



DRAFT for Discussion

Transformation and strengthening of agricultural research and innovation systems for development

REGIONAL STRATEGY

for countries of Central Asia and the Southern Caucasus



October, 2011

ACRONYMS

AIS	-	Agricultural Innovation System
AR4D	-	Agricultural Research for Development System
CAC	-	Central Asia and (Southern) Caucasus
CACAARI	-	Central Asia and the Caucasus Association of Agricultural Research Institutions
GDP	-	Gross Domestic Product
GCARD	-	Global Conference on Agricultural Research for Development
GFAR	-	Global Forum on Agricultural Research
FAO	-	Food and agricultural Organization
ICT	-	Information and communications technology
MDG	-	Millennium Development Goals
M&E	-	Monitoring and Evaluation
NGOs	-	Non Governmental organizations
NARS	-	National Agricultural Research System
RDI	-	Research and Development Institution(s)
R&D	-	Research and Development
SRF	-	Strategy and Result framework

From the compilers:

This document is based on national reports by CACAARI national experts on the transformation of the National Agricultural Research and Innovation System for Development, the GCARD-2010 Roadmap, data from other regional fora, data from the Global Forum on Agricultural Research (GFAR), Global Conference on Agricultural Research for Development (GCARD), Consultative Group on International Agricultural Research (CGIAR), FAO, World Bank and other international institutions and development programs, as well as on findings of the preliminary discussions with national and international experts in the field of agricultural science, representatives of the agricultural education system and of extension experts, ICT specialists in the agricultural sector, agricultural producers, and many other stakeholders.

However, its Russian version is currently circulating and correcting in accordance with comments and recommendations.

Dr. Botir Dosov – CACAARI Technical Consultant (11 - 11, 2011).

COVER PHOTO - "Integration of science and industry – a task of transformation": Dr. T. Aitbaev (Agricultural Science) – Director of the Kazakhstan Research Institute of potatoes and melon crops of JSC “KazAgroInnovation” and a farmer demonstrate economically valuable traits of sweet pepper.

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Executive Summary

The consequences of climate change have a negative impact on agriculture, which has already been affected by the severe outcomes of the recent global economic crisis. In addition projected population growth, particularly of the urban population, will increase demand for food and prices, which in turn will result in even greater use of limited natural resources. Ultimately, these problems are a particular threat to vulnerable groups of population, including to people with low incomes. Thus, societies face the challenge of solving these problems, and necessary action to take is required to ensure a peaceful, sustainable and prosperous future in the CAC.

Given these challenges, national AR4D system sets for itself as primary objectives to provide assistance in solving these issues in order to improve agricultural productivity, increase the quality and quantity of food through intensification and diversification of agriculture and to develop the mechanisms for efficient use of natural resources, mitigating the negative impact of the consequences of climate change. A priority cross-cutting theme is the requirement to take into account needs of vulnerable and low income groups of population and to minimise projected adverse effects of the above mentioned threats.

In this regard, AR4D system of the CAC focuses joint efforts on three main goals of agricultural research:

1. Improving the welfare of the rural population, particularly vulnerable groups as well as those dependent on agriculture;
2. Guaranteed improvement of the quality, volume and nutritional status of food through the intensification and diversification of agriculture to protect vulnerable and low income groups;
3. Rational use of natural resources and mitigating adverse effects of climate change.

The above three targeted research areas of AR4D in the CAC are compatible with the four system-level outcomes, which the Consultative Group on International Agricultural Research (CGIAR) is focusing on in the coming years:

1. Poverty reduction in rural areas;
2. Improving food security;
3. Improving nutrition and health;
4. Sustainable management of natural resources.

Transformation of AR4D in the CAC aligns with the six principles of the GCARD1 Roadmap¹, and suggests strengthening of all its constituent elements: (i) innovative research, (ii) education and capacity building, (iii) extension services that should be accompanied with development of ICTs.

¹ (i) identification of priorities and necessary measures to take determined and shaped by national, regional and global development needs; (ii) promoting equal participation and transparency among all stakeholders in agricultural innovation; (iii) increasing investment in human, institutional and financial resources to adequately solve appearing issues and to achieve goals set; (iv) development of required human and institutional capacity to generate relevant agricultural knowledge, and its implementation into practice, and achieving new results; (v) introduction of innovative systems into development programs and strategies; (vi) covering activities through monitoring and evaluation, and reporting.

Implementation of these set tasks is impossible without adequate participation of all stakeholders, and particularly without due government attention and increased investments in agricultural research and innovation.

In the CAC an increase of investments in AR4D is supposed to be equal up to 1% of gross agricultural output by 2015, up to 2% by 2020, and up to 3% by 2025.

The full package of measures on transformation of agricultural research and innovation systems is proposed to be undertaken in three phases, each of which is to be accompanied by assessment of the activities, and of the goals achieved with implementation lessons learnt for future activities:

- Short-term phase 2012-2013;
- Med-term phase 2014-2015;
- Long-term phase 2016-2017.

The main activities are:

- Conducting a baseline study of consistent patterns between investment in AR4D, innovative development and productivity increase and the role of agricultural research, capacity building and knowledge sharing in the pursuit of development goals at all levels, thus justifying the planned and increased investment in AR4D;
- Conducting an inventory of all relevant projects and studies, and those studies that are part of programmes currently being implemented;
- Identifying existing and projected needs in agricultural research, and assessment of the amount of the funds required to conduct them;
- Identifying sources of funding for different categories of expenditure for research activities;
- Increasing financial recognition of the vital contribution of agricultural scientists to economic growth;
- Minimizing taxes of funds for research activities. Simplifying procedures for obtaining patents and copyrights on scientific developments, and improving rewards and the commission fee system for the use of scientific inventions;
- Applying tax incentives for private companies involved in funding activities of research institutions, agricultural consulting agencies and extension systems;
- Developing and implementing a system of monitoring and evaluation the efficiency of agricultural research, in terms of its implementation in agricultural production;
- Implementing a funding system for AR4D based on the results of monitoring and evaluation of the impact of agricultural research, assessment of supply and demand for staff in diverse fields, and of national priorities of agricultural development.

These and other proposals presented in this draft of a regional framework are to be discussed by all stakeholders before and at the Regional Brainstorm meeting “Transforming and

Strengthening National Agricultural Research and Innovation Systems in CAC region”, to be held in Tashkent, Uzbekistan on 29 November - 03 December 2011.

In the final document agreed upon by all stakeholders, the following should be clearly identified:

- ✓ required activities;
- ✓ resources necessary to implement these activities;
- ✓ expected outputs and outcomes from the implementation of each activity;
- ✓ those responsible for the implementation of each activity;
- ✓ implementation timeframe for each activity;
- ✓ mechanisms/tools for monitoring and evaluation of each activity.

We hope that prior to approval this Regional Strategy will be widely discussed in order to achieve consensus on achieving its conclusions.

1. Goals and objectives of the transformation of AR4D

1.1. The goals, objectives and expected impact

The process² of transformation and the strengthening of the agricultural research and innovation system for development has three goal levels:

Overall Goals: Maximum contribution to the achievement of development goals, in particular: (i) improving living standards, (ii) increasing and expanding food security; (iii) strengthening favourable environment, as well as indirect contribution to: (iv) ensuring social justice; (v) development and expansion of healthy life style for all; (vi) strengthening supportive social environment; (vii) integration processes of socio-economic development.

Purposes: (i) improving agricultural productivity; (i) increasing quality and quantity of food supply; (iii) minimising adverse impacts on the environment through rational use of natural resources; (iv) mitigating negative impact of climate change on agriculture. In addressing these issues, there is a responsibility to take into account needs of vulnerable and low income groups of population.

Objectives³: (i) identifying the main priorities of agricultural research as determined by the needs of science and society at national, regional and global levels; (ii) ensuring equal opportunities for participation and transparency among all stakeholders in the planning and implementation of agricultural research and innovation development aimed at the achievement of the goals set; (iii) expenditure increase to finance development of improved systems for agricultural research, education and consultation; (iv) development of the human and institutional capacity required for the generation of relevant agricultural knowledge, and linkage with its users, and achievement new results; (v) integration of innovation activities with goals of development program and policy; (vi) disclosure efficiency of measures taken by monitoring and evaluation, and reporting.

