position in the land market and credit operations in the near future.

[9] In the past, some credit was distributed within the context of several pilot studies carried out by the WB, IFAD, the IMF, and other international organizations. For example, during 1997-99, the WB provided credit for institutional changes. While neither agricultural nor rural credit is available currently, it is expected to be provided soon within the framework of the ADCP.

Growing linkages

Three types of linkages exist between international organizations and other actors. First, formal relations are developed with policy units in order to legitimize the goals of the projects undertaken by these organizations. Meetings with local and national policy units are among the key linkage mechanisms used. Second, direct interactions are developed with project beneficiaries. Close contacts are developed with farmers by organizing training programs for promotion of new farming techniques and agribusiness practices. These usually take place in the localities of the participants. Meetings with the beneficiaries are held for feedback. Third, formal and informal relations are growing with private market participants (input suppliers, processors, marketing agents, agribusiness consulting firms, agricultural communication units). Program outputs are disseminated through newsletters, memos, and TV programs.

Constraints

Azerbaijan currently needs exposure to new processes as much as to new products. International organizations expose the country to new processes. However, the incomplete and weak legal framework hinders their performance. The existing legal framework does not fully address the problems of Azerbaijan. Around one million internally displaced people (IDPs) are the center of attention for international NGOs and development agencies, and their immediate needs require quick decisions that for the most part call for legal permission. However, slow, unclear, and strict procedures in public offices undermine the effectiveness of these organizations.

Local conditions seem largely unfavorable to international organizations. These organizations typically carry over their original organizational structures to the country under investigation and, to a large extent, adapt to local conditions. They have clear mandates and policies but face daunting difficulties in meeting the need for qualified personnel. They also experience serious difficulties in joint program planning because of low capacity for this in counterpart institutions. However, in the last couple of years, the situation seems to be improving with regard to client linkages, qualified human resources, and joint program planning. There are still constraints in external conditions, however.

The effectiveness of these linkages is hampered by various factors. Communication difficulties with policymakers and insufficient local capacity for project collaboration are at the top of the list. Externally, the collaborating parties' inadequate material and financial resources, and the weak legal system constrain the activities of international organizations.

Table 2 (henceforth referred to as the interaction matrix) summarizes the interactions discussed in this section. The types of interactions between the components of the AIS and the linkage mechanisms used in these interactions are placed in the off-diagonal cells of the matrix. The first row of the matrix presents the information obtained from actors in the policy component. It shows the mechanisms and the ways in which actors in this component influence the rest of the system. The second row indicates how the research component influences the rest of the system. Information placed in the columns of the matrix indicates by which mechanisms others in the system influence the policy component. The thick arrows show the direction of influence. Table 3 presents the key factors constraining the interactions of individual components and the effective use of linkage mechanisms.

Figure 2, adapted from OECD (1999b), shows the organizational structure of the AIS. Organizations are classified under six functions: general policymaking (F1), R&D performance (F2), policy formulation, coordination, supervision and assessment (F3),

technology diffusion (F4), financing R&D (F5), and technology application (F6). This figure helps us visualize the organizations with similar roles and linkages between them. For example, organizations in the first layer perform only two functions: F1 and F2; those in the second layer perform only two functions: F2 and F3. The *Ministries and Committees* box shares the first and second layers at the same time, implying that the organizations within this box perform functions F1, F2, and F3. Equally important is the type of link between organizations implied by unidirectional and bidirectional arrows. The box at the bottom of the figure includes private agents, all of which are involved in technology application.

