GLOBAL IAASTD REPORT CHAPTER 7

Options for Enabling Policies and Regulatory Environments

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Key Messages

1. Policy approaches to improve natural resource management and the provision of environmental services benefit from security of access to and tenure to resources and land and the explicit recognition of the multiple functions of agriculture. Options include increased investment in sustainable surface water delivery to stop aquifer water-mining; establishment and strengthening of agencies administrating large water systems that cross traditional administrative boundaries; systems for monitoring forest conditions and forest dwellers' welfare; more resource efficient use, more transparent allocations of use and better enforcement of regulations over forests and lands; and recognition of communal rights of local and indigenous communities.

2. Mechanisms to better inform and democratize AKST policy making are fundamental to achieving development and sustainability goals. The complexities of the globalizing world require vast amounts of knowledge for informed policy development on emerging technologies, trade, environmental and other issues to support the objectives of the IAASTD. Options include increased comparative technology assessment, strategic impact assessment, and increased trade capacity development for developing countries. Strongly improved governance is needed to respond to discontinuities arising from global environmental change and conflict. Options include adoption of enhanced governance mechanisms at all levels (i.e., to institutionalize transparency, access to information, participation, representation and accountability) will help assure that social and environmental concerns, including those of the small farm sector, are better represented in local, national and international policy making.

3. Market mechanisms to internalize environmental externalities of agricultural production and reward the provision of agroenvironmental services are effective to stimulate the adoption of sustainable agricultural practices and improve natural resources management. Market mechanisms include payment/reward for environmental services (PES) is one approach that recognizes the multifunctionality of agriculture, and creates mechanisms to value and pay for the benefits of ecosystem services provided by sustainable agricultural practices such as low-input/low-emission production, conservation tillage, watershed management, agroforestry practices and carbon sequestration. Other approaches include, taxes on carbon and pesticide use to provide incentives to reach internationally or nationally agreed use-reduction targets, support for low-input/low-emission, incentives for multiple function use of agricultural land to broaden revenue options for land managers, and carbon-footprint labeling of food. Incentive and regulatory systems structured to generate stable revenue flows that contribute to long-term sustainability of service-providing landscapes will benefit small-scale farmers and local communities.

4. Decisions around small-scale farm sustainability pose difficult policy choices. Special and differential treatment is an acknowledged principle in Doha agricultural negotiations and may be warranted for small farm sectors without a history of government support. New payment mechanisms for environmental services by public and private utilities such as catchment protection and mitigation of climate change effects are of increasing importance and open new opportunities for the small-scale farm sector.

5. Opening national agricultural markets to international competition before basic national institutions and infrastructure are in place can undermine the agricultural sector, with potential long-term negative effects for poverty alleviation, food security and the environment. Some developing countries with large export sectors have achieved aggregate gains in GDP, although their small-scale farm sectors have not necessarily benefited and in many cases have lost out. The poorest developing countries are net losers under most trade liberalization scenarios. These distributional impacts call for differentiation in policy frameworks as embraced by the Doha work plan (special and differential treatment and non-reciprocal access). Trade policy reform aimed at providing a fairer global trading platform can make a positive contribution to the alleviation of poverty and hunger. Developing countries could benefit from reduced barriers and elimination of escalating tariffs for processed commodities in developed countries; deeper preferential access to developed country markets for commodities important for rural livelihoods; increased public investment in local value addition; improved access for small-scale farmers to credit; and strengthened regional markets.

6. Intensive export oriented agriculture has increased under open markets, but has been accompanied in many cases by adverse consequences such as exportation of soil nutrients, unsustainable soil or water management, or exploitative labor conditions. AKST innovations that address sustainability and development goals would be more effective with fundamental changes in price signals, for example, internalization of environmental externalities and payment/reward for environmental services.

7. Better integration of sanitary and phytosanitary standards (SPS) and policy and regulation related to food safety, plant and animal health needs to be better integrated internationally to more effectively utilize the limited national resources that are available for issues. Strong international food safety standards are important but present major regulatory costs for developing countries; lack of resources means that these countries are often only able to implement SPS standards for the purpose of trade facilitation with little benefit to domestic consumers who are affected by a wide array of food-borne illnesses. Confining Codex, OIE and

IPPC to work within their constitutional mandates may be of less relevance today given the globalization of agriculture and trade. The efficacy of working within the traditional international mandates is challenged by the emergence of alternative regulatory mechanisms that integrate food safety, animal and plant health related standards and production practices in on-farm HACCP plans. Revising SPS-related policy and regulatory measures within a biosecurity framework may be one option for promoting cross-sectoral interventions, as is increased international support for domestic application of food safety measures in developing countries.

8. IPRs may undermine research and use of ASKT to meet development and sustainability goals. Even though license agreements may promote technology transfer by clarifying roles and responsibilities in some cases, policy mechanisms are needed to protect and remunerate traditional knowledge and genetic resources used to develop industrialized products. Even though IPRs have a role in a commercial approach to innovation, in many countries it is the public sector research institutions that promote the introduction of IPRs in agriculture. This promotion may be at odds with the public tasks of contributing to poverty alleviation and household nutrition security. Reliance on IPR based revenues is likely to lead to a change in public research priorities from development to business opportunities, e.g., commercial crops like maize and oil crops at the cost of research on small grains and pulses.

9. Climate mitigation options employing the agricultural sectors are not well covered under current national and international policy instruments. A much more comprehensive agreement is needed that looks forward into the future if we want to take full advantage of the opportunities offered by agriculture and forestry sectors. Achieving this could be accomplished through, among other measures, a negotiated global long-term (30-50 years), comprehensive and equitable regulatory framework with differentiated responsibilities and intermediate targets. Within such a framework there could be a modified Clean Development Mechanism, with a comprehensive set of eligible agricultural mitigation activities, including: afforestation and reforestation; avoided deforestation, using a national sectoral approach rather than a project approach to minimize issues of leakage, thus allowing for policy interventions; and a wide range of agricultural practices including zero/reduced-till, livestock and rice paddy management. Other approaches include reducing agricultural subsidies that promote GHG emissions and mechanisms that encourage and support adaptation, particularly in vulnerable regions such as in the tropics and sub-tropics.

7.1 Natural Resources and Global Environmental Change

"*We are moving now into new, post-industrial, third-generation agriculture (TGA). The challenge for TGA is to combine the technological efficiency of second-generation agriculture with the lower environmental impacts of first-generation agriculture. …. Policy tools, many of which are now available, must be further developed and integrated. Through a combination of regulation against pollution and degradation, the creation of markets for public goods through the rural development regulation, and enabling and educating consumers to opt for goods produced to high environmental standards, the environmental benefits of agriculture could be delivered to a high level alongside outputs of food and fibre*." (Buckwell and Armstrong-Brown, 2004)

7.1.1. Resources, processes of change and international, national and local policies

The broad history of the relation between natural resources, i.e. the natural world, and agriculture has been one of a slow transition from small patches of agriculture in a surrounding matrix of natural habitat, to one of small patches of natural habitat embedded in a matrix of agricultural or otherwise human influenced land. This trend is likely to continue at the global level over the next 50 years.

There is an obvious, but in fact poorly quantified, two-way interaction between agricultural land and natural systems. This interaction has changed significantly as the global "footprint" of agriculture has expanded. Natural systems provide "services" to agriculture both as sources of environmental goods (provisioning services) and also as sinks (regulating services), whilst agriculture often acts as a driver in natural resource degradation. Natural systems provide not only environmental goods and provisioning and regulating services. In Millennium Ecosystem Assessment (MA) terms, the most critical services natural systems provide to agriculture are "supporting services," such as nutrient cycling, pollination. Over the past 50 years, agriculture has gone from being a relatively minor source of off-site environmental degradation to becoming a major contributor to natural resource depletion and degradation, acting through habitat loss and fragmentation, invasive alien species, unsustainable use (over harvesting), pollution (especially of aquatic systems) and, increasingly, climate change.

Policy responses to this trend toward natural resource degradation have occurred at international, regional and local levels. An essential component of all necessary policy reforms for mitigating agricultural impacts is to integrate environmental, natural resource, and biodiversity concerns into policy making at the highest possible level in order to achieve the necessary facilitation and leverage on lower-level policies. For example, in the European Union the revised EU Sustainable Development Strategy (EUSDS II) includes biodiversity conservation, but still lacks an overarching commitment to reduction in drivers that other sectoral policies could then address in more detail within the stronger mandate provided by EUSDS II. Further revision of the EU-SDS could provide better integration of the EU's internal and global commitments (WSSD, Doha and Monterrey) and provide better harmonization between different European sustainable development processes (Cardiff, Lisbon, Gothenburg and Johannesburg) and instruments (Extended Impact Assessment and Indicators for Sustainable Development). High level integration can also be achieved, to some extent, via Multilateral Environmental Agreements (MEAs), for example through the agreed Programme of Work for Agricultural Biodiversity of the UN Convention on Biological Diversity (CBD).

The CBD Agricultural Biodiversity work program focuses on (i) assessing the status and trends of the world's agricultural biodiversity and of their underlying causes, as well as of local knowledge of its management, (ii) identifying and promoting adaptive-management practices, technologies, policies and incentives, (iii) promoting the conservation and sustainable use of genetic resources of actual/potential value for food and agriculture, (iv) assessing the impact of new technologies, such as modern biotechnology in general and Genetic Use of Restriction Technologies (GURTs) in particular. The work program also has cross-cutting initiatives for conservation and sustainable use of pollinators and soil biodiversity, studies the impacts of trade liberalization on agricultural biodiversity, identifies policy to promote mainstreaming and integration of biodiversity into sectoral and cross-sectoral plans and programs. But the CBD is a framework, or umbrella agreement that requires its constituent Parties to adopt policies and enact legislation for effective implementation of its Decisions.

Even if its Decisions are adopted and implemented fully at the national level, there is a danger that the CBD, like many other policy instruments, will be continually "running behind the future," (e.g., the CBD 2010 Target) to significantly reduce the rate of biodiversity loss. Historically, the principal policy instrument has been the establishment of protected areas, although this has been ineffective where prime agricultural land and high biodiversity compete, as can be seen by the under-representation of lowland, fertile land in the majority of current national protected area systems (WCMC, 2006).

Broadly, natural habitats around the world can be divided into three categories, each requiring different, but overlapping or integrated sets of policies to ensure their survival in the long-term (Chomitz, 2007).The first category can be defined as wilderness: the majority of the land (or aquatic) area is natural, and anthropogenic land use has had a minor impact. With the exception of the major tropical rainforest regions of Amazonia, the Congo, Indonesia and Papua New Guinea, the majority of these areas are in temperate regions and do not harbor high levels of biodiversity, although they may provide valuable ecosystem services, especially in terms of water supply and carbon sequestration. Policies that promote establishment of protected areas in these regions are still feasible due to lack of pressure from alternative land use, but even in these areas, protected area design must consider the external threats arising from climate change (e.g., increased wild fires, and global transport of pollutants).