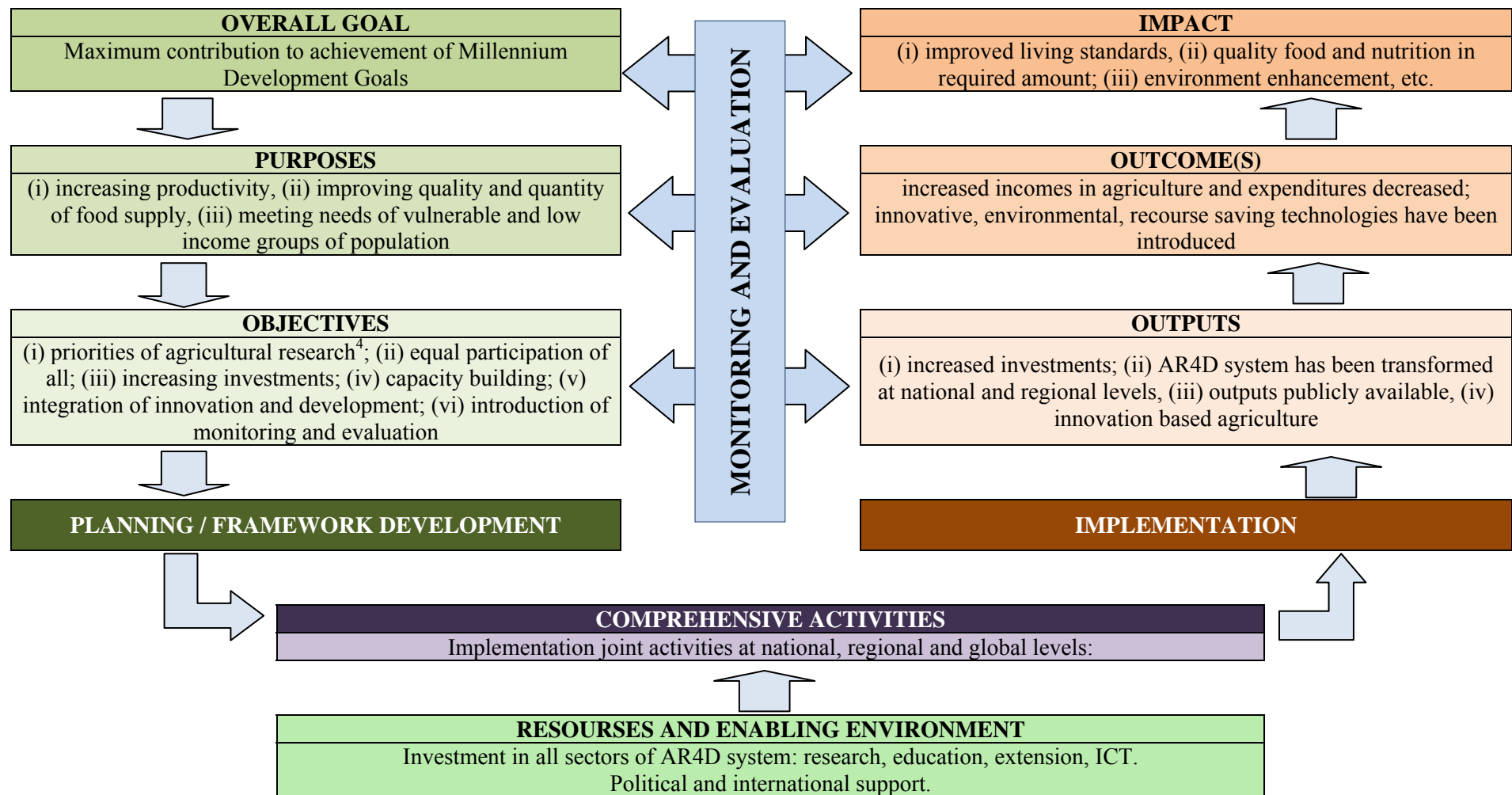
The objectives of the AR4D transformation indicate how goals can be achieved, or in other words, what needs to be done so that the agricultural research and innovation system is able to generate the necessary knowledge and introduce it into practice to solve issues in agriculture and meet the needs of rural producers, including smallholders.

During the AR4D transformation process "objectives" should be transformed into "outputs", "purposes" into "outcomes", "overall goal" into "impact". That will require the development and implementation of comprehensive measures and investment of the required resources, particularly finance and continuous monitoring of progress.

² The transformation process of AR4D is schematically described in Picture 1.

³ Objectives of the AR4D transformation is similar to conditions of the GCARD1 Roadmap.

Picture 1. Scheme of AR4D system transformation process and impact on agricultural and socio-economic development



⁴ Main priorities of agricultural research extracted from the CAC national reports can be found in Annex 1. Topics of agricultural research can be found in Annex 2.

1.2. Need for immediate action

Socio-economic development policies in Central Asia and the Caucasus are in tune with the global trend aimed at the achievement of the Millennium Development Goals⁵ in accordance with commitments countries took to reduce poverty, hunger, illiteracy, infant and maternal mortality and to combat infectious diseases, promote gender equality and to stop environmental degradation.

“We are convinced that the Millennium Development Goals can be achieved, ... with renewed commitment, effective implementation and intensified collective action by all Member States and other relevant stakeholders at both the domestic and international levels, ... increased mobilization of resources for development, increased effectiveness of development cooperation and an enhanced global partnership for development.”

From resolution adopted by the sixty fifth session of the UN General Assembly – The UN Summit, Keeping the Promise: united to achieve the Millennium Development Goals (MDGs)

Present models of consumption and resource use leads to land degradation and, in some cases, the extinction of entire species of plants and animals. Climate change causes a threat of rising sea levels and of devastating droughts and floods. At the same time agriculture, with huge resource potential, is one of basic sectors of economy, and needs to be able to generate the required resources not only to other sectors of economy, but also for the improvement of welfare of the population. Focusing joint efforts at solving issues in agriculture and increasing its productivity is therefore an important objective at all levels.

Taking into consideration global goals, trends and the mechanisms available to achieve them while setting national goals for agricultural development and their prioritisation allows international institutions for agricultural research to more effectively provide assistance in achieving national goals, as well as to support rational development of transformation strategies for the national AR4D institutions allowing them to contribute maximally to national development. The correlation between global, regional and national AR4D transformation processes, is driven by inclusive national needs into regional ones, which in turn are integrated into global priorities.

⁵ International development goals in the Millennium Declaration that all 189 United Nations member states and 23 international organizations adopted at the UN Millennium Summit and have agreed to achieve by the year 2015

by increasing incomes and extending access to food and nutrition production.

These goals cannot be achieved only by transformation of agricultural research systems aimed at generating necessary knowledge and innovation. It also requires development of a favourable environment and ensuring all necessary resources and political support and promotion of agricultural research.

The CAC countries require to take a more holistic approach which takes into account not only productivity factors but also issues of food security and nutrition, livelihood and environmental sustainability based on coordinated activities among countries and the finding of necessary compromises.

Joint efforts of all stakeholders should be concentrated on this process: public and private sectors, including producers, intermediaries and consumers of agricultural knowledge and innovation, and international development institutions of the AR4D at national, regional and global levels. These objectives are systematized in the provisions of the GCARD1 Roadmap⁶ and reflected in this CAC Regional Strategy.

The Roadmap highlights *"responsibility of all those who care about the future of agriculture and its role in development"*. Despite the high standards of objectives to be achieved by societies, particularly in achieving the MDGs, as well as the above mentioned six objectives, which require a radical rethinking of agricultural innovation and its specific role in achieving development goals, which is a complex challenge – it is important to continue to move forward, and make an individual contribution to joint activities. **There is no need to wait for favourable conditions which provide an opportunity to do something to achieve these goals; all stakeholders should now reflect on what contribution he/she could make for the common good.**

During World War II, Leningrad was in a complete blockade with critical minimum food supplies and complete lack of heating. At that time the local Botanical Institute was in danger of losing its collection of rare plants. Despite severe and intolerable conditions, scientists managed to save about 4 000 rare plants, many of which were placed in their homes. Scientist Dr. N.I.Kurnakov saved in his apartment almost the entire collection of cacti. Botanists had spared no effort or health to improve food supplies in Leningrad. In spring 1942, staff of the Botanical Institute raised 5.5 million pieces of planting vegetables. During the siege, experiments to extract vitamin C from pine needles were successfully carried out at the institute and advice on how to plant vegetable crops was given to the city population. That was effective support of the people of Leningrad in their fight against hunger, muscular dystrophy, scurvy.

