

KEY ISSUES IN AGRICULTURAL RESEARCH FOR DEVELOPMENT IN CENTRAL ASIA AND THE CAUCASUS

1. BACKGROUND: CENTRAL ASIA AND THE CAUCASUS REGION

The region of Central Asia and the Caucasus (CAC), consisting of five countries in Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan) and three in the Caucasus (Armenia Azerbaijan and Georgia), attained independence after the breakdown of the former Soviet Union in 1991. The region is endowed with a large geographical area (land) of 419 million ha (mha), of which 11.4 mha are irrigated and 256 mha are rangelands. Climatologically, the region is characterized by cold to very cold winters (< 10 to -40 C) and mild to warm summers. The moisture regime can vary from arid to semi-arid, and rainfall is low with variable patterns.

The region after independence in 1991 underwent tremendous economic and social changes. The socio-economic structures developed during the Soviet period collapsed, economies shrank, incomes fell, and agricultural production received a serious setback and steep decline making food security a major concern, and resulting in increase in poverty. The percentage of people living below the national poverty line (in 2007), although reduced in most countries compared with the 2005 data, range from 15.4 (Kazakhstan) to 74.9% (Tajikistan) (UNESCAP, 2008). The per capita income had declined by an average of almost 50% between 1991 and 2000, compared with an average increase in low and middle income countries over the same period. However, the GDP per capita (in USD) has increased in several countries due to progress in petrochemical sector, and ranged from 1,656 (Tajikistan) to 10,223 (Kazakhstan) in 2007 (UNESCAP, 2008). One of the major causes of the failure of the system was the dismantling of the existing cooperatives/collectives-based farming systems and introduction of small farms based on leased lands from the state. Others included unpreparedness of the new governments to handle this dramatic change, inexperience of the newly created farmers to farm small pieces of lands, lack of appropriate support systems including those for investment, small agricultural machinery, market participation, extension system, etc. As a result, the region took about 10 years to start to recover from this decline and make necessary adjustments so that agriculture could contribute to the required food security and economic growth in the region. It should also be emphasized here that the region has tremendous potential to develop, given its background and resources, and become a leading region in agriculture production in the world.

2. REGIONAL DEVELOPMENT GOALS AND THEIR LINKAGE TO AGRICULTURE DEVELOPEMNT

The main development goal of all the governments in the CAC region during post-independence has been and continues to be to improve the wellbeing of their people. To achieve this, the countries needed to provide fast and effective economic growth and implement social reforms and programs. For the former, they needed suitable economic, fiscal and monetary policies and reforms to create a stable macroeconomic environment and maintain low inflation rates. For achieving the social wellbeing of the people, they needed to spend a considerable share of the state budget (may be up to 1/3 of budget) for restructuring public infrastructures (water, roads, transport, telecommunication, etc.), either by improving the existing ones or by creating new ones, and creating effective institutions/ensuring reforms for social and development programs (education, health, environment, knowledge creation and sharing, poverty reduction, gender equality, etc.) for both the urban and rural populations. In this, the role of reducing poverty especially in the rural areas, enhancing food security, and improving the ecological environment was considered vital. And to achieve this, greater attention and investments, compared to the past, were required to increase the effectiveness and development of agriculture sector and its commercialization, enterprises for processing agricultural products, and management of natural

resources (land, water, forestry, rangelands, etc.). The importance of agriculture sector in achieving the development objectives was also realized considering the fact the sector provided sustainable livelihoods for the vast majority of the population in the CAC countries that lived in rural areas and also to some in urban areas. This was a good enough reason to convince the policy makers in the governments that attention to and investments in agriculture sector were essential if the food security was to be achieved, the export trade was to be enhanced, ecological environment was to be preserved, the rural livelihoods were to be improved, and the reduction in poverty was to be achieved.