The second major category of land could be termed frontier: land potentially suitable for agriculture that is close to an expanding agricultural system. Effective policies for the sustainable management of natural resources in these areas are difficult to design and implement. In most countries, traditional concepts of agriculture are used to develop protection policies based on the ecosystem representation and species richness as sole criteria. However, (*sensu* Peres and Terborgh, 1995) the development of sustainable natural resource management policies in terms of local community support and resilience in the face of climate change will be critical in coming years. Also critical will be the acknowledgement that appropriate policies and institutional arrangements (e.g., providing positive incentives to farmers to adopt sustainable soil management practices in areas where soils are depleted) can ultimately result in improved natural resources quality through agricultural use (Izac, 1997).

Increasingly, improved methods of measuring and mapping total ecosystem value of natural land are allowing land-use planners and land-holders to make informed economic decisions based on a broader range of criteria than agricultural production alone (Troy and Wilson, 2006). This is allowing policy makers to introduce land-use planning “rules” (zoning) and economic incentives to better conserve natural environments in complex agricultural land-use mosaics.

At a relatively large scale, this kind of planning is increasingly emerging in the Brazilian Amazon and Atlantic rainforests, (Campos and Nepstad, 2006; Wuethrich, 2007, respectively), where government and land-holders are slowly forging agreements on establishment of a complex mosaic of protected areas, sustainable use forests and agricultural land. This represents a shift in policy away from prescriptive land use decisions made by the imposition of protected area on unwilling land-users towards the use of incentives, including payments for conservation. Auction bids for direct payments for conservation services such as native forest protection, reforestation, and restoration of riparian vegetation can further improve efficiency (Chomitz et al., 2006). Under this type of policy, eligible landowners voluntarily decide whether to apply for participation, and the resultant conservation network emerges as a consequence of many independent choices about participation. Similar incentive-based schemes may be found in the US Conservation Reserve Program (CRP), the Bush Tender program in Australia and the Costa Rica Environmental Services Payment program (see references in Chomitz et al., 2006).

In the more "crowded" landscapes of Europe and the west coast of the USA, where remaining natural land exists in an agricultural and urban matrix rather than the converse, similar trends towards land use planning based on ecosystem service valuation and "multifunctionality" are being explored (Zander et al., 2007). In California, a spatially explicit conservation planning framework to explore trade-offs and opportunities for aligning conservation goals for biodiversity with six ecosystem services (carbon storage, flood control, forage production, outdoor recreation, crop pollination, and water provision) has been used. Although there are important potential trade-offs between conservation for biodiversity and for ecosystem services, a systematic planning framework offers scope for identifying valuable synergies (Chan et al., 2006).

In Europe, agroenvironmental subsidies have been used as incentives to maintain and promote biodiversity-friendly land use on agricultural land. There has been some criticism that the schemes do not deliver all of the environmental and biodiversity benefits for which they were designed, especially as the scale of implementation becomes too small and fragmented (Whittingham, 2007). One option that avoids this situation is the adoption of regional planning approaches (e.g., the OECD environmental farm plan programs) to generate more coordinated land use patterns across larger landscapes (Manderson et al., 2007).

A recent summary (Chan et al., 2006) of the policies for sustainable development at the interface between tropical forest and agriculture shows how these can be used to promote the trends described above:

At the international level:

- Mobilize carbon finance to reduce deforestation and promote sustainable agriculture.
- Mobilize finance for conservation of globally significant biodiversity.
- Finance national and global efforts to monitor forests and evaluate the impacts of forest projects and policies – including devolution of forest control.
- Foster the development of national-level research and evaluation organizations through twinning with established foreign partners.

At the national level:

- Create systems for monitoring forest conditions and forest dwellers' welfare, make land and forest allocations and regulations more transparent, and support civil society organizations that monitor regulatory compliance by government, landholders, and forest concessionaires. The prospect of carbon finance can help motivate these efforts.
- Make forest and land use regulations more efficient, reformulating them to minimize monitoring, enforcement, and compliance costs. Economic instruments can help.

In wilderness areas:

- Avert disruptive races for property rights by equitably assigning ownership, use rights, and stewardship of these lands.
- Options for forest conservation include combinations of indigenous and community rights, protected areas, and forest concessions. Some forests may be converted to agriculture where doing so offers high, sustainable returns and does not threaten irreplaceable environmental assets.
- Plan for rational, regulated expansion of road networks—including designation of roadless areas.
- Experiment with new ways of providing services and infrastructure to low-density populations.

In frontier areas:

- Equitably assign and enforce property rights.
- Plan and control road network expansion.
- Discourage conversion in areas with hydrological hazards, or encourage community management of these watersheds.
- Use remote sensing, enhanced communication networks, and independent observers to monitor logging concessionaires and protect forest-holders against encroachers.
- Consider using carbon finance to support government and community efforts to assign and enforce property rights.
- Encourage markets for environmental services in community-owned forests.

In disputed areas:

- Where forest control is transferred to local by communities, build local institutions with upward and downward accountability.
- Where community rights are secure and markets are feasible, provide technical assistance for community forestry.
- Make landholder rights more secure in “forests without trees.”
- When forest tenure is secure, use carbon markets to promote forest regeneration and maintenance.

Mosaic lands:

- Reform regulations to reward growing trees. Promote greener agriculture—such as integrated pest management and silvo-pastoral systems—through research and development, extension efforts, community organization, and reform of agriculture and forest regulations.
- Develop a wide range of markets for environmental services—carbon, biodiversity, water regulation, recreation, pest control— to support more productive, sustainable land management.

7.1.2 Reducing the impacts of climate change and the contribution of agriculture to climate change

Agriculture can contribute to climate change in four major ways:

- Land conversion and plowing releases large amounts of stored carbon as CO_2 from original vegetation and soils,
- Carbon dioxide (CO_2) and particulate matter is emitted from fossil fuels used to power farm machinery, irrigation pumps, and from drying grain, etc., as well as fertilizer and pesticide production;
- Nitrogen fertilizer applications and related cropping practices such as manure applications and decomposition of agricultural wastes result in emissions of nitrous oxide (N_2O); and
- Methane (CH_4) is released mostly through livestock digestive processes and rice production.

The share of the agricultural sector to total global GHG emissions is approximately 58% of CH_4 and 47% of N_2O making it a significant contributor with a good deal of potential for reduction in emissions in mitigation strategies (Smith et al., 2007). With appropriate policies, each of these well-known sources of GHG can be mitigated to some extent.

Many of these mitigation options are “win-win” as long as they are supported by policy interventions that remove entry barriers and reduce transaction costs. For example, lower rates of agricultural extensification into natural habitats and the re-use/restoration of degraded land, could be encouraged through the participation of farmers in emissions trading, or biofuel production. Farmers can benefit financially depending on the amount of credits generated through carbon storage projects under the Kyoto Protocol, as is already occurring in a number of countries. Despite some transaction costs associated with quantifying and maintaining stored carbon, farmers who implement conservation agriculture; use cover crops to reduce erosion; or reforest degraded lands with tree species that have commercial value could profit financially by selling their credits in an emissions trading market. Agricultural N_2O and CH_4 mitigation opportunities include proper application of nitrogen fertilizer, effective manure management, and use of feed that increases livestock digestive efficiency. To date, there is little policy or legislation that recognizes the ability of the agricultural sector to provide GHG reductions through mitigation of N_2O and CH_4 and that provides positive incentives for farmers to adopt more sustainable practices.

Under the Kyoto Protocol Clean Development Mechanism (CDM), deliberate land management actions that enhance the uptake of carbon dioxide (CO_2) or reduce its emissions have the potential to remove a significant amount of CO_2 from the atmosphere in the short and medium term. The quantities involved may be large enough to satisfy a portion of the Kyoto Protocol commitments for some countries (but are not large enough to stabilize atmospheric concentrations without additional major reductions in fossil fuel consumption). Carbon sequestration options or sinks that include land-use changes (LUCs) can be deployed relatively rapidly at moderate cost and could play a useful bridging role while new energy technologies are being developed. A challenge remains to find a commonly agreed and scientifically sound methodological framework and equitable ways of accounting for carbon sinks. These should encourage and reward activities that increase the amount of C stored in terrestrial ecosystems but at the same time avoid rewarding inappropriate activities or inaction. Collateral issues, such as the effects of LUC on biodiversity and on the status of land degradation, should be addressed simultaneously with the issue of carbon sequestration in order to exploit potential synergies between the goals of UN CBD, CCD, and CCC conventions and the Kyoto Protocol. Such measures would also improve local food security and alleviate rural poverty (FAO, 2004b).

7.1.3. Managing the natural resource base of agriculture

7.1.3.1 Soils, nutrients and pests

Soils: Multifunctional agriculture recognizes the many ecosystem services of soil, including: (a) services that support the growth of plants, including nutrient regulation, water supply and water cycle; (b) storage of carbon in soil organic matter and hence regulation of GHGs; (c) regulation of the impact of pollutants through biological activities and absorption on soil particles; (d) habitat for a very large component of biodiversity (e.g., soil microorganisms and invertebrates); (e) biodiversity pool, such as habitats, species and genes; (e) physical and cultural environment for humans and human activities; (f) source of raw materials; (g) archive of geological and archeological heritage (Kibblewhite et al., 2007). The framework European Commission strategy for soil protection (CEC, 2006) is based on identification of risk of loss of function, and the putting place of remediation measures to mitigate threat. Many of these remediation measures could be applied to agricultural lands, but will need to be driven by a different mix of command and control, incentive based, or market-based trading policy measures appropriate to different situations. Policies based on payments per tonne C or market sales of C are likely to be more efficient than those based on a per hectare basis, but will require new methods and techniques to provide cost effective information about the relationship between carbon sequestration and land quality, use and management in addition to estimates of base line for effective enforcement and verification (Antle and Mooney, 2002). Policy measures that promote carbon sequestration in soils would most likely generate positive results for the other functions listed above (Swift et al., 2004).

Projected increases in certified organic agriculture raise additional sets of opportunities for AKST to contribute to maintaining productivity and soil nutrient levels while controlling costs and improving labor efficiencies (Ch 5). Policy options for reforming institutional environments, policies and programs to be more conducive to sustainable agricultural methods (Egelyng and Høgh-Jensen, 2006) include:

- Investing in the development of organic certification (and small-scale) compliant pest-, weed- and soil nutrient management-, particularly non-proprietary, methods, such as biocontrol using natural enemies, and non-chemical, cultural methods of pest management and similar public good types of AKST.
- Reforming tax systems to shift the conditions under which certified organic farming compete with energy intensive agricultural systems, involving a shift from taxing wages towards taxing pollution and consumption of resources. (Ch 2)
- Increasing awareness of organic certification to domestic consumers in developing countries;
- Supporting development of methods for organic certification compliant pest (and weed) and soil nutrient management, particularly non-proprietary, methods for the public good, such as biocontrol using natural enemies, non-chemical, and cultural methods of pest management.
- Supporting AKST to further energy efficiency in organic agriculture;
- Developing certified organic seeds that are better adapted to low-input farming landscapes (Ch 2).
- Investing in low external input technologies aimed at soil fertility improvement. [Ch 6]

Nutrients: Although in many countries policies for reductions of point source pollution have been successfully introduced, controlling non-point source pollution remains a more difficult challenge. Agriculture's contribution to non-point source pollution varies widely as a complex function of land use, cropping system, soil type, climate, topography, hydrology, animal density, and nutrient management techniques. Despite this complexity, research based nutrient management practices that are effective at reducing non-point source pollution are available. Wider implementation of currently recommended nutrient management plans is important for further gains in environmental quality.