1.3. Limited resources and their role in achieving set objectives

The cornerstone strategic objective of the agricultural research and innovation system and of agricultural production should be: **"how limited resources can sustainably achieve maximum productivity"**. Meanwhile it should be borne in mind that all resources used in agricultural production are limited. These can be categorised in the following five groups:

⁶ Principles of the GCARD1 Roadmap

- Natural resources: land, minerals, water, forest, biological, agro-climatic and all other types;
- Human resources: intellectual and physical potential;
- Investment or capital resources: financial resources, grants, machinery and equipment, facilities, fuel, fertilizers, chemicals and other non-natural resources;
- Organisational resources: capacity to coordinate actors in and around value chains and in complex natural resource management systems;
- Knowledge: understanding of science, information, technologies, scientific and technical progress.

All of these resources, limited in various degrees, are necessary for the efficient operation of agricultural production, processing, marketing, policy making etc. The efficiency, effectiveness and sustainability of use of these resources are the challenges for agricultural research and innovation system.

Thus, the agricultural research system including: science, education and implementation (extension) is or at least should be the "central processor"⁷ for agricultural innovation system. However, there is a need to strengthen and transform the agricultural research system which is not possible without enhanced government attention and support.

The system of agricultural research and innovation should:

- design and implementation of a system of rational and efficient use of natural resources;
- provide the necessary intellectual capacity that in synergy with existing labour potential will significantly increase return on capital use in agriculture;
- develop the agricultural science base, demonstrate practical feasibility and actively promote an agricultural innovation system that has to eventually replace agricultural production based on subsistence agriculture;
- generate advanced knowledge in the field of agricultural science, information, technologies and result in scientific and technical progress.

Given the invaluable contribution of agricultural research and innovation system in the achievement of immediate and more distant objectives, governments should give due attention to their stimulation, transformation and strengthening, taking into account that natural, human and capital resources and knowledge are limited resources for research organizations, agricultural education and extension systems. Therefore, government support should not be limited only to expenditure increase for fundamental and applied agricultural research, education, training and the development of extension systems, but also provide greater social protection and economic freedom, expansion of facilities and areas for experiments and testing, providing safety of workers at all levels.

⁷ By analogy with central processing unit of personal computer that performs data processing operations

1.4. Participation of all stakeholders⁸

The current reality makes it clear that problems in agriculture, the potential threat of instability in the economy and environment, projected impacts of climate change and population growth are problems not of any single group of the population or any single economy sector, but a situation that is a burden for all, not only at national but also at regional and global levels. Accordingly, solution of these problems is the responsibility of not only managers, researchers and investors, but also many others, especially those who will be directly affected, namely, consumers and smallholders.

Therefore, in the process of developing necessary innovative knowledge, and passing it to farmer and smallholders, all stakeholders should be involved, especially those who are the ultimate beneficiaries of reforms achievement under the stated objectives. Such full participation in the transformation processes by consumers and rural producers, especially smallholders, ensures the enabling environment for generating innovative knowledge required to overcoming difficulties.

Integration of farmers, increasing participation of interested customers in the process of agricultural research and implementation of its results into production and improving access to agricultural knowledge, will increase the practical value of scientific developments and will facilitate their integration into innovation system.

2. The increased investments in agricultural research and innovation

Although, increased investment in agricultural research is not the only requirement for its strengthening, it remains the most significant factor in successful transformation processes, and requires special attention.

The main sources of funding for agricultural research should come from both the public and private sector, and include projects and programs funded by donors where this is possible, as well as being drawn from the funds of research institutions.

2.1. Public and private sector

The public sector represents government, state and regional organizations providing funds to support agricultural research systems. Planning of public expenses on agricultural research should take into account current and planned financial resources of the private sector, which generally support targeted programs and projects. The coordinated donors' support and some funds of research organizations that cover part of expenses should also to be considered. Thus, government funds should play the role of balancing source that covers those areas of agricultural research system which suffer from the deficit of funds.

⁸ As mentioned in national strategies set out in Annex 4, organizations, institutions and representatives of the diverse forms of property and population groups should be actively involved in the transformation processes of agricultural research and innovation based on objectives achievement.

If the rational and comprehensive process of transformation of agricultural sector is properly carried out, along with farms and smallholders productions, large agricultural enterprises will be evolutionally formed, which will compete⁹ for better positions in agricultural input and output markets. In developed economies big companies spend huge amount of their capital on R&D, which returns in increased productivity and profits accordingly.

Robert Solow¹⁰ who was awarded Nobel Prize in 1987 for his contribution to the economic growth theory, noted that: raising capital gives additional 12.5% increase in output, while remaining 87.5% increase is result of technological change. Later this model has been supplemented by another element – human capital. Thus, increased investment in knowledge generation along with investment in human capital boost the profitability.

The expenditures of the profit-oriented enterprises are justified by choosing between expected profit and relevant risks. An important factor of agribusiness is competitiveness which is ensured by innovations. That factor motivates agribusinesses to allocate substantial funds to purchase advanced science and research developments and employ advanced technologies.

Currently most of the major large agricultural enterprises in the region address this problem creating joint ventures in partnership with large foreign and transnational companies. However, if the capacity of agricultural research institutions in the region is improved, private sector will get more interested in investing and funding targeted research projects¹¹. In return private companies can fully have profits, as well as ownership of invention produced within research financed. Also private companies will have an opportunity to increase their profits through large-scale introducing research developments, and ownership of property rights/patent that may bring extra income as a royalty from exploitation of research developments by other companies.

Thus, attracting private sector as a trigger of agricultural innovation system would contribute to solve problem of under-financing of the agricultural research system.

To increase investments of private sector in agricultural research system requires its investment attractiveness which can be ensured by:

- required and sufficient intellectual (scientific), production capacity;
- appropriate legal framework, which regulates relations between customers and researchers;
- enabling environment linking research outputs with agricultural production;
- motivation mechanism stimulating research based on payment system¹², so that researchers compete for better performance, and author-oriented system of patenting and royalties, awards for scientific achievement.

⁹ Enterprises directly or indirectly related with agribusiness, food, biotechnology, bio-stimulants, protection of animals and plants, chemical industry for agricultural production.

¹⁰ He found that the increased use of capital explained 12.5 percent of the change in gross output per man-hour while the concept of technical change explained the 'residual' 87.5 percent.

¹¹ Perhaps "applied" at an initial phase and "fundamental" research in the later phase along with progress in agricultural research and increase in capital turnover of private enterprises.

¹² JSC «KazAgroInnovation" introduced a rating system and competition based payment that encourages researchers for more productive work.

However, there are some problems at initial phase of transformation of agricultural research system that do not allow research institutions, including educational institutions to have appropriate investment attractiveness for private sector. Main impediments to investment attraction are:

- lack of financial resources;
- out of date office and laboratory equipment and facilities;
- not sufficiently developed system of capacity building;
- weak research promotion policy, etc.

The absence of demonstration of opportunities for both fundamental and applied research, poor and fragmented integration with international research centers, little government attention and low level of documented acknowledgement of inventions in the form of prestigious certificates, awards provokes lowering investment attractiveness and reduces the interest of public and private sectors to invest in national agricultural research systems. However, required conditions can be created if sufficient funds would be invested to launch transformation of agricultural research system.

Thus, present agricultural research system gets stuck in a vicious circle: its under-funding does not allow improving its investment attractiveness, which in turn requires necessary financial investments. To solve this problem government support is certainly required. Increasing public spending on agricultural research at initial stage will be a catalyst for transformation of agricultural research and innovation system.

It should be mentioned that along with positive aspects of funding of agricultural research by private sector, there is some sensitive part of government support. Financial inflows to R&D by private sector are usually made into high-profit areas. In addition, investing company is more interested in funding of the research that crucially affects on productivity. For that reason, risk of disproportionate and inharmonious transformation of agricultural research system is increasing, thus hindering the holistic development, which ideally should consider the needs of all spheres of agriculture. Following this scenario, agricultural sector would develop only in a direction, where interest of private sector and high return. At the same time such system of agricultural research will not be able adequately/totally satisfy the needs of all interested parties (stakeholders).