3. CURRENT AND POTENTIAL CONTRIBUTIONS OF ARD TO OVERALL DEVELOPMENT GOALS

3.1 Current Contributions

Agriculture is of paramount importance in the CAC region because of the role it plays in the development needs of its countries. First, the sector, as emphasized earlier, supports the livelihoods of the large majority of the population in rural areas (from 36% in Armenia to 74% in Tajikistan) and to some extent in urban areas (FAO, 2007/08). In this, the role of the arable land, especially the irrigated, plays an important role in contributing to food security of these countries. In addition, the rural household farming (could be called kitchen farming/mini-farming, *dehkon*) involving several million households (for example, over 4 million in Uzbekistan) on small pieces of land provided around the houses (0.25-0.35 ha), is very common and supports the livelihoods of a large proportion of the rural and urban populations (up to 60% in Uzbekistan, for example), significantly contributes to food security and poverty reduction in the region. Second, the sector provides employment to a large population in rural areas (33.5% in Kazakhstan to 50% in Tajikistan) (UNESCAP, 2008), and urban areas (especially through *Dehkon* farming), and thus, supports the livelihoods of not only in rural but also in urban population of the region. Third, it significantly contributes to the GDP of the most CAC countries that range from 6.3% in Kazakhstan to 31.5% in Uzbekistan (FAO, 2007/08). Fourth, it is major source of hard currency earnings for some countries in the region, and fifth, the sector, as it utilizes the most important components of the natural resources that directly affect the environment, e.g., soil, water and plant biodiversity, assumes special significance in protecting the environment through the sustainable use of these natural resources.

Thus, the current contributions of agriculture assume special significance for ensuring food security, poverty reduction, and protecting the environment through sustainable use of the natural resources; all three important in the region's overall development needs. In addition, the region has a large area (270 million ha) of rangelands which provide the vital feed resource for livestock, important in biodiversity conservation, and could play important role in environment protection.

Cereals (wheat, barley), food crops (potato), cotton, horticultural crops (vegetables and fruits), livestock (small ruminants, sheep and to lesser extent goat, and cattle that provide meat and milk) are important agricultural commodities. The region has a rich genetic heritage of a large number of fruits, vegetables and nut trees (almond, walnut), which serve as good and stable sources of food supplies to the region's population and support their food security.

3.2 Scope for Potential Contributions

The CAC region has tremendous potential for contributing to agricultural development since the two important prerequisites, i.e., institutional infrastructure and human resources do exist in the region. In addition, traditional agricultural practices, rich genetic wealth (both plants and animals) and vast arable areas and rangelands provide enormous potential for future agricultural development in crop production (food and commercial), livestock (both small and large

ruminants for meat and milk and milk products), horticulture (fruits, vinery and vegetables), and agro-forestry. The region has inherited vast irrigation systems from the former Soviet Union for use in irrigated agriculture. Similarly, the region offers good conditions for livestock production due to vast rangelands. There is a tremendous scope of the use of quality seed of high yielding varieties, fertilizers and pesticides. Also, there is good scope for the conservation of the vast plant and animal genetic resources. Similarly, there is a good potential for diversification of agriculture in the region. Additionally, a large tract of land in Kazakhstan, with potential for agricultural production, is not exploited and kept fallow for various reasons for future use. All of these offer tremendous opportunities for food production and could immensely help in achieving food security and further reduction in poverty, and thus contribute to the regional development needs.

4. KEY RESEARCHABLE ISSUES

The agriculture sector in CAC is presently facing many problems and challenges that have been caused by the breakdown of the former Soviet Union in 1991. The task has been, and continues to be, to address them to make agriculture sector sustainable and more responsive to the needs of the farming community and rural poor to improve their livelihoods, and to meet the agricultural development goals of the CAC countries. Based on the review of different reports, the following six major challenges for ARD have been identified for the CAC region:

1. Food security
2. Improving the declining living standards and improving livelihoods
3. Protecting the environment
4. Achieving structural reforms
5. Meeting the special challenges (both existing and future)
6. Strengthening national agricultural research systems

Different types of research activities have been proposed for achieving relevant results to meet these challenges and most of them are being carried out by the eight national programs of the CAC region. The key researchable issues related to challenges 1-5 that can contribute to agricultural development, challenged by the poor and poor agricultural producers and farmers, are highlighted below. The issues related to challenge no. 6 will be discussed under Section 6.