Site-specific, nutrient management planning should guide the implementation of agricultural nutrient management practices that will be profitable and protective of the environment. Modern agricultural science innovations can increase not only efficiency of production, but also efficiency of nutrient use. Examples include (i) increased plant nutrient recovery and nutrient retention by animals; (ii) improved understanding and modeling of the fate and transport of nutrients in soils;

and (iii) development of mitigation and bioremediation strategies such as wetlands, riparian buffers, and filter strips to limit total nutrient exports from agricultural systems.

Adoption of efficient agricultural nutrient management practices may be limited by current market processes that do not provide for positive or negative externalities and the politics of crop and animal production. Social and political pressures to prevent nutrient overloads from agriculture are increasing, but many in the sector cannot afford the high transaction costs to introduce mitigation measures and maintain profits under current agricultural business models without subsidies. In countries where these subsidies have been introduced the key policy challenge is to improve cost effectiveness through competitive bidding; environmental cost-benefit analysis; and performance-based payments for farmers to remove environmentally sensitive land from crop production.

Pests: Invasive alien species (IAS) are a threat to global biodiversity and can have devastating effects on both agricultural and natural systems at large scales after small isolated introductions. A major policy challenge from IAS is the fact that the vast majority of current and future IAS were either poorly known species, or were unknown as pests, before their introduction to a new location. This is the main reason for the failure of past policies to deal with IAS, even those using the best available risk assessment methodologies (Keller et al., 2007).

Future IAS policies should be based on the following principles in order to mitigate this weakness.

- National IAS systems should be linked to regional and global databases of known IAS and their treatment;
- IAS control systems should be based on a “pathways of entry” approach where detection and control effort is focused on the most likely points of entry into a country (or region). Introductions of IAS occur through various channels or pathways, both intentionally and unintentionally. Primary pathways of intentional introduction of potential IAS include horticultural products, food products, and exotic pets, the use of non-native organisms in aquaculture and for restocking of marine and inland water systems for commercial and recreational fisheries; scientific research; horticulture; trade in pets and aquarium species; biocontrol agents; and ex situ breeding projects. Pathways of unintentional introductions include ballast water and ballast sediments, ship hulls, packaging materials and cargo containers, garbage and waste, international assistance programs; tourism; military activities, and unprocessed materials, such as timber.
- Risks posed by pathways of IAS prior to introduction and establishment should be addressed and mitigated both before the IAS reach the border and at the border. Preventing introductions before they occur is the most effective and cost-efficient approaching to addressing

IAS issues. Removing IAS once they have become established requires significantly more financial, technical, and personnel resources than preventing their introduction; and, often, complete removal is not even possible.

- An operating principle of the system should be that it is based on a list of approved species for deliberate introduction, and that any species not on the list must pass through a risk assessment process before being approved for entry.

A number of policy initiatives have been undertaken for specific major pathways of introduction including:

➢ *Importation of living plants and plant material.* Many attempts are being made to address plant-related pathways of invasive species. One voluntary initiative, based on the Missouri Botanic Garden St. Louis Declaration, is developing and implementing self-governed and self-regulated codes of conduct for nursery professionals, government agencies, the gardening public (specifically Garden Clubs), landscape architects, and botanic gardens/arboreta, designed to stop use and distribution of invasive plant species. Working with these respective industries, the process has generally appealed to the responsible use and import of horticultural products by the private sector to minimize the introduction of IAS. There is an urgent need for the IPPC to more effectively address, perhaps through a quarantine/sterilization-based ISPM, based the problem of "hitchhikers" on horticultural products, which are potential IAS, but may not be considered plant pests per se (e.g., spiders, ants).

➢ *FAO Code of Conduct for Responsible Fisheries.* This code includes a section encouraging the use of legal and administrative frameworks to promote responsible aquaculture, including discussions with neighboring states prior to the introduction of non-indigenous species, minimizing the impacts of nonindigenous or genetically altered fish stocks, as well as minimizing any adverse genetic or disease impacts. While the Code serves as a useful guide, it is not focused on specific prevention, management and control measures related to IAS within the field of aquaculture and fisheries.

Given the role of trade in the production and transport of goods, approaches to regulating pathways of IAS should consider relevant trade rules and agreements. The World Trade Organization's (WTO) Agreement on Sanitary and Phytosanitary Measures (SPS Agreement) defines the basic rights and obligations of WTO members regarding use of sanitary and phytosanitary measures to protect human, animal or plant life or health from the entry, establishment or spread of pests, diseases, disease carrying organisms; and prevent or limit other damage from the entry, establishment or spread of pests (see 7.3.3 for details).

7.1.3.2 Genetic resources and agrobiodiversity

Three major types of policy tools are available to support conservation of genetic resources (1) public investment in *in situ* and *ex situ* conservation; (2) stronger intellectual property rights over genetic inventions, particularly in developing countries; and (3) material transfer agreements (Rubenstein et al., 2005). Apart from ecological approaches to agriculture, connected to nature management, strategies for conservation and sustainable use of agricultural genetic resources also include "*ex situ*" and "*in situ*, on farm" approaches. *Ex situ* conservation in gene banks is well established for major crops under the auspices of the FAO by the centers of the CGIAR, and at national plant and farm animal gene banks. A Global Crop Diversity Trust has recently been initiated to generate funds for the sustainable conservation of the most important collections worldwide, on behalf of all future generations, and Norway is hosting a long-term conservation facility in the Arctic at Svalbard. Public policies converged progressively through the International Undertaking (1985) to the International Treaty on Plant Genetic Resources for Food and Agriculture (IT PGRFA - 2005) providing special rules for the conservation of PGRFA, their sustainable use and the sharing of benefits arising from their use. It also contains mechanisms for facilitated access and benefit sharing through its Multilateral System. Many signatory countries (116 in June 2007) are yet to implement the Treaty. Policy options range from contributing to the Global Crop Diversity Trust (currently mainly OECD countries, but also countries like Colombia and Brazil), to establishing or expanding national *ex situ* collections (e.g. India), and for liberal or restrictive regimes for access to these collections, including the sharing of information on these resources. The agricultural sector generally supports liberal access regimes in order to promote availability of genetic resources for plant breeding in support of food security and rural development.

On-farm policy approaches to management of genetic resources include various types of support to farmers who maintain and further develop genetic resources, such as payments based on cultural heritage (e.g. historic cattle breeds), technical support to foundations for crop-hobbyists (e.g. old apple variety clubs in Europe) to participatory plant breeding strategies in many developing countries (Almekinders and Hardon, 2006). Such mechanisms may conflict with existing policies and laws that focus on seed system development, including seed laws, plant breeder's rights, etc. The EU recently developed the concept of "conservation varieties" for this reason. National policies to bring these objectives in harmony with each other are supported by the concept of Farmers' Rights of the IT PGRFA. However, countries may make these rights 'subject to national law and as appropriate' (Art. 9 – ITPGRFA) which provides broad options for national priorities and implementation strategies. The use of a range of standard economic tools (taxes, subsidies, "cap and trade" with permits) can help maintain higher level of plant genetic diversity in seed markets recognizing that information barriers limit market efficiency (Heal et al., 2004).

Recent advances in molecular biology have provided a whole new set of tools for investigating biodiversity, including the diversity of agricultural plants and animals. While there has undoubtedly been significant loss of diversity over time of plant and animal genetic resources for agriculture at the varietal level, there is some evidence that overall losses of genetic diversity when measured at the genetic level have not been so great and that modern biotechnological breeding tools can regenerate some of this diversity, especially if the tools can be transferred to developing country agricultural research levels through support for initiatives such as African Agricultural Technology Foundation and Public Sector Intellectual Property Resource for Agriculture (PSAPRA) (USDA, 2003).

Livestock: The livestock sector is an important source of greenhouse gases and factor in the loss of biodiversity, while in developed and emerging countries it is a significant source of water pollution.[1] Current decision-making on the livestock–environment–people nexus is characterized by severe under-pricing of virtually all natural processes that go into livestock production process. This includes neglect of major down-stream externalities. Limiting livestock's impact on the environment to more socially optimal levels requires measures to reduce land and other natural resources requirements for livestock production. This could be achieved by intensification of the most productive arable and grassland used to produce feed or pasture; and retirement of marginally used land, where this is socially acceptable and where other uses of such land, such as for environmental purposes, are in demand, and have higher value. Intensification can lead to gradual reductions of resource use and waste emissions across the sector. For example, precision feeding and use of improved genetics can greatly reduce emissions of gases (carbon dioxide, methane, etc.) and of nutrients per unit of output.

The major policy goals for addressing environmental pressure points arising from current policy and market processes in the livestock sector are:

- controlling expansion into natural ecosystems;
- managing rangeland in a sustainable way;
- reducing nutrient loading in livestock concentration areas; and
- reducing the environmental impact of intensive feed production.

Because the major stressors arising from the livestock sector differ in different parts of the world – ranging from overgrazing in Australia and sub-Saharan Africa, biodiversity loss from pasture expansion in Latin America, to pollution arising from intensive pig production in Europe and SE

[1] (The following text draws heavily on a major review of the negative impact of livestock production on the environment by Steinfeld et al., 2006.)

Asia – the mix and emphasis of the policy instruments will need to be different in different parts of the world, but could include measures to:

- Limit livestock's land requirements,
- Correct distorted prices,
- Strengthen land titles,
- Price water and water quality internalizing all externalities,
- Remove subsidies,
- Liberalize trade, and
- Support intensification and promoting research and extension of cutting edge technology.

The choice of policy instruments should take into consideration the broader goals of efficiency; effectiveness and equity (Hahn et al., 2003), given the major economic contribution and social role played by the livestock sector globally.

Aquaculture: "Traditional" aquaculture has been an integral part of one of the world`s most sustainable agricultural systems – the polyculture Chinese fish-farm (FAO/IPT, 1991) for around 3000 years, but recent rapid expansion of commercial aquaculture, in the absence of appropriate policies, is generating negative environmental and social impacts that threaten to undermine the long-term sustainability of the industry. In recognition of these growing negative impacts, broad environmental management principles have been agreed for the sector (e.g. FAO Code of Conduct for Responsible Fisheries, Article 9; FAO Technical Guidelines for Responsible Fisheries No. 5. Development of Aquaculture). However, these have often not been well integrated into national policy and legislative frameworks.

A number of policy tools have been used to regulate unsustainable aquaculture expansion (e.g., banning of mangrove utilization for aquaculture practices, determining maximum production per area, standards for feed, rules for disease control, and use of drugs, to harmonize the expectations of aquaculture entrepreneurs with the exigencies of the ecosystem often have recourse to control and command strategies (e.g., licenses, use of pharmaceuticals).

Regulations focused on individual production units alone cannot guarantee sustainability at the landscape level because they do not consider the cumulative impacts of multiple farms on a particular area. In addition, existing regulatory structures for aquaculture mostly do not allow, or facilitate, a production mode or approach that is conducive to long-term sustainability. Nutrient cycling and reutilization of wastes by other forms of aquaculture (polyculture) or local fisheries are frequently prohibited or discouraged.

