CWANA CHAPTER 4
LOOKING FORWARD: POLICIES, INSTITUTIONAL AND ORGANIZATIONAL ARRANGEMENTS FOR AKST DEVELOPMENT AND APPLICATION

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Key Messages

1. **Natural resources will continue to become limited**. As globalized trade continues to expand and markets to liberalize, CWANA's competitiveness in agriculture will rely more and more on increased productivity and higher product quality. Degraded land, depleted water resources and expanded deserts imply that agriculture will take place in less favorable environments. Further trade liberalization, implementation of which is expected to come into effect after the Doha development round closes, will make trade barriers, production support and export subsidization obsolete when trying to compete in international and domestic markets. All these future prospects are calling for AKST as a means to sustain CWANA agricultural competitiveness.

2. **Applying AKST advances is crucial if we are to meet the challenges for sustainability and development in the CWANA region.** CWANA agricultural research systems must adjust to the context of new challenges such as land degradation, water scarcity, migration, loss of biodiversity, increase in population growth rates and climate change. At the same time, with support from the Consultative Group for International Agricultural Research (CGIAR) and the Food and Agriculture Organization of the United Nations (FAO), they have to orient themselves toward new directions of research such as biotechnology, agrobiodiversity, GIS technology, IPM, water and soil conservation, rangeland and drought management, value chains and market research. Applying advanced AKST may bring new varieties of crops, breeds of livestock, and advanced technologies that are suitable to tackle the problems of biotic and abiotic stresses and to meet the challenges for sustainable development.

3. **Agricultural productivity improvements will depend on substantial public and private investments in agricultural research and extension.** The national agricultural research systems (NARS) are generally weak, and investments in agricultural research and extension are low. This situation is not likely to improve, considering current dismissal of agriculture as an engine of economic development and the lack of constituency for stronger NARS. Increasing public investments and providing incentives to the private sector to engage in research and extension to complement public efforts will likely help acquire adequate capacity to contribute to poverty alleviation, food security and economic progress. Moreover, a sustained public sector role in agricultural research will be essential, particularly for production areas in less favorable environments, unlikely to be served by the private sector.

4. **Private ownership of intellectual property rights (IPR) is increasing, making it likely that developing countries will find more barriers preventing their access to international research spillovers.** A self-reliant research policy is required to build domestic AKST capacity, with research directed toward identifying biodiversity and variety of species. Ways to achieve

such an objective include identifying CWANA agricultural resources and biodiversity and establishing CWANA-based IPR (e.g. Arab IPR League) and forums for equitable exchange of IPR-based research results.

5. **Food safety and quality standards are important for trade, access to industrial-country markets and domestic consumers' health, as outbreaks of food illness are expected to increase.** The cost of assuring quality in food will increase due to intensive use of chemicals, transformation of traditional systems, and large-scale production structures and trade. Compliance with food safety regulations and quality assurance in CWANA has been relatively slow and is mostly driven by government laws made to secure traditional export markets, responding to provisions of importing countries. In local markets as well, it is important to safeguard the right to food safety for all consumers. Good agricultural practices at the farm level with stringent veterinary controls along the supply chain are required to ensure the safety of both fresh and processed foods. Institutions in charge of protecting public health and of promoting the adoption and implementation of standards have to be strengthened. Legislation needs to be enacted and strictly enforced. Prioritizing local consumer awareness, private enterprise commitment, and risk assessment and laboratory infrastructure will ensure good traceability of food.

6. **AKST in the CWANA region has too often used a nonholistic approach with little involvement of stakeholders.** As a consequence, it is lagging behind international trends in innovativeness and effectiveness. Adopting a participatory and integrated approach can support AKST in CWANA to face the fast pace of its population growth and find a relevant role vis-à-vis agricultural needs and trends at national, regional and international levels.

7. **Developing and applying AKST in CWANA is not truly geared toward the goals of alleviating poverty and promoting sustainability.** These goals, however, are expected to be major paradigms of agricultural development in the next decades. Transparent, participatory and accountable mechanisms for setting AKST priorities at institutional level can enhance the implementation of policies that are able to tackle poverty in CWANA while also addressing the sustainability dimension.

8. **Proper and well-established links among agricultural education, research and extension are important if AKST is to work efficiently.** The source of knowledge for education and extension is directly connected to the results of scientific research, and the research is driven by collaborating with extension workers who are well aware of local problems and are in close touch with farmers. The curricula of agricultural education and the content of the courses must be up to

date and applicable to the needs of the market. These needs can mainly and correctly be determined by extension activities, which are the best way to tap into local knowledge. In CWANA countries these links are not well established because legitimate interaction among agricultural education, research and extension sectors is lacking. To enhance AKST effectiveness, links among agricultural education, research and extension are to be strengthened so that all links, including farmers, can be included in the system. Policy options for forging well-established links are to put these institutions under one authority such as the land-grant universities in the U.S. or to ensure legitimate horizontal and vertical interaction among them.

9. If persistent needs for national agricultural technology are to be effectively met, NARS in the CWANA region should be structurally empowered and their activities supported by regional and international resources. AKST development in CWANA suffers from lack of an enabling environment. The educational and research infrastructure is poor; policies and institutions place only limited emphasis on domestic and regional efforts toward developing AKST. This situation requires a radical policy shift to favor strengthening educational infrastructure and adopt a policy framework that provides human capacities and offers incentives for AKST development.

10. Policies that promote agrobiodiversity and use of traditional knowledge lead to sustainable development of agriculture, despite the intensification of farming systems. Green Revolution practices and intensification of farming systems with the introduction of new varieties of crops, livestock, mechanization and aggressive use of chemicals cause us to lose traditional knowledge and biodiversity. Formulating new agricultural policy to protect and enhance agrobiodiversity has to become an important part of the agroenvironmental objectives and actions for many CWANA countries. Developing these policies will be in response to growing public concern over the increasing pressure on natural and existing ecosystems brought by agricultural activity. Actually, government policies toward biodiversity should balance the tradeoff between benefiting the economy and conserving biodiversity.

11. Future AKST in the CWANA region is to be visualized as transitional, to benefit from local knowledge and incorporate and transform local agricultural practices into scientific ones. Options in that line include recording, preserving and researching local knowledge, devising new AKST models to take advantage of local agricultural practices and considering traditional knowledge as a base of every international attempt for modernization in a CWANA country.

12. The CWANA region continues to lack appropriate technologies that could help effectively address key concerns like desertification, low productivity and loss of biodiversity. One reason for this is that the available technologies are not necessarily appropriate, as they are not based on indigenously developed or documented AKST. This problem can be addressed by national, regional and international initiatives aimed at strengthening research, technology development and extension capacities within the CWANA region.

13. **Higher, stable and continuous economic growth substantially encourages farmers to make better use of AKST.** In CWANA, the per capita consumption of food is low, especially of meat and milk products. Higher demand for agricultural products would mean more cash flowing in to the farmers, who in turn would most probably seek out and use appropriate AKST.

14. **Continuing population growth is likely to increase rural-to-urban migration.** This will result in small-scale farming employing those sectors of the population that have limited opportunities of movement and choice, mainly women These sectors will have to rely on agriculture to support their livelihoods and at the same time face harsh environmental conditions due to climate change and difficult market access because of global trade. Technological innovations in agriculture, which are not designed or applied to meet the needs and conditions of women, carry the risk of further increasing the burden on women as providers for their families, and may impair women's productivity. The negative consequences of these trends can be contained if institutions adjust to the changing circumstances in rural areas. This means, for example, that women's role as farmers is acknowledged together with their role as food providers and, often, as heads of household. If their rights are redefined accordingly, their access to resources will be facilitated, their agricultural work supported and their livelihoods and lives of their families enhanced. Also, policies aimed to build capacity may be put in place so that rural livelihoods can depend on diversified sources of income, thus reducing the vulnerability of disadvantaged sectors. If AKST addresses the needs and priorities of these new farmers and adopts a more participatory model of development, it may boost the role of agriculture and sustain the livelihoods of the sectors that increasingly rely on it.

4.1 Implications of Future Challenges for AKST-related Policies

4.1.1 Market and trade issues

Markets and trade are important factors in determining the access to and adoption of AKST. Rising demand for agricultural products and more competitive markets are likely to result in higher demand for AKST. For example, protectionist policies would not encourage the adoption of certified seeds, while liberalization and appropriate marketing policies may be accompanied by the adoption of more productive technologies, higher efficiency and economic growth. We are interested to find the best ways and options to develop AKST based on our assessment of market and trade developments in the region.

4.1.1.1 Trade arrangements

Although trade liberalization globally represents the goal of multilateral trade negotiation under the auspice of the World Trade Organization (WTO), most WTO members have engaged in regional or bilateral agreements due to the relative ease of forming regional blocs. The CWANA region is not an exception. It has seen emerge many regional and bilateral trade agreements among neighboring countries. For instance Egypt has concluded about 40 agreements (ESCWA, 1998). In 1981 the gulf countries established the Gulf Cooperation Council to enhance intraregional trade and cooperation. In February 1989 the Arab Maghreb Union was established in Marrakech. The Customs Union between the European Union (EU) and Turkey is a unique event in the region; it has increased trade volume between the two partners and has been particularly profitable to Turkey. These arrangements are to be fostered to facilitate AKST adoption in the region.

WTO trade negotiations, however, also create threats for developing countries and for the CWANA countries in particular. Not only benefits are expected. For example, WTO blue box payments for reducing production and setting land asides will be reduced according to a tiered formula. Under this formula, members having higher levels of trade-distorting domestic support will make greater overall reductions to achieve harmonious results. The same approach will be valid for the total aggregate measure of support and market access. So developing countries, which need more support for their agricultural sector, will be affected by these developments.

Intraindustry trade is also growing among regional trading groups. Such a trend is an indication of economic integration and economic diversification and development. Intraindustry trade within the regional trading blocs occurs mostly between neighboring countries with similar demand structure. Transportation and transaction costs are among the constraints that hamper its development within the region. Policy and institutional changes are required to follow these developments and overcome the current constraints.

Since the EU is an important partner for many CWANA countries (e.g. the Mediterranean countries), its enlargement with the entrance of the Central and Eastern European countries (CEECs) will bring benefits but also threats to the region. There would also be benefits if Turkey were to enter the EU; it would bring the EU boundary closer to CWANA and be an excellent opportunity to increase mutual trade.