Another sensitive issue of the process of funds increase by private sector is deprivation of smallholders who do not have sufficient funds to invest in agriculture and therefore far less likely to maintain their interest in competition with larger investors of agricultural research and, accordingly, will have a smaller share of agricultural market. As a result, we will have a tendency of artificial monopoly over segments of not only agricultural research but also of full agricultural sector. That will in turn negatively impact on income equality of agricultural producers and rural/agricultural population.

However, this imbalanced situation can be levelled by a rational use of public sector's funds, donors' aid and own smaller resources of institutions, as well as removing tax burden on tangible and intangible assets and activities that are experiencing a shortage in funding.

Thus, public funding should be a tool for balancing and harmonious development of agricultural research and innovation system.

While increasing public or private sector investments into AR4D the financial incentives for researchers should be at a focus, so they would be more motivated and stimulated for better delivery of results. Their efforts and results should be supported and protected under improved patent system, which guarantee attractive earnings. Such system should use a competition as a tool of motivation. A "healthy competition"¹³ will ensure good financial support for talented and effectively working scientists.

As to agricultural research which is under private sector, increasing revenues from proprietary research will also stimulate investment in research by owners themselves.

As transformation of agricultural research is taking place, and investment of public sector and private sector is increasing, share of the latter has to be increased in total funding. Despite all positive arguments of public funding, agricultural research system as part of national economy should be more or less based on market principles and fair competition. In this case, public sector should act as investor that is interested in increasing productivity in all spheres of agriculture.

2.2. Funding of donor agencies

Undoubtedly, the role of donors in supporting agricultural research cannot be overestimated, especially at initial stage of reforms, as they ensure conducting research on diverse topics related with agriculture, food policy, environment, negative impact of climate change, etc. In addition, they support viability of sensitive areas of applied research, monitor results of programs and projects implemented, and provide useful lessons how to improve future projects. However, at present, the fragmented system of donor assistance cannot be considered as effective.

Despite the positive impact of donors' aid, its effect could be much higher given ensured by coordination of activities.

Nowadays majority of international donor organizations, research and development centres are operating in the region. In addition, many projects are funded by governments of developed and rapidly developing countries and international financial institutions. Money of foreign taxpayers is disseminated in national development processes, including in agriculture, and satisfying in various degrees the needs of agricultural research, capacity building/education and extension systems. However, these efforts are fragmented, and majority of implementing activities are based on programme approach. It is therefore necessary to focus efforts in the region on improving mechanism of donor coordination.

Creating mechanism for coordination and coherence among donors would greatly increase expected outcomes, bridging between segments of agriculture.

¹³ Healthy competition is mentioned in section 5.4.

Creating mechanism of aid coordination within all sectors of national economy is quite challenging, while its creation for a particular sector, such as agriculture is quite feasible and appropriate, where coordination role of aid flows¹⁴ should be exercised by ministry of agriculture of any particular country.

It should be mentioned that many donors are interested in implementation of targeted programs in agriculture at regional or sub-regional level, as these programs have far-reaching goals, and provide better outcomes because of their systemic approach than single projects. In addition, coordinated approach is acceptable for most donors to increase effectiveness of their assistance and to avoid overlapping.

For example, the Seventh Framework Programme of the European Union is funding scientific research and technological development for 2007-13. It is supposed to promote development of research infrastructures, strengthen innovation capacity of small and medium-sized enterprises, development of regional research clusters, and greater integration of science and society.

Thus, it is suggested to have annual regional meetings of donors and other main actors, including the Ministries of Agriculture and private actors operating in agriculture in each CAC country on alternate basis. Following points might be included in agenda of the regional donors' meeting:

- inventory of implemented and ongoing projects and programs;
- roadmap for Agricultural Development;
- challenges and needs of agriculture development at national and regional levels;
- offered projects and programs;
- areas of agricultural research and innovation suffering from under-resourcing;
- agricultural education and vocational training that require support of international educational and research centers;
- group discussions and round tables, etc.

In addition, it is useful to disclose information on implemented and ongoing projects and programs at appropriate web sites.

As a result of coordinated donors' activities, return on financial and technical assistance will be sharply increased, gaps between agricultural production, research, education, and extension will be reduced.

3. Result-focused agricultural research

Agriculture in the CAC faces problems some of which are a legacy of past decades, while others are caused by the unstable situation of the global economy and of the environment. Concerns about these problems compounded by countries' understanding that increasing food prices, greedy consumption of natural resources, which in most cases is not rational, are primarily a threat to smallholders and vulnerable groups of population. It should be mentioned that

¹⁴ Ministry of agriculture of the CAC should also coordinate the flow of external loans, as majority of investment projects have many research components that are usually regarded as grants (research expenses are not paid back).

population growth that will lead to increased food consumption and use of even more natural resources requires a comprehensive approach to solve the problems.

Given these challenges, national AR4D system sets for itself as primary objectives to provide assistance in solving these issues in order to improve agricultural productivity, increase the quality and quantity of food through intensification and diversification of agriculture and to develop the mechanisms for efficient use of natural resources, mitigating the negative impact of the consequences of climate change. A priority cross-cutting theme is the requirement to take into account needs of vulnerable and low income groups of population and to minimise projected adverse effects of the above mentioned threats. All these require rethinking of the AR4D role in achieving these goals, as well as generation of the knowledge that will facilitate this process.

Thus, conventional agricultural research system cannot adequately address existing needs of agricultural and rural population to reduce anthropogenic impact on environment and its consequences. Therefore, it must be transformed into a system of result-focused agricultural research and innovation.

In this regard, AR4D system of the CAC focuses joint efforts on three main goals of agricultural research:

1. Improving welfare of rural population, particularly vulnerable groups of population, as well as those dependent on agriculture.

The smallholders group constitutes a large part of agriculture, which varies in each country of the CAC. They produce a tangible part of the agricultural goods and food. However, because of their autonomy from the larger farms and low level of income, they are more exposed to changes in the economy, environment and climate. A distinctive feature of their activities is the focus on own needs and limited income available. Products that are in their possession, after allocation its part for their own needs, are sold in local markets. Because of small volume of production, which is not sufficient to cover the cost of transportation, storage and payment of fees (or taxes), they are not profitable to export products to larger markets, nor can they invest in development and introduction of new technologies that will improve productivity and/or reduce production costs. These opportunities are available for larger farmers.

One of the solutions might be to implement measures to increase agricultural productivity and develop market infrastructure where needs of smallholders will be taken into account.

Thus, productivity improvement in areas where smallholders and vulnerable groups of population are operating should be a cross-cutting issue of AR4D, and the focus concerted and coordinated efforts of national AR4Ds as well as international development centres.

In a broader sense, it is required to develop market infrastructure with improved road and transport infrastructure, improved mutually beneficial mechanism for commercial and industrial relations between large and small producers, as well as to strengthen public support and to introduce tax incentives or minimization of tax burden for smallholders.

2. Guaranteed improvement of the quality, volume and nutritional status of food through the intensification and diversification of agriculture to protect vulnerable and low income groups

Increasing tension in the food sector due to growing prices and production costs, especially in livestock and crop sectors, causes a strong concern of the governments and poses serious challenges to the AR4D. There is a need to put joint efforts to increase agricultural productivity, to introduce innovations into agricultural production that will eventually reduce the cost of food. In this process, quality improvement, productivity increase and cost reduction are important terms for healthy food supply especially to vulnerable groups of population, women and children.

In addition, more broadly, it is required further development of market relations, increase of social subsidies, observance of price parity, disease prevention, addressing of population needs, etc.

3. Rational use of natural resources and mitigating adverse effects of climate change

Recognizing that exploitative treatment of nature, irrational use of its resources without preservation are passing, the CAC countries comprehend a joint approach to resolve those issues. However, the measures undertaken are not enough to move towards development, since they are aimed at struggling with consequences of environmental degradation, but not at eliminating its causes. The issues of irrational use of natural resources, anthropogenic impact on the environment are addressing from local to regional and global levels.

Problems of rational use of natural resources become crucial because of imminent threats of climate change, negative impact on resource-oriented sectors of national economies, on population health, on food security, on ecosystems, and cause a mass migration from environmentally catastrophic territories.

Each century has its own challenges to public health; in the century we live in such a challenge is climate change.