FAO and progressive industries are now increasingly promoting an ecosystem approach to aquaculture which will “balance diverse societal objectives, taking into account knowledge and uncertainties of biotic, abiotic and human components of ecosystems including their interactions, flows and processes and applying an integrated approach to aquaculture within ecologically and operationally meaningful boundaries” (FAO, 2006a). The purpose of an ecosystem approach should be to plan, develop and manage the sector in a manner that addresses the multiple needs and desires of societies, without jeopardizing the options for future generations to benefit from the full range of goods and services provided by aquatic ecosystems.

Policy options for improved environmental performance of the aquaculture sector could include:

- further development of guidelines for environmentally sound and sustainable aquaculture industry and promotion of compliance with the guidelines;
- promotion of the adoption of exclusion zones that protect wild stocks in areas considered to be essential to their continued survival in the wild and/ to maintain commercial wild fisheries;
- improved integration of aquaculture development with wild fish stock management, including, where appropriate, enhancement strategies for aquatic species to help wild stock fisheries recover and to provide additional recreational opportunities;
- promotion and enforcement of regulations that require Strategic Environmental Impact Assessment of potential aquaculture developments at the landscape level and develop land use plans that maintain total production within environmentally sustainable limits;
- adoption of production unit design and management practices that encourage integration, recycling and reuse of effluents, provide for disposal and/or processing of wastes;
- adoption of production unit design and management practices that minimize and, where practicable, eliminate the use of agriculture and veterinary chemicals and ensure the correct use and disposal of registered chemicals;
- support for the development and use of diets and feeding strategies which minimize adverse environmental impacts;
- promotion of improved monitoring and enforcement of management systems to reduce the risk deliberate and unintentional releases.
- development of appropriate protocols regarding the safe transfer and culture of exotic species and the translocation of live product within and between states, including living modified organisms (see Myhr and Dalmo, 2005)
- promotion of industry training and education opportunities in environmental awareness, clean production methods and best practice; and
- promotion of an information clearinghouse and information dissemination system for environmentally sound aquaculture.

7.1.3.3 Water scarcity, water quality and the distribution of water

The broad policy recommendations which can be made for improved water management in the agricultural sector have their roots in the same fundamental paradigm shift that is required for all aspects of sustainable development – full cost accounting and recognition of the multi-functionality and interdependence of landscapes. There is a need for overall reform in the water sector which must address the following: getting technical water bureaucracies to see water management as a social and political as well as a technical issue; supporting more integrated approaches to agricultural water management; creating incentives to improve equity, efficiency, and sustainability of water use; improving the effectiveness of the state itself, particularly its regulatory role; developing effective coordination and negotiation mechanisms among various water development and management sectors; and empowering marginalized groups, including women to have a voice in water management (Merrey et al., 2007).

Improve investment in sustainable irrigation. There are four principal reasons to invest in irrigation over the next three to five decades:

(1) to reduce rural poverty -- in countries and regions that rely on agriculture for a large portion of their GDP (much of SSA), increased agricultural productivity is the most viable option for poverty reduction;

(2) to keep up with food demand and changing food preferences;

(3) to adapt to changing condition -- increasing competition for water will require investments that enable farmers to grow more food with less water; increasing climate variability and extremes, due to climate change, may require further irrigation development and changes in the operation of existing schemes; and

(4) to increase multiple benefits and ecosystem services from existing systems, while reducing negative impacts (Faurės et al., 2007).

Investment has traditionally meant public expenditure on new irrigation systems (capital investment). A broader definition is needed that includes public investment in irrigation and drainage development, institutional reform, improved governance, capacity building, management improvement, creation of farmer organizations, and regulatory oversight, as well as farmers' investment in joint facilities, wells, and on-farm water storage and irrigation equipment. The appropriate focus for both policy and investment will depend on both the scale and type of irrigation, and the structure of national economies (Faurės et al., 2007)

Develop locally relevant groundwater management strategies that support aquifer recharge and manage demand. A large body of evidence from Asia suggests that groundwater irrigation promotes greater interpersonal, inter-gender, interclass, and spatial equity than do large irrigation projects. Evidence from Africa, Asia, and Latin America also suggests that groundwater is important in settings where poor farmers find opportunities to improve their livelihoods through small-scale farming based on shallow groundwater circulation. However, pumping costs are rising, and irrigation–supporting subsidies are compromising the viability of rural energy providers. India is a prime example. Moreover, the impacts of groundwater depletion on water quality, stream flows, wetlands, and down-gradient users in certain pockets are rapidly threatening to undermine the benefits. In arid regions, where fossil groundwater is a primary source of water for all uses, intensive groundwater irrigation may threaten future water security. In addition, with anticipated shifts in precipitation patterns induced by climate change, groundwater's value as strategic reserve is set to increase world wide (Shah et al., 2007). Because groundwater use and dependency will continue to grow in many parts of the developing world, participatory approaches to sustainable groundwater management will need to combine supply-side measures, such as artificial recharge, aquifer recovery, inter-basin transfer of water and the like, with demand-side measures, such as groundwater pricing, legal and regulatory control, water rights and withdrawal permits and promotion of water-saving crops and technologies (Shah et al., 2007).

Establish and strengthen the authority of agencies administrating large water systems that cross traditional administrative boundaries. The state has historically played a leading role in water development, both in supporting large-scale irrigation, hydropower, and flood control as well as facilitating private and small-scale farmer managed irrigation (Merrey et al., 2007). There are good reasons for the state's central role in regulating and managing this vital public good resource. While the state remains the main actor to initiate reforms, these reforms are needed at all jurisdictional levels, from local to national level, and even at regional level. A recent trend has been to promote river basin organizations to manage competition for water at the basin level. There is general agreement on the long-term benefits of effective integrated management of river basins, especially with increasing competition and environmental degradation. But attempts to impose particular models of river basin organizations in developing countries, especially models derived from the experiences of rich countries, are not likely to succeed because the objectives and institutional contexts differ so greatly (Shah et al., 2005). An externally imposed one-size-fits-all strategy for managing such complexity is unlikely to be effective. Numerous models for institutional arrangement for basin water governance exist, and their effectiveness will depend on local basin and national conditions (Molle et al., 2007).

Better integration of water use between agricultural and industrial users. Water use by agriculture could limit the amount available for other uses when water becomes scarce, however usually the opposite is true. Higher value uses (e.g., domestic purposes and industries in urban areas) have precedence; hence agriculture must adapt to reduced allocations. Uses with lower priority than agriculture are aquatic ecosystems and the environment (CA, 2007). Industrial and domestic use can also affect agriculture through the discharge of untreated wastewater from urban areas into surface-water systems can decrease the quality of water used in irrigation. Intersectoral water allocation is to a large extent a product of broader political and economic considerations, such as the political clout of urban areas and industrial interests (see Molle and Berkoff, 2005). Negotiating and crafting new types of organizational arrangements for managing irrigation, therefore, are not possible without considering broader institutional arrangements and policies in the water, agricultural, and rural sectors as well as currency, trade, and overall macroeconomic policies (Merrey et al., 2007).

Water markets to better allocate water amongst uses and users. Water markets are playing an increasingly important role in the developed world in allocating water on a regional basis. There are examples in which government has used markets or market-like arrangements to resolve vexing problems of allocation. Water pricing is one market vehicle that has received considerable attention. The difficulties of implementing water pricing in developing countries, however, are substantial. Pricing policies for full cost recovery of infrastructure development and operation and maintenance, for example, risk seriously aggravating water deprivation and poverty (Dinar, 2000; Molle and Berkoff, 2007). A sliding-scale pricing strategy is one possible solution (Schreiner and van Koppen, 2001). Another water market reform mechanism is tradable water rights, which represents the greatest degree of privatization in water management. In addition to clearly defined water rights (including transfer rights), water markets require physical infrastructure that allows water to be transferred, and institutional arrangements to protect against negative impact on third parties (Easter et al., 1998). Earlier enthusiasm for market- based water reforms was at best premature (Merrey et al., 2007). The conditions necessary for market based reforms to contribute to sustainable water management in agriculture are extremely rare in developing countries and uncommon even in rich countries. The Chile and Valencia (Spain) water market reforms have been held up as examples, but closer inspection raises many questions (Bauer, 1997, 2005; Ingo, 2004; Trawick, 2005). As in all market and private property rights situations, questions of regulation (who sets the rules and what are the rules?) and capture of benefits (who wins and who loses in imperfect markets?) are central for assessing market-inspired reforms. A phased approach of vesting rights in existing users and currently excluded users and of clarifying regulatory mechanisms before developing detailed water market mechanisms may be more appropriate and politically more feasible than a rush to markets (see Bruns et al., 2005).

Encourage water-saving irrigation practices and technology. Farmers in most industrialized countries have only recently begun to adopt water saving practices, whereas in developing countries they have been relying on traditional water saving practices for a long time. Low levels of adoption of water-saving may be because the knowledge and incentives are not in place for farmers to benefit directly by saving water. There is an important role for the private sector in making low-cost agricultural water management technologies such as treadle pumps, small power pumps, and bucket and drip kits more widely available. Such technologies can be readily acquired and used by individual small-scale farmers, both men and women, and in many situations can substantially improve nutrition and incomes (Shah et al., 2000; Namara et al., 2005; Mangisoni, 2006; Merrey et al., 2006). Restrictive policies in some sub-Saharan African countries are retarding the wider use of these technologies, in marked contrast to South Asian countries.

Reform of irrigation management to involve local stakeholders. The establishment of Water User Associations and contracting the management of lateral canals to individuals can improve water management by providing incentives for users and managers to conserve water and improve fee collection to increase irrigation revenues. However, pilot projects to transfer management from the state to user groups on government built schemes have rarely been scaled up effectively to cover larger areas. Many governments were reluctant, even when project documents promised to do so. Another reason was the failure to recognize the critical differences between government- and farmer- managed irrigation systems. Management transfer programs in countries as diverse as Australia, Colombia, Indonesia Mali, Mexico, New Zealand, Senegal, Sri Lanka, Turkey, and the United States have demonstrated some positive results from involving farmers and reducing government expenditures, but they have rarely shown improvements in output performance or quality of maintenance (Vermillion, 1997; Vermillion and Garcés-Restrepo, 1998; Samad and Vermillion, 1999; Vermillion et al., 2000). The few notable exceptions are middle-income developing countries such as Mexico and Turkey and high income countries such as New Zealand and the United States. Research in the 1990s on irrigation management transfer processes and outcomes produced many case studies and some useful guidelines for implementation (e.g., Vermillion and Sagardoy, 1999). There is broad agreement on the necessary conditions, but very few cases where they have been met on a large scale (Merrey et al., 2007).