4.1 Issues Relating to Food Security: The Urgent Need of the Region

Need for effective financing of agriculture and farms to support newly-emerged small-scale farmers and *dekhon* farming (rural household plots farming/kitchen garden farming/mini-farming) in the region

Across the CAC region, full support to and financing of agriculture and farms has been lacking and needs much greater support. This was necessitated with the advent of the newly-emerged farmers after dismantling of the collective/cooperative farms. The support system desires technical guidance, inputs (including small machinery), extension of technologies or market participation. Also, a similar support is required for the large number of *dekhon* farmers in the region. This also means providing loans at lower rates of interest and micro-financing, attention to economic and social aspects, and appropriate institutional structures to link investment in agriculture to development.

Key Issue 1: Provide effective financing of agriculture and farms to support newly-emerged small-scale farmers and dekhon (rural household farming/kitchen farming/mini-farming) in the region

Need to enhance sustainable crop production in irrigated areas and rainfed/“less-favored”/“lagging” areas for the existing and new crops while protecting the natural resource-base

Some countries have tried to increase production by increasing the productivity per unit area in irrigated crop production and have succeeded to some extent by adopting improved technology. In the CAC region there is enormous potential for this by using the existing and by introduction of new crops in the system

(crop diversification). There is also an option to increase production in the rainfed or “less-favored” or “lagging” areas (according to World Bank, 2008), where agricultural production is significantly limited by factors such as moisture due to low and variable rainfall, recurrent droughts, extreme temperatures, short cropping season, shallow and nutrient-depleted soils, socio-economic factors and lack of infrastructure, is always lower than the irrigated areas as they generally receive less and variable rainfall. However, it should be remembered that the irrigated areas are very limited in the countries of the CAC region, and thus, the efforts on sustainable increases in productivity must ensure that the inputs, especially the scarce water, are judiciously and efficiently used, and that the natural resource-base is protected. These productivity gains will at least remove some pressure on most governments in maintaining politically acceptable levels of food security.

Key Issue 2: Enhance the sustainable productivity of agriculture in the irrigated or rainfed/less-favored or “lagging” areas while protecting the natural resource-base

Need to fully explore the potential of livestock production in the region

The CAC republics had inherited rich animal populations from the Soviet Union at the time of independence. These animal populations were productive and were supported by well managed and grazing-controlled large rangelands for grazing and by other feed resources which were also well organized. Post-independence, the system could not be sustained for want of grazing controls and lack of feed resources. As a result, the livestock productivity and production significantly fell, and even the livestock populations dropped significantly. All this adversely affected the availability of meat and dairy products in the countries of the region and also the income of the livestock farmers. Besides, mismanagement of rangelands resulted in their degradation adding to the problems to the environment. The region has huge demands for livestock products internally and also huge potential to produce for the international market. The region needs to improve its livestock breeds, nutrition, management systems, health and also marketing of livestock products.

Key Issue 3: Need to explore the full potential of livestock sector in the region

Need to pay special attention to horticulture sub-sector

The region has a rich heritage of different types of vegetables, fruits and vinery production. There is a huge local demand and also the capacity to compete in International markets. The research needs and priorities developed so far have not really been deeply considered in this area for the region. Therefore, this area deserves special attention and is a good key researchable issue.