*Dr. Margaret Chan,
Director General of the World Health
Organisation*

In this regard, the CAC AR4D face the challenge for rational management of natural resources, mitigating negative impacts of climate change, finding the best or optimal ways to use agricultural ecosystems in a changing climate. At the same time it should be done with a minimal negative impact on biogeocenosis. Solving this challenge will contribute to sustainable agriculture activities of smallholder and vulnerable groups of population under ongoing climate change.

Rational use of natural resources with a minimum negative impact on the environment, mitigation of climate change is a complex issue and its solution depends on the consistent implementation of activities not only at national but also at sub-regional, regional and global levels. It requires joint efforts to conduct baseline research that examines all aspects of use of natural resources: increasing agricultural productivity, reduction of operation costs, conservation of natural landscapes, maintenance of natural diversity, providing a healthy environment, preserving of ecosystems.

To wide extent environmental policy supporting programs for environmental protection and rational use of natural resources; improvement of mechanism of nature management in line with

ongoing reforms in agriculture; a gradual transition to international environmental standards of production and processing; establishment of a unified system of monitoring of natural resources and of environment; ensured ecological safety of new production and processing technologies; protection of people and environment; minimizing negative impact of climate change; improvement of environmental education and training, and better disclosure of environmental conditions have to be introduced.

In addition, there is a need for coordinated activities between CAC national authorities for environmental management, as well as implementation of environmental programs of national and regional scope.

The above mentioned three main goals of agricultural research of the CAC AR4D have similar content to the four system-level outcomes that GCARD research is focused at in the coming years. All agricultural research priorities and activities are aimed at achieving the following goals:

1. Poverty reduction in rural areas;
2. Improving food security;
3. Improving nutrition and health;
4. Sustainable management of natural resource.

Compliance of the three foci of the CAC with the four system-level outcomes of GCARD research is shown in the following table:

Three foci of the CAC AR4D	Four system-level outcomes of GCARD research
<i>1. Improving welfare of rural population, particularly vulnerable groups of population, as well as those dependent on agriculture.</i>	<i>1. Reduced rural poverty</i>
<i>2. Guaranteed improvement of the quality, volume and nutritional status of food through the intensification and diversification of agriculture to protect vulnerable and low income groups.</i>	<i>2. Improved food security</i>
	<i>3. Improved nutrition and health</i>
<i>3. Rational use of natural resources and mitigating adverse effects of climate change.</i>	<i>4. Sustainably managed natural resources</i>

4. Transformation of AR4D

Science-based agricultural strategy should obviously take into account multifunctional modern agriculture, its influence on implementation of key social, demographic, environmental and political activities. In this comprehensive approach the AR4D should justify budget expenditures for agricultural development, demonstrate contribution of agricultural sector in national economy, lay foundation for its innovative growth.

4.1. Innovation systems

Governments of the CAC countries are aware that reforms in agriculture to improve its productivity is impossible without encouraging and support of agricultural science and innovation system, introduction of modern technologies, and mobilization of actors of agricultural research and innovation. It is required to implement major changes in the system of agricultural research and to create enabling environment for development of national innovation systems, to develop effective mechanisms of innovation promotion. Thus, transformation of system of agricultural innovations is focused at three major interrelated issues: (i) expansion of innovations supported by agricultural science, (ii) increasing the readiness of agriculture to innovate, and (iii) strong linkage between developers and users of innovative knowledge.

The process of transforming and strengthening the system of agricultural research and innovation focused on improving agricultural productivity as well as population welfare, should solve the issues related with intellectual and human capacity and with development of strong communication links between academic institutions, regional (provincial) scientific and research organizations, experimental stations, testing centers, agricultural enterprises, farmers, smallholders and other users of scientific information. Establishing systemic connection between research institutions and producers will provide an opportunity to effectively implement science findings and disseminate best practices.

Currently, development of innovation systems in the region is considered as a necessary condition for protection from crisis situations and enhancing agricultural productivity. Promoting innovative activities of agricultural sector will enhance not only the production chain, but also significantly improve investment climate in agriculture.

In agriculture sector five main areas need to be transformed in innovation system: (i) selection and genetics, (ii) production and processing, (iii) management, (iv) socio-economic development, and (v) environment that more specifically acts as a factor really impacting on development of agriculture-based food systems and reflecting their multi-functionality. Therefore, the integration of agricultural science into the overall strategy of agricultural development is of increasing importance and urgency.

4.2. Agricultural education

In the process of strengthening and transforming the system of agricultural research and innovation, issues of human development in agriculture of the CAC have enormous significance, and therefore they are the most important priorities of agricultural policy. The aim of transformation of agricultural education is the capacity development in agricultural sector at a level that is adequate to needs of its innovative development.

The weak correlation between agricultural education and innovative technologies defines urgency of transformation and strengthening of agricultural education system. A great demand for innovative technologies in agriculture hinders its development. To solve this problem, the following actions have to be undertaken:

- improving professional knowledge of specialists in modern agricultural industry who are involved in promotion of development of innovative systems;

- training of young specialists in the agricultural universities that are able to develop and introduce innovative technologies;
- bridging the gap between curriculum of agricultural education and current trends in production technology and management of innovation systems;
- strengthening and extending logistical facilities of agricultural training and educational institutions;
- development of modern mechanisms of human resources management of agriculture adequate to effectively balance supply and demand on agricultural labour market.

As international experience shows¹⁵, in the long-term the agricultural universities should be transformed in educational-research centers generating new agricultural knowledge and innovative technologies which are in demand. Therefore such institutions should have: sufficient funds for education and research activities, quality professing system, appropriate logistics, etc.

To achieve this, agricultural higher education system including agricultural colleges has to be under jurisdiction of Ministry of Agriculture which institutional, financial and logistic support providing to agrarian universities should be embedded in state development programs.

Creating a mechanism of interaction of (i) agricultural education, (ii) private and (iii) public sectors will strengthen innovation-focused research supported by establishing direct relations with large agricultural producing and processing enterprises. As result of this arrangement fundamental research will be intensified, as well as applied research based on it, and thus the overall agricultural research system will be enhanced.

Therefore, it is necessary to carry out large-scale but thoroughly considered transition of agricultural education to a new level that meets the need of prompt recovery and further innovative development of agricultural sector. That will also require institutional transformation of the AR4D system. At the same time the process of transformation may go in two ways: evolution way – development of the system and impartial necessity of its transformation at a new level; or revolution way when many elements of the system not ready for transformation may not stand up to those transformations.

In the CAC with its specific features, establishment and development of large research centres under agrarian universities, which will include a multi level system of education¹⁶ must be based on a rational approach, with a view to keep integrity of the AR4D, and individual areas of research without loss of scientific and human potential. These processes require more involvement of public, private sector, and other AR4D components, as well as contribution of international development centers and universities from developed and fast growing economies. This will provide an opportunity to develop own research capacity of agricultural universities in the CAC, and to

¹⁵ Experience of universities in developed countries.

¹⁶ High schools, bachelor degree, master degree, postgraduate study, post-doctoral study, as well as professional trainings.

integrate into it only those of the existing research institutions that will benefit from this merger in order to keep and enhance scientific and human resource capacity, to improve logistics.

4.3. Extension system

The main purpose of reinforced extension system should be promotion of reform and development of agriculture sector through establishment of an integrated system of knowledge transfer to agriculture producers.

Participation of all stakeholders from public and private sectors, in particular, research institutes, universities, NGOs, entrepreneurs, suppliers, producers and processors, can partially fill the existing vacuum of the weak extension system. Enhanced extension can contribute to intensified mobilization of labour, material and financial resources, to focus efforts on key areas where research, education and consulting services are now in high demand.

Currently, various forms of cooperation between agricultural research, education and production are implemented in the region and relationship between the AR4D actors is effectively being developed.

This process is accompanied with a reform of R&D, agricultural education and training, particularly of specialists and consultants of extension service which aims at build bridges between science, education and production and to address the needs of farmers.

The most important requirement for an efficient extension service is an inclusive combination of education, knowledge sharing, science and consulting. However, positive effect of these activities is not significant, because integral elements of extension were separately developing in various agencies of the public sector.