We do not expect that enlargement of the EU to the east will divert foreign investments to the newly added countries instead of the countries in CWANA region, as the incentives to invest in these regions are dissimilar and the foreseen investments in CEECs had begun to be realized even before the expansion.

4.1.1.2 Trade negotiations: more integration

Since the inception of WTO in 1994 efforts have focused on launching a new, comprehensive round of multilateral trade negotiations. From the Seattle ministerial meeting up to the Doha Declaration there have been advances on a number of trade and nontrade issues. The ministerial conference at Cancún, Mexico, set a milestone toward achieving the Doha Development Agenda round of trade negotiations as mandated by ministers at the 2001 Doha conference. However, given the few achievements in past negotiations, observers remain skeptical that a new comprehensive round can be completed as planned (Miner, 2001). The big players are expected to make additional policy reforms (e.g. trade legislation in the USA and European Common Agricultural Policy (CAP) reforms in the EU) before undertaking strong concessions and commitments in the upcoming negotiations.

It is somewhat disappointing that benefits from agricultural trade liberalization have not materialized as was predicted. There are at least two reasons why trade benefits were only partial. First, negotiations on agriculture alone do not consider the comparative advantage principle. As a result, the Doha Declaration made provisions for broad-based negotiations extending trade negotiations to further liberalize trade for the industrial products and services of which nations may take advantage (Ingco, 2002). Second, national policies and legislation are creating additional cross-national boundary transaction costs and limiting liberalization efforts. Gerber (2000) pointed out that trade relations remain far denser within nations than between nations and a lot of trade does not occur according to predictions of the neoclassical model. Accordingly, “deep” economic integration requires that not only border barriers but also domestic policy barriers be removed. More integration is needed to achieve regional cooperation to develop AKST.

4.1.1.3 Recurrent and newer issues

The main issues already identified in the General Agreement on Trade and Tariffs (GATT) on agriculture embodied market access, export competition and domestic support. However, a body of new trade and nontrade concerns are emerging and attracting growing public interest. The agreement on agriculture already included issues of food security, food safety and quality, environment concerns, resource conservation and rural development (Miner, 2001). Additional issues raised in the last negotiation meetings included animal welfare, biotechnology, species preservation, landscape safeguards, poverty reduction and preservation of rural culture (Miner, 2001).

Newer border-trade topics embodied items such as the rules of origin, standards and technical barriers, intellectual property rights, sanitary and phytosanitary (SPS) standards, dispute settlement and the role of small countries (Gerber, 2000). Among the nontrade domestic policy issues are foreign investment, competition policies, and labor and environmental standards. All these issues affect AKST; more investment is required, CWANA seeks more aid in the area of SPS and in general there is need for research and capacity building.

4.1.1.4 Regional links: the EU-CAP reform

Traditional regional links are shaping export markets and observed trade flows. According to Diao et al. (2002), export markets for many developing countries are concentrated in a few countries in the North because of geographic proximity and historical links. As a result trade negotiations will be shaped by regional blocs. North African and Middle Eastern countries are thus more interested in the EU agricultural markets and consequently in EU agricultural reforms under the 2003 CAP reform.

Indeed, the work program annexed to the Barcelona Declaration cites the following objectives with regard to the countries that have signed the declaration, which are options for AKST development as well (Chioccioli, 2002):

- integrated rural development
- support for policies implemented by Mediterranean countries to diversify production
- reduction of food dependency
- promotion of environment-friendly agriculture

4.1.1.5 Food safety and product quality

With the decline in the use of traditional trade barriers such as tariffs and quotas, there is evidence that technical and regulatory barriers are increasingly used instead. In industrial countries many firms are moving toward adopting international standards. This move is relatively

slow in CWANA countries and might therefore represent an obstacle to international trade. Food safety and quality standards are important for trade and access to markets in industrial countries but also for domestic consumers' health, with a view to reducing food-borne morbidity and mortality and improving nutritional and hygienic quality. Food-borne diseases such as *Salmonella* and *Escherichia coli* infections remain responsible for high levels of morbidity and mortality in the general populations of CWANA, but particularly for at-risk groups, such as infants and the immunocompromised. Many zoonoses such as brucellosis and tuberculosis that are associated with handling diseased domestic and wild animals are also prevalent in CWANA countries. Because of intensive use of chemicals, transformation of traditional systems, large-scale production structures and trade, the cost of maintaining quality in foods will increase. Organic agriculture is an alternative to traditional farming systems and greatly appreciated by consumers, mainly in industrial countries (import markets). In many countries, including CWANA, products are registered with country of origin designated to assure consumers of the assumed high quality. Compliance with food safety and quality assurance in CWANA has been driven by government laws to secure traditional export markets. In recent years, several CWANA countries such as Bahrain, Morocco and Pakistan have planned and implemented extensive reviews of their food safety systems, updating their legislation and generally improving their systems as a whole (WHO, 2001). In local markets as well it is important to safeguard the right of food safety to all consumers, protecting their health from unsafe or potentially unsafe food by preventing health hazards associated with microbiological and chemical contamination and additives. Good agricultural practices at farm level with stringent veterinary controls along the supply chain are required to ensure the safety of fresh and processed foods. Highly useful preventive and cost-effective approaches to food safety (such as the Hazard Analysis Critical Control Point System or HACCP) exist and CWANA countries should adapt and adopt them. Institutions in charge of promoting the adoption and implementation of standards have to be strengthened, and strategic partnerships between the multiple concerned disciplines (such as health, agriculture, and food industry and trade) encouraged. Consumer education is key to preventing food-borne diseases. Donor support for building capacity in the area of food safety is to be called upon, and legislation needs to be enacted and strictly enforced.

4.1.2 Pricing policies

Pricing policies for agricultural products ought to follow the rules of a free market. Further, strategic planning is needed to shift toward market-oriented agriculture policy closely integrated with national development objectives, without compromising food security or food sovereignty. This however depends on the prevailing local market structure and the engagement in multilateral and regional economic cooperation and negotiation toward establishing free markets. If the

conditions of a free competitive market are prevailing, this will lead to efficient price formation, which in turn influences positively the development and adoption of AKST.

In most CWANA countries, however, agricultural markets are not competitive. Small-scale farmers in particular are facing problems of scale, with market power in favor of the middleman. Marketing conditions and marketing margins are changing as a result of evolving supermarket requirements, mostly affecting small farmers. Under these conditions pricing policies will be developed in parallel with the development of coordination strategies. Vertical coordination will guarantee stable prices and markets. Farmers' associations are also an effective way to create market power for small- and medium-scale farmers. Vertical coordination and farmers' associations are more likely to favor the adoption of AKST in response to new requirements of the supermarket phenomenon that characterizes the new marketing scene. For instance, supermarkets are adopting private quality schemes. Farm enterprises need to adopt these private standards if they want to stay in business.

The pricing policy, when coordinated by bureaucratic mechanisms through administered prices, does not reflect marginal production costs. Under this scenario, for administrative convenience, monopolies are created that lead to prices that are distorted when compared with product quality. It should be noted that in this scenario there is no market-based price formation and no possibility to compensate for seasonal deficiencies and overstocks. Prices set by the government are rarely revised and do not reflect the opportunity cost on the international market, which brings negative added value for some producers if evaluated on the basis of international market prices. Because of government intervention, entrepreneurs will find it more profitable to trade on the basis of barter or mutual agreements, as the transaction costs will be too high. In this case, producers see no necessity to seek alternative resources or adopt newer techniques, because they have no incentive to improve their work processes.

Most CWANA countries have made significant progress toward establishing free market conditions. Negotiations are under way with major trading partners to enter into trade relations based on WTO rules. At the national level, agricultural production is no longer centrally planned and is now in the hands of private sector farmers who are free to choose what crops to grow. Agricultural incomes have risen significantly as a result. Government policy toward trading inputs and outputs, including processed goods, is steered toward creating a liberal market, although some interventions that cause distortions and inefficiencies remain in some countries. In these countries, governments are undergoing reform programs to completely liberalize the sector and redefine the relationship between government agencies and the private sector. This will create a more favorable environment with freer markets and prices. Liberalization will likely be

accompanied by better access to AKST, first to meet international markets' requirement, second to be competitive in the marketplace; third, international markets will have access to AKST.

The private sector must be prepared to assume the role of market regulation and to serve as an engine of growth for the whole agricultural sector. Working directly with farm associations, private enterprise will improve marketing conditions by changing traditional concepts of how to market and by creating useful information systems and fostering business links. Useful information will be needed about prices, but also about quantities and the quality of products as required by the supply chain actors. This will improve price formation mechanisms. While helping the industry to process high-quality products efficiently and create better conditions to foster processing capacities through transferring technologies, this will also lay the foundation for sustainable growth in the industry and provide the agricultural sector with the means to respond to ever-changing market conditions. The private sector may also be involved in AKST development through involvement in joint ventures with research institutions to make AKST available as a public good to smaller farms.

Changes in price-formation policies will occur mainly as a result of shifts in the demand curve and as a consequence product prices will be affected differently. What factors will cause this shift?

- Demographic—growth in population normally brings equal growth in demand for all types of goods. However, concomitant changes in the age structure may affect the demand and consequently the price for certain goods. For instance, an increase in the percentage of children in CWANA countries population may cause a higher demand for milk.
- Economic—changes in per capita income levels may affect the degree of demand for most goods. Increase in income will change the food patterns, with expensive meat and sea products dominating. The demand for less tasty foods containing starch will decline as incomes increase. If the income level falls, less expensive necessity foods, such as bakery products, will prevail.
- Socio- and psychological—these factors have recently emerged because of growing concerns about human health. Thus recently there was a decline in the demand for beef, especially in Western Europe, resulting from fears that mad cow disease could cause mortal disorder in the human brain. Avian flu caused a drastic decline in the demand for poultry. But the demand for olive oil grew in view of the belief that it reduces the risk of cardiovascular diseases as compared with adipose or other vegetable oils.

While the above factors will directly influence the demand for final agricultural products they also indirectly influence the derived demand for AKST. Demand- or market-oriented production will focus more on the adoption of AKST.

Price disparities have been most visible at the producer level, where prices for agricultural products increased much less than prices for means of production. Calculations indicate that the rise in price for means of agricultural production is 40% faster than for agricultural products. Purchasing prices set by monopolistic processing industries are below world market prices, and farmers have no option but to accept them.