Key Issue 4: Need to pay a much greater and special attention to horticulture sub-sector

Need to emphasize research on fisheries

So far, very little attention has been paid to the fisheries and aquatic production systems in the region, which are important sources of food in the region and have potential for exports. Moreover, research needs and priorities in fisheries and aquatic production systems have not really been examined and dealt with from the research perspective. This is an area that needs significant attention.

Key Issue 5: Need to emphasize on research on fisheries and aquatic production systems

Need to pay attention to trans-boundary animal and plant diseases and pests

Trans-boundary diseases and pests, which spread in crops and animals, affect the region severely as it is at the crossroads of Asia and Europe. Examples are foot and mouth and rinderpest diseases in livestock and rust diseases and Sunn-pest in wheat that adversely affect livestock and crop production. The research needs and priorities for the region to reduce the risk and effects of trans-boundary diseases and pests and

prevention of their spread as part of global system is also an area of importance for the region, and thus, must be addressed to avoid potential losses from their spread in the region in future.

Key Issue 6: Need to pay attention to trans-boundary animal and plant diseases and pests

Need to develop and manufacture machinery for the use of small-scale farmers

Although small-scale farmers were created in the region, no efforts were made to develop and manufacture machinery for their use. This created some problems for the new farmers as they did not have access to the required small machinery for carrying out farm operations. Thus, it becomes an important researchable and development issue for agricultural engineers to develop/adopt and test the new prototypes for their suitability to small-scale farming and for commercial production in the region. This will require considerable efforts on the part of the governments and private sector, but will contribute to improved agricultural production

Key Issue 7: Need to develop and manufacture machinery for use by small-scale farmers

**4.2 Issue Relating to Improvement of the Declining Living Standards and Livelihoods of Farmers:
Better life for all**

Need to study and analyze livelihoods and poverty in rural areas and increase income and improve livelihoods of farmers and rural people

Although the region's agriculture has shown some recovery and now heading for a stabilized situation, it would be useful to study and analyze the livelihood patterns and the poverty levels in rural areas. It would also be useful to augment their income if their standards of living are to be improved. This could be done by increasing their earned income in agriculture by diversifying of the activities with the agricultural products that they produce and by improving the rural nonfarm economy. This will require increasing access of the rural poor to assets, improving the asset use by creating and supporting rural institutions for competitiveness with emphasis on territorial development to improve the nonfarm economy, and providing social assistance. In this, involvement of private sector will be required. In the context of CAC region, small farmers will need to be organized and prepared by providing the required support for new food markets that are fast emerging in the region. This will also require improving the skills of the farmers to provide them access to the jobs in the new nonfarm economy.

Key Issue 8: Study and analyze the declining living standards and livelihoods in rural areas and develop opportunities for household income generation

Improve the livelihoods of small-scale subsistence farmers in mountain areas

Mountain areas in CAC region, important especially in Azerbaijan, Georgia, Tajikistan, Turkmenistan, and Kyrgyzstan, support the livelihoods of significant proportion of the region's population. The productivity of the subsistence farming systems in mountains on sloping lands, mainly dryland, is low, thus, making the population as one of the poorest in the region. This, together with the harsh living conditions, promotes out-migration and land abandonment. Barley cultivation and migratory small ruminant production are the main sources of subsistence to the population. Soil erosion by water run-off, managing slopy lands and degradation of grazing lands are major problems. For this, resource conserving, more productive methods of land use, and activities on diversification of income sources are required.

Key Issue 9: Improving the livelihoods of small-scale subsistence farmers in the mountains of CAC region

Organize and promote the role of rural women in agriculture research and development

Rural women play a recognizably active and important role in small-scale farming in the CAC region. They also add to the income of their households by actively participating in the farming of the small pieces of land around their homes and selling the produce to local markets. This role contributes to achieving their household food security and also to the urban food security. However, these women have

no voice in decision-making processes. It is time to recognize this and help them organize and promote their role in decision-making, including the role in setting priorities in ARD.