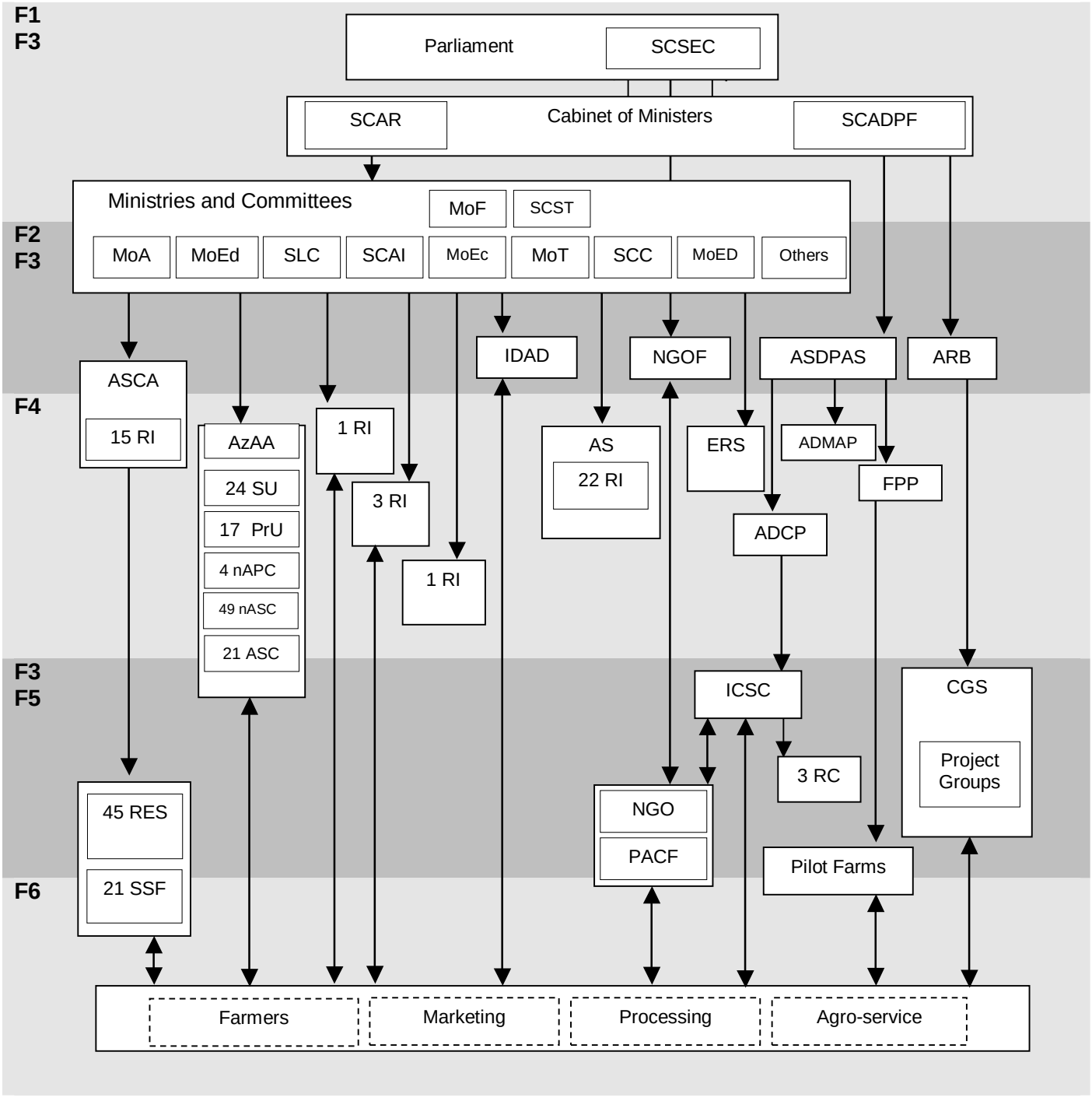
Table 2. Linkage Matrix

Policy Component (P) (Reorganization)	**Formal & weak**	**Formal & weak**	**Formal & weak**	**Mixed & weak**				**Formal & medium** Priority setting Programe devel. & review
Formal & weak	**Research Component (R) (Reorganization)**	**Formal & weak**		**Mixed & weak**	**Mixed & medium**	**Informal & medium**	**Informal & medium** Information sharing Problem diagnosis Technology diffusion Exchange of staff	**Formal & weak** Workshops/seminars Information sharing Personnel training
Formal & weak	**Formal & weak**	**Education Component (E) (Reorganization)**				**Informal & weak**	**Informal & medium**	**Formal & weak** Workshops/seminars Information sharing
Formal & weak			**Credit Component (C) (Reorganization)**					**Formal & weak**
Formal & medium Information sharing	**Formal & medium** Information sharing			**Extension and Information Component (I)**		**Formal & medium** Program developmnt Problem diagnosis Priority setting Tech diffusion/demon Training	**Formal & medium** Program developmnt Tech. diffusion Info&finance shraring Workshops Seminars	**Formal & weak** Tech. diffusion & demonstration Information sharing
Formal & medium	**Informal & medium**				**Private Enterprise Component (M)**	**Mixed & medium** Tech. demonstration Training		**Mixed & weak** Program developmnt Tech. developmnt Workshops
Informal & medium Information sharing	**Informal & medium** Information sharing Problem diagnosis Technology diffusion Exchange of staff	**Informal & weak** Information sharing			**Mixed & weak** Tech. demonstration Training	**Private Farm Component (F)**		
Informal & medium Information sharing	**Informal & medium** Information sharing Problem diagnosis Technology diffusion Exchange of staff	**Mixed & medium** Information sharing		**Formal & weak** Program development Sharing of info. & finance Workshops	**Informal & weak**	**Mixed & medium** Problem diagnosis Priority setting Technology diff. & demonstration	**Private Consultancy Component (D)**	**Formal & weak** Program developmnt Tech. diffusion Info &finance sharing Workshops
Formal & medium Priority setting Program development Program review	**Formal & weak**			**Formal & strong** Priority setting Program development Technology development Technology diffusion and demonstration Information sharing	**Mixed & weak**	**Formal & medium** Problem diagnosis Program developmnt Tech. demonstration Information sharing Training	**Formal & medium** Program developmnt Tech. diffusion Info&finance sharing Workshops	**External Assistance Component (X)**

Table 3. Factors Constraining Interactions and Linkage Mechanisms

Policy	Unclear science and technology policy; heavy reorganization; excessive organizational fragmentation; overlapping mandates; limited qualified human resources; lack of appropriate sources of finance; limited physical resources; inoperative information dissemination units; limited sharing of facilities.
Research	Unclear mandates; absence of agricultural research priorities; excessive fragmentation of the research system; heavy reorganization; lack of appropriate sources of finance; limited qualified human resources; over-employment; poor access to knowledge about and information on new technologies; inefficient use of existing resources.
Education	Unclear agricultural education policy; limited physical resources; lack of finance; absence of supportive procedures and regulations; poor system linkages; limited qualified human resources; low mobility of experts; inadequate access to information.
Credit	Agricultural credit institutions not yet operating.
Extension & information	Farmers' lack of interest in extension services; lack of initiatives to utilize the existing agricultural knowledge and information stock; organizational rigidities and long administrative procedures in public offices; weak cooperation between private and international organizations; limited qualified human resources; inadequate access to market information; and inadequate sources of finance.
Private enterprises	Limited managerial skills; limited physical resources (e.g., computer-based information sources and storage facilities); information on market developments; high customs duties and cross-border difficulties; long quality-control procedures; farmers' lack of interest in and poor capacity to utilize new seed varieties; lack of mechanisms (e.g., workshops and seminars) to obtain information on international markets; weak legal framework; ineffective monetary transactions.
Farm organizations	Small farmers' land plots too small for them to think about farming for markets; cross-border difficulties; lengthy quality-control process for imported inputs; lack of knowledge about imported new varieties; underdeveloped market infrastructure (roads, transport, communication, etc.); excessive economic risk; poor farm management skills; lack of access to information sources.
Private consultancies	Unclear agricultural priorities; farmers' weak response to market developments; low public awareness of environmental problems; long administrative procedures; inadequate access to market information; inadequate international linkages; weak client linkages; lack of proactive research.
External assistance	Communication difficulties with policymakers; insufficient local capacity for project collaboration; limited qualified personnel; inadequate material and financial resources of national collaborating parties; weak legal system.

Figure 2. Agricultural Innovation System – Organizational Structure



Functions

F1: General policy making
F2: Policy formulation, co-ordination, supervision, and assessment
F3: Financing R&D
F4: R&D Performance
F5: Technology diffusion
F6: Technology application

Source: OECD (1999).

VI. ANALYSIS OF THE AIS

Knowledge is embedded in people as well as in organizations. Therefore, the establishment of linkages is essential for knowledge to flow from the source to areas where it can be used effectively. Table 2 presents a linkage structure with linkage types and linkage mechanisms in place. The AIS represented by table 2 indicates that the nine components of the system interact on the basis of formal (*f*), informal (*i*), or mixed (*m*) relations. It further shows the linkage mechanisms actively used by actors in the system. To examine the system, we first decompose table 2 into two matrices: AIS[Types of Links] for the linkage types and AIS[Mechanisms] for the actively used linkage mechanisms. Then, we apply the concepts defined in Section IV in order to characterize the system.

The matrix AIS[Types of Links]

The components of the system are placed in the diagonal cells of AIS[Types of Links], where P denotes policy, R research, E education, C credit, I extension and information, M input supply-processing-marketing, F farm organization, D private consultancy, and last, X external assistance. Relations between these components are placed in the off-diagonal cells, where *fw* stands for a formal-weak relation, *fm* formal-medium, *fs* formal-strong, *iw* informal-weak, *im* informal-medium, *is* informal-strong, *mw* mixed-weak, *mm* mixed-medium, and *ms* mixed-strong. Zeros that appear in some of the off-diagonal cells imply that the interaction does not exist; that it exists at a negligible level; or that the investigator was unable to identify it.

The system of linkages represented by AIS[Type of Link] shows several features. First, the system is not fully identified. It has a total of 72 relations, but only 45 of them are identified, implying a density of 0.63 (= 45/72). The credit component (C) is fully detached from the rest of the system. Second, the system is fairly flexible, as reflected in the components' communicating through formal, informal, and mixed channels. Of the 45 relations, 25 are formal, 11 informal, 9 mixed. Third, the relationship between the public (P, R, E, C) and private (I, M, F, D) sectors is at an early stage of development. This is reflected in the dominantly informal relations between (R, E) and (I, M, F, D). Equally important is the willingness of (M, F, D) to develop contacts with P, which is implied by (*fm, im, im*) in the first column and (0, 0, 0) in the first row. Fourth, the relationship between the components of the private sector is much stronger than that between the components of the public sector. The relations between P, R, E, and C are all formal and weak, while those between I, M, F, and D are overwhelmingly of medium strength. Last, X has in one way or another developed relations with all the components in the system. Among these relations, the strongest are with I, F, D, and P.

$$\text{AIS[Type of Links]}^{10} = \begin{bmatrix} P & fw & fw & fw & mw & 0 & 0 & 0 & fm^1 \\ fw & R & fw & 0 & mw & mm & im & im^1 & fw^1 \\ fw & fw & E & 0 & 0 & 0 & iw & im & fw^1 \\ fw & 0 & 0 & C & 0 & 0 & 0 & 0 & fw \\ fm^1 & fm^1 & 0 & 0 & I & 0 & fm^1 & fm^1 & fw^1 \\ fm & im & 0 & 0 & 0 & M & mm^1 & 0 & mw^1 \\ im^1 & im^1 & iw^1 & 0 & 0 & mw^1 & F & 0 & 0 \\ im^1 & im^1 & mm^1 & 0 & fm^1 & iw & mm^1 & D & fm^1 \\ fm^1 & fw & 0 & 0 & fs^1 & mw & fm^1 & fm^1 & X \end{bmatrix}$$

Assigning 0.3 to a weak relation, 0.6 to a medium one, and 1 to a strong relation allows for more realistic representation of the cause-effect structure underlying AIS[Type of Links]. Figure 3 (below) presents the scaled version of AIS[Type of Links] and the cause-effect structure associated with it. According to this structure, D has considerable control over the system (or it is the key *source* of influence); its effect on other components is much greater than others' influence on it. Interestingly, however, R is highly interactive[11] with the rest of the components, and is followed by X, I, and F. Furthermore, P is found to be the *sink* of influence since it is influenced by others more than it influences them. Last, C has very low interaction with the rest of the system.