Notwithstanding government support to producers in the form of subsidies, most means of production such as agricultural machinery, fertilizers, pesticides, and veterinary services are inaccessible for producers. Also, food-pricing policies, based on an extensive system of food subsidies, have a negative effect on macroeconomic variables such as the rate of inflation, the balance of payments and the exchange rate. Moreover, the subsidy system has destabilized industrial output and investment. Restricting the benefits of subsidies only to those most deserving would lower the inflation rate, reduce the volume of imported food (thus the government deficit), and increase industrial output and investment. Subsidies to producers will come through public services such as research and extension and may be a more effective way to diffuse and adopt AKST.

To overcome the negative consequences of the transition to free market conditions it is necessary to take several measures to improve agricultural policy:

- Prices and agricultural trade should be liberalized. Unless prices for agricultural products are harmonized with world market levels and payments are made directly to producers, we cannot expect significant growth in the agricultural sector, and productivity will remain low.
- The primary task is to improve price-formation policies through increased competition at the level of farms. Antimonopoly legislation should be developed. Creation of a more competitive environment in the sphere of purchases will increase farm income and encourage farmers to improve productivity, marketing and trade, and quality of agricultural processing.
- It is necessary to abolish the system where production requirements are based on government order and production scheduling is done by the state. For products that in government's opinion represent national interests, a price policy should be introduced that would stimulate their voluntary production based on profitability.
- Public purchases should be based on market prices. Productivity could be improved using a contract-based system. In future, the state and farmers will buy and sell futures contracts in response to changes in market conditions and generate income before harvest.
- It is necessary to undertake thoroughgoing reforms in agricultural and trade policies. Trade barriers should be removed and a system of customs duties established. Export and import licensing should be abolished; private companies should be allowed and encouraged to take

part in international trade on condition that only the above-mentioned customs duties are collected from them.

4.1.3 Research policy for NRM

One of the most challenging issues is the emerging expansion and diversification of the research portfolio. In addition to conventional topics, AKST is called upon to cover a variety of new research and innovation domains.

Pasture management: Agricultural land for the whole CWANA region is mainly devoted to permanent pasture and rangeland. The proportion of rangeland to total land is 83 percent, the lowest proportion being in Southwest Asia (55%), the highest in the Arabian Peninsula (98%). In many CWANA countries, rangeland carrying capacity is decreasing because of overgrazing.

Research and technical options for improved rangeland management are available, e.g. practicing rotational grazing, corralling to rehabilitate degraded spots, seeding and planting possibly supported by fertilization and water harvesting, practicing agroforestry, maintaining livestock biodiversity and reducing the number of artificial water points. However, these practices have often been developed in completely different ecosocial regions, and adaptation of these technologies in other countries is important. Further research in the area of rangeland will contribute to solving environmental problems and to developing a livestock industry in the region, and it will mitigate the climate change problems.

Soil and water management: Research in soil salinity management will be essential for the region. Research priorities in this area include development of measures to prevent soil salinity; land reclamation by using low-cost technologies to improve the properties of saline soils; assessment of soil salinity through GIS technologies; biological reclamation of saline soils; biodrainage systems (tree plantation) in saline and waterlogged soils; selection of salt-tolerant crop species and varieties; and development of halophyte agriculture.

In the field of irrigation and drainage management: deficit irrigation, conjunctive or drainage water use, irrigation scheduling, irrigation, drainage-water quality management, identification of optimum furrow length, water discharge, development and adoption of advanced water-saving technologies, selection of promising irrigation technologies. In rainfed areas: supplementary irrigation, water and soil conservation technologies, diversification of cropping patterns, crop residue management, land leveling, integrated plant nutrition management, irrigation, wind and water erosion control, GIS technologies and erosion control, traditional and introduced soil

conservation technologies in mountain areas, slope land management, and watershed management.

Integrated pest management: Integrated pest management (IPM) is an effective and environmentally sensitive approach that relies on a combination of common-sense practices. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. IPM takes advantage of all appropriate pest management options including, but not limited to, the judicious use of pesticides. Use of biological alternatives instead of harmful chemicals, research on soil biota, especially on nematodes, for soil-borne diseases and on parasitic weeds could alleviate many problems farmers of the region face.

Organic farming: Industrial countries have developed markets for organic products and there are today numerous opportunities for organic agriculture. Organic crops include cotton, cereals and potatoes. Beef, dairy, and sheep and goats are the focus for livestock. The Swiss Agency for Development and Cooperation has already implemented a project for organic cotton in Central Asia. Research and implementation activities aimed at adopting organic agriculture can potentially meet the challenges CWANA farmers face.

Conservation agriculture and reduced tillage research: Promotion of research in the field of conservation agriculture could save water, labor, fertilizers and pesticides and fuel; it could solve many problems connected with the degradation of natural resources in the region. The management of cover crops and crop residues will be closely related to carbon emission issues, and will increase nutrient and soil organic matter content.

Livestock: For many poor households in CWANA countries, livestock is an important asset. In this region where many challenges impose themselves in the field of natural resource degradation, integrating crops and livestock production is a promising agricultural system for low-income small-scale farmers. AKST therefore needs to find ways to ensure that crop and livestock resources will be developed sustainably with enhanced output per unit while increasing area productivity. Lack of feed resources, poor genetic makeup and lack of effective cover for animal health are the main constraints hampering livestock development in the region. Conservation of local livestock breeds would be required to sustain development, and nontraditional feed resources need to be developed to contain rangeland losses. Development and access to quality animal health services and genetic material for upgrading of livestock should be possible. Embarking on such initiatives in the region could be made possible through AKST.

Crop management: The region needs to enhance germplasm and take advantage of its genetic resources. Advanced plant breeding may help achieve productivity gains, introduce resistance to pests and diseases, reduce pesticide use, improve crop tolerance for abiotic and biotic stress, improve the nutritional value of some foods, and enhance the durability of products during harvesting and shipping. Raising productivity could increase smallholder incomes, reduce poverty, increase food access, reduce malnutrition, and improve the livelihoods of the poor.

Drought tolerance: CWANA countries are classified as drylands, susceptible to desertification and mostly drought prone (UNEP, 1997). These countries vitally need drought management and mitigation. Thus CWANA governments have to make difficult tradeoffs between short-term benefits and long-term solutions. Droughts always require immediate attention because they threaten human lives, but long-term solutions are also necessary. From this perspective, it is essential to note that drought-tolerant crops, varieties and hybrids are essential for countries of the region.

High-value crops: The main objective of the research system in the region during the process of commercialization and diversification remains to generate new technologies that improve productivity and farmer income. In addition to the productivity objective, research should focus on providing farmers with the flexibility to decide on crop choices and to move relatively freely to growing the crops they choose. Gearing farmers to meet more exacting safety and quality standards ought to be an essential part of the strategy.

Postharvest methods: Many times, large shares of food produced are lost after harvest. Reducing postharvest losses has been an important focus of AKST and development programs in the past. But on several occasions technical innovations have faced sociocultural or socioeconomic problems like low profit margins, additional workload, or incompatibility with the existing production or postproduction system. The divergence between technical recommendations and the realities of rural life translated in many cases into a low adoption rate. Now the rationale for improvement in postharvest systems has been shifting from preventing loss to opening new market opportunities. Making markets work for the poor is emerging as the new rationale for development, reflecting a shift away from governmental operation of postharvest tasks to frameworks that enable private sector initiatives in this field.

Biotechnology: Agricultural biotechnology will contribute to poverty reduction and food security if scientists can develop technologies to increase quality and yield of food crops, and if small-scale farmers adopt the technologies. Research has to focus on crops, livestock and fish. Major crops are rice, maize, wheat, sorghum, millet, oilseed and potato. Biotechnology should also focus on

high-value cash crops: cotton, soybean and vegetables that can increase the incomes of small-scale farmers through crop diversification. Fish and livestock—cattle, sheep, goats, pigs and chickens—are also important. The technology must be simple, low cost, and carry little or no risk to human health and the environment.

Genetic engineering could be widely used as a breeding technique. Genetic engineering involves the transfer of one or more precisely selected genes into the genome of the host organism. The ability of genetic engineering to transfer genes across the species barrier or indeed across kingdoms is precisely what gives the tool such power and what attracts such controversy. Gene banks and genetic engineering can also be used to speed up the breeding process by inserting a specific gene into an otherwise desirable genetic background without requiring multiple generations of backcrossing to eliminate unwanted change, as is necessary with conventional breeding. Biotechnology can also be used to develop vaccines for animals. Bio-information could support molecular research, e.g. breeding and GMO activity.

Value-added technologies and market analyses: Value addition to primary goods offers a major income opportunity and is not being achieved in many countries of the region. Research and development of value-added products and markets could increase income of poor farmers and be used to generate income in rural areas. For value chains and market analyses, this type of research is essential: analysis of constraints of access to market information; development of better methods to communicate price and quality information; new technology to reduce postharvest losses; role of production for different markets; availability of external and domestic markets for the poor; improved access to financial capital and markets; input markets and services; and capacity building in marketing.

Given existing research capacities and capabilities in the CWANA region, it is unlikely that such an overwhelming agenda will be met under the business-as-usual scenario.

4.1.4 Investment and funding policy

During the twentieth century, highly accelerated improvements in agricultural productivity have significantly contributed to poverty alleviation, food security and economic progress. These productivity improvements have been achieved as a result of substantial and deliberate investments in agricultural research and development (R&D). Because of associated high returns, it is recognized worldwide that a minimum target of spending on investment in agricultural R&D should be set by developing countries, in addition to ensuring larger share gains from international public spillovers.

Historical trends of investments in agricultural R&D show, however, that government spending slowed in the Middle East, North Africa, and Central Asia and the Caucasus. Meanwhile, international technology spillovers and corresponding knowledge have also decreased. Taking into account the low density and poor to medium performance of NARS, these trends currently pose critical challenges to AKST development and application. Business-as-usual prospects show that higher investment will be of great value to ensure a critical level of AKST self-reliance. This is vital in light of persistent signals that developing countries are not likely to benefit, as they used to do, from international spillovers from the North and from the CGIAR centers.

It is suggested that under globalization, countries would still have opportunities to benefit from investment spillovers by interacting with nations and communities who are well equipped in agricultural science, technology and information. However, risks are likely to be faced regarding the availability, price and quality of needed new technologies. Research agendas and investment structures are changing in the direction of diverging research objectives between industrial countries and developing ones, and of the emergence of private corporate bodies providing AKST (Alston et al., 2006).