Key Issue 10: Organize and promoting the role of rural women in agriculture, and agricultural research and development

4.3 Issues Relating to Protection of the Environment: Essential for the region

Need for enhanced efforts to protect land and water degradation

Arable land and water occupy a special place in the CAC region as it supports the much-needed crop productivity and production. These limited areas of land have supported irrigated agriculture for quite some time now, and have now at places shown some signs of fatigue. This can present a major threat to rural livelihoods, which may be increased by the rising human population and the use of inefficient technologies. The water misuse has also resulted in the problem of salinity. Similarly, overgrazing and use of the rangelands for barley cultivation has led to irreversible degradation of rangelands, and also irreversible loss of precious biodiversity. Thus, this warrants for an immediate and special attention to protect this precious land and the water resource that is so vital for the irrigated agriculture and livelihoods of the farmers. There have been efforts lately to protect these important resources for irrigated agriculture. But special efforts are required to protect the land and water from further degradation through the use of efficient land/crop management practices. Likewise, water-use efficient techniques will have to be used to save water from degradation at the farm level. Also, efforts will be required at the basin level to protect both of these valuable natural resources.

Key Issue 11. Enhancing efforts on protecting the precious land and water resources

Need to protect forest degradation and embark upon afforestation and agro-forestry programs/campaigns

Forests are valuable resource in all the countries of the CAC region. In the past, they were given utmost attention to nourish and protect them. Now, signs of forest degradation are visible in most countries of the region. Protection of forests and encouraging agro-forestry becomes important in view of advancing desertification and climate change in the region. Considering this, concerted efforts are required by all to protect forests from further degradation and embark on appropriate afforestation and agro-forestry programs/campaigns in the region.

Key Issue 12: Protect the much useful forests from degradation and

Need for enhanced efforts on protecting the biodiversity

The CAC region has rich heritage of vegetables, fruits, vinery and nut trees. It is visibly seen in any local markets even in the rural areas. In the erstwhile Soviet Union, the Vavilov Institute of Plant Genetic Conservation in Tashkent used to serve as a regional repository for PGR of field crops, vegetable crops and grapes for the whole of Central Asia. Similarly, the Grapes Research Institute and Vine Making in Tbilisi was the repository for grape varieties for whole of the Caucasus. The region has made good progress on establishing gene banks in each of the eight CAC countries due to ICARDA's efforts. Also, the region has made a good progress in germplasm documentation and utilization from their gene bank collections. Similarly, efforts in breed characterization of the prevailing small ruminants in the region have provided some very useful information. Different activities useful for conservation of genetic resources need strengthening to facilitate the work. Capacity building for conservation, evaluation and utilization would be needed.

Key Issue 13: Enhance efforts on protecting precious vast natural biodiversity present in the region

4.4 Issues Relating to Achieving Structural Reforms: Requirement for better agriculture

Develop legal frameworks for land tenure, access and property rights

During the post-independence, the countries in the CAC region dismantled the large collective/cooperative farms and allotted their farm lands to prospective farmers who were earlier workers in the large farms. Some countries in the region made arrangements to lease lands to the farmers on long-term basis. The transition led to decline in crop areas and production. Although some countries are doing this, now is time and need to make reforms and develop legal frameworks on land tenure, access and rights to the properties. Land ownership is known to go a long way in providing stability to the small famers, and indirectly help land improvements and their protection from land degradation.

Key Issue 14: Developing legal frameworks for land tenure, access and property rights

Need to improve the structures for irrigation and drainage

The countries in the CAC region inherited elaborate irrigation system and structures for ensuring efficient irrigated and drainage systems in agriculture. These systems and structures could not be sustained in the post-independence period and collapsed causing a variety of problems from inefficient irrigation methods to problems of water and land degradation including the serious problem of soil salinity. Some countries have repaired some of these large irrigation and drainage systems while others lag behind in this process. But, still a lot is desired to be done and achieved as such actions require huge investments. It will be essential to address this important issue urgently if the countries would like to improve the productivity and production of the irrigated agriculture, an essential element for food security,