The matrix AIS[Mechanisms]

This shows only the links established through specific linkage mechanisms in List #3 in the Appendix. The structure of the system is significantly different. First of all, its density declines from 0.63 to 0.35. Next, some kind of polarization tends to emerge between the private and public sectors. The components (D, X, I, F) move upward, while the others move downward. D remains the dominant component, and is followed by I. The component X is most interactive, and is followed by F. On the other hand, P remains the most subordinate component (see figure 4). It is important to note that X attracts most attention from others, as manifested by the fact that it is the most interactive component of the system.

$$\text{AIS[Scaled Links]} = \begin{bmatrix} P & 0.3 & 0.3 & 0.3 & 0.3 & 0 & 0 & 0 & 0.6 \\ 0.3 & R & 0.3 & 0 & 0.3 & 0.6 & 0.6 & 0.6 & 0.3 \\ 0.3 & 0.3 & E & 0 & 0 & 0 & 0.3 & 0.6 & 0.3 \\ 0.3 & 0 & 0 & C & 0 & 0 & 0 & 0 & 0.3 \\ 0.6 & 0.6 & 0 & 0 & I & 0 & 0.6 & 0.6 & 0.3 \\ 0.6 & 0.6 & 0 & 0 & 0 & M & 0.6 & 0 & 0.3 \\ 0.6 & 0.6 & 0.3 & 0 & 0 & 0.3 & F & 0 & 0 \\ 0.6 & 0.6 & 0.6 & 0 & 0.6 & 0.3 & 0.6 & D & 0.6 \\ 0.6 & 0.3 & 0 & 0 & 1 & 0.3 & 0.6 & 0.6 & X \end{bmatrix}$$

[10] The links with a superscript 1 in AIS[Type of Links] represent those established through specific linkage mechanisms. These are the links to which a value 1 is assigned to create AIS[Mechanisms].

[11] Points on the 45-degree line in the Cause-Effect diagrams represent the case in which cause is equal to effect.

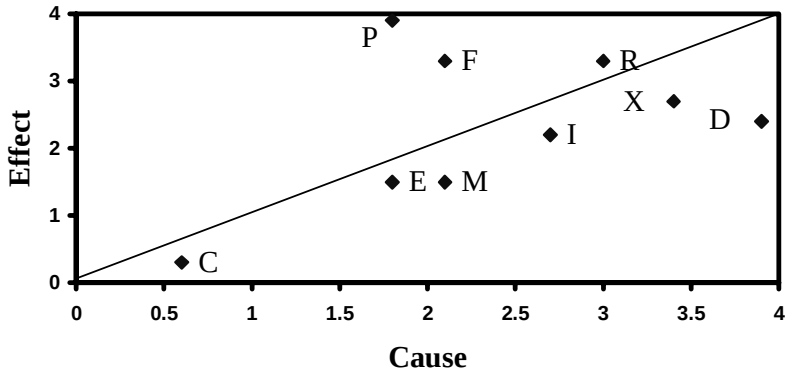
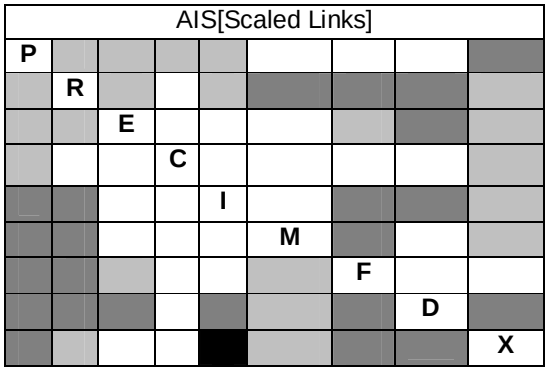


Figure 3. A cause-effect structure of AIS[Scaled Links]



$$\text{AIS[Mechanisms]} = \begin{bmatrix} P & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & R & 0 & 0 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & E & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & C & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & I & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & M & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 & 0 & 1 & F & 0 & 0 \\ 1 & 1 & 1 & 0 & 1 & 0 & 1 & D & 1 \\ 1 & 0 & 0 & 0 & 1 & 0 & 1 & 1 & X \end{bmatrix}$$

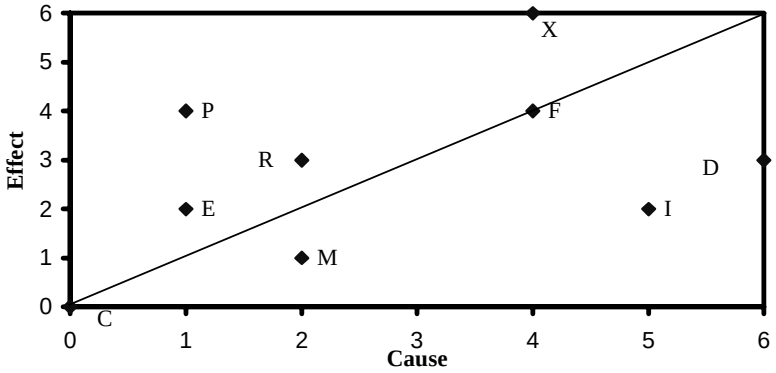
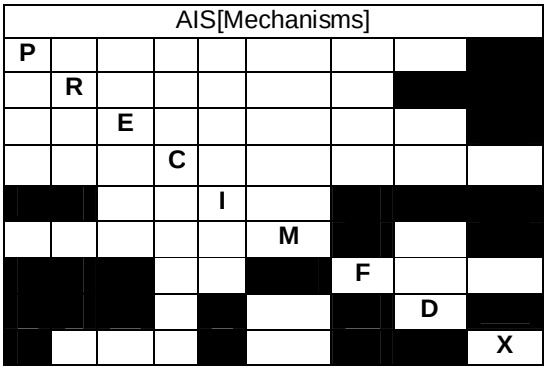


Figure 4. A Cause-Effect Structure of AIS[Mechanisms]



VII. SUGGESTIONS FOR A BETTER SYSTEM OF INNOVATION

The existing AIS of Azerbaijan lacks an innovation culture. Agents in the system do not have incentives to initiate innovation activities. The foremost reason for this is that markets and institutions are not yet developed. The key obstacle is not only the absence of a framework to guide innovation activities, but also the absence of initiatives to develop one. At present, the AIS needs to address the following:

A national agricultural policy, a science policy, and a technology policy are the prerequisites for agricultural development in general, and for the establishment of an agricultural innovation system in particular. Setting agricultural research priorities, revitalizing the crucial parts of the research system and tuning them to market developments, and preparing the curriculum of agricultural education institutions all require clear direction at the policy level. Unfortunately, the absence of such direction jeopardizes the growth of not only public but also private entities in the agricultural sector.