As a result, only substantial self-reliance in agricultural R&D will ensure developing efficient agriculture production systems that are able to successfully compete in price and quality in domestic and international markets (Pardey et al., 2006a, 2006b). This is of particular importance for the future of small-scale farmers who cannot generate or do not have access to the AKST needed to improve their livelihoods.

Therefore, it seems that business as usual will not, under all circumstances, ensure a continuous flow of affordable AKST. An increase in national spending of CWANA countries will be still needed to counter increasing monopoly building in the AKST system that may be detrimental for agricultural development and sustainability objectives by excluding developing and less-developed countries from AKST benefits.

4.1.5 Intellectual property rights policy

Growing IPR protection as one endorsed by WTO members is intended to promote innovation and technology transfer and dissemination to the mutual benefit of both the producer and the user of the technology. This is why all countries are called upon to establish and enforce appropriate IPR-related regulations to help innovation take place in sectors vital for socioeconomic and technological development. As a result if required regulations are adopted, technology transfer toward less-developed countries can occur (Abbot, 2003). Such cooperation comprises assistance in preparing law texts related to IPR promotion, enforcement and protection;

prevention of their abuse; implementation of institutions and agencies serving this aim; and last but not least, personnel and technical training.

However, in developing countries, regulations protecting IPR can be perceived as a means of principally serving rich countries since they are the technology generators. Holding IPR, AKST producers will invest only in industrial countries with established and functional laws that comply with international standards. It is true that developing countries are more and more present, but the technology generated in these countries comes either from multinational companies that relocate their production plants or from small national companies.

In addition, perfect compliance with trade-related intellectual propriety rights (TRIPS) does not guarantee that poor countries will have access to new top technologies. Often infrastructures are insufficient and professionally qualified personnel lacking to make use of them. Furthermore, technology patenting is not always followed by use in production, which prevents consumers from taking advantage of technological progress.

Abolished trade barriers and globally protected IPR may be antagonistic, if effective holding and use of IPR is not rightly controlled. According to the WTO report on interactions between trade exchanges and competition policy, IPR protection and competition policy are seen as complementary notions aimed to promote competition and consumer welfare. But in some cases, IPR protection might threaten competition (Drexl, 2003). To avoid such a negative outcome, we might suggest that IPR protection be placed under the control of a global competition law. But, should harmonized competition laws include a sensitive concept like IPR protection? If yes, what would be the effect of that extended law on high technologies?

At present, few CWANA countries have established IPR protection laws and hence are not likely to take advantage of accessible new technologies to strengthen their own capacity for innovation. While working toward establishing a domestic legal environment (market competition and IPR protection laws), developing countries can consider

- abolishing barriers, for better access to innovation
- supplying adequate engineering and managing skills
- promoting an adequate national marketing environment
- reducing the technology gap
- implementing IPR standards for dynamic competition

These suggestions are acceptable if the imported technology is relevant and if the importing country has adequate capacity, policy, regulation and institutions to optimally exploit IPR provision.

In a fair-competition environment with protected IPRs, innovation, consumer welfare and development are evident consequences. In other words, competition enhances dynamic efficiency, which through protection can give access to an exclusive right to innovation through appropriation in respect to patent law while diverting free riders and misappropriations. This gives the consumer better access to innovation and encourages information dissemination. Monopoly ownership, resulting from IPR protection, may not be harmful to innovation in given applications (scientific research, computer licenses, etc.).

However, often an optimal mix of competition policy and patenting laws is required to effectively induce a productive equilibrium between innovation and IPRs, as mentioned above, creating stronger markets.

4.2 Implications of Future Challenges for AKST-Related Institutions and Organizations

In such a rapidly growing world with tremendous challenges, CWANA has a lot to worry about while striving for a better and sustainable future. CWANA countries share complex situations, beginning with their harsh climate and scarce resources. These factors are compounded by high population growth rates; they pass through wars and natural disasters, and end with the newly emerging issues of globalization and trade liberalization. All these factors have significant implications on the ability of CWANA countries to achieve development and sustainability goals, and more specifically to reduce hunger and poverty and improve livelihoods. Institutional arrangements and partnerships are major actors in developing and applying AKST. Their effect varies, reflecting different levels of involvement and maturity across the region.

4.2.1 Cooperation

Institutional and organizational arrangements of interest comprise regional and international conventions (Framework Convention on Climate Change, biodiversity, etc.), regional organizations (e.g. the Arab Center for the Studies of Arid Zones and Dry Lands—ACSAD), national institutions, local and community-based arrangements to enhance technology generation, transfer and adoption, access to new technology and better technology management.

These arrangements affect directly (as direct drivers) the generation, access, dissemination and use of AKST in achieving development and sustainability goals. If the CWANA region is to attain development goals, member countries need to cooperate and coordinate their efforts.

CWANA countries need to coordinate and collaborate within and across the region to deliver the development objectives, especially with reference to poverty alleviation, amelioration of hunger, and socioeconomic and sustainable development. Also they need to establish networks to preserve and develop natural resources and human capital, to mitigate natural disasters such as droughts and floods, and to resolve conflict over natural resource management.

Global cooperation: Institutional arrangements within developing countries are needed to conform with and provide input into overall government reform, particularly into restructuring their economic, social and related fields. Cooperation principles should be based on an action- and results-oriented approach and be consistent with the principles of universality, democracy, transparency, cost-effectiveness and accountability. These institutional arrangements should elaborate strategies and measures to increase national and international efforts to promote sustainable and environmentally sound development in the CWANA countries and to promote economic growth.

To be effective, these efforts need to be coordinated and implemented by private or public organizations in relation to international organizations in the form of networks to support and facilitate the transfer and adoption of technology. The involved organizations include

- national research centers
- nongovernmental organizations (NGOs)
- trade associations (chambers of commerce, associations of enterprises)
- state and parastatal institutions for converting economic and policy approaches (ACSAD)
- private service providers, active NGOs

These institutions and international networks contribute to development, diffusion and adoption of AKST. They should be enabled by financial funds, strong networking capabilities, continuous learning and assessment, explicit incorporation and voice of producers in the AKST process, business management and planning approaches, and clear and transparent priority-setting mechanisms to achieve significant success in realizing the development and sustainability goals.

Regional cooperation: Regional and subregional cooperation includes the regional development banks, NGOs, and regional economic and technical cooperation organizations. Within their respective agreed mandates, these organizations can contribute to AKST development and adoption by

- promoting regional and subregional capacity building

- promoting the integration of economical, social and environmental concerns in regional and subregional development policies
- promoting regional and subregional cooperation, where appropriate, regarding issues related to sustainable development

In particular regional organizations for technology generation, evaluation, diffusion and study will need to be developed. It is likely that new AKST will flow toward the region from all around the globe, promoting R&D in this field. This will be further enhanced by the increased pressure on natural resources associated with increased population. Countries of the region may be encouraged to share resources (water, energy, gas), which would help stabilize the price of such goods. Nevertheless, a basic assumption for stronger regional cooperation is the high level of commitment for institutional development and reform from various countries, especially from industrial countries and donors.

Such cooperation is more effective if an outward liberalization policy is adopted. If an inward-looking and protective approach in dealing with development issues is adopted, it is not likely to enhance the development and application of AKST to achieve development goals and reduce poverty in CWANA.

In the latter case, increased prices and the monopoly of some associations will prevent poorer—or nonoil-producing—countries from developing and applying AKST. Under this scenario, countries will continue to have inward-looking policies that will hinder any potential cooperation across borders. In addition, links with R&D institutions will be weak and thus access to new technology and innovation will be limited. This will likely have long-term implications on reducing poverty and achieving development goals.

Given these expected negative results, CWANA countries will more likely take a proactive role in going through a transitional phase to enter global markets. Such a phase will be enhanced through developing the regional trading blocs that are already emerging, making it easier to develop and apply AKST at national, regional and international levels. Regional cooperation will be enhanced in the fields of research and AKST. It will mainly target product processing, storage and marketing—ultimately providing food security and protecting human health and the environment. This will contribute strongly to poverty alleviation and will improve the quality of life in the region. As a result, investment in science and technology in general and in agricultural R&D in particular will be enhanced on national and regional levels—thus contributing to achieving the development goals.

National cooperation: Of equal importance to CWANA countries are what arrangements national institutions will make and the effects they will have on developing and applying AKST in their efforts to achieve the development goals.

It is assumed that CWANA will adopt knowledge-driven economic development in which AKST is the key factor. CWANA countries will enjoy needs-based decision making integrated within countries of the region and across regions, leading toward achieving the development goals and improving livelihoods.

While CWANA countries struggle for integration within the global market through regional trade areas, they need to face major challenges including developing AKST infrastructure at different levels such as academia and research as well as developing and planning for transformation and change management under globalization. Overall, the process of change should feed into enhanced well-being of nations and improved health, education, and use of natural resources and infrastructure.

Policy and institutional reform in various sectors will be a major feature of this storyline. National policies, plans and legislation will be improved to support integration into the global market and to meet all the required criteria and conditions for promoting investment and facilitating trade. In parallel, public institutions will need to be developed to accommodate the changes. Local producers will strive to meet the conditions for entering the global market. The role of the private sector and other national stakeholders will be enhanced through better cooperation, and strengthened public–private partnership will be witnessed with more emphasis on gender equality and empowerment of local communities. CWANA countries will live in an era flourishing for development institutions, especially those working on AKST and other relevant issues including natural resources and property rights. Farmers' organizations will emerge as a major player to support research and technology transfer and application and protection of farmers' rights. Civil society organizations promoting the conservation of natural resources will advocate land conservation and rehabilitation. Education and capacity building for various players will be integrated into various activities. Sustainability will become a culture and way of living for the people of CWANA, leading the countries and the region toward more accomplishments on the scale of development goals.

As stated earlier, inward policies would contribute to increased prices. Also, the monopoly of some associations would prevent poorer—or nonoil-producing—countries from development and application of AKST. CWANA countries would suffer from focusing on food security from the local

perspective, and not in the global context. Research and development would focus on adaptive research, but investment in basic and applied research might not get priority. As a result, the capacity to innovate would be limited. The media would continue to be under central control, sifting the information, and thus agricultural informatics and the flow of scientific information would be blocked to a greater extent. Consumers would have to rely on limited information and because of the limited role civil society would have, consumer activism would not take root. The human resource quality would remain at low ebb and agriculture continue to be complacent with unskilled or low-skilled labor, with scarce capacity to transform agriculture and thus increase its productivity. Overcontrolled governance would prevent agriculture and its relevant institutional arrangements from responding to the change out of and across borders.