Key Issue 15: Improve the structures for irrigation to make irrigated agriculture to improve efficiency of the irrigated agriculture

4.5 Meeting the special challenges (existing and future)

The existing reports in the region on the priority of agricultural research issues have covered almost all the researchable activities that may be required to meet the challenges of agriculture development in the region, i.e., food security, improving declining living standards and livelihoods, protection of environment, structural changes and capacity development. However, research activities to meet some special challenges in the region have not been much emphasized. These include climate change due to global warming, Aral Sea problem, and the problem of desertification, which are bound to affect agriculture and its development in the region. The issue of challenge of climate change was mentioned in one report on research priorities (Paroda et al., 2007), but no definite research activities were proposed. Thus, the research activities that would be required to prepare the region for these special challenges are highlighted below:

Prepare to meet the challenges of global warming (Climate change)

Global warming is causing the problem of climate change which is already adversely affecting agriculture and its production especially in the drier regions of the world. This problem, which in future, is expected to be a recurrent phenomenon, will be directly affecting agriculture and its production. Therefore, the region should prepare itself to face the consequences of the climate change. For this, a better understanding of the effects of climate change on agriculture would be required. Also, measures for adaptation to the climate change will have to be developed for plant and animal production, which will involve development of new plant varieties and agricultural practices in case of plants, and efficient animal husbandry practices in case of animals.

Key Issue 16: Aligning agriculture research and development to meet the challenges of global warming, i.e. adaptation to and mitigation of climate change

Need to address issues that relate to the Aral Sea problem

The Aral Sea problem is a serious sub-regional problem in Central Asia. Although the problem has received attention from the concerned governments but much more is required to be done considering the magnitude and seriousness of the problem. The problem very much concerns the environment and agriculture and its development, and may predicate the consequences in future, if not attended to a scale that it deserves. Therefore, the issues relating to agriculture, e.g., water quality and flow, salinity, etc. should receive research attention.

Key Issue 17: Need to address the issues that relate to Aral Sea problem considering its great importance and serious implications in environment and agriculture

Need to address the desertification issue

In the CAC region, desertification is a major issue and is associated in some ways to salinity and water-use issues. It is time that appropriate actions are thought of and some researchable issues to deal with this important problem are considered for implementation.

Key Issue 18: Need to address the issue of desertification.

5. Priorities among the Researchable Issues

Achieving food security followed by improving the living standards of the people (poverty reduction), protecting the environment, and providing clean ecological environment are the most important development goals of all the governments for ensuring well-being of their people. To help achieve these goals different governments in the region have implemented a number of structural and policy reforms in their countries, and some are ahead of others, but much more is left to be desired in these areas.

Considering the regional goals, the CAC-NARSs have done a good job in identifying the challenges facing agriculture (food security, improving living standards and protecting the environment) that fits well into the identified development goals for the region. Although, the role structural and policy reforms to help agriculture and farms and farmers have been emphasized, a great priority and much emphasis is required for these researchable activities that will help achieve the desired results. Similarly, certain actions to improve the structure and function of agricultural research, education, extension have been initiated to help agricultural development in the region. But, much more is need to be done in these areas as they are a weak link to ensure good results for agricultural development. The implementation of research and development activities that will be addressing the priority challenges facing agriculture in CAC region will generate new and improved technologies which provide practical solutions to important issues that impact these challenges, and lead to productivity and production increases and improved livelihoods and environment protection. This of course will be predicated by effecting necessary changes like improved institutions to help farmers obtain modern inputs and market their produce, and an appropriate policy environment and its interaction with technology and institutions. These issues are also highlighted in Section 6 below.

The points raised in the above paragraph should provide some good “food for thought” to the stakeholders who will participate in the e-consultations. It would be appropriate to prioritize the researchable issues after receiving their feedback.