The design of these three policies should consider the implications of innovation for long-run economic growth. First, knowledge accumulation from investment in new technologies and human capital plays a significant role in economic growth. Labor-intensive and natural resource-intensive pathways to growth are limited by the availability of natural and human resources and are subject to decreasing returns, while pathways driven by knowledge do not seem to face such constraints. Therefore, information and communication technologies and

human capital are the most important technologies. Second, this accumulation is determined by the initial distribution of endowments, follows a nonlinear path, and is shaped by the interplay of market and nonmarket organizations. The privatization of land and agroprocessing enterprises should therefore receive more attention from policymakers. Third, the design and coordination of institutions and procedures involved in handling more complex interdependencies deserve special attention, as growth leads to the increasing specialization of tasks. Last, the science and technology policies should be able to take advantage of globalization.

Effective agricultural research priorities, and science and technology strategies need to be developed. This requires up-to-date agricultural knowledge and information inventories and clear directions at the policy level. Once established, they should clear the way for private entities to start their profit-making endeavors.

Financing mechanisms should be established and coupled with general guidelines for the agricultural, science, and technology policies. In this regard, allocation of the resources in the newly established oil fund should be based on these guidelines. However, this fund should not be seen as the only source. There is a need to speed up reform of agricultural credit institutions, as the presence of sound financial sources would promote investment in the agricultural sector on the one hand and induce synergy at least between the policy and the credit components of the innovation system on the other.

An enabling environment, one with an effective legal framework, a property rights system, and an enforcement mechanism, is needed to facilitate innovation activities. Needless to say, in such an environment it would not be difficult for the private sector both to utilize and to shape the existing knowledge infrastructure to meet market demand. This interaction between the private sector and the knowledge infrastructure would accelerate the flow of knowledge embedded in humans (i.e., in tacit form) and in organizations (i.e., in specialized form). The enabling environment with the above qualifications would further pave the way for the growth of interface agents that could bring together related but disconnected agents in the innovation system.

The heavily shaded cells in matrix 1 indicate areas where linkages have to be established (or strengthened) urgently; the lightly shaded cells show areas of secondary importance; and the empty cells are areas where no channels of information are needed at the present time because the functions represented by the empty cells can be established through pathways. For example, there is no need at the moment to establish the link I→P because the pathway I→R→P has already accomplished that. It should be pointed out that using the heavily shaded cells only would help the knowledge and information contained in the system flow from one place to another. A unique feature of our graph-theoretic presentation of the existing institutional interactions is that it allows us to see all the possible pathways (or strategies) in the system represented by table 2. Consider, for example, the pathway P→C→F→I→R→P. This is one of the feedback channels (or loops) that let the policy component assess the effectiveness of credit policy. Suppose that the government implements a new credit policy (P→C), which would increase the supply of credit to farmers (C→F). These farmers would pass on the information about the effectiveness of the credits they received to the extension and information component (F→I). This information could then be shared in a meeting with researchers, farmers, credit specialists, and extension agents (I→R). Finally, researchers could communicate the results of the meeting to policymakers (R→P). Once this circle of interactions is completed, the government would be able to roughly assess the effectiveness of its credit policy. An alternative policy feedback channel is

P→C→M→I→E→P. One can extend the list for other kinds of feedback mechanisms or interaction pathways.

Matrix 1 could be further used to develop alternative innovation strategies. Consider, for example, a strategy aiming at the diffusion of a new crop variety. Obviously, farmers, F, are the end users, while the sources of the variety might vary. Suppose, for simplicity, that the external assistance component, X, is the supplier of the new variety. The questions are: What are the possible pathways of interaction between X and F? Which pathway is the best? Concentrating only on the heavily shaded cells in matrix 1, we can come up with quite a few pathways, each of which corresponds to different policies. The simplest pathway to diffuse the variety is to contact farmers directly and teach them how to plant it: that is, X→F. But this one-edge path is very difficult to realize, as the importation of new varieties would normally be subject to quality control by the government. In the case of quality standards, pathways including X→I→F, X→I→M→F, X→E→I→F, X→E→I→M→F, and X→E→R→I→F all become unfeasible. The assumption that national research institutes test the quality of the imported variety reduces the number of feasible pathways to two: X→R→I→F and X→R→I→M→F. These pathways hold different implications for the development of the agricultural sector. In the first pathway, the variety is tested at the experiment stations of research institutes and the results are then passed on to the extension and information component. Finally, extension specialists convey the information on the new variety to farmers. The second pathway induces the private sector to take part in the diffusion process. Imports of the successful variety are allowed, and farmers have access to the variety through market transactions. This option lets the market system develop, while the burden of training farmers is shifted to the shoulders of profit-seeking firms. Which pathway is more efficient depends on the objectives and constraints of both the policy and farm components.

Matrix 1. Interactions to be Strengthened

P								
	R							
		E						
			C					
I→P				I				
					M			
						F		
							D	
								X

Intermediary institutions, such as marketing associations, farmers' organizations, trade and commerce organizations, and platforms for constructive dialogues should play a more active role in bringing together the components I, M, F and P and R. Specifically, links between these components could be strengthened through policy dialogues where the intermediary institutions could pass information from I, M, F to P and R. Such transmission of information should help P and R reassess agricultural policy and agricultural research priorities, respectively. The shaded cells in matrix 2 show interactions to be developed to tie the productive components (M, F) to the policy and research components (P, R) through the information and extension component (I). The key role is assigned to I, as it is expected to be the center of gravity of interactions between (I, M, F) and (P, R).

Matrix 2. A Pathway: P,R,I,M,F								
P								
	R							
		E						
			C					
				I				
					M			
						F		
							D	
								X

Research should not be an isolated phenomenon; it can be integrated into the system at two stages. The first stage requires the above-mentioned intermediary organizations and the private consultancy component to help R, M, and F exchange information. In the next stage, R could, through joint research activities with X, expose itself to global processes. With successful completion of these stages, national research institutions would be able to enhance their research capacity and develop effective research priorities. The ultimate benefit is that the research organizations would be able to take the lead in shaping the national research system according to the needs of the country. The shaded cells in matrix 3 show interactions to be developed to link R first to M, F, and D, and then to X.

The public research and advisory institutions, professional farmer organizations, companies providing services, private enterprises, and NGOs all participate in the innovation processes, either separately or acting in concert, if they are encouraged to do so through incentives or specifically targeted offers of funding. The recently launched competitive grants system (CGS) has been a positive step in this respect. Private consultancies, private research centers, and NGOs are all eligible to apply for research funding from the CGS. The precondition that research proposals must be of a collaborative nature should speed up the interactions and induce competition between public and private research centers.

Matrix 3. A Pathway: R,M,F,D,X								
P								
	R							
		E						
			C					
				I				
					M			
						F		
							D	
								X

The shaded cells in matrix 4 show the possible linkages required to support the activities of the private components M and F financially. Three possible channels are likely to exist. First, the government could expand credits to the small and medium businesses or farms (P→C→M or P→C→F), and in turn M and F could exchange ideas with policymakers to enhance the effectiveness of credits received (P→C→M→P or P→C→F→P). Second, M could extend credits to F (M→F), but this requires a legal framework to enforce contractual arrangements. Last, X could extend credits or loans to M and F, which would need to be coupled with the government's rural development strategies.