Unfortunately, extension system in many countries of the CAC is not well developed and in experiences the lack of financial, material and manpower resources, and its relation to production is often not constant. Thus, weak extension is a gap in the AR4D. In this regard, an establishment of such system that could unite the system of training, applied research and consulting in many CAC countries is required. In the long-term, agricultural universities, specialized agencies under jurisdiction of Ministries of Agriculture, as well rural advisory service centers funded by public sector and/or international donors, agricultural production and processing holdings can create a foundation for such complex systems.

Development of this establishment with integration of research and education will improve efficiency of extension services; promote linkages relation innovations to agriculture. In addition extension system may coordinate the activities of scientific, educational and other organizations, on needs assessment of rural producers in the ICT services, on collection, analysis and dissemination of information, on preparation and publication of educational, reference, information and advertising literature, on conducting conferences, symposia, exhibitions and other scientific and practical activities at national and even regional levels.

Main objectives of forming extension system and its strengthening should be:

- improving system of scientific assistance to agricultural sector in order to combine fundamental and applied research with a system of knowledge sharing;
- modernization of a system of retraining and advanced training for agricultural sector to enhance consulting services;
- establishment of a system of information and consultation services for agricultural producers and producers.

To achieve these goals it is necessary to undertake following measures:

- designing and implementation of research funding mechanisms focused on the needs of farmers, including budget and extra-budget funding;
- design and implementation of mechanism relating research outputs to farmers, as well as providing consulting and information services;
- conducting training courses for managers, professionals, consultants and lecturers of agriculture sector on the main perspective development directions in agricultural universities and training centres.

One of the main conditions of successful operation of extension system is government support and integrated development of agricultural science and education, which should be directed to formation of farmers demand for R&D in the sector, to organization of advisory services and knowledge dissemination system among farmers and other professionals in the sector, to constant upgrading of technologies and to development of an effective modern high-tech industry.

4.4. ICT in transformation of AR4D

Naturally, the process of development of agricultural science is integrating with development of other fields of science and technology industry. Undoubtedly, the progress in information and communication technologies (ICTs) has tremendous impact on development of agricultural innovation systems (AIS). The development of ICT certainly has no specific features in agriculture and direct influence on population welfare and improvement of food security, but these technologies serve as useful tools for development, transfer, application and dissemination of agricultural knowledge intended to increase agricultural productivity, which in turn has a significant impact on socio-economic development.

Apart from that, the ICT is replacing, where it is effective, human resources, particularly in the area of exchange, receive, transfer and dissemination of information. Mobile connection and Internet services have a significant impact on a speed and stability of flows of agricultural information from producers to consumers. The ICT development predicts its huge impact on intensification of agriculture and stability of its operation.

However, there are some constraints over effective use of ICT in agricultural research investment and innovation of the CAC. These are¹⁷:

¹⁷ Adopted from Presentation of “Status of ICM for AR4D in the Central Asia and South Caucasus” by Dr. Oleg Shatberashvili, at Workshop on Information and Communications Management for Agricultural Innovation in Southeast Asia Bangkok, 27-29 September 2011.

- *Insufficient financial resources to conduct viable research*, which does not allow to attract skilled ICT professionals, as well as insufficient funds for purchase of machinery, equipment and payment for communications services;
- *Underdeveloped extension system and low capacity* are hindering the efficiency of extension specialists' operation with ICT;
- *Uncompleted and ongoing organizational transformation in the AR4D system* does not allow keeping sustainable activities. For example, many agricultural information centres were abolished during the transition to market economy;
- *Insufficient efforts of AR4D to introduce ICT in agriculture*. The most successful and high-quality online agricultural information services, in general, are not created in the system of agricultural research;
- *Poor functionality of Agricultural Innovation Systems* cannot adequately transfer the agricultural knowledge to farmers;
- *Weak focus on the needs of smallholder*. Agricultural science is traditionally focused on large-scale production. New areas of research aimed at addressing problems of smallholders are not developed, and not enough focused on market relations, and has not enriched with variety of technological and organizational schemes, in which ICT should be an important tool.

To solve the above problems, it is necessary to develop and implement a set of interrelated activities aimed at:

- improving the funding mechanism to increase the impact of ICT on transforming AR4D, as well as in agricultural development;
- improving the national legal frameworks in the promotion of investment in ICT sector;
- increasing investment in capacity building in information system management and developing sustainable ICT projects;
- strengthening regional cooperation and multilateral partnerships among stakeholders, especially by creating incentives for building regional backbone ICT infrastructure;
- providing affordable access to ICTs by reducing the cost of international adherence to the internet, charged by backbone providers, as well as facilitating the creation and development of regional ICT backbones and Exchange Points in Internet access to reduce the interconnection cost and broaden network access;
- development and implementation of government programs aimed at reducing investment risks and transaction costs for operators entering the less attractive rural areas and market segments with low income;
- assisting to accelerate the development and implementation of national financial mechanisms, including funding of pilot ICT projects, microfinance, etc.;
- increasing the opportunities for access of public and private sector in financing mechanisms to accelerate the funding of ICT infrastructure and ICT-based services;
- revitalization of the multilateral, regional and bilateral development organizations to support national ICT systems through their involvement in the planning of agricultural development and the ICT sector.

5. Required measures

5.1. Gradual financing increase of AR4D

As synthesis of national reports shows that in the CAC region the average share of investments in agricultural research in agricultural GDP is 0.1%¹⁸. This indicator is one of the expressions¹⁹ how significantly AR4D can address existing issues in agriculture.

“... Average agricultural research investments as a percentage of agricultural GDP in developing countries²⁰ are 0.58%, compared with 2.4% in developed economies...”

from the GCARD Road Map

CGIAR is calling to triple the global investments in AR4D in the next 15 years²¹ to ensure the achievement of development goals, considering the huge backlog in investment caused by underfunding in the past twenty years.

There is a trend in CAC national economies to increase investment in the AR4D which is in line with global development. For example, in Kazakhstan, it is projected to gradually increase investments in agricultural research up to the level of developed agrarian states: in 2014 up to 1% of gross agricultural product and in 2020 up to 2% of agricultural GDP which corresponds with the GCARD Roadmap. In Turkmenistan, in 2020, total investments in AR4D will increase 17.1 times²² in comparison with 2000.

Along with AR4D financing it is required to increase public investments in rural development (e.g. rural infrastructure, improved access to water and education), as well as on a food supply system. Maximum impact of these investments will be depending on adequate funding of the AR4D.

In the CAC an increase of investments in AR4D is supposed to be up to 1% of gross agricultural output by 2015, up to 2% by 2020, and up to 3% by 2025.

In measuring the effectiveness and efficiency of investment in AR4D the growth of agricultural GDP²³ is considered as an indicator, rates of which should be increased proportionately in line with increased investments in AR4D²⁴.

¹⁸ more precise figure is 0.096%.

¹⁹ Main indicators of agricultural development is presented in Annex 5.

²⁰ the less economically-developed countries

²¹ A Draft Strategy and Results Framework for the CGIAR. For discussion at the Global Conference on Agricultural Research for Development (GCARD) 20 March 2010, CGIAR <http://alliance.cgxchange.org/strategy-and-resultsframework-and-mega-programs>

²² from national report of Turkmenistan

²³ While the agricultural GDP increases, its share in GDP may remain unchanged or even decrease due to increase in gross output of other industries such as manufacturing, communications, etc.

²⁴ Growth rates of agricultural GDP should be measured after 1-2 years investment made and innovations introduced, since investment increase on AR4D cannot immediately positively impact the growth of in agricultural product.

5.2. Actions for sustainable financial development of AR4D

The following actions are proposed to ensure increased investment in ARD:

- to conduct baseline research on the correlation between investments in AR4D, innovation development and productivity growth, as well as on the role of agricultural research, capacity building and knowledge dissemination in achievement of development goals at all levels for justification and planning of investment growth into AR4D²⁵;
- to make an inventory of all implemented projects and studies that are currently relevant, and those studies that are part of program studies being implemented;
- to estimate existing and future needs in agricultural research and to assess investment required for AR4D to address them;
- to identify sources of funding for different types of expenditures for AR4D;
- to increase financial recognition of the vital contribution of agricultural scientists to economic growth;
- to minimize taxes of funds for research activities; to implement a system to stimulate and reward scientific achievements; to simplify procedures for obtaining patents and copyrights on scientific developments, and improving rewards and the commission fee system for the use of scientific inventions;
- to apply tax incentives for private companies involved in funding activities of research institutions, agricultural consulting agencies and extension systems;
- to develop and introduce a system of monitoring and evaluation of the efficiency of agricultural research, in terms of its implementation in agricultural production.