As governments embark on more people-caring and outward-looking policies, they become more proactive to provide equitable access to education, health and information. Thus AKST development will be enhanced, focusing mainly on processing, storage and marketing rather than agricultural production.

Local organizations will receive more support from local and national governments. Governments will become more proactive to provide equitable access to education, health and information. The aim will be to improve knowledge about the environment and to ensure an optimal national natural resource management (NRM) system. In addition, new actors will engage in agricultural production. The goal of achieving a better quality of life as opposed to generating income will get prominence. Higher awareness and responsibility levels will help fight problems like environmental pollution and public health hazards on national and regional levels, and thus achieve sustainability goals.

Affected by WTO negotiations, environmental problems will be solved through technology and market-oriented institutional reform. People will pay for the pollution they create. Under these policies with expanded property rights, people providing ecosystem services will be paid. Ecotechnologies for managing ecosystem services will be demanded as interest in increasing economic values of property rights grows and benefits of ecosystem services increase.

In addition, countries will be encouraged to produce and sell products tailored to diversified market niches. This is applicable to both regional and global markets. Problems of agriculture in CWANA will be addressed holistically and efforts made to align agriculture with WTO negotiations aimed at global reduction of subsidies and removal of barriers to agricultural trade. Markets for ecosystems services and relevant technologies will be created and developed as a result of agricultural multifunctionality and diversification. New companies and cooperative institutions will

evolve to provide these services. These companies, however, requiring large amounts of capital and knowledge, will develop in rich countries and operate as multinationals in poor countries, imposing their own fees and operating under less control from local governments or institutions. Poor countries will be at a disadvantage and may not approve of such institutions.

4.2.2 Capacity building for innovation

Public research organizations: CWANA countries do not possess the institutional, managerial or financial capacity to absorb current levels of project aid or to sustain project activities after foreign aid is phased out. The challenge for donors is to continue moving beyond the resource-transfer model of financing the construction of buildings and purchase of equipment and vehicles for NARS and pursue a model based on human capability and institutional building that is geared to the specific needs of CWANA countries at this stage of their development. The following constraints face most NARS of developing countries in their institutional development: weak research management, institutional instability (donor driven), human resource instability, funding instability, research program instability, limited relevance of research and deficiency in priority setting, defective linkage with the world knowledge system; insufficient links within the NARS themselves with universities, the private sector and NGOs, and with outside partners such as international agricultural research centres, regional institutions and advanced research institutions in industrial countries; and weak monitoring and evaluation of research. Generally speaking, the role of foreign assistance has been prominent in developing NARS in the region. Building agricultural research capacity means developing the capacity to design organizational rules that will help people organize, support, conduct and monitor agricultural research. Research management capacity development measures may involve

- setting medium- and long-term research plans and strategies to serve as a frame for priority research programs and projects, in light of integrated sustainable development priorities and policies
- identifying appropriate research instruments for achieving research objectives
- transforming human, physical and financial resources of research institutions into research outputs and practical technologies
- upgrading and executing research agenda consistent with minimum environmental degradation
- monitoring, evaluating and revising the agricultural research system

The agricultural research agenda must respond to the challenges of the world food supply. It will be influenced by the choices of research investments and strategies made by governments and institutions in both industrial and developing countries.

It is now recognized that a rigid borderline between public and private sector roles cannot be established, and there are many gray areas where public–private partnerships are needed, often in conjunction with civil society and producer and community organizations. In some least-developed countries, the withdrawal of the public sector from markets has left a vacuum that the private sector has not adequately filled, because of high transactions costs and risks. This means that the public sector needs to take a more active role in coordinating activities, jointly financing and building the capacity that the private sector needs to fill its role. In addition it must finance core public goods, especially infrastructure. Many responsibilities are also being devolved to local or state governments for decentralized program implementation, providing additional challenges and opportunities. Strategies such as contracting out to the private sector, providing targeted matching grants to support activities within the public interest, expanding collaborative action in the context of development of market supply chains and trade associations, various types of consultations and coordination forums with the private sector are all important. CWANA countries, while signing free trade agreements and proceeding with trade liberalization, are facing tremendous direct and indirect challenges that will need to be addressed carefully; among these is the capacity of local public and private entities as well as regulatory and institutional maturity.

Farmers need to recognize that agriculture is the key to sustainable development, food security and biodiversity conservation; it is central to international action in trade and investment. It has been the main user of freshwater resources and central to producing bioenergy. Thus farmers have begun—but not yet sufficiently—to form partnerships, covering such areas as how to manage water, land, genetic resources and energy. Farmers have also strengthened partnerships in research and technology. Such partnerships have been good, but they must be supported by capacity building and good governance. Successful development of agriculture requires democratic, consultative processes that involve farmers' organizations. On the other hand, indigenous communities should continue to seek partnerships and associations with governments and transnational bodies to maintain access to traditional lands, based on principles of good faith and equity.

Public–private partnerships: When discussing partnerships, we should note that sustainable development requires partnerships among all stakeholders and at all levels. In particular, the regional aspect has been stressed as crucial, if implementation is to achieve the stated goals. Despite the fact that many encouraging partnerships toward implementing the declarations and conventions have emerged following Rio, real implementation has been less satisfactory due to the lack of resources and political will. Implementation has also been hindered by structural and institutional failings, such as questionable government policies and incentives associated with trade and agriculture. The international community has a responsibility to consolidate the

multistakeholder dialogue by establishing an institutional structure to facilitate the building of partnerships.

Recent approaches adopted by some international entities such as the World Bank's strategy in rural investment to promote agricultural growth and poverty reduction are founded on the fact that the public sector, the private sector and civil society can work together to enhance productivity of the agricultural sector and promote its competitiveness in ways that reduce rural poverty and sustain the natural resource base. These actions involve a rich mixture of science, technology, people, communication, management, learning, research, capacity building, institutional development and grassroots participation.

4.2.3 Governance and information

It is essential in striving for sustainable development to seek and maintain transparent democratic institutions capable of protecting the environment and natural resources while providing basic needs and economic opportunities. In communities where people came together to protect their ecosystems, they also had better schools, health care and economies. Hence, developing institutional capacity has been the core of the recent national and global attempts to achieve the Millennium Development Goals. Moreover, and with continuous globalization, sustainable urbanization that covers environmental, social, economic and institutional sustainability should be based on the proposition that transformation from rural to urban life requires a change in the institutional framework.

4.2.3.1 Governance principles

While rapid technological advances may in many cases help achieve economic growth without harming the environment through what is known as "green economics", real cases have raised the question: How can the international community guarantee that it will not continue to fail? The answer lies in emphasizing that greater overall sustainability goes hand-in-hand with less institutional constraints on decision-making powers, greater openness of political competition, and more widespread civil and political rights. Inevitably, national efforts to achieve sustainable development must focus on productive capacity and the institutions that are its key determinants, as well as human and natural resources. Moreover, capacity must be strengthened to be able to monitor performance where the results would feed into the process of influencing policy at the highest level.

It is essential to stress that all types of institutional setups could play a role in achieving the IAASTD sustainability goals. For CWANA, on the political level, the democratic deficit in decision making, both nationally and internationally, had to be overcome. Far too many governments and

institutions in position to act focused only on narrow interests without special focus on the will of the people. Parliaments had been working, at national and international levels, to provide a parliamentary dimension to the work of intergovernmental organizations working on sustainable development issues.

Local governments, on the other hand, could show leadership through increasing the coherence and integration of their own policies, including integrating sustainable development concerns across ministries and ensuring that existing policies have not worked against each other.

Trade liberalization has been a means to an end, not an end in itself. Each of the international regimes and institutions should be judged on its contribution to eradicating poverty and maintaining a viable natural resource base. The new perspective must build the bridges between trade and environment, between investment and development, and between finance and sustainable development.

4.2.3.2 Transparency and accountability

The poor state of governance and weak protection of rights of vulnerable communities, including smallholders, is attributed to lack of transparency and accountability in government as well as corporate activity, which restricts the ability of citizens, civil society groups and public representatives to effectively monitor the performance of various public and private institutions. Access to information is the first step toward promoting and institutionalizing public accountability at various levels; while its absence or lack of it often results in arbitrary and nonparticipatory decision making, weak monitoring, inefficient project execution, human rights violations and rampant financial corruption in public bodies (Transparency International, 2006) Lack of access to information also contributes to sustaining excessive bureaucratic controls, eliminating stakeholder participation and weakening democratic institutions.

Currently, almost all government activity in CWANA takes place in a pervasive culture of official secrecy, manifest in both official attitude and various pieces of legislation (e.g. Official Secrets Act 1923 in Pakistan). Any disclosure or sharing of information, if and when it takes place, is on a “need to know” basis, as determined by official authorities, and not in recognition of the ”right to know” as a fundamental human right. As a result, whether information is made accessible or not and at what time or in what manner it is disclosed is determined by the government. Citizens and communities have hardly any say or control over it, even though the information and records held by various government departments may have direct implications for their environment, health, safety and well-being as well as their ability to make political or economic choices. It particularly

affects the weaker members of society, as the powerful find ways to access the information they require by using their contacts and influence.

The culture of secrecy is so predominant that it has seriously undermined almost all mechanisms created for providing access to government information. Official statements and press releases often provide one-sided information and lack credibility. Annual reports are either not published or lack details and appropriate analyses, which could help in determining the credibility of data presented and in assessing the year's performance of related departments. Parliaments either do not exist or parliamentary proceedings do not provide adequate mechanisms for maximum disclosure of information about public policies and plans, participation of farming communities, transparency and accountability. Information could also be made accessible through Web sites but most government Web sites provide little that is useful. All of this is, partly or wholly, because there are no comprehensive policies that recognize the right to information as a fundamental human right and that provide an efficient legislative and institutional framework to assure this right.