Further “coping” strategies proposed for addressing water scarcity (see also Ch 6 for more details on the options), need attention at policy levels to incorporate their potential into water management agendas to optimize the use of limited water resources:

a) *Desalinization*: Currently, the costs of desalinated water remain too high for use in irrigated agriculture, with the exception of intensive horticulture for high-value cash crops, such as vegetables and flowers (mainly in greenhouses), grown in coastal areas (where safe waste disposal is easier than in inland areas), but recent advances in membrane technology are reducing costs. At the global level the volume of desalinated water produced annually (estimated at 7.5 km^3) is currently quite low, representing about 0.2% of the water withdrawn for human use (FAO, 2006b).

b) *Urban wastewater*: Two features complicate policies pertaining to wastewater use in agriculture: most wastewater is generated outside the agricultural sector, and many individuals and organizations have policy interests pertaining to wastewater use (Qadir et al., 2007). Millions of small-scale farmers in urban and peri-urban areas of developing countries use wastewater for irrigating crops or forest trees or for aquaculture, reducing pressure on other freshwater resources. Surveys across 50 cities in Asia, Africa and Latin America have shown that wastewater irrigation is currently a common reality in three-quarters of cities (IWMI, 2006). Most domestic wastewater generated in developing countries is discharged into the environment without treatment but the dominant trend is for more wastewater treatment as countries develop national integrated water resources management plans or improved environmental policies, for example in Mexico, Brazil, Chile and Costa Rica (UNCSD, 2005). Israel currently uses 84% of its treated sewage effluent in agricultural irrigation and in a few cities, such as Windhoek in Namibia, the water is treated to a very high standard so that it can even be used as drinking water (UNIDO, 2006).

c) *Virtual water and food trade*: The import of food from water-rich countries allows water-poor countries to save water they would have used to grow food (equivalent to the import of 'virtual water'), and scarce water reserves can be used for more valuable domestic, environmental and industrial purposes. Countries with limited water resources might also change their production patterns to prioritize production of agricultural commodities requiring less water and to import those requiring more water (FAO/IFAD, 2006). Whereas the strategy of importing virtual water is appealing from a water perspective, political, social and economic issues, rather than water abundance or scarcity, drive much of the current world food trade.

d) *Improving the productivity of water use in agriculture* (see Chapter 6 for detailed options). *P*roductivity gains could improve overall water use efficiency in irrigated and rainfed agriculture. Agronomic improvements to improve overall productivity will also reduce the global "water footprint" of agriculture. This could be achieved by, for example, improving the efficiency of fertilizer use; improving soil moisture retention capacity through build up of organic matter; preventing crop productivity losses due to insects, diseases and weeds; or reducing post-harvest losses due to insects, fungi and bacteria. Each of these is an area for research and technology development, or even for the reintroduction of older management systems, to promote water use efficiency gains which places a high demand on AKST (CA, 2007; Hsiao et al., 2007).

7.2 Trade and Markets

7.2.1 Trade and markets: the enabling policy context for AKST contributions to sustainability and development goals

Market and trade policies can limit or enhance the ability of agricultural and AKST systems to drive development, strengthen food security, maximize environmental sustainability, and help make the small-scale farm sector profitable to spearhead poverty reduction is an immediate challenge around the world. Over seventy percent of the world's poor are rural and most are involved in farming; about 2.5 billion people, or 40% of the world population, depend on agricultural activities for their livelihoods, an increase of a billion over the past half century (FAOSTAT, 2005). In the poorest countries agriculture is the engine of the rural economy (Diouf, 2007).The steep decline in commodity prices and terms of trade for agriculture-based economies has had significant negative effects on the millions of small-scale producers. Although there has been a recent upturn in commodity prices, in part due to an increase in demand compounded by a weak US dollar, market analysts do not anticipate that will continue (FAO, 2006c). Continuing overproduction in NAE countries contributes to these depressed world commodity prices.

Supporting the rural farm sector has been and continues to be a preferred option in NAE and other countries; it offers a compelling option for reducing poverty in developing countries (Lappe et al., 1998; CA, 2007; Diouf, 2007). Agriculture provides multiple public goods, such as the conservation of ecosystem goods and services (e.g., biodiversity and watersheds), poverty reduction and food security (Inco and Nash, 2004; McCalla and Nash, 2007). How to structure trade and market policy platforms to drive development and support the multiple functions of agriculture is a highly debated issue, discussed in a large body of literature. It is generally acknowledged that analyses, projections and related policy options derived from research on trade and market policy are controversial and susceptible to different interpretations. Some studies suggest that liberalization has been associated with reduced poverty and enhanced food security, whereas others indicate the opposite (FAO, 2006c).

The uptake of AKST by farmers does not occur in an economic vacuum. It takes place in a national market environment that is, in turn, partly determined and shaped by international trade (and its effects on national and market processes).

Policy options are determined by distinct national circumstances and different states of development (Dorward et al., 2004; FAO, 2006c; Morrisey, 2007; Morrison and Sarris, 2007).

Policy options will differ as a function of a country's stage of economic development and governance overall; the stage of development, composition and competitiveness of its agricultural sector; and its initial factor conditions and endowments.

The IAASTD mission statement leads to an assessment of policies that pay particular attention to poorer rural sectors and poorer countries. A "business as usual" policy will not enable these countries to address development and sustainability goals. Agricultural export trade can offer opportunities for the poor, but there are major distributional impacts among countries and within countries that in many cases have not been favorable for the small-scale farm sector and rural livelihoods. There is growing concern that developing countries have opened their agricultural sectors to international competition too extensively and too quickly, before basic institutions and infrastructure are in place, thus weakening their agricultural sectors with long-term negative effects for poverty, food security and the environment (Diouf, 2007; Morrison and Sarris, 2007). The poorest developing countries are net losers under most trade liberalization scenarios (FAO, 2006c).

The assertion that greater openness will benefit poor developing countries irrespective of their stage of agricultural development (and the trade policies and implementation practices of their trading partners) is increasingly questioned in the literature, and by developing countries and other relevant stakeholders (African Group, 2006). This literature indicates that the investments required to allow shifts of resources out of traditional agricultural activities into higher value alternative activities (either agricultural or non-agricultural) are not likely to occur where market failures are pervasive without some form of state intervention (Morrison and Sarris, 2007). For countries at earlier stages of development, trade reform can be damaging to food security in the short to medium term if introduced before a package of policy measures to raise productivity and maintain employment has been implemented (FAO, 2006c).

There is broad agreement across the IAASTD sub-Global reports and in the literature on the need to increase investment in human capital, land tenure (titling and expansion of land ownership by small producers and landless workers), water access, technology, infrastructure, nonagricultural rural enterprises, organizations of small scale farmers, and other forms of expansion of social capital and political participation for the poor and vulnerable (Díaz-Bonilla et al., 2002). A reinvigorated look at how these policy packages can be funded, given that developing country general revenues are often reduced when tariffs are reduced, and overseas development assistance (ODA) to the agricultural sector has been flagging. Developing countries must address significant local production, marketing and institutional constraints. There is wide agreement in the literature that a renewed donor effort is urgently needed if development and sustainability goals are to be advanced, and specifically to enable a supply response to any opportunities for the small-scale farm sector that may arise from future trade negotiations (Diaz-Bonilla et al., 2003; FAO, 2006c; Diouf, 2007).

Trade policy reform aimed at providing a fairer global trading platform can make a positive contribution to the alleviation of poverty and hunger (FAO, 2006c; Diouf, 2007; Morrison and Sarris, 2007). Approaches that are tailored to distinct national circumstances and different stages of development, and that target increasing the profitability of the small-scale farm sector, are effective options to reduce poverty in developing countries. Flexibility and differentiation in trade policy frameworks will enhance the ability of developing countries to benefit from agricultural trade; pursue food security, poverty reduction and development goals; and minimize potential dislocations associated with trade liberalization.

7.2.2 Policy challenges and tradeoffs

Whether and how ASKT systems are generated, delivered and used in ways that promote poverty reduction and environmental sustainability can be enhanced or limited by trade and market policies. The sub-Global IAASTD reports identify many policy challenges:
(i) crafting trade rules that allow developing countries needed flexibility to pursue development, poverty reduction and food security agendas, and that address the distributional impacts of welfare benefits and loses from trade liberalization;
(ii) achieving remunerative prices for small-scale farmers;
(iii) increasing the value captured by small-scale producers in vertically integrated agrifood chains;
(iv) addressing the increased regulatory responsibilities required by trade agreements with limited tax revenues, which can be diminished by tariff reductions;
(v) addressing the environmental externalities of agriculture; and
(vi) improving governance of agriculture sector policy making, including decisions about AKST research, development and delivery, and trade policy decision-making.

There are also important synergies and tradeoffs between policy options that merit special consideration. Potential liberalization of biofuels trade is a clear example, presenting tradeoffs between food security, greenhouse gas (GHG) emission reductions, and rural livelihoods which need to be carefully assessed for different technologies and regions. There are likely to be significant tradeoffs between for example policies to promote agricultural development, such as the reduction of agricultural subsidies and increased investment in roads to help rural farmers, and environmental and social impacts such as increased tropical deforestation and increased agricultural land concentration in some parts of the developing South. Forest protection policies in many of these countries may not be sufficiently strong to resist the increased economic pressure to expand the agricultural land and increase tropical deforestation. Note that these concerns also apply to other policy interventions that may work to increase agricultural rents including increased road building and other market access measures that tend to increase the pressure on forests (Angelsen and Kaimowitz, 1999).

7.2.3 Policy flexibility to pursue development, poverty reduction and food security agendas

There is broad acknowledgement that agricultural trade can offer opportunities for the poor under the right circumstances. Numerous studies show that the impact of the economic growth spurred by trade on poverty, hunger and the environment depends as much on the nature of the growth as on its scale. National agricultural trade policy to advance sustainability and development goals will depend upon the competitiveness and composition of the sector. Appropriate trade policy for the agriculture sector in developing countries will depend upon the extent to which the sector produces exportable products, import substituting basic foods, and non-tradable products (Morrison and Sarris, 2007). Advice to developing countries has tended to focus on promoting opportunities for increased exports to international markets (traditional and non-traditional crops) rather than enhancing competitiveness or market opportunities in domestic and regional markets; greater balance among these policy approaches may be indicated.

Market conditions and opportunities for domestically or regionally produced staples are potentially more favorable to poorer developing countries than are the opportunities for expanding exports to the global market (Diao and Hazell, 2004; Morrison and Sarris, 2007). For example, Africa imports 25% of basic grains such as maize, rice, and wheat. Domestic production could potentially replace some of these imports.

Appropriate agricultural trade policy at early stages of development, for countries with an important agricultural sector, may include moderate levels of import protection, and in countries where applied tariffs are already low, further liberalization may not be appropriate (Morrison and Sarris, 2007). A recent FAO study concluded that, for countries at earlier stages of development, trade liberalization can be damaging to food security in the short to medium term if introduced before a package of policy measures to raise productivity and maintain employment has been put in place (FAO, 2006c). Lower tariffs will imply intensified competition from imported foods for the domestic agricultural sector. Reduced tariffs also increase vulnerability of domestic production to competition arising from import surges. A number of instances have been reported in which a developing country’s agricultural production has been negatively affected by such sudden, short-run increases in food imports (FAO, 2006c).