Matrix 4. A Pathway: P,C,M,F								
P								
	R							
		E						
			C					
				I				
					M			
						F		
							D	
								X

The low degree of the partnership between public and private actors and of the operation of exchange and communication mechanisms between them characterizes the AIS of Azerbaijan. The shaded cells in matrix 5 show the interactions to be developed to link P and R to the activities of M, F, and D. In this endeavor, priority must be given to the establishment of a strong extension and information component (I) because it is the key component that would facilitate the flow of information from the private sector to the policy and research institutions or vice versa. The X's interactions with the private sector would be especially important in the case of foreign direct investment in the agro-processing sector, which is highly likely to bring in new knowledge through investments in machinery and equipment.

Matrix 5. A Pathway: P,R,I,M,F,D								
P								
	R							
		E						
			C					
				I				
					M			
						F		
							D	
								X

The shaded cells in matrix 6 indicate interactions to be nurtured to let stakeholders' interests be partly represented in research priorities. Typically, stakeholders exert pressure on the formation of a research agenda through two channels. The first is by using funding as a threat, and the second is by influencing general policymaking through interest group activities. The important point is that these pressures are not always unproductive as they could provide information on the true preferences of actors that are directly or indirectly influenced by research results. Furthermore, NGOs, foundations, the private sector, and other intermediaries might be important voices for farmer concerns, and might be important partners in the governance of agricultural research systems.

Matrix 6. A Pathway: M,F,D,P,R								
P								
	R							
		E						
			C					
				I				
					M			
						F		
							D	
								X

VIII. CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

This study seeks to map the existing agricultural innovation system in Azerbaijan, using graph-theoretic concepts. The primary objectives are to describe the system, identify the areas to be strengthened, and offer options to improve the workings of the system. The study intends to be descriptive rather than prescriptive.

The key observations suggest that the essential elements of the system are at an embryonic stage, and significant accomplishments in policymaking, institutional development, research, education, and credit institutions are yet to come. In particular, efforts should be focused on the formation of public policy, science and technology institutions and organizations, and the development of links through intermediary organizations between the public and private components of the system. At present, the public component is under construction, lacking sectoral priorities, clear organizational mandates and objectives, qualified human resources, physical and financial resources, and motivation to initiate interactions with the private sector. The private component, however, is attracted to activities of international organizations. The public and private components are isolated and have limited basis for interaction.

The future is full of challenges for policymakers in the republics of the former Soviet Union in general, and those in Azerbaijan in particular. The first and foremost challenge is to *enhance the understanding of an agricultural innovation system* among policymakers, which is a necessary condition for designing and implementing the coupled agricultural, science, and technology policies. During this endeavor, as argued by Cooper (1991), theoretical frameworks that have been developed from empirical studies of innovative firms in the industrialized countries could be of great importance since they could provide useful guidelines for policy studies in the region from at least two points of view. First, innovation theories contain insights into how and why technical capabilities are developed in the advanced countries. In effect, they give some new dimensions of meaning to the concept of "accumulation of local technological capabilities," which has come to play an important part in technology policy in developing countries. Second, innovation studies have much to tell us about the structure of international markets, and this kind of information is important in defining strategies for nontraditional agricultural export development.

The second challenge is to *develop methodological guidelines* in order to empirically evaluate national institutional setups with a view to obtaining comparable results at the international level. As argued by Capron and Cincera (2000), the present literature does not report any operational guidelines for assessing the institutional linkages underpinning national innovation systems. Such guidelines could also be used as a benchmarking approach in the management of agricultural, science, and technology policies. An equally important issue, which has not received enough attention from the literature, is, as argued by Nelson (1993), the need for *well-articulated and verified analytical frameworks* linking institutional arrangements to technological and economic performance.

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APPENDIX

AN AGRICULTURAL INNOVATION STUDY

Questionnaire

Country _____

Tuğrul Temel
International Service for National Agricultural Research
ISNAR, CGIAR

November 2000

Study Goal

To describe and analyze the agricultural innovation system of the country.

Objectives

1. To describe the role of agents involved in agricultural innovation activities and analyze agents' interactions in the innovation process.

2. To identify constraints to the functioning of an effective agricultural innovation system.

3. To recommend changes that will enhance the innovation process.

Expected Benefits

1. Better understanding of the functioning of an agricultural innovation system in a market-oriented economy.

2. Information on which to base the development of effective innovation policies and institutions that promote agricultural development.

Information Management *– All data and information gathered for this study will be summarized for analysis and contribute to the preparation of an ISNAR research report focusing on the stated goal, purpose, and objectives of this study. Both the summarized information and the final research report will be returned to the cooperating organization(s) within the country. Data from individuals and interview notes will remain completely confidential.*

Section 1
General Organizational Information

The organizations involved in agricultural technology innovation (see List #1) are many and varied. All are involved in some way in the development, diffusion, and/or application of agricultural innovations. This section seeks to document the characteristics of such organizations and the process of change being experienced by them during this transition period.

Form # 1 – Respondent information
Form # 2 – Classification of organization
Form # 3 – Change and influence on organizational performance

FORM # 1. RESPONDENT INFORMATION

Name of respondent _____
Job title _____
Organization _____
Address _____
_____
_____
_____

Phone_____ **Fax** _____ **E-mail** _____

FORM # 2. CLASSIFICATION OF ORGANIZATION

Legal name of organization _____
Legal status of organization: private _____; semi-public _____; public _____
Scope of organization: local ___; regional ___; national ___; international ___
Type of organization: Gov't ___; Business ___; NGO/NPO ___; Donor/Dev. ___
Number of employees: Professional _____ Support _____ Total _____
Organizational mandate

Main activities (*check most important only*)
policy __; finance __; research __; extension/information __; education __;
farm production __ credit __; input supply __; processing __; marketing __;
external assistance __

Major organizational changes since independence (1991)
Newly established ___
Restructured ___
Reassigned ___
Other ___ Describe _____

1. Please provide an organization chart showing relationships between departments or divisions within your organization. Provided: Yes ___ No ___
2. Please provide a chart showing official assigned relationships (linkages) between your organization and other organizations within the innovation system. Provided: Yes ___ No ___

FORM # 3. CHANGE AND INFLUENCE ON ORGANIZATIONAL PERFORMANCE

Factors	Factor Changes since 1990			Influence on Performance since 1990*		
	None	Some	Great	Positive	None	Negative
Internal Environment						
Mandate						
Objectives						
Policies						
Procedures						
Regulations						
Organization type (pub/pri)						
Organization structure						
System linkages						
Client linkages						
Human resources						
Financial resources						
Physical resources						
Information flows						
Program planning						
Program management						
Program outputs						
External Environment						
Economic system						
Social system						
Political system						
Legal system						
National markets						
International trade						
Globalization						
Other (specify)						

** Performance refers to the **effectiveness** of an organization in fulfilling its mandate.*

Section 2
Innovation Activities

Innovation activities are all those processes needed to develop, diffuse, and apply useful new or improved technologies that may be in the form of products, processes, or information.

On the basis of the above definition, is your organization involved in any kind of innovation activity? (see Form # 4 for list) Yes ___ No ___
If yes, complete forms below.

Form # 4 Kinds of innovation-related activities of your organization
Form # 5 Goals of innovation-related activities of your organization
Form # 6 Sources of knowledge and information about innovations
Form # 7 Types of funding used for innovation activities of your organization
Form # 8 Factors constraining organization's innovation activities
List # 2 Examples of possible factors constraining innovation activities

FORM # 4. KINDS OF INNOVATION-RELATED ACTIVITIES OF YOUR ORGANIZATION

Innovation Activity	Primary	Secondary	None
Technology policy			
Technology financing			
Technology development			
Technology evaluation			
Technology demonstration			
Technology information diffusion			
Technology introduction (selling)			
Technology acquisition (local)			
Technology acquisition (int'l)			
Technology training			
Technology integration			
Technology use			
Other (specify)			

Note: Check all that apply

FORM # 5. GOALS OF INNOVATION-RELATED ACTIVITIES OF YOUR ORGANIZATION

Goal	Primary	Secondary	None
Introduce new products or processes			
Increase market opportunities			
Improve production flexibility			
Increase commodity production			
Increase commodity quality			
Reduce labor costs			
Reduce material costs			
Reduce energy consumption			
Reduce environmental damage			
Fulfill regulations or standards			
Provide knowledge and information			
Generate own income			
Other (specify)			

Note: Check all that apply.