The few countries in CWANA that have enacted and implemented right-to-information laws include Pakistan, Tajikistan, Turkey and Uzbekistan. Even where such laws exist, they do not conform to best international practices and hence offer little opportunity to promote a culture of transparency and accountability. This situation has adverse implications across the board but especially in relation to AKST, which is the mainstay of economy of many CWANA countries. This lack of transparency and access to information explains, at least partially, the grave nature of the problem of corruption. On the Corruption Perception Index (CPI) of Transparency International in 2005, not even one country from CWANA is among the top 20 better-performing countries. Among the first 50 best-performers, only 7 are from CWANA. Almost all the major countries in CWANA are among the poor performers on CPI. For instance in 2005, out of 158 countries, Turkey ranked 65, Egypt, Saudi Arabia and Syria 70, Morocco 78, Iran 88, Algeria 97, Uzbekistan 137 and Pakistan 144.

4.2.3.3 Information technology

New information and communication technology (ICT) potentially will have a profound effect on transmitting information and knowledge on agriculture and natural resource management. New systems will be emerging to provide up-to-date market, weather and extension information to rural producers, processors and shippers (USAID, 2005). Geographic information systems (GIS) will be increasingly used in linking geographic information to agriculture and NRM to help decision makers. GIS will allow more efficient use of inputs, which will not only save money in materials but also make labor available for other activities (World Bank, 2007). Innovations in biological and

information sciences have resulted in several emerging fields that hold promise for the development of future agricultural technologies. The new fields of bioremediation, nanotechnology, genomics and bioinformatics will increase knowledge that can be shared and used to improve sustainable agricultural production and protect ecosystem functions in industrial and developing countries alike (USDA, 2003).

We will need to facilitate the exchange of scientific information and knowledge among all stakeholders in the CWANA region, and between them and the outside world. The goals of facilitating sustainable development and developing a global partnership for development can only be realized in cooperation with the private sector to make available the benefits of new technologies, especially information and communications (World Bank, undated). To meet the need to exchange information and knowledge, it is highly essential to improve and enhance ICT in the region. ICT will help bring together the scientific strengths and talents available in the region to collectively tackle the formidable challenges and tasks ahead (World Bank, 2007).

There is great potential to improve the access to information necessary for boosting production, using traditional communications technologies (such as radio) to disseminate information and ideas on agricultural technologies, markets and investors (USAID, 2005). For information without proprietary constraints, national and international agencies are increasingly using modern communication technologies, such as the Internet, to disseminate information. While such technologies are important bridging mechanisms for sharing information and experience between various sections of society and across countries (Juma and Gupta, 1999), and their use is likely to grow in the future, excessive reliance on them with the presence of the digital divide could prevent those CWANA countries with the least capacity and the greatest need for information (such as on biosafety and other risk-related fields) from having timely access to the latest knowledge they need. Measures should be taken to complement information dissemination through the Internet, including establishing information clearinghouses to act as bridges for sharing information and experience, and disseminating the lessons learned between various sections of society and across countries (Roozitalab, 2000). Appropriate specialized Web sites organized and managed by international organizations should play a more prominent role in spreading AKST. To deliver solutions for the poor in CWANA, biotechnology and information technology should be actively linked so that new scientific discoveries worldwide can be accessed and applied to the problems of food security and poverty in a timely manner (IFPRI, 1999). In addition to the growing challenge of facilitating and regulating access to information and information technologies, CWANA countries will need to harness modern science and skills for propoor growth, in a world in which agriculture is becoming more knowledge and information intensive. The challenges here require global efforts to reach agreements on access for the poor

to proprietary information and technologies. In addition, a modernizing agricultural sector requires harnessing new skills and capacities to use modern science and technology (World Bank, 2007), a formidable task ahead for CWANA countries.

To summarize, considerable advances in Internet and electronic commerce and their application to the needs of CWANA countries present great opportunities to provide new cost-effective knowledge systems. They offer much potential to make agricultural growth more propoor, but at the same time they are often controversial. The challenge will be how to use these new advances together with developments in biotechnology and other agricultural technologies to make the complex agricultural systems of CWANA more productive and sustainable.

4.2.4 Social factors

Market and trade: Competitive global markets in the past years have favored corporate farming to the detriment of small-scale economies, diversity in agricultural products and farming systems. Small-scale farmers, semi-, low-skilled or informal laborers are likely to suffer most from purely market-oriented agricultural production. Women, who constitute the majority in these categories, are likely to suffer more from liberalization policies in agriculture (Baden, 1998).

Since ”markets are not abstract, neutral entities but are real processes of exchange embedded in social institutions, including gender relations” (Baden, 1998) a number of policies can be adopted to balance their negative effects. These include providing credit to initiate new businesses, information on new market possibilities and requirements, and training on compliance with new production standards. Also, constructing infrastructures to facilitate movement between rural areas and the markets, and storing, transporting and preserving agricultural produce could be effective ways to integrate farmers from the most remote areas and enhance female participation in the market. This would increase the control by farmers over the returns for their agricultural work and eventually empower them, particularly the female farmers. This might also positively affect the general economy of many rural households.

Agricultural market liberalization has generally reduced state intervention. A different approach might assign a new positive role to the state to support fair globalization of the market. Alternative systems of agricultural production that favor locally produced and organic products of quality can support small economies, help preserve local systems of agronomic management and benefit the environment. They can also help diminish the marginalization of the most vulnerable rural sectors.

Climate change: Addressing climate change has recently become an urgent concern. Pollution and unsustainable development megaprojects in the past have mostly affected dwellers of marginalized areas, which are, for example, often chosen as sites for dams (McCully, 1996). Displacement, worsening health standards and general impoverishment are among the related consequences. Unpredictable changes in the ecosystem can cause droughts and other ecological disasters that will affect the most vulnerable people—mainly poor women, children and the old.

Some see paid ecosystem services as the solution to pollution. These, however, like other market-based solutions to environmental degradation, could have a negative effect on the poor, who, unable to pay for these services, will have to cope with increasing pollution that negatively affects their health. Development of ecofriendly technology, on the contrary, such as less harmful substitutes for pesticides and fertilizers, and alternative sources of energy, will partially limit environmental pollution and will primarily benefit rural users.

Agricultural policies and AKST development: Focusing AKST development on discovering alternative sources of energy, improving agricultural production and optimizing the use of available natural resources can be the first step toward sustainability. A sustainable approach to development of agricultural technology will not aim at agricultural production per se but will integrate a number of concerns such as environmental, sociocultural and economic ones. It will also include the needs of all stakeholders in establishing priority areas, research performance and technology development by adopting a gender-sensitive participatory approach.

For many years now, including end users in development intervention is considered a premise for sustainability (Zuger, 2005). This is because AKST developed with a top-down, non-participatory method is unlikely to address the diverse conditions, needs and preferences of end users. Technology developed under a purely market-driven system also is likely to focus on profitable topics, marginalizing the needs and interests of those who lack the financial means to support research or influence its development. Technology can become a tradable good available to the most affluent countries and people only.

The exclusion from technology development of the actual doers of agricultural duties leads to ineffective results. In CWANA countries women contribute significantly to agriculture therefore should participate in AKST development. A gender-blind approach to AKST can produce inefficient results, is likely to improve only the agricultural work of men and also can disempower the overlooked end users. Because men's work is considered productive, as opposed to women's domestic work, which is regarded as unproductive, it is generally considered more worthy of

investment. As a result, research and social spending are directed to irrigation infrastructures more than to safe drinking water, with women and children usually being the ones to fetch water (WEDO, 2003). Cash crops, mainly cultivated by men, often receive more attention than subsistence crops, generally grown by women (Chambers, 1983). Agricultural machinery is mainly designed for male users and their needs. Because engagement with mechanized agriculture often corresponds to more powerful positions in intrahousehold or community dynamics (Boserup, 1970) a gender-blind AKST can cause women to be disempowered.

In a truly participatory approach to agricultural technology, both men and women farmers will develop AKST and produce machinery with technical characteristics that make it easier for smaller and weaker persons to use. This could help limit the gender division of labor. For long in the CWANA region men have been assigned the use of machines, leaving the manual and time-consuming jobs to women and children (Rassam and Tully, 1988). A gender-sensitive AKST development will also expand the range of crops on which to focus, by including subsistence crops and local varieties as well as cash crops. It will take into consideration all phases of agronomic management plus postharvest duties and related domestic activities that are often neglected. By integrating local and gender-differentiated understanding of seeds and the cultural values connected to food preservation, preparation and storage, AKST could enhance the success of technological adoption and eventually be more effective in enhancing rural livelihoods. This is particularly important in the case of ethnic minorities, who connect dietary habits and the preservation of landraces to their culture.

A gender-sensitive approach to agriculture development is particularly important in areas characterized by feminization of agriculture. In countries like Syria male farmers often migrate to urban areas in search of work and women are in charge of the agricultural work (Abdelali-Martini et al., 2003). Nonetheless, women are not considered farmers, and policy makers and development planners overlook their needs and preferences, negatively affecting agricultural production, women's daily labor and rural livelihoods. Furthermore, laws and policies rarely adapt to these changing circumstances. Entitlement and access to land, water and seeds rest with absent husbands or fathers, upon whom women must depend to get access to the basic means for their daily work. Control over key economic resources can determine intrahousehold distribution of benefits from increased agricultural productivity (Tipilda et al., 2005, p. 2). Also, labor laws rarely protect the rights of women farmers or those of the informal workers, whose number is constantly growing in the agricultural sector of CWANA. Policies should be formulated that reflect the changes in social composition of rural areas and deal with emerging issues. Moreover, policies aimed to build the capacities of the rural population can help diversify the

sources of household income, thereby decreasing their vulnerability. This is particularly important in light of the agricultural sector being increasingly marginalized.

Technology: Literacy rates in the CWANA region have recently risen. However, the gender gap in education is still wide. According to the Economic and Social Commission for Western Asia (ESCWA), in 2002 almost half of the female population in the Arab countries was illiterate (ESCWA 2005). Policies should be pursued that support women's school attendance and completion, and training in fields that are usually male dominated. This is particularly important in rural and agricultural areas where access to education is limited by poor infrastructure. Cultural norms disfavor female education; poverty causes high school dropouts because children are needed to help provide income for the household. Many girls abandon school after puberty because both the trip to school and the lack of proper toilet facilities in the buildings jeopardize their modesty and honor. Safe means of transport to reach the school and proper facilities could improve their attendance. Finally, the quality of education could be improved by removing stereotypical gender images in school texts. By training students in the latest agricultural technologies or other skills the labor market requires, education could become a path in the rural areas towards better employment.