For many developing countries sustainable food security depends on local food production; ensuring policy space for these countries to maintain prices for crops that are important to food security and rural livelihoods is essential (FAO, 2006c). Trade policies designed to ensure sufficient levels of domestic production of food, not just sufficient currency reserves to import food, and to balance domestic production with food stocks and foreign exchange reserves, are reported as important components of food security and sovereignty in the ESAP, LAC and SSA IAASTD sub-Global reports. Agricultural policies in industrialized countries, including export subsidies, have reduced commodity prices and thus food import costs; however this has undermined the development of the agricultural sector in developing countries, and thus agriculture's significant potential growth multiplier for the whole economy (Diaz-Bonilla et al., 2003). Reducing industrialized countries' trade distorting policies including subsidies is a priority, particularly for commodities such as sugar, groundnuts and cotton where developing countries compete. Some observers point out that net agricultural importing countries (particularly net food importers in Africa) will suffer a balance of payments loss from the negative terms of trade effect as world commodity prices rise, but at the same time stress the importance of lifting subsidies to benefit the rural sectors of these countries, where poverty is concentrated, because of higher world agricultural prices (Panagariya, 2004).

The steep secular decline in commodity prices (Fig. 7.1) and terms of trade for agriculture-based economies has had significant negative effects on the millions of small-scale producers. For example, from 1980 to 2001, the price of robusta coffee fell from 411.7 to 63.3 cents kg^{-1}; cotton fell from 261.7 to 110.3 cents kg^{-1} and rice (Thai) dropped from $521.40 to 180.20 per tonne. (Ong'wen and Wright, 2007). Even the best performing agricultural subsector (horticultural products) saw an annual 1.35% price decline over 1961-2001 (FAO, 2005a). Although the increase in the volume of exports over the past two decades has resulted in a 30% aggregate trade revenue increase for developing countries as a whole, this volume-driven increase accrued to a small number of net exporting developing countries. Export earnings of the least developed countries (LDCs) fell by 30% during that time, with countries in SSA suffering most from the fall in prices and incomes (FAO, 2005a).

[Insert Figure 7.1]

Although most aggregate agricultural production is not traded internationally, and most primary producers do not supply global commodity chains, national agricultural planning is increasingly oriented towards exports. Intergovernmental institutions are advising governments how to integrate small scale producers into these supply chains, with the goal of reducing poverty, particularly in developing countries dependent on commodity exports for the majority of their hard currency revenues (UNCTAD, 2005). This export focus has left small scale producers, the majority of the rural poor, ever more vulnerable to international market factors. For example, as a result of a supermarket price war in the United Kingdom, Costa Rican banana plantation workers wages fell from US $12-15 a day in 2000 to $7-8 in 2003 (Vorley and Fox, 2004).

The increase in absolute numbers of agriculturally dependent populations during the past two decades, together with the inability of primary producers to capture more than a small fraction of those increased trade incomes, has meant that growth in agricultural trade flows have had on aggregate a very modest effect on poverty reduction. This implies that policy options are needed to provide greater opportunities for small-scale producers to increase their profitability in such an international context. Failure to do so will result in missed opportunities to promote sustainable development.

7.2.3.1 Special products, special safeguard mechanisms and deeper preferences

There is broad agreement that the rules of the international trading system should recognize the food security and development needs and priorities of developing countries (FAO, 2006c). Flexibility and differentiation in trade policy frameworks (i.e., “special and differential treatment”) can enhance developing countries’ ability to benefit from agricultural trade; pursue food security, poverty reduction and development goals; and minimize negative impacts of trade liberalization. This includes the principle of non-reciprocal access, i.e., that the developed countries and wealthier developing countries should grant non-reciprocal access to less developed countries has a significant history and role to play in trade relations to foster development. Preferential market access for poorer developing countries, least developed countries and small island economies will be important.

At the household level depressed prices can mean inability to purchase AKST, the need to sell productive assets, or missed school fees. World Trade Organization country categories that better reflect the heterogeneity of food security conditions in developing countries’ food security could help ensure that no food insecure country is denied use of these mechanisms. These measures aim to provide tariff options to developing countries so that they may support rural livelihoods. The formula for applying safeguards under some regional and bilateral trade agreements can limit their effectiveness (see e.g., CAFTA) and may need to be revisited if safeguards are to effectively address rural livelihood issues (Priyadarshi, 2002; Stiglitz, 2006).

Flexibility and differentiation in trade policy will thus enhance developing countries’ ability to benefit from agricultural trade, and pursue food security, poverty reduction and development goals. Multilateral trade regime is currently based on the principle of "reciprocity for and among all countries" with the principle of reciprocity among equals, but differentiation between those countries in markedly different circumstances. The principle of non-reciprocal access, i.e. that the developed countries and wealthier developing countries should grant non-reciprocal access to countries less developed than themselves, has a significant history and role to play in trade relations to foster development. The European Union for example followed this approach by unilaterally opening its markets to the poorest countries of the world, and eliminating most tariffs and trade restrictions without demanding any reciprocal concessions (Stiglitz, 2006; Stiglitz and Charlton, 2007).

The WTO July Framework Agreement of 2004 acknowledges that developing countries will need to designate some products as special products based on livelihood security, food security and rural development concerns. Developing countries may require significant time periods for investments in their agriculture sectors, including targeted ASKT research, development and delivery to the small scale sector, enhanced institutional and organization capacity and governance, to make the sector competitive on the international market (Polaski, 2006).

When they signed the Agreement on Agriculture, some developing countries bound tariffs on important food security and other sensitive crops at very low levels, increasing the vulnerability of their farmers to the drop in global commodity prices. At the same time many DCs did not reserve the right to use emergency safeguard measures. The experience of the GATT round shows that following trade liberalization agricultural imports in developing countries have risen more rapidly than have exports, leading to import surges and a deterioration of net agricultural trade.

7.2.3.2 Distributional impacts of welfare benefits and loses from trade liberalization

Most of the gains from any further liberalization are likely to accrue to developed countries and the larger, wealthier developing countries (FAO, 2006c). For developing countries, the projected, or potential, welfare benefits resulting from the most likely Doha Round scenarios for the Agreement on Agriculture and non-agricultural market access outcomes are just US $6.7 billion and concentrated in just a few developing country WTO members (Anderson and Martin, 2005) (Fig. 7.2). The poorest countries including those of SSA, except South Africa, are net losers according to these estimates (Anderson et al., 2005; Jaramillo and Lederman, 2005).

[Insert Figure 7.2]

There are major differences and distinct distributional impacts between regions, among countries within a region, and between different farm sectors within any particular country (Fig. 7.3). One analysis of World Bank CGE projections (Anderson and Martin, 2005) for likely Doha outcomes calculated that the "benefit to the developing countries is more than $17 per person per year, or almost $.05 per person per day" whereas high income countries would realize more than ten times the per capita welfare benefits of developing countries (Ackerman, 2005).

[Insert Figure 7.3]

Model-based analyses that have been used to bolster the case for further trade liberalization are often overoptimistic in their assumptions as to the ability for resources to be invested in "higher return" activities (and the assumption of full employment in developing countries); the use of their results in arguing for further trade liberalization in poorer economies could be misleading (Morrison and Sarris, 2007). The models assume that markets function competitively (ignoring vertical integration within value chains that can limit competition); assume that within highly aggregated regions producers have access to similar technologies; and assume faithful implementation of commitments by all parties (Morrison and Sarris, 2007). Additionally, many CGE models are based on assumptions, such as a net zero tax revenue impact from tariff reductions, and full employment, that be difficult or impossible to realize in the real world.

"[T]here is a general consensus that the trade agreements, reforms and policies adopted throughout Latin America and the Caribbean within the last ten to fifteen years have had uneven impacts, with many of the benefits concentrated in the hands of the elite few, while the poorest often bear the brunt of the ills wrought by greater exposure to the world market. The fact is that trade liberalization has not reduced poverty nor inequity. And clearly there are winners and losers" (IADB, 2006).

7.2.3.3 Meeting new regulatory costs associated with international trade

Developing countries are facing significant new regulatory costs related to international trade, e.g., meeting international SPS standards, with fewer resources due to tariff revenues losses (which represent a significant percentage of collected tax revenues in many countries). For many countries, decreased tariff revenues means decreased funds available for social and environmental programs and agriculture sector development, as other taxes (such as consumption taxes) can be politically and administratively difficult to collect. Concern that the high costs of regulatory measures to comply with sanitary and phytosanitary standards will divert resources from national food and animal safety priorities, is an example. The fundamental practical question of how developing countries can advance sustainability and development objectives without significant increases in donor driven efforts is noted across the developing South.

Tariffs represent about a quarter of tax revenue in developing countries; other taxes are hard to collect in poor countries, particularly with large informal sectors (Panayatou, 2000; Bhagwhati, 2005). Tariff revenue reduction as a result of liberalization can represent a significant proportion of government revenues (Díaz-Bonilla et al., 2002; FAO, 2006c). This compounds the effects of structural adjustment programs, which weakened the institutional capacity of developing governments to carry out basic functions such as tax collection, enforcement of laws, and provision of basic health, sanitation and education services (Jaramillo and Lederman, 2005).

7.2.4 Policy options to address the downward pressure on prices for the small-scale sector

[Insert Figure 7.4]

7.2.4.1 Subsidies

Price stability at remunerative prices is an important factor in determining farmer's capacity to invest and innovate rather than pursue low-return, risk-averse behavior (African Group, 2006; Murphy, 2006). Reducing or eliminating agricultural subsidies and protectionism in industrialized countries, especially for those commodities in which developing countries compete (e.g. cotton, sugar and groundnuts) is an important objective of trade reform to reduce the distortionary impact in those markets (Fig. 7.4) (Díaz-Bonilla et al., 2002; Dicaprio and Gallagher, 2006; Nash and McCalla, 2007).

[Insert Figure 7.5]

For developed countries agriculture is a very small share of the economy and employment, yet subsidies and other supports are highest, unfairly tilting the benefits of agricultural trade in their favor (Watkins and Von Braun, 2002). Agricultural research, farmers' support, and investment in infrastructure have also been greatest in these countries (Pardey, 2001). The result is increased concentration of agricultural production capacity in the very few countries. This leads to a relevant question is: where subsidies are used, what would be the impact of their elimination on the redistribution of production capacity? Developing country income would be some 0.8% higher by 2015 if all merchandise trade barriers and agricultural subsidies were removed between 2005 and 2010, with about two-thirds of the total gain coming from agricultural trade and subsidy reform (Anderson et al., 2005).

In globally integrated markets, international prices affect domestic prices across the globe, even for small farmers who grow only for the domestic market (Stiglitz, 2006). Nevertheless reducing trade distorting export subsidies in industrialized countries, although widely agreed to be necessary, is also acknowledged as insufficient by itself to establish higher world prices for many commodities. For example, the reduction or lifting of export subsidies by the US and EU is critically important for some commodities such as cotton, but is unlikely to have a large positive effect on developing countries as a whole, e.g. there will be a number of countries that gain but also a number of countries that lose (Ng et al., 2007). The short-run impact of global subsidy reform will largely depend on whether a country is a net importer or exporter of the products concerned. Countries such as Argentina, for which products subject to export subsidies for some WTO members constitute a large share of exports, are likely to benefit greatly from elimination of export subsidies. Conversely, countries such as Bangladesh that export virtually no products that are subsidized in industrial countries but import a substantial share of such products (13% of imports) are unlikely to benefit in the short run from removal of export subsidies (Ng, Hoekman, and Olarreaga, 2007).

Econometric simulations suggest that removal of trade distorting subsidies would increase agricultural commodity prices only modestly; for example, even cotton, which is heavily subsidized, would increase an average of merely 4 to 13.7%, depending on policy scenario assumptions, defined baseline and other factors (Baffes, 2006). It is questionable however if such a price increase from depressed agricultural commodity prices reported by FAO (2005b) would suffice to reach the “normal” price, which, according to the WTO, is the zero degree of trade distortion.