FORM # 6. SOURCES OF KNOWLEDGE AND INFORMATION ABOUT INNOVATIONS

Activity	Agents	P	S	N
Policy	Parliament's Agricultural Committee			
	Cabinet of Ministers Agricultural Committee			
	Ministry of Agriculture			
	Ministry of Science & Education			
	MoA Division(s) of Agr. Sci., Ed. & Ext.			
Finance	Ministry of Finance			
Research	Director, Biological Sciences, Academy of Sci.			
	Agricultural research council (apex)			
	Agricultural research institutes			
	Research departments at institutes			
	Researchers			
Extension and Information	Agricultural extension offices			
	Extension program leaders			
	Extension specialists or agents			
	Agricultural communications unit (radio, news)			
Education	Agricultural & veterinary academies			
	Departments at academies			
	Professors			
	Post-graduate students			
Farm production	Large farmer organizations			
	Small farmer organizations			
	Large farms (joint stock & cooperative)			
	Small commercial farmers			
Credit	MoA rural credit program			
	National bank with rural credit line			
	Local bank with rural credit line			
Input supply	Seed supply unit			
	Fertilizer supply unit			
	Pesticide supply unit			
	Equipment supply unit			
Processing	Public processing units			
	Private processing firms			
Marketing	Public marketing units			
	Private marketing firms			
External assistance	Donor/development agencies (e.g., TACIS, FAO)			
	International NGOs/PVOs			
	IARCs (e.g., ICARDA, CIMMYT)			
	International networks and consortia			
Other	Professional meetings			
	Fairs and exhibitions			
	Computer-based information (e.g., Internet)			

Note: P = Primary, S = Secondary, N = Never

FORM # 7. TYPE OF FUNDING USED FOR PRIMARY INNOVATION ACTIVITIES OF YOUR ORGANIZATION

Type of Funding	Primary	Secondary	Never
Own (internal) resources (e.g., sales)			
Client contracts & subcontracts			
Collaborative contracts & subcontracts			
Competitive grants			
Competitive matching grants			
Noncompetitive grants			
Noncompetitive budget (core funding)			
Patents and copyrights			
Awards and prizes			
Loans and credits			
International donor assistance			
Other (specify)			

LIST # 2. EXAMPLES OF POSSIBLE CONSTRAINTS TO INNOVATION ACTIVITIES

Internal Constraints

1. Mandate, Objectives, Policies, and Procedures

- Unclear mandate
- Long administrative procedures
- Fulfilling regulations and standards

2. Organization and Linkages

- Organizational rigidities
- Lack of int'l interaction in technology transfer
- Lack of interface agents

3. Human, Financial, Physical, and Information Resources

- Lack of qualified personnel
- Low degree of mobility of experts
- Lack of appropriate sources of finance
- Funding gap between technology suppliers and users
- Inadequate access to information

4. Program Planning, Management, and Outputs

- Lack of knowledge and information on technology
- Lack of information on markets
- Lack of farmers' responsiveness
- Farmers' lack of demand for technology transfer

External Constraints

- Lack of market infrastructure
  - roads, transport, and communication tools
- Lack of regulations and legal framework for:
  - private property rights
  - appropriability of benefits
- Lack of expertise in patent and license management
- Excessive perceived economic risk
- Low political priority

FORM # 8. FACTORS CONSTRAINING YOUR ORGANIZATION'S INNOVATION ACTIVITIES

Factors	Give Specific Constraints
Internal Environment Mandate Objectives Policies Procedures Regulations *Organization type (public/private)* *Organization structure* *System linkages* *Client linkages* Human resources Financial resources Physical resources Information flows *Program planning* *Program management* *Program outputs*	
External Environment Economic system Social system Political system Legal system National markets International trade Globalization	

Section 3
Innovation Linkages of Your Organization

Linkages are vital to an innovation system since many activities are involved and many different agents are engaged in innovation activities. Some agents are linked together and some act independently in an environment which may be cooperative or competitive. In any case, the vitality of an innovation system depends on quality of relationships between agents within the system.

Form # 9 Strength of linkages with other agents
Form # 10 Linkage mechanisms used by your organization with other agents
Form # 11 Factors constraining your organization's *linkage* activities
List # 3 Linkage mechanisms

FORM # 9. STRENGTH OF LINKAGES WITH OTHER AGENTS

Activity	Agents	Strength			
		S	M	W	N
Policy	Parliament's Agricultural Committee				
	Cabinet of Ministers Agricultural Committee				
	Ministry of Agriculture				
	Ministry of Science & Education				
	MoA Division(s) of Agr. Sci., Ed. & Ext.				
Finance	Ministry of Finance				
Research	Biological Sciences, Academy of Sciences				
	Agricultural research council (apex)				
	Agricultural research institutes				
	Research departments at institutes				
	Researchers				
Extension and Information	Agricultural extension offices				
	Extension program leaders				
	Extension specialists or agents				
	Agricultural communications unit (radio, news)				
Education	Agricultural & veterinary academies				
	Departments at Academies				
	Professors				
	Postgraduate students				
Farm production	Large farmer organizations				
	Small farmer organization				
	Large farms (joint stock co's & cooperatives)				
	Small commercial farmers				
Credit	MoA rural credit program				
	National bank with rural credit line				
	Local bank with rural credit line				
Input supply	Seed supply unit				
	Fertilizer supply unit				
	Pesticide supply unit				
	Equipment supply unit				
Processing	Public processing units				
	Private processing firms				
Marketing	Public marketing units				
	Private marketing firms				
External assistance	Donor/development agencies (e.g., TACIS, FAO)				
	International NGOs/PVOs				
	IARCs (e.g., ICARDA, CIMMYT)				
	International networks and consortia				
Other					

Linkage Strength: S = Strong; M = Medium; W = Weak, N = None
*Note: Where linkages **are strong and medium**, show important **linkage mechanisms** on **Form # 10** using **List 3**.*

LIST # 3. LINKAGE MECHANISMS

Linkage Type	Linkage Mechanism	Code
A. Planning & Review	Joint problem diagnosis	1
	Joint priority setting and planning	2
	Joint program development	3
	Joint review and evaluation	4
B. Program Activities	Joint technology development	5
	Joint technology evaluation	6
	Joint technology demonstration	7
	Joint technology diffusion	8
C. Resource Use	Exchange of personnel/staff rotation	9
	Joint use of facilities (e.g., laboratories)	10
	Sharing of financial resources and materials	11
D. Information	haring of information	12
	Joint use of information sources (e.g., lib., Internet)	13
	Joint reporting	14
	Joint publication of documents	15
	Joint seminars and workshops	16
E. Training	Joint training of students	17
	Joint training of staff (short-term)	18
F. Other	_____	19
	_____	20