5.3. Planning of agriculture development

The transformation of the agricultural research and innovation system requires a well-functioning system of strategic forecast and planning in agricultural development.

In this regard within the AR4D transformation short, medium and long-term prospects the following should be developed:

- socio-economic, innovative and environmental development forecasts, periodically updated and used to set up or revise the priorities and strategic planning in agriculture;
- national and regional programs and projects aimed at achieving selected priorities in the agricultural sector;

²⁵ Despite the existence of such studies widely in international experience, this research in the CAC region would justify bigger governments' attention to AR4D and increase investments.

- objectively verified indicators for implementation of strategic plans, national and regional programs²⁶.

5.4. Healthy competitive environment

Increased investment in transforming and strengthening of AR4D will impel agricultural research, education, extension systems' entities and individuals to be more result-focused to get bigger 'stake'. However, only joint coordination and awareness by research institutions and organizations of the ongoing AR4D activities can turn negative perception of "overlapping" activities into a positive perception of "healthy competition" activities that will promote continuous improvement of scientific, professional capacity, logistical framework aimed at developing new demand-driven agricultural innovation and in associated areas of science and economics. Thus, healthy competition being a trigger of development in the market economy, can effectively stimulate the vivacity of agricultural research and innovation system.

5.5. Strengthening extension system

Transformation of extension system should be a priority in the short term development of AR4D. Enhanced extension system will assist farmers in making economic and innovative decisions on improving productivity, introduction of new technologies, and stand up to food and economic crisis, as well as climate change impacts through improved information management, application of R&Ds.

5.6. M&E²⁷ and reporting

Introduction of monitoring and evaluation system is required to track AR4D impacts on achieving development goals and to provide relevant information to investors. Such system should monitor impact of investments in AR4D on improvement of agricultural productivity, increasing quality and quantity of food, minimizing negative impacts on environment through rational use of natural resources, mitigating negative effect of climate change on agriculture. A priority cross-cutting theme is the requirement to take into account needs of vulnerable and low income groups of population and to minimise projected adverse effects of economic and climate change threats.

However, an objective monitoring and evaluation system in AR4D transformation process is not limited only to assessment and disclosure of investment performance. It helps keeping track whether reforms carried out are in the right direction are and what measures we need to take and what needs more attention to timely and effectively achieve goals set. Monitoring and evaluation system provides information on "objectives" compliance with "outputs", "purposes" with "outcomes" and "overall goal" with "expected impacts".

²⁶ Measuring indicators of these plans, as a rule, should be a recommendation to parties concerned, but compulsory for ministries of agriculture and AR4D system;

²⁷ Role of monitoring and evaluation in transforming AR4D schematically depicted in Picture 1.

6. Phases of AR4D transformation

Obviously, transforming of agricultural research and innovation systems requires the joint efforts of all its actors to increase their contribution to the growth of agricultural productivity and streamline its operation, economically use natural resources and mitigate negative impact of climate change. An important aspect is meeting the needs of vulnerable and low income groups of population and taking into account projected negative impacts of climate change. These reforms cannot be implemented immediately and require gradual implementation of coordinated action by all stakeholders and parties involved.

The full package of measures on transformation of agricultural research and innovation systems is proposed to be undertaken in three phases, each of which is to be accompanied by assessment of the activities, and of the goals achieved with implementation lessons learnt for future activities:

- Short-term phase 2012-2013;
- Mid-term phase 2014-2015;
- Long-term phase 2016-2017.

Short term phase 2012-2013

During the short-term phase the agricultural research and innovation systems should be strengthened as well as its components: innovation, education and extension. Increased investments in agricultural research and enhancement of extension system should be a priority in the short-term phase of the transformation. To stimulate these financial injections it is necessary to minimize taxes for agricultural research and advisory activities as well as to encourage investors by lowering taxation of their activities. It is also required to include increased "investment for agricultural research" as an agenda item of national and regional development programs.

At this phase it is proposed, that:

- AR4D transformation programs for mid-term has been developed;
- a system of strategic forecast and planning of agriculture development has been designed;
- an inventory of required regulations and normative documents has been identified;
- a package of arrangements to mobilize of all actors of agricultural innovation systems has been developed;
- joint regional research programmes has been developed for mid-term;
- investment strategy for development of AR4D in the CAC region has been elaborated;
- an Agricultural Information Management System has been designed;
- target indicators have been identified and a package of measures to address the needs of vulnerable and low income groups has been defined;
- a monitoring system to track activities on AR4D transformation, on assessment of investments impact on improvement of agricultural productivity, food security, and on meeting needs of vulnerable and low income groups of population has been designed and introduced.

Midterm phase for 2014-2015

An important aspect in the midterm phase of transformation of AR4D is to increase investments in improvement of existing and development of new infrastructure for agricultural research and education. To achieve this goal, all AR4D participants have to put efforts to improve agricultural development and innovation systems in accordance with new rapid changes in the agriculture.

At this phase it is proposed, that:

- the outcomes of the AR4D transformation in short-term phase have been assessed, and lessons have been learnt to improve effectiveness in the mid- and long term phases;
- a system for strategic forecast and planning of agriculture development has been introduced;
- long term research programs at national and regional levels have been identified and approved;
- necessary legislative and regulatory documents, including funding mechanism for research projects and programs, have been designed and approved;
- environment for equitable participation and accountability of all actors in the agricultural innovation systems, including youth and women, has been created;
- measures for commercialization and/or providing necessary funds for extension system have been developed and implemented;
- investment strategy for AR4D development has been adopted;
- comprehensive agricultural capacity building system is well functioning;
- agreement on development of a regional fund for agricultural research has been approved and signed;
- an Agricultural Information Management System has been introduced;
- the package of measures to address the needs of vulnerable and low income population has been developed.

Long term phase for 2016-2017

At this phase of transformation AR4D should become well-functioning to ensure agricultural development and improvement of livelihoods of farmers and smallholders.

At this phase it is proposed, that:

- the outcomes of the AR4D transformation in mid-term phase have been assessed, and lessons have been learnt to improve effectiveness in the long term phase;
- agricultural innovation systems have been widely applied;
- enabling environment, including political, legal, institutional framework, and logistics have been created for introducing conservation and environment, ‘green’ technologies in agriculture integrating: research, education and extension;
- environment for equitable participation and accountability of all actors in the agricultural innovation systems, including youth and women, has been created;
- the total investments in agricultural research and development has been increased up to more than 1% of agricultural GDP;
- sustainable operation of extension system at its full capacity has been achieved and ensured through its commercialization and/or allocation of required amount of funds;
- research institutions, organizations and centers are able to partially finance their own fundamental and applied researches;

- research centers under agrarian universities are developed along with appropriate logistics, scientific and human resource capacity;
- at least 50% of needs of vulnerable and low income groups have been addressed;
- AR4D has been integrating with non-agricultural areas of science to more efficiently address challenges of economy and society.

AR4D as well as entire scientific and educational community always should remain a benchmark of civilized relations for society, tolerance, patriotism and commitment to ideas of humanism, and self dedication to prosperity and bright future of present and future generations.

7. Conclusion

Negative impact of climate change on agriculture which would exacerbate already severe consequences of global economic crisis, expected population growth with urban bias will increase demand for food and its price which in turn will necessitate even greater use of limited natural resources. In case agriculture will develop without "required action", challenges of agriculture will turn into economic ones, and perhaps even into political issues, which may become a trigger for unstable civil and inter ethnic situation. "Taking necessary measures" is thus a requirement for ensuring a peaceful and stable prosperous future in the CAC and "transformation" of system of agricultural research and innovation for development is one of the most important requirements of this process when "all" should be acting as "one".

Annex 1.