6. Changes required to Achieve the Desired Objectives

The success of an agreed research agenda applied through planned and pertinent research activities will depend upon several factors. These include the efficiency of the research system, the institutions supporting research and research processes, and appropriate investments for assuring sufficient funds, infrastructure and capacity development. The CAC region is undergoing transition and needs to pay attention to making appropriate changes that are essential to achieve the desired research objectives. Required to effect these changes would be a strong commitment of their respective Governments to provide agricultural research and development a priority place in the national development agenda of the CAC countries. Also required would be strong partnerships in agricultural research for development, which could jointly address food security, conservation of natural resources, important policy issues, upgrading the knowledge of the agricultural scientists, and restructuring of the agricultural research, education and extension systems that could lead to improved productivity and production leading to the improved rural livelihoods and poverty alleviation, and environment protection. The following is highlighted in this section:

6.1 Strengthening National Agricultural Research Systems (NARS): Meeting challenges of the new research agenda

Need for greater investment in and restructuring of the agricultural research system to meet the needs and challenges of the agricultural development

The lack of investment and planning have contributed to dysfunctioning of the existing agricultural research and education systems that were distributed in newly independent countries and were of very high quality during the Soviet times. Infrastructure for research became obsolete and linkages through which agricultural research could contribute to innovation, the well being of producers and economy of the state were broken and ceased to exist. This very much highlights the need for the CAC countries to invest heavily in agriculture research than what they have been able to do so far. The returns for investments in agricultural research and development in countries, where agriculture is a key element of the livelihoods and welfare of the rural populations and significantly contributes to national GDP, are well documented and accepted internationally.

Similarly, there is a need to improve agricultural research and its innovative systems in accordance with the new rapid developments in agriculture sector of these countries. These will include (i) Reorientation to satisfy the needs of smallholder producers and the market chain, meaning that the system has to become more inclusive in the research cycle and contributory to agricultural innovations at national, regional and even global levels, (ii) Reforms in the structure of the research system especially its accountability and reward systems so that it can attract active, young people with new skills and capacities for modern research of global standards, and (iii) Increased investment in infrastructure especially its knowledge generation and exchange infrastructure such as libraries and research publications.

Restructuring of agricultural research may also necessitate creation of an apex body in each country of the CAC region to link and coordinate national agricultural research, education and extension. Placing all the agricultural research, education and extension institutions and programs of each country under this apex body would ensure effective linkages, coordination and collaboration among research, education and extension institutions. The use of such an organization has been amply demonstrated in many of the developing countries.

The changes in research system would also involve strengthening innovation in agriculture using innovative approaches for this region. This would mean strengthening institutions for research in agricultural policy and investment, revamping farm investment support systems, seed systems, water management systems, land asset reforms especially around lease of land to small holders, Intellectual Property Rights, farmer organizations and ushering in new forms of farmer aggregation (not around cooperatives of the Soviet times but new types of farmer organizations, which aggregate farmers for input support and market participation), etc.

Action may also be required in introducing the coordinated research improvement programs for each of the major commodities and research areas/disciplines in each country headed by senior scientists/professors belonging to the commodities/research areas/disciplines. Such arrangements have paid heavy dividends in some of the developing countries that have used such arrangements. Another area which would require attention is formulizing and enhancing cooperation at regional, inter-regional and global levels. Changes would also envisage empowering the civil society organizations (farmers organizations, NGOs, women' organizations, private organizations, agri-universities, etc.) to play an active role in deciding the national and regional agricultural research agendas and development goals.