Technologies can be developed and applied to meet the needs of women in particular. For example, biofortification and foods enriched to supply the nutrients that women in CWANA tend to be deficient in, such as calcium, iron and zinc, should be considered (Gender Advisory Board, 2004). Currently in several CWANA countries, technologies suitable for women farmers are lacking, particularly labor- and energy-saving farm and household technologies. This lack of suitable technology impairs women's productivity (Kasnakoglu, 1997). Agricultural technology developed with close attention to alleviating some of the labor constraints experienced by rural women potentially can improve not only the well-being of the woman farmer but also of others in her household who are dependent on her care (World Bank, undated). Alleviating the labor burdens of rural women is an important dimension in empowering them. Technology targeted at men and implemented with men's goals and situations in mind may put women at a disadvantage by leading to an increase in the amount of labor they must expend to attain the same level of production (Gender Advisory Board, 2004).

There are no easy answers to the question of what kind of technology will promote the autonomy of women in rural societies of CWANA. These women may indirectly—but drastically—be affected by technological innovations. Technologies, as seen in many instances during the Green Revolution, may displace women and actually decrease their income (Gender Advisory Board, 2004). Such biotechnologies carry the risk of increasing the burden on women as providers for

their families: increasing competition and lowering world market prices as a consequence of applying modern technologies could lead to the migration of men from rural areas. Such migration will cause an increase in the heavy burden that women must carry alone, and consequently lead to their impoverishment (Pingali and Rajaram, 1998). If the present global power structure and the current bias towards males in agricultural research, extension and development policies persist, modern agricultural technologies will most likely further widen the gap between men and women, and between rich and poor. Public research also generally bypasses women and their needs or approaches women for efficiency reasons to diffuse technical innovations more rapidly. In this way, women are expected to accept modern biotechnology (Zweifel,1995). If women's situations, concerns, technological skills, use of technologies and knowledge continue to be overlooked, women will be displaced and marginalized by technology development, with many of their activities becoming sidelined or taken over by men. This will have resulting implications for the health and well-being of women and children, environmental sustainability, and income levels in developing countries (Gender Advisory Board, 2004).

The need is urgent in both research and priority setting to ensure that women will be in a position to benefit from modern agricultural technologies, rather than being disadvantaged as has often occurred in the past (Gender Advisory Board, 2004). Women's participation both before and during the introduction of new technology is of central importance. Their participation should go beyond consultation, aiming to implement outside innovation more easily, and to include shared responsibility, trust and cooperation. The exchange among women of technology and knowledge they have developed would be a more sensitive step in improving women's autonomy than expensive and advanced technology. If women are involved in the whole innovation process, they can set their own priorities collectively for appropriate capital-intensive technology (Pingali and Rajaram, 1998). This implies the need to change national and international research and agricultural policy in favor of women's possibilities and capacities (Zweifel, 1995). There is also need to increase the participation of women in the biotechnological sciences and other modern sciences, especially at senior levels, as well as their representation in regulating and making policy for biotechnology (Gender Advisory Board, 2004).

To conclude, technologies developed and implemented to meet the needs of women and women farmers have the potential to contribute to the IAASTD development goals, mainly through alleviating their labor burdens. Measures should be taken to ensure that modern agricultural technology will not undermine women's autonomy but will rather help women gain more autonomy. Acknowledgement of this autonomy leads to the logical conclusion that women must play a key role as decision makers in designing the direction of research and in agricultural policy-making processes and governance in the CWANA region.

4.3 Options for Strengthening AKST Future Effectiveness

The previous chapter identified the most prominent challenges that agriculture might face in the CWANA region over the next 50 years should agricultural practices continue to operate according to a business-as-usual scenario. In this section, agriculture-related technology is presented as a key tool to address these challenges and the role of various technology management practices (and support systems) in reaching development goals is examined.

4.3.1 Options to improve AKST generation

Options exist for improving the generation of AKST:

- research policy and funding
- intellectual property rights
- farmers' innovation capacity

At present most CWANA countries do not adequately invest in agricultural research to generate AKST. The research capacity required to generate appropriate environmentally friendly technologies to increase agricultural production has not yet been fully built. And agricultural research has been largely concentrated in public agricultural research institutions (Roozitalab, 2000).

Developing effective and efficient research systems to generate agricultural technology in the region will require CWANA countries to set research priorities that are well attuned to the needs of farmers and preferences of consumers, and to mobilize all partners to generate technology.

4.3.1.1 The future outlook for generating agricultural technology

In developing countries, where growth in food production had relied heavily on plowing up new land and on irrigation development, technology was increasingly responsible for production growth after 1965 (Oram, 1995). However, since shrinking land and water reserves are placing a greater burden on technology, increase in food production during the next 25 years will have to be achieved using less water, labor and cultivated land. This can be done only if scientists can develop new crop varieties with high water-use efficiency and high yield potential (ADB, 2001).

Concerted and systematic efforts should be made to develop priorities for technology generation and R&D that are consistent with socioeconomic, cultural, agricultural, environmental and political realities and goals (Gender Advisory Board, 2004). Agricultural technology generation needs to be directed to the needs of the poor. It needs to focus on the problems of marginal dry areas and to emphasize simple, low-cost technology appropriate for smallholders and resource-poor

farmers. For example, biotechnology can address the issue of poor-quality seed and introduce improved materials into the local seed sector (USAID, 2005). Inappropriate technology could radically change local employment patterns; although it could increase production, it could cause greater unemployment and hence poverty.

Technology generation in the following areas should receive high priority (Oram, 1995):

- technologies to improve natural resource management
- technologies to protect crops from biotic stresses without heavy reliance on pesticides
- genetic improvement of key crops

4.3.1.2 Need for increased public-private sector collaboration

Public investment in agricultural technology is crucial for achieving future food security and reducing poverty. Accelerated public investments are needed to develop technology applications that address difficult problems in rainfed and marginal areas (ADB, 2001). However, most governments in CWANA have limited resources to finance technology research, and few CWANA countries or even international public-sector institutions have the resources to create an independent source of modern technology, such as biotechnology innovations. Additional private investment is required. Currently, it is the private sector that has the knowledge, skills and capital to solve the problems of small-scale farmers, even though comprehensive data on private sector biotechnology research in developing countries are not available (FAO, 2004). Meanwhile, the private sector is unlikely to undertake much of the R&D needed by small-scale farmers because it sees little potential for return on investment. Hence financial incentives or policy initiatives are essential for increased collaboration in technology generation and R&D between public and private sectors.

The leading role of the public sector in technology generation cannot be overemphasized. Agricultural research is often long term, large scale, and risky, and while returns to generated technologies are often high, the firm responsible for developing the technology may not be able to appropriate the benefits accruing to the innovation. The benefits of agricultural research often accrue to consumers (through reduction in commodity prices due to increased supply), rather than to the adopters of the new technology, so social returns may be greater than private returns to research. Therefore, a sustained public sector role in funding agricultural research will be essential, particularly for production areas in less favorable environments that the private sector is unlikely to serve (World Bank, undated).

The challenge for CWANA countries is not to develop new agricultural technologies (such as plant breeding techniques or disease diagnostics) but to design and implement the capacity-

building programs and regulatory systems needed to facilitate the sustainable transfer and adaptation of these technologies to the relevant farming systems (Dhlamini, 2006).

4.3.1.3 Technology transfer

One of the lessons of the Green Revolution was that agricultural technology could be transferred internationally, especially to countries that had sufficient national agricultural research capacity to adapt the imported high-yielding cultivars to suit local production environments (FAO,2002). Advances in agricultural technology hold great promise, but the full benefits of scientific breakthroughs will not be realized unless the new technologies are properly disseminated and CWANA farmers adopt them successfully. Concerted and systematic efforts to transfer new technologies should incorporate participatory approaches as well as a clear assessment of users and beneficiaries.

4.3.1.4 Public engagement

Evidence has shown that public engagement is identified as an important precondition for the appropriate and successful transfer of new, modern technology (Gender Advisory Board, 2004), as farmers in resource-poor areas are innovators and adapters (Chambers et al., 1989). Indeed, technology transfer strategies that have proved successful in CWANA countries have used a community approach and direct farmer participation. Thus technologies can be transferred through extensive programs of on-farm demonstrations, where local extension services play a vital role (Haddad, 2004).

4.3.1.5 Knowledge transfer

Because new technologies are more demanding for both the farmer and the extension agent, they require more information and skills for successful adoption than did the initial adoption of modern varieties and fertilizers. A bottom-up information flow combined with adaptive, location-specific research is particularly important in transferring complex crop-management technologies (World Bank, undated). While transferring new technologies, it is important to recognize and take into account the social status of recipients as well as employment patterns and cultural norms in the community. In the context of transferring “controversial” technologies, such as biotechnology, it should also be recognized that farmers and communities may have knowledge that will affect decisions on how the technology is used in the local context (Gender Advisory Board, 2004). At present, there is widespread distrust of biotechnology and the public needs to be engaged in dialogue before it is disseminated widely (ADB, 2001). The public should be made aware of the potential risks, harm and benefits of new technologies being transferred and given opportunity to discuss them. It is also important to inform communities about the service level they would require for the technology they may want to use. Communities should especially have a clear

understanding of long-term costs and maintenance implications, so that they can choose what is most appropriate for them under their budget constraints (World Bank, undated). All these aspects should be clearly explained to the public at all levels in terms that are understandable and relevant to local farmers (USAID, 2005).

4.3.1.6 Technology adoption

Experience has shown that a number of key conditions help maximize the benefits of a growing agriculture sector for poor people by facilitating the adoption process of modern agricultural technology.

4.3.1.7 Good governance

Good governance is crucial to ensure that new agricultural technology reaches the poor (ADB, 2001). In each CWANA country, successful local adoption of innovations from others will depend on incentives and barriers producers face. In addition to investment in technology generation and transfer, significant policy and governance reform is required to ensure that the poor in CWANA benefit most from greater investment and higher agricultural productivity. The increasing importance of new, knowledge-intensive technology requires a market-friendly environment for adopting and adapting new technologies and removing restrictions on technology imports, which must be encouraged through continued progress in economic liberalization. Alongside favorable macroeconomic and trade policies, good infrastructure and access to credit, land and markets must be in place. Equitable conditions give farmers incentive to adopt new and sustainable technologies and diversify production into higher-value crops—actions that raise incomes and lift households out of poverty (World Bank, undated). Decentralization of existing extension service structures that encourage a bottom-up flow from farmers to extension and research will also help farmers cope with the additional complexity of efficiency-enhancing technology, as local governments are usually more knowledgeable about rural agricultural needs and adept in dealing with them.