Main priorities of agricultural research in the CAC region:

1. Formation and preservation of the gene pool of crops, creating new competitive crop and hybrids, seed development and introduction into of agricultural production of non-traditional crops;
2. Improvement of existing and introduction of new resource saving technologies for production, processing, including deep processing of grain, and storage of agricultural products;
3. Introduction of biotechnology developments into plant breeding and rapid breeding of agricultural plants and animals, production of virus-free high quality seed and planting material, cloning and embryo transfer, etc.;
4. Development of new highly efficient and environment friendly methods to control pests of agricultural crops and forest plantations, development of measures that are acceptable to organic farming to combat pests;
5. Improvement and introduction of technologies for efficient use of natural, inter alia, soil and water resources, preservation and improvement of soil fertility, improving land reclamation and development and introduction of modern technologies on design, construction and operation of irrigation and drainage structures and systems for efficient use of water resources;
6. Preserve the gene pool of farm animals and birds, improvement of productive traits and their breeding, development of new technologies of feeding and farm management;
7. Development and implementation of effective measures to improve food supply, to introduce modern technologies, to provide quality services of veterinary and research organizations in the industry;
8. Development and implementation of complex measures for prevention, diagnosis and treatment of infectious and noninfectious diseases of farm animals, as well as food safety; testing and use of new vaccines and medicines;
9. Mechanization of technological processes in agricultural production, designing agricultural machinery for different natural-zone conditions and production capacity, and development of a comprehensive program of engineering and maintenance;
10. baseline study of basic economic problems of food security of the country, development and introduction of advanced methods of management in small farms;

Annex 2.

Agricultural research studies in the region

During synthesis of need, challenges and priorities in agriculture as set out in the national reports following topics for research in the region have been revealed:

- restoration and preservation of agricultural biodiversity;
- restoration of degraded land and improvement of management of natural resources;
- development of breeding using modern biotechnologies, including to improve drought resistance; organization of seed development;
- mitigation of negative impacts of climate change;
- improvement of agricultural technologies, introduction of innovative, resource-saving and environment friendly technologies and practices;
- restoration and preservation of gene pool of farm animals, fish, including listed in the Red Book, and their selection;
- recovery, use and preservation of diverse grassland;
- improvement of production technologies, processing and storage of agricultural goods;
- agriculture in remote, inaccessible and environmentally difficult areas;
- animal health care, particularly prevention and treatment of communicable diseases;
- scientific basics for organization of agricultural cooperatives;
- issues of implementation of research outputs and transfer of new knowledge to agricultural producers;
- sales and marketing of agricultural products;
- fight against desertification;
- control of trans boundary diseases of agricultural crops, animals, birds.

Annex 3.

Six pillars of AR4D transformation

The GCARD Roadmap establishes an inclusive, rolling process of reform and capacity development that aims to mobilize the full power of agricultural knowledge and innovation towards meeting agriculture and food-related development needs. It proposes a **six-point plan for transforming agricultural research for development around the world**, requiring actions from all those involved in the generation, access and use of agricultural knowledge:

1. The need for collective focus on key priorities, as determined and shaped by science and society;
2. The need for true and effective partnership between research and those it serves;
3. Increased investments to meet the huge challenges ahead and ensure the required development returns from AR4D;
4. Greater capacities to generate, share and make use of agricultural knowledge for development change among all actors;
5. Effective linkages that embed research in the wider development context and actions enabling developmental change;
6. Better demonstration and awareness of the development impact and returns from agricultural innovation.

Annex 4.

AR4D transformation stakeholders / actors

- Rural producers, including smallholders, farmers' cooperatives/societies of producers;
- Processors of agricultural products, as well as public organizations and private entities that provide necessary resources;
- Community of rural population, non-governmental organizations, including women and youth organizations, societies representing interests of ethnic minorities and vulnerable groups of population;
- Commercial banks, credit unions, private investors;
- Community and national funds supporting variety of activities in agriculture and rural areas;
- State committees, state-owned companies, state funds coordinating and funding research on agriculture and food security;
- Research institutes, centers and organizations that represent both public and private sector;
- Agrarian universities, agro-oriented academic institutions, universities, community colleges;
- Government agencies, departments or units, and private entities responsible for coordinating and conducting activities on agricultural advisory services, information distribution and innovation introduction as well as media;
- Ministries and agencies responsible for managing and coordinating of agricultural activities as well as units of other ministries related to agriculture;
- International Centers for Agricultural Research, as well as international financial organizations, institutions, foundations and development agencies and other donors.

Annex 5.

Outcome indicators of AR4D transformation

Main indicators of agricultural development in accordance with objectives and goals defined by Regional Transformation Strategy of AR4D are:

- indices of agricultural gross production (e.g. agricultural GDP) and food industry;
- investment in agriculture and agricultural science;
- income of people living in rural areas, as well as of agricultural population, investment in AR4D per researcher, and level of salaries;
- consumption of basic food products per capita;
- net income from foreign food trade;
- indicators of share of domestic food products in domestic market;
- profitability of production in different areas of agriculture and locations;
- indices of technical equipment of agricultural organizations, and science;
- indicators of price parity,
- growth index of social services for rural population, and others.

Annex 6.

**New concepts used in the Regional Strategy for Transformation and Strengthening of
Agricultural Research and Innovation in the CAC**

Name	Brief description
Investment attractiveness of AR4D	Current agricultural research system is in a vicious circle: it is underfunded and that not allowing to improve investment attractiveness, which in turn require necessary financial investments. Therefore, enhancing "investment attractiveness" is one of the objectives over transformation and strengthening AR4D.
Sound / Healthy competition	Subject to collective coordination of AR4D activities and public awareness about ongoing activities by institutions and organizations, negative understanding of "overlapping" activities will grow into a positive understanding of "sound competition" activities that will promote continuous improvement of scientific, professional capacity, logistics focused on development of new innovations that are in demand in agriculture and in associated areas of science and economics.
Three main goals of AR4D in the CAC region	<p>CAC AR4D system sets for itself as primary objectives to provide assistance in solving these issues in order to improve agricultural productivity, increase the quality and quantity of food through intensification and diversification of agriculture and to develop the mechanisms for efficient use of natural resources, mitigating the negative impact of the consequences of climate change. A priority cross-cutting theme is the requirement to take into account needs of vulnerable and low income groups of population and to minimise projected adverse effects of the above mentioned threats.</p> <p>In this regard, AR4D system of the CAC focuses joint efforts on three main goals of agricultural research:</p> <ol style="list-style-type: none"> 1. Improving the welfare of the rural population, particularly vulnerable groups as well as those dependent on agriculture; 2. Guaranteed improvement of the quality, volume and nutritional status of food through the intensification and diversification of agriculture to protect vulnerable and low income groups of population; <p>Rational use of natural resources and mitigating adverse effects of climate change</p>

Annex 7.**Proposed format of Action plan on achievement of AR4D transformation²⁸ goals
for discussion at Regional Meeting**

№	Name of activity	Expected outcome	Responsible for implementation	Implementation timeframe	Monitoring and evaluation mechanism
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					

²⁸ Content of action plan, i.e. activities are subject to discuss before and after Regional Meeting

Annex 8.**Phrases used in the Regional Strategy**

Public sector	Public or government sector – set of enterprises, organisations and agencies that belong to government and are managed by government bodies or appointed individuals. Public sector of economy represents all economic resources that belong to a government and all organisations that used as a tool government regulation of national economy. It is national budget, government production enterprises, government health care organisations, education and defence organisations, government lands.
Private sector	Part of national economy which is not under government control. Private sector represents households and companies that belong to private capital. Private sector of national economy can be corporate, financial and individual sector of national economy. Household is economic unit that consists of one or several persons that provide national economy with resources; and it is usually using earned money to buy goods and services to meet needs of human being. Individual sector – part of national economy which is related with households. Corporate sector is a part of national economy that related with enterprises and their activities.
Cost of living	Calculated by value of so-called consumer basket. The latter is calculated from minimum acceptable standards for consumption of essential goods and services. Such standards for consumption shall use, as a rule, actual cost structure of 10% of the poorest group of population. In international practice normative and statistical methods are applied for calculating a cost of living. Normative method is based on scientific norms of minimum consumption of goods and services necessary for reproduction of productive forces. Statistical method is based on data for real minimum of consumption of material goods.
Agricultural population	All rural and urban population, livelihoods that related with agriculture, fishery, and forestry. This indicator shows all economically active population in rural areas as well as those who are not employed and supported by breadwinners.
Biogeocoenosis	System that includes community of living organisms and closely related set of abiotic factors of environment within the same area and associated with each other in a cycle and energy flow. It is a stable self-regulating ecological system where organic compounds (animals, plants) are inextricably linked with inorganic ones (water, soil).