FORM # 10
LINKAGE MECHANISMS USED BY YOUR ORGANZIATION WITH OTHER AGENTS

Activity	Agents	Linkage Codes (See list 3)					
Policy	Parliament's Agricultural Committee						
	Cabinet of Ministers Agricultural Comm.						
	Ministry of Agriculture						
	Ministry of Science & Education						
	MoA Division(s) of Agr. Sci., Ed. & Ext.						
Finance	Ministry of Finance						
Research	Agricultural research council (apex)						
	Agricultural research institutes						
	Research departments at institutes						
	Researchers						
Extension and Information	Agricultural extension offices						
	Extension program leaders						
	Extension specialists or agents						
	Agricultural communications unit						
Education	Agricultural & veterinary academies						
	Departments at academies						
	Professors						
	Post-graduate students						
Farm production	Large farmer organizations						
	Small farmer organization						
	Large farms (joint stock co's & cooperatives)						
	Small commercial farmers						
Credit	MoA rural credit program						
	National bank with rural credit line						
	Local bank with rural credit line						
Input supply	Seed supply unit						
	Fertilizer supply unit						
	Pesticide supply unit						
	Equipment supply unit						
Processing	Public processing units						
	Private processing firms						
Marketing	Public marketing units						
	Private marketing firms						
External assistance	Development agencies (e.g., TACIS, FAO)						
	International NGOs/PVOs						
	IARCs (e.g., ICARDA, CIMMYT)						
	International networks and consortia						
Other							

*NOTE: Where strong and medium linkages are shown on **Form # 9**, use number codes shown on List # 3 (next page) to indicate most important linkage mechanisms on this form.*

FORM # 11
FACTORS CONSTRAINING YOUR ORGANIZATION'S *LINKAGE* ACTIVITIES

Factors	Give Specific Constraints
Internal Environment	
Mandate	
Objectives	
Policies	
Procedures	
Regulations	
Organization type (pub/private)	
Organization structure	
System linkages	
Client linkages	
Human resources	
Financial resources	
Physical resources	
Information flows	
Program planning	
Program management	
Program outputs	
External Environment	
Economic system	
Social system	
Political system	
Legal system	
National markets	
International trade	
Globalization	

Section 4
Example of an Innovation

(For selected agents involved with research, education, extension, and production)

Please provide the following information about **one agricultural technological innovation** in which your organization was involved in any way in the last 5 years.

1. Briefly describe this innovation.
2. Type of innovation: new product; ___ new process; ___ new information; ___
3. Source of this innovation (who developed it?).
4. What kind of innovation activity was involved? (*see* **Form # 4)**
5. What was the primary goal of this innovation? (*see* **Form # 5**)
6. What were your source(s) of information about this innovation? (*see* **Form # 6**)
7. What financial source(s) supported this innovation activity? (*see* **Form # 7**)
8. What factors constrained your organization's involvement in this innovation activity? (*see* **Form # 8**)
9. Which other agents were strongly linked to yours for this innovation activity? (*see* **Form # 9**)
10. What linkage mechanisms were used by your organization with each of the other agents (shown in your answer to question 9) for this innovation activity? (*see* **List 3**)
11. What factors constrained your organization's *linkages* with other agents for this activity? (*see* **Form # 11**)

Section 5
Science and Technology Policy

(For selected agents involved with policy and finance only)

1. What are the country's important national economic development goals?
2. Is there a national science and technology policy?
   Yes __ No __ Don't know __
3. Who formulates science and technology policy?
4. Briefly describe this policy.
5. What are the country's important agricultural sector goals?
6. Is there a national *agricultural, science,* and technology policy?
   Yes __ No __ Don't know __
7. Who formulates agricultural, science, and technology policy?
8. Briefly describe this policy.
9. What mechanisms does your government use to promote innovation?
10.

Mechanism	Primary	Secondary	Never
Tax cuts for innovation investment			
Special funds for innovation investment			
Technical support services			
Low-cost loans or credits to enterprises			
Subsidies for high-technology equipment			
Duty reductions for importation			
Incentives for exportation			
Other			

List of People Interviewed

Mr. Rafil Huseynov
Adviser
Ministry of Agriculture
Government House,
U. Gadjibekov st. 40
Baku
Azerbaijan
Tel./Fax: + 994 12 939 462

Mr. Muhtarov Imran Agalar oglu
Head of Unit
Agro-chemical Services Unit
Ministry of Agriculture
Government House,
U. Gadjibekov st. 40,
Baku
Azerbaijan
Tel./Fax: +994 12 935 749

Mr. Mejidov Pafig Neymatulla oglu
Head of Department
Economy and Pragozing Department
Ministry of Agriculture
U. Hajibekov st. 40
Government House
Baku
Azerbaijan
Tel./Fax: + 994 12 980 833

Dr. Seferov Surkhay
Head of Department
Department of Scientific Research & Education
MoA
U. Hajibekov st. 40
Government House
Baku
Azerbaijan
Tel./Fax: + 994 12 935 874

Mammadov Faig Nurali oglu
Deputy chairman
State Committee of Science and Technology
S.Vurgun street 24
Baku
Azerbaijan
Tel./Fax: +994 12 982 813

Hajiyev Murtuzali Mammadali oglu
Head of Unit
Ministry of Agriculture
Information Dissemination Unit
U. Hajibekov st. 40
Government House
Baku
Azerbaijan
Tel./Fax: +994 12 935 164

Hajiyev Baylar
Head of Department
Ministry of Education
Agriculture Education Department
Aga Ne`matulla st
Baku
Azerbaijan
Tel./Fax: +994 12 935 178

Dr. Kosayev Eldar Muhtar oglu
Deputy Director General
Azerbaijan Agrarian Science Center
U. Hajibekov st. 40
Government House
Baku
Azerbaijan
Tel./Fax: + 994 12 931 037 / 974 931

Dr. Mammadov Fuad Husey oglu
Director
Azerbaijan Scientific Research Institute of Vegetables
Pirshaga Sovkhoz No. 2
Baku 370098
Azerbaijan
Tel./Fax: + 994 12 972 136

Dr. Nabiev Mammadzada Hummat oglu
Head
Agency for Support to the Development of the Agricultural Private Sector
CGS Secretariat
U. Hajibekov st. 40
Government House
Baku
Azerbaijan
Tel./Fax: +994 12 986 562 / 981 395
Email: snovruz@ azeurotel.com and mnabiev@usa.net

Dr. Abbasov Ziyad Mehrali oglu
Director
Azerbaijan Scientific Research Institute of Agricultural Mechanization
A. Aliev Street 57-A
Ganja
Azerbaijan
Tel./Fax: + 994 12 576 476

Dr. Verdiyev Ahmad Coban oglu
Director
Azerbaijan Scientific Research Institute of Economy and Organization of Agriculture
Darnagul direct, 3097
Baku 370130,
Azerbaijan
Tel./Fax: + 994 12 615 498

Dr. Cabrailov Shakir Abis oglu
Deputy Director
Azerbaijan Scientific Research Institute of Economy
and Organization of Agriculture
Darnagul direct, 3097
Baku 370130
Azerbaijan
Tel./Fax: + 994 12 612 715

Dr. Amanov Mail Vali oglu
Director
Azerbaijan Scientific Research Grapes and Wine-making Institute
Absheron district
Mehdiabad, Baku
Azerbaijan
Tel./Fax: +994 12 435 331

Dr. Safarov Ramiz Kabuter oglu
Director
Azerbaijan State Scientific Veterinary Control Institute
Baku
Azerbaijan
Tel./Fax:+ 994 12 42610 / 426 008

Mr. Mammadov Fakhraddin Halil oglu
Director
Azerbaijan Scientific Research Cotton Institute
Vokzal St, Institute Direct
Ganja
Azerbaijan
Tel./Fax: + 994 12 574 589