4.3.1.8 Dissemination in a package

Exploiting the growth potential of staple crops from dissemination of modern technology requires not only investment but also changes in farm management and a transition from current farming traditions to more modern systems. Since the returns to technology adoption are low if modern inputs are used in isolation and not supplemented by other technologies, modern technology needs to be disseminated in a well-defined package of technologies and services to be successful in the field (World Bank, undated). Farmer surveys of successful technology adoption experiences from Jordan indicate that farmers prefer accepting new technologies as packages, rather than accepting only one component at a time (Haddad, 2004). However, in practice,

components of a promising package could be taken up in a piecemeal, stepwise manner, where the sequence of adoption would be determined by factor scarcities and the potential cost savings achieved, as was often the case in disseminating and adopting Green Revolution technologies (FAO, 2002).

4.3.1.9 Training farmers

Informal training in understanding modern technology is necessary for farmers, local communities and the public to participate effectively in development programs. Extension services in CWANA are often weak in this respect, and knowledge in the labs often does not reach farmers or the beneficiaries of technologies (Gender Advisory Board, 2004). In addition, if rural people are to obtain relevant technical, entrepreneurial and management skills, they need adequate training. In an increasingly technical and communications-oriented world, specialized training schemes (in computing and accounting, for example) are needed, including programs for women, who dominate many service and trading activities (World Bank, undated).

4.3.1.10 Constraints to adoption

Modern technologies that increase agricultural productivity do exist, but many factors prevent farmers from adopting them. As researchers want to maximize production, this can lead to technologies that require a high degree of management and a high level of precision. But farmers tend to want robust technologies and are prepared for lower potential returns if their risk and vulnerability are reduced (CGIAR, 2002). Evidence so far suggests that technologies that are embodied in a seed, such as transgenic insect resistance, may be easier for small-scale, resource-poor farmers to use than more complicated crop technologies that require other inputs or complex management strategies. On the other hand, some biotechnology packages, particularly for livestock and fisheries, require a certain institutional and managerial environment to function properly and thus may not be effective for resource-poor smallholders (FAO, 2002). Farmers should assess the different management options available and adapt them to fit their own circumstances and production goals.

Given the technical and financial constraints that they face, many resource-poor farmers in CWANA countries are unable to adopt the very technology that is intended to reduce their poverty. An example is an agricultural technology designed to produce nontraditional crops that will expand nontraditional exports, which can result in agricultural growth and overall economic growth. However, the nontraditional export sector's contribution to poverty reduction may be relatively small because nontraditional export growth is often concentrated around cities where there is greater access to transportation and other market facilities (World Bank, undated)

4.3.2 Options to improve AKST access and use

Access to natural, physical and financial resources. The world has the technology to feed a population of 10 billion people. However, access to such technology is not assured (FAO, 2002). New technologies—particularly biotechnology and information technologies—require new approaches to facilitate access to CWANA countries, especially for the poor (World Bank, 2007). The range of potential barriers includes issues related to civil society and governments accepting the technology; it includes financial, informational, educational and technical barriers that keep poor farmers marginalized and unable to adopt new, unaffordable technology; it includes intellectual property rights.

Farmers in developing countries experience a need for support services and resources such as access to credit, infrastructure, and services such as transportation and market facilities (Gender Advisory Board, 2004). The high cost of modern technologies is one of the most serious setbacks to their use, slowing adoption. High cost of a technology can be further exacerbated by poor investment of both public and private sectors (USAID, 2005).

The policy bias against agriculture in developing countries and the trade barriers put up by industrial countries is well known (USAID, 2005), and a situation that calls for reform in both camps. Particularly important are government policies to enhance access for smallholder producers and other agricultural and NRM entrepreneurs to regional and world markets (domestic and international trade policies), as well as to build the capacity of developing country governments in these areas. Improving national macroeconomic policies is critical (World Bank, 2003, in USAID, 2005) to support agricultural trade and market access as well as markets for agricultural inputs and services, and to facilitate entrepreneurship.

Information on agricultural technologies, markets and investors affects decisions on adopting the technology. Therefore, to boost production, it is crucial to improve access to this information using communication technologies (Gender Advisory Board, 2004). Policies that improve access to global knowledge and technology should be identified and introduced to reduce the gap between knowledge systems and technologies available to agronomists, plant breeders and farmers in developed and developing countries.

4.3.3 Options to activate enabling factors of AKST generation and application

In its report, the UN Task Force on Science, Technology, and Innovation concludes that to achieve the MDGs, developing countries must strategically embrace the role of science and technology in their development efforts. Then they must begin “improving the policy environment,

redesigning infrastructure investment, fostering enterprise development, reforming higher education, supporting inventive activity, and managing technological innovation." These components are part of the enabling environment that will encourage the generation, transfer and adaptation of agricultural technologies, leading to greater productivity and sustainable development (USAID, 2005).

CWANA countries will have many crucial decisions to make in meeting their sustainable agricultural goals. These decisions need to be made and implemented based on decision makers' knowledge of the unique environmental, social and economic characteristics of their country. Those CWANA countries with strong research, health and education capacity will offer a supportive environment for technology development and investment (USDA, 2003). The role of the civil society (consumer groups and small-scale farmers' societies) in technology assessment cannot be overemphasized.

The European Commission notes a growing recognition that technology development needs to be "meshed with social, economic and policy dimension to have impact on beneficiaries" (EIRAD, 2004, in USAID, 2005). Modern biotechnology, for example, will not solve all the problems of food insecurity and poverty in CWANA. But it could provide a key component to a solution if given the chance, and if steered by a set of appropriate policies that would guide an increased public investment in R&D, foster regulatory arrangements that inform and protect the public from any risks arising from the release of GMOs, implement intellectual property management to encourage greater private sector investment, and introduce appropriate regulation to protect the interests of small farmers and poor consumers (IFPRI, 1999).

Policy research is needed to better understand the political and institutional factors that promote or inhibit the use of new ideas in CWANA at all levels (local, national and regional), and specifically those factors that encourage institutions and mechanisms for effectively articulating science and technology policies. Other areas for policy research:

- identification of policies that improve access to global knowledge and technology
- the interface between technological change, institutional change and policy environments
- . formulation of and education about appropriate policies for biotechnology and biosafety
- . investigation of policies on intellectual property

New technologies, particularly biotechnology, will require new approaches to regulate their use. Some of these technologies remain controversial because of potential health and environmental risks (World Bank, 2007). It will be necessary to have biosafety procedures in place to ensure that the benefits of these modern technologies are realized (FAO, 2003). It will be also necessary to

provide appropriate regulatory mechanisms to ensure that modern biotechnology products such as GMOs that might interact with the environment are as safe as the products of traditional biotechnology (ADB, 2001), and that the benefits of GMOs outweigh their risks. The sociopolitical ramifications of new agricultural biotechnologies should not be overlooked. These include the potential widening of the prosperity gap between the North and the South; the exploitation of indigenous genetic resources without appropriate compensation to indigenous populations; and an increased inequality in the distribution of income that biotechnology might create since the privileged classes derive earlier and greater benefits from the introduction of powerful technologies than do the socially disadvantaged (Leisinger, 1996). The good news is that sound domestic policies and international cooperation can go a long way toward reducing the sociopolitical risks of new technologies.

Technology regulation should be science based (FAO, 2002), and the regulatory framework should not be regarded in isolation from the broader policy context of agriculture and the contribution that technology might make in the particular economic, social and environmental context of individual countries (ADB, 2001). In addition, the establishment of an effective regulatory capacity must go hand-in-hand with investment in technology appropriate for farmers (USAID, 2005). For example, to realize the goal of facilitating environmental sustainability, appropriate regulatory institutions should be in place to limit environmental degradation. Since the underlying driving force for environmental degradation through the harmful use of farming technologies is frequently poverty rather than factors inherent in agricultural technology itself, farmers should realize personal economic benefits from using environmentally friendly technologies and also recognize the social benefits from environmental protection. Only when sustainable agricultural technologies are profitable for farmers will they comply with regulatory requirements and employ environmentally sustainable production techniques (World Bank, undated).

It is the responsibility of national governments to ensure that national regulatory systems are applied, enforced and monitored (ADB, 2001). The regulatory capacity of the public sector in CWANA countries to address food safety and environmental issues will determine the success of modern technologies in individual countries. Without functioning regulatory systems, the private sector is unlikely to invest in modern technologies appropriate for CWANA countries. Effective intellectual property regulations are also important for any long-term investment in modern agricultural technology on the part of the private sector. Regional cooperation in intellectual property and biosafety regulations has great potential for simplifying both technology access and agricultural trade (USAID, 2005).

Judgment and dialogue are essential elements in any science-based regulatory framework (FAO, 2002). At present, there is widespread distrust of biotechnology, and modern biotechnologies such as genetic engineering in food and agriculture cannot succeed unless the public is engaged in dialogue and convinced of its safety and usefulness before these technologies are disseminated widely (ADB, 2001). It is important for CWANA communities to be informed about the technology they want to use, the service level they require, and especially to have a clear understanding of long-term costs and maintenance implications, so that they can choose what is most appropriate for them under their budget constraints (World Bank, undated). Public engagement will be a precondition for the appropriate and successful implementation of modern technologies in CWANA, since communities may have knowledge that will affect decisions on uses of modern technology in the local context (Gender Advisory Board, 2004).

In each country in CWANA, the successful local development of technologies or the transfer and adaptation of innovations from others will depend on the supportive environment faced by investors and producers alike. Only if countries have appropriate policy, regulatory and institutional frameworks in place to support science and technology can they contribute to the achievement of sustainable development goals by increasing agricultural productivity and stimulating economic growth (USDA, 2003).

Improved technologies alone cannot do the entire job of sustainable agricultural development. A combination of improved incentives and policies, reinvigorated institutions, and increased investments must occur in CWANA if agriculture is to develop and the benefits are to be spread widely (USAID, 2005). The potential value of modern science to agriculture and the environment in CWANA countries will not be realized without major additional efforts involving all stakeholders, including civil society, producers, consumers and governments (Serageldin and Persley, 2000).