Key Issue 1: Need for greater investments in agricultural research and restructuring of the research system to coordinate the national agricultural research system and to meet the national agricultural development goals

Need for changes in agricultural education system in line with the goals of agricultural research and development and market needs

Agricultural education systems in the CAC republics during the Soviet era were structured and organized based on needs of the then centrally-commanded systems of agricultural research and production. Post-independence, educational systems failed because (i) the CAC countries could not sustain them because of lack of investment, (ii) they were dominated by the ageing academicians trained in the Soviet period, and (iii) could not attract students for want of opportunities for employment in the agriculture sector. There is now need to renew the educational system to attract young people, train them appropriately according to world standards to meet national needs for research, extension and agricultural education to contribute to agricultural development in the CAC countries and the region. Also, agricultural education needs to be redesigned to focus on training in the use of biotechnology, ICT and material science for agricultural innovation and development. Moreover, education should be directed towards increasing market participation in the country, with region and with littoral states, and with the global markets. Additionally, the education system needs to be integrated with the needs of agricultural research, extension and development. In line with these, the curricula of the agricultural faculties will need to be updated to meet the needs of the new agriculture in the countries and the region, and in line with the world markets.

Key Issue 2: Introduce changes in agricultural education system in line with the goals of agricultural research and development

Need to create an effective extension system for the country at the national level to create linkages with farmers, researchers and civil society and to facilitate technology transfer

Agricultural Extension Systems of the conventional type to support farmers were not developed during the Soviet times. New forms of extension systems to support small holder farmers and producers, very different from the collective farms of the Soviet period, were also not developed and have taken their time to emerge lately. Thus, either lack of poor linkages between research, extension, farmers especially the women farmers, and the policy makers are the norm in the region. Needless to emphasize that the lack of this interaction has diluted the effectiveness of the technology transfer to farmers, who have thus been deprived of the new innovations in agricultural research for improving productivity and production, and led to missed opportunity for increasing their agricultural productivity levels. It has also adversely affected farmers' participation and role in exercises that set agenda for agricultural research and development. It is now imperative that an effective extension system is put in place which would help the farming community in more than one way.

The new system would also need to develop an appropriate extension system that links to agricultural innovation systems and support smallholder agriculture and market participation. There is a need for a greater use of ICTs and transforming extension on the emerging needs in ARD in the CAC region.

Key Issue 3: Creating an effective extension system for the country to create linkages with farmers, researchers and civil society organizations, and to facilitate technology transfer

Need for capacity development for effectively carrying out the agreed research agenda through research activities

It is an important aspect essential to achieve the set objectives of the research agenda. It involves developing good infrastructure (buildings, facilities, equipment, etc.) for research and building scientific capacity of the scientists and technicians to carry out the required research activities to accomplish the set research objectives. The research areas that may need special attention are: use of biotechnology (including molecular markers) in crop and animal breeding, and plant genetic resources conservation and utilization; disease-resistance breeding; establishing seed systems; conservation agriculture; salinity management; agricultural engineering and farm machinery; policy and marketing reforms; competitiveness and trade; adoption and impact assessments;

Key Issue 4: Need for capacity development in research infrastructure and enhancing research capabilities of the researchers and technicians

Need to strengthen research linkages at national, sub-regional, regional, inter-regional and international linkages in agricultural research and development

In addition to strengthening the research systems and linkages at the national level, linkages among them have to be built at sub-regional, regional, inter-regional and with the global research systems considering the merits of these linkages. It is important to establish and formalize these linkages through the government channels and requirements to make them officially recognized and sustainable. Joint regional actions could address and provide good solutions to complex natural resource management problems and trans-boundary domains (hydro-salinity, rangeland management, livestock production, water-use efficiency, conservation agriculture, diseases and pests, mechanization for small-scale farming, climate change, and issues relating to vegetables and fruits and biodiversity). ICARDA and the CGIAR program for sustainable agriculture in development in CAC have been playing an important role in establishing and strengthening these linkages since 1995. In this, organizations such as CACAARI, AARINENA, and APAARI through GFAR support can also play important roles in establishing and assisting in these linkages at different levels.

Key Issue 5: Need to strengthen agricultural research and development linkages at sub-regional, regional, inter-regional and global levels.