Policy tools in addition to subsidy cuts may be needed to raise agricultural prices to remunerative levels (African Group, 2006). Proposals for a plurilateral commitment from major exporting countries not to allow trade at prices below cost of production (CoP) – dumping – and for OECD member countries to publish full CoP figures annually are options that merit further study. (Full CoP would include the primary producer’s production costs + government support costs [Producer Subsidy Estimates] + transportation and handling on a per unit basis.) Publication of full CoP figures, when compared to freight on board (FoB) export prices would enable calculation of the percentage of the price that is dumped on world markets (IATP, 2005). Further refinements of the dumping calculation methodology have been made in the context of determining the extent to which industrialized animal production receive input subsidies from below CoP feed grains (Starmer et al., 2006).

7.2.4.2 Supply management for tropical commodities

On average, prices of tropical products (taking dollar inflation into account) are only about one seventh of what they were in 1980 (UN General Assembly). Essentially, less income is earned as more commodities are produced. At the same time, retail prices of products made from coffee (roasted and instant coffee) have increased substantially over the same period. This phenomenon also applies to many other primary commodities produced by developing countries, e.g., cocoa, sugar, cotton, maize, spices. An OECD report acknowledges that “there is concern not only that oligopolistic retailing and processing structure will lead to abuse of market power, but that the lion’s share of the benefits of any future reforms in the farming sector may be captured by the processors and retailers…” (Lahidji et al., 1996) (Fig. 7.6).

[Insert Figure 7.6]

The view on supply management held by most institutions and conventional economic perspective is that supply management has been tested and is too costly and prone to problems of free-riding and quota abuse. However, it is also the case that supply management is being used in many commercial markets, given this success a new approach to supply management, that is regulated through the private sector rather than government, may be an effective and fundamental solution to a growing world problem. A variant on this policy approach is to refocus global commodity supply management on the concept of sustainable development. The option suggests that the International Commodity Agreements (ICAs) could be reformed to reduce price volatility, building on the coffee, cocoa and sugar lessons of the 1980s.

The African proposal to explore supply management mechanisms is an option to achieve the production control mechanisms common to other economic sectors (African Group, 2006). Policy options to help meet the sustainability and development objectives include a bundle of mechanisms to stabilize and increase prices. Supply management mechanisms should be investigated, market by market, to determine their potential to do this. One critical policy issues is whether the objective should be price stabilization or price increases (Lines, 2006). To address the continued slide in global commodity prices an increasing number of development groups and policy analysts are suggesting that supply management can provide a viable means of dealing with this chronic problem. In the OECD supply management is used to regulate the supply and demand of more than 50 goods on the world market.

7.2.4.3 Escalating tariffs

Current tariff structure is a disincentive for investment in the creation of value-added agroprocessing in the developing south, because developed countries use escalating tariffs. Escalating tariffs discourage development by placing higher tariffs on manufactured goods than on raw commodities and materials. Levying much higher tariffs on processed agricultural products than raw commodities makes it more difficult for developing countries to promote and gain from value-added local agroprocessing industries, which could provide much needed off-farm rural employment (Wise, 2004). Reducing or eliminating tariff escalation would greatly facilitate off-farm diversification in developing countries (Koning et al., 2004) and encourage value-added agroprocessing (Stiglitz, 2006).

The fisheries sector in many of the poorest countries face trade barriers to diversifying production and exports towards value-added processing products. These barriers include tariff escalation, stringent standards, and rules of origin requirements, among others (ITCSD, 2006). Negotiations on regulating fisheries subsidies have attracted considerable attention at the WTO, but other areas that are critical to the fisheries sector, including market access, non-tariff barriers, and measures taken under multilateral environmental agreements, have not been addressed. Many stakeholders in the debate, foremost among them the fishing communities whose livelihoods are at stake, have been marginalized in these discussions (ITCSD, 2006).

7.2.5 Options to increase market size, competition, and value capture in commodity chains to increase incomes for small-scale farm sector

7.2.5.1 Regional integration

Regional integration to create larger, regional markets with common external tariffs but no restrictions to internal trade, as a substitute for lack of a large domestic market, can help maintain more consistent demand and stable, higher prices, for locally produced commodities. Large domestic internal markets have often been found to be a pre-requisite to agriculture based growth in Asian economies, since they facilitated the shifting of the commodity from surplus to deficit areas, helping to ensure effective demand was maintained even in times of surplus and therefore assisting in stabilizing prices (Morris and Sarris, 2007).

Supporting food production encourages local and regional market integration. In many low income countries especially in Africa, emphasis on cash crop production for export has encouraged transportation networks linking rural areas direct to ports bud neglecting internal connections such as local market feeder roads that would benefit small scale farmers producing for local and regional markets. Greater emphasis on food production for local markets reduces the need for domestic farmers to contract as suppliers to multinationals and encourages greater independence. While some producers will continue to find it profitable to link into global commodity chains, regional integration can create the opportunity for small scale producers to diversity their markets with potentially significant benefits for rural livelihoods (Morrisey, 2007).

7.2.5.2 State trading enterprises for developing country export commodities

Many observers note that that in many marginalized markets the private sector has not filled the gap left by withdrawal of the state from its significant role in providing secure outlets for small-scale producers including more remote producers or producers in higher risk environments (Morrison and Sarris, 2007). The reestablishment of state trading enterprises (STEs) for developing country commodities, if designed with improved governance mechanisms to reduce rent-seeking, may provide enhanced market access for small-scale farmers in developing countries and create competition in concentrated export markets. Export state-trading enterprises can thus offer a competitive counterweight to concentrated export markets.

STEs have real costs and it is widely acknowledged that they have been marred by corruption and cronyism in some countries. Nonetheless, properly overseen and controlled by farmers' organizations, they offer important benefits, especially in developing countries where the private sector is under-capitalized (Stiglitz, 2006). Nonetheless, STEs can potentially provide a useful counterbalance to the market power of global agribusiness thereby increasing competition. STEs may be only market for producers in remote areas of developing countries, and governments can insist that STEs provide this service, whereas they cannot demand it of private corporations (Murphy, 2006).

Current WTO rules require that governments complete questionnaires about any STEs operating in their country, but no similar requirement applies to transnational agribusiness, although they may control a significant share of global trade in a particular commodity. This information generation requirement could be expanded to include any company – private or public – with, for example, more than a given percentage of the import or export market. This information could be gathered by the WTO or under the auspices of the UN Conference on Trade and Development which has a long-standing mandate to monitor restrictive business practices (Murphy, 2006).

7.2.5.3 Microfinance

Almost all small-scale agricultural systems benefit significantly from rural credit; this credit will not flow from commercial sources, so policy action is needed (Najim et al., 2007). Microfinance programs and banks present a key alternative strategy for many developing countries' agricultural market infrastructure.

Because so much of the developing South's agricultural output is generated by small-scale farmers and other microentrepreneurs, microfinance (as the set of financial services whose scale matches the needs of micro and small producers) is the mechanism by which agricultural producers are able to expand their production, buy fertilizer and other inputs and technologies, smooth seasonal fluctuations in household and enterprise income, and introduce flexibility into small-farm/microproducer investment and asset building.

Newer financial services and products, such as crop or rain insurance, are critical to reducing the risk associated with adopting new technology, transitioning to sustainable agricultural practices, and innovating production and marketing methods. Credit terms tailored to agricultural production and marketing, such as loan repayment terms that track with seasonal crop production, are vitally important to enabling agricultural producers to take advantage of economic opportunities.

7.2.5.4 Alternative trade channels: Fair Trade, certified organics, and mark of origin

As a means of developing pro-poor procurement, initiatives such as Fair Trade and environmentally linked production systems, such as organic and eco-friendly production, were introduced as alternatives to the mainstream commodity markets. While these models offer small-scale producers better terms of trade, the market share for these trading systems has been slow to grow and still only occupies a small percentage of global trade. Nevertheless, the principles were proven and a new generation of business models needs to be designed that can provide windows for the less endowed producers to enter mainstream markets through trading platforms that promote greater stability of demand (Berdegue et al., 2005).

There are now almost 600 Fair Trade producer groups across 54 Latin American, African and Asian countries selling 18 certified products (FLO, 2008). Over five million farmers, farm workers and their families currently benefit from Fair Trade with many more seeking to enter these markets (FLO, 2008). Sales of Fair Trade certified products increased 42% between 2005 and 2006 with a value of over US $2 billion in 2006 (FLO, 2007).

Fair Trade is no longer a niche market with certified products now sold by large mainstream food processing corporations (such as Proctor and Gamble and Nestle), giant retailers (such as Carrefour, Costco, and Sam’s Club), and fast food chains (such as McDonald’s and Dunkin’ Donuts) (Krier, 2005; Raynolds et al., 2007). (For a business perspective on this growth see Kroger, 2004; Roosevelt, 2004). Market research suggests that there is a very large pool of potential Fair Trade consumers. In the UK, the ethical food market is currently valued at US $3.2 billion per year (Co-operative Bank, 2003). In the US, 68 million consumers with purchases of US $230 billion per year are identified as “Lohas” (lifestyles of health and sustainability) shoppers (Cortese, 2003).

Fair Trade is increasingly envisioned in Latin America as an avenue for bolstering small-scale production in domestic markets and for South-South trade, in addition to northern markets

(Bisaillon et al., 2005). Mexico has already developed its own Fair Trade labeling organization (Comercio Justo Mexico) and certification agency (Certimex). This expanded vision of Fair Trade's future is encouraging efforts to expand Fair Trade to include basic food products, such as corn and beans.

There are a number of policy options for promoting Fair Trade as a concrete vehicle for ameliorating poverty and hunger and bolstering environmental sustainability and rural livelihoods. These policies can foster Fair Trade by strengthening the involvement of Fair Trade organizations, producers, traders, and consumers. Governments and multilateral organizations could complement existing ethical business and civil society initiatives, and thus broaden Fair Trade's benefit streams, via a suite of policy options. These include: educating consumers, producers, and businesses about Fair Trade; supporting producer cooperatives and worker organizations to ensure that they have the capacity, information, contacts, and product quality to enter Fair Trade networks; committing to source Fair Trade items; and encouraging the creation of new Fair Trade networks, for example, for basic food stuffs to promote South-South trade.

Similarly, certified organics can work as an effective policy instrument to promote broader rural development and environmental protection goals. Policy options exist to make institutional and policy environments more conducive to certified organic agriculture and less conducive to energy intense (net energy consuming) agriculture. A number of recent case studies confirm the benefits for small-scale farmers of participating in certified organic farming schemes (Eyhorn, 2007; FAO, 2007).

With organic global sales now approaching USD $40 billion, certified organic agriculture (COA) offers a challenging, but attractive rural development pathway for small-scale producers and for policy makers wishing to support the production of global public goods. Organic agriculture can help develop an alternative global market that improves agricultural performance through better access to food, relevant technologies, and environmental quality and social equity (FAO, 2007).