Dr. Aliev Sardar Zeynel oglu
Director
Azerbaijan Scientific Research Institute of Feed and Pasture
Khirdalan district
Guzdek, Baku
Azerbaijan
Tel./Fax: + 994 12 439 628

Dr. Ahmadov Mohtasim Gureys oglu
Deputy Director
Azerbaijan Scientific Research Institute of Agriculture
Sovkhiz no. 2
Baku 370098
Azerbaijan
Tel./Fax: + 994 12 974 931
Email: musayev@artel.net.az

Dr. Aliyev Bahram Huseyn oglu
Director
Azerbaijan Scientific Research Institute of Erosion and Irrigation
Mirali Gashgay Street 36
Baku
Azerbaijan
Tel.: + 994 12 400 382

Mr. Seydayev Mahir Mohommad oglu
Director
Private vegetable seed supply marketing firm "Maysema Ltd."
Musabeyov st 4
Bayil District
Baku
Azerbaijan
Tel.: + 994 12 643 436 / 69 28 48

Mr. Wahid Jemai
Director General
International Trade in Raw Cotton and Other Cotton Products (MARKETING & PROCESSING)
Tel./Fax: 4122 641 0629
Email: info@jecot.com

Mr. Osman N. Paksu
Director General M.K.T. Production-Commerce Company
(MARKETING & PROCESSING)
Istiglaliyat Street 31,
Baku
Azerbaijan
Tel./Fax: + 994 12 971 304 / 971 307
Email: onp@baku-az.net

Mr. Samed Safarov
Deputy Director
Azerbaijan State Champagne Production Company
370029
M.Narimanov St
quarter 2058
Baku
Azerbaijan
Tel./Fax: +994 12 669 505 / 679 224

Mr. Ilham Mammadov
Managing Director
Azerbaijan Dairy Corporation (ADC)
Dairy products marketing firm
R.Rza Sreeet 11
Baku
Azerbaijan
Tel./Fax: +994 12 922 160

Mr. Abdullayev Abdulhuseyn Memmed oglu
President
Plant Protection "EMA" Company
S. Mehdiyev st. 88
Baku
Azerbaijan
Tel./Fax: +994 12 390 080 / 396 991

Mr. Naig Mamedgasanov
Director General
"Tauz-Baltija" Ltd. Company
Azadlik Avenue 42
Baku 370122
Azerbaijan
Tel./Fax: + 994 50 220 4536 / 989 473 / 989 473

Mr. Memmedov Memmed Cahangir oglu
President
Agro-Chemical Ltd. Company
E. Elekperov St. No.93
Baku
Azerbaijan
Tel./Fax: + 994 12 970 649 / +994 50 327 6798 / + 994 12 303 062

Ms. Shovcat Alizadeh
Country Representative OXFAM GB (International NGO)
Hajibeyov street 17
Baku
Azerbaijan
Tel./Fax: + 994 12 983 861 / 981 301
Email: ashovcat@oxfam1.baku.az

Mr. Hasanov Azer Safiyar
Grant Programme Coordinator OXFAM GB (International NGO)
Hajibeyov street 17
Baku
Azerbaijan
Tel./Fax: + 994 12 986 318 / 981 301
Email: program@oxfam1.baku.az

Mr. Vugar Ahmedov
Managing Director
Black Land Consulting
U. Hajibekov st. 40
Government House
Room 1101
Baku 370016
Azerbaijan
Tel./Fax: + 994 12 987 720 / 937 441
Email: Akhvugar@hotmail.com

Mr. Saleh Huseynov
President
AgroEco-Consulting Centre
Ismail Dagistanli St. 57/40
Baku
Azerbaijan
Tel./Fax: + 994 12 601 053 / 977 726 / 401 318
Email: ngocci@azdata.net

Dr. Mubariz Ismailov
Consultant
Sulaco Ltd
T. Mamedov St. 20
Baku 370014
Azerbaijan
Tel./Fax: + 994 12 951 247 / 951 130
Email: ats@aspi.baku.az

Dr. Muslum Mammadov
Director
Scientific Ecology Association "Ekoyl"
H.Cavid Avenue No. 31ª
Baku 370014
Azerbaijan
Tel./Fax: + 994 12 940 618
Email: ekoil@azerin.com

Mr. Nazim Agayev
Rahber Sabirabad Agribusiness Centre
Building of Statistic Unit, floor 2
Sabirabad district
Azerbaijan
Tel./Fax: + 994 855 310 153

Mrs. Saida Huseynova
President
Social and Economic Research Centre
Vakif street 3/103a
Baku 370007
Azerbaijan
Tel.: + 994 12 472 934 / 942 934 / 97 29 34
Email: siar@azeri.com

Mr. Rahim Huseynov
Chairman of the Board
Marketing Specialists Society
88[a] Zardabiav
Center of Economic Reforms, 7th floor
Baku 88[a]
Azerbaijan
Tel./Fax: + 994 12 301 717
Email: mmc@baku_az.net

Mr. Elshan Ismayilov
Manager
Ismayilli Agrobizness Consulting Company
Nizami street 12
Ismayilli district
Azerbaijan
Tel./Fax: +994 187 545 23

Mr.Arif Jahangirov
Managing Director
Ganja Business Group
M.Sabir st
Ganja city
Azerbaijan
Tel./Fax: +994 12 541 412

Mr. Elchin Halilov
Director
Gafgaz" Business Development Organization
Mashaty St 4
Ganja city
Azerbaijan

Mr. Yusif Valiyev
1st Vice-President
Agriculture-Industry Bank of the Republic of Azerbaijan
Kadirli street 125
Baku
Azerbaijan
Tel./Fax: + 994 12 975 324 / 982 731
Email: markaz@baku-az.net

Dr. Karimov Nabi Ismayil oglu
Director
Regional Experimental Station of SRI of Agriculture
Nizami street 1
Zakatala
Azerbaijan
Tel.:/Fax: +994 174 53721

Mr. Xalilov Fuad Huseyn oglu
Director
Information and Consulting Services Center
Agency for Support to the Development of the Agricultural Private Sector
Government house,
U. Gadjibekov st. 40
Baku
Azerbaijan
Tel./Fax: + 994 12 935 449 / 986 570
Email: gasimov@azeurotel.com

Mr. Surxay Tagi-zade
Director
Azerbaijan Farm Progress (NGO)
Government house
U. Gadjibekov st. 40
Baku
Azerbaijan
Tel./Fax: +994 12 935 510

Sabir Suleyman
Editor-in-Chief
Journal called "Azerbaijan Farmer"
Government house
U. Gadjibekov st. 40
Baku
Azerbaijan
Tel./Fax: +994 12 935 510

Mr. Hacibey Ramazanov
Director
"Magara" farm organization
Zagatala District
Jar village
Azerbaijan

Mr. Hanhuseyn Ahmedov
Manager and Owner
"Alahmad" farm organization
Saatli district
Azerbaijan
Tel.: +994 50 3204 777

Mr. Fataliyev Teymur Safarali oglu
Manager and owner
"Fatali" farm organization
Azerbaijan
Tel.: + 994 12 310 1252

Mr. Gunduz Soltanov
Farm Manager
"Asadly" farm organization
Sabirabad city
Asadly village
Azerbaijan
Tel.: +994 55 372 0802

Mr. Sahip Ahmedoglu Kocayev
Farmer (Live-stock)
Saatli district
Azerbaijan

Mr. Jumshud Shikhaliyev
Farm manager
"Elite" Seed Production Farm (private)
Agjabadi district
Azerbaijan
Tel./Fax: +994 50 317 6607 / 319 4438