COA is value-added agriculture, which is accessible to small farmers who can not purchase off-farm synthetic inputs such as fertilizers and pesticides (Egelyng and Høgh-Jensen, 2006) and the knowledge intensive methods practiced in COA are particularly compatible with traditional and local knowledge capacity for innovation. COA may provide a way out of poverty for developing country farmers. Widening adoption is therefore a clear policy option; several governments now have targets for the expansion of certified or compliance assessed organic production. To this end, the FAO/IFOAM/UNCTAD International Task Force on Harmonization and Equivalence in

Organic Agriculture has generated international organic guarantee tools, adoption of which would help support further development of organic market.

Policy options generated by the FAO International Conference on Organic Agriculture and Food Security (Rome, 3-5 May 2007) include increased advocacy and training on organics, investing in organic awareness in agricultural and environmental education, building organic knowledge in university and research institutions, transitional crop insurance, providing organic training to extension officers, and supporting investments that facilitate the transition of small-scale producers to organic agriculture have been incorporated into developing countries national policies and legal frameworks (FAO, 2007).

A number of Latin American countries have also adopted policies and legal frameworks to promote organic agriculture. For example, Costa Rica adopted a national law to develop organic agriculture which sets out a series of mechanisms and incentives to support the organic sector (Asamblea Legislativa de Costa Rica, 2006). These policy tools include incentives to promote increased professional education on organic production, organic certification options for the national and international market, crop insurance for farmers transitioning to organic production, special credit lines for small and medium scale organic producers, and tax exemptions on inputs for organic production as well as on profits from the sale of organic products.

Mark of Origin or Appellation: An approach that has been widely used in France as a means of locking in added value is via protection of specific spatial areas, such as a defined geographic area know to produce a high quality brand, or an area that has traditionally developed a specific type of food processing. The classic examples of this are the wine denominations that allow buyers to purchase products based on geographic location, grape variety and year. Whereas this has proven to be very effective in areas that respect such legal definitions, the products are generally based on long-term consumer loyalty and cultural standards. As such this system is unlikely to be applied to mainstream products unless this strategy is used in combination with other standards such as air-miles and or carbon footprints.

Certification: Another approach to locking in access to higher value markets is to join a certification scheme such as those offered for organic production and rainforest production. All of these movements aim to capture a premium price for producers who can provide evidence that they are meeting and have been monitored to prove their compliance with specific ethical standards. While the area of certification is gaining appeal, the system is extremely expensive and unless charges can be passed onto consumers the ability of poor producers to comply with such regulations will be doubtful.

An Agricultural Market Analysis Unit could be established and supported in developing countries. This unit would be concerned with coordinating and developing policy on the development of market-orientated strategy in agriculture and setting policy guidelines for agricultural research. The Unit would also coordinate its activities with relevant regional bodies and work closely with the private sector and, especially, with those private-sector support groups working to stimulate production for growth markets.

Many actors in the agricultural sectors in poor developing countries are still not familiar with the idea of competitive markets. A National Market Education Programme could be established targeted, primarily at farmers, traders and agricultural product processors. Such a programme needs to be linked to the Agricultural Market Analysis Unit (see above). Market Information Services (see below) and run in conjunction with other stakeholders including Ministries of Agriculture, Education and Trade, farmers' and traders' associations and other private sector actors and with extension services.

The program needs to set targets for training farmers to understand how competitive markets work, to take advantage of market information and to inform them of the difficulties and opportunities associated with market conditions. Issues addressed need to include the stimulation of collective activity to improve economies of scale, linking supply variety and quality to market needs, negotiation of sales and inputs and the use of credit and business management. The program should have a limited duration and should be administered efficiently as a separate unit within a national agricultural development reform program.

Many small- and medium-scale farmers, traders and processors in poor developing countries have limited access to information about prices and market conditions of the commodities they produce. Farmers find themselves in a weak bargaining position with traders which results in lower-than-market farm-gate prices, high transaction costs and wastage. Market Information Services need to be established at local, national, and regional levels to collect, process, and disseminate market information in the appropriate language of intended recipients. Such services need to be fully coordinated with each other and involve full participation of stakeholders.

To assist developing countries to compete successfully in the world economy research and extension institutions need to develop or acquire new skills and expertise in market analysis and market linkage. Producers need to ensure that there are viable markets for any existing or new products. They need to ensure that the quality and packaging of those products meet the requirements of customers both on the domestic and export market. Research and extension services have a vital role to play in this effort and must be prepared to reform quickly to meet the challenges of globalization.

In many respects national research programs have succeeded in their goal to achieve food security, the current emphasis should now be to develop dynamic and commercially orientated research that supports improved market analysis, market access and added value processing. Extension services should now focus on assisting producers to trade more effectively within a liberalised market. Special attention should be given to aspects such as linkage of production to markets, access to credit and collective marketing which will enable the millions of atomised, small-scale farmers to gain from economies of scale in their input and output markets.

Government research services need to work closely with the private sector which is increasingly developing its' own research capacity, particularly in regard to higher value commodities and research related to issues and problems further up the value chain.

7.2.6 Market mechanisms to optimize environmental externalities

Agriculture generates environmental externalities (see 7.1). There are currently few market mechanisms that internalize these externalities.

The environmental impacts of agricultural trade stem at least in part from the globalization of market failures, as well as the lack of market mechanisms to internalizing the environmental externalities of production and account for the positive externalities (Boyce, 1999). Trade liberalization leading to the displacement of traditional jute production in Bangladesh by imported synthetic fibers is an example. Nearly the entire price advantage enjoyed by synthetics over jute would be eliminated if environmental externalities were factored into the price (Boyce, 1999). At the same time, traditional producers receive no compensation for the positive environmental externalities, e.g., biodiversity conservation, associated with many forms of traditional production. Similarly, U.S. corn production which requires significant energy and agrochemical inputs which cause significant environmental externalities is sold at below the cost of production in Mexico, displacing traditional corn production in the small and medium farmers who plant diverse traditional varieties (Nadal and Wise, 2004).

Trade agreements bring two distinct kinds of production into direct competition, with vastly different environmental impacts and with significant ramifications. In both cases the market price for the modern product fails to internalize or account for significant environmental externalities. At the same time, the positive environmental externalities that are present in many forms of traditional agriculture are not assessed.

7.2.6.1 Policy options for internalizing environmental externalities

Some OECD countries adopted economic measures, including environmental taxes on agricultural inputs as a part of a policy package to reduce the environmental impacts of pesticides, fertilizer and manure waste. Denmark, Norway and Sweden, for example, have introduced taxes on pesticide use, as incentives to reach pesticide use reduction targets. Similarly, the Netherlands imposed an excise manure tax. The recent reforms of the European CAP may be interpreted as a move towards rewarding farmers, not only as producers of food, but as caretakers of natural resources and environmental services. European support for organic agriculture is another important aspect of this recognition (Halberg et al., 2006).

Many critical ecosystem services are under-valued or un-valued; there are no market signals that would spur technological development of alternative supplies (Najim et al., 2007). Charges to internalize cost of transportation energy expenditure in globalized agriculture, such as "food mile" taxes are one policy approach. Food mile taxes could help internalize the social and environmental externalities of transport, including the climate impacts, pollution, and the cross-border movement of pests and livestock pathogens, among others (Jones, 2001).

Policy approaches to assist small-scale producers to articulate their carbon rating will be key, especially as an over-simplified response may be to simply ban long haul agricultural goods, and provide greater support to local food systems and season procurement policies that could end year round supply of off-season goods. In some cases though, an integrated analysis of energy costs and GHG emission from distant developing country production as compared to local northern country production will be favorable for developing country production. For example a recent analysis showed that Kenyan flower production exported long distances to the European market nonetheless generated fewer GHG emissions than hot-house flower production in the Netherlands (DFID, 2007).

7.2.6.2 Payments for agroenvironmental services

Ecosystem services remain largely un-priced by the market. These services include climate regulation, water provision, waste treatment capacity, nutrient management, watershed functions and others. Payments for environmental services (PES) reward the ecosystem services provided by sustainable agriculture practices. PES is a policy approach that recognizes the multifunctionality of agriculture and creates mechanisms to value and pay for these benefits. In principle, payments for environmental services (PES) such as watershed management, biodiversity conservation and carbon sequestration, can advance the goals of both environmental protection and poverty reduction (Alix-Garcia et al., 2005).

PES is an approach that, like economic instruments used for pollution prevention, seeks to support positive environmental externalities through the transfer of financial resources from beneficiaries of the services to those who protect or steward the environmental resources that provide the service. PES schemes often focus on environmental services provided by forest conservation, reforestation, sustainable forest extraction, and certain agroforestry and silvo-pastoral practices. Carbon sequestration services are also involved in several PES schemes, both to increase active absorption through reforestation or to avoid carbon emissions through forest conservation.

A key objective of PES schemes is to generate stable revenue flows that can help ensure long-term sustainability of the ecosystem that provides the service; and to structure the arrangement so that small farmers and communities, not just large landowners, may participate and benefit (this may involve increased transaction costs, and tends to be more effective where farmers are well organized). Examples in Latin America show that community participation and equitable rules are key; promoting rural livelihoods must be a stated objective of the PES program otherwise the lion's share of benefits will go to wealthy landowners. In one example in Costa Rica 70% of PES for carbon sequestration in one year went to a single wealthy landowner (Rosa et al., 2004).

PES revenues can be generated by user fees, taxes, subsidies, and grants by IFIs and donor organizations and NGOs. Long standing programs, including those established by New York City and Quito, Ecuador, which levy increased fees on water users to fund watershed conservation are well known. A similar, smaller programs in the Cauca Valley of Colombia works on a similar principle; farmer associations organized a PES program which levies additional water use fees to promote the adoption of conservation measures on over one million hectares and maintain dry-season water flows (Mayrand and Paquin, 2004).

PES schemes may also include measures to assist local communities with market development and revenue diversification as part of the compensation, or payment, package for the environmental service protected and provided. For example, in Brazil, rubber tappers receive payments for forest conservation services they provide through their management of forest resources. In the US, the Conservation Reserves Program provides funding to farmers to remove sensitive lands from production, prevent land degradation and preserve biodiversity.

Other projects promote the adoption of improved silvo-pastoral practices in degraded pasture areas that may provide valuable local and global environmental benefits, including biodiversity conservation; payment-for-service mechanism are being employed to encourage the adoption of silvo-pastoral practices in three countries of Central and South America: Colombia, Costa Rica, and Nicaragua. The project has created a mechanism that pays land users for the global environmental services they are generating. Another example is the Coffee and Biodiversity project supported by the GEF and the World Bank in El Salvador, which provides marketing and technical support as a proxy for direct payments, to promote biodiversity protection and habitat creation on shade-grown coffee plantations via niche marketing of “shade-grown,” song-bird friendly coffee (Pagiola and Agostini, 2002).

Supportive national policy environments are important. In 1997 Costa Rica reformed its forest law to allow land users to receive payments for specified land uses, including new plantations, sustainable logging, and forest conservation. The amended law recognizes four types of environmental services: carbon sequestration, biodiversity conservation services, hydrological services, and scenic beauty and ecotourism. The law also introduced a fuel tax to finance forest conservation and established an agency (Fonafifo) to raise funds and manage the PES scheme. Similarly, the Ecuadorian National Biodiversity Policy recommends the establishment of markets for environmental services, and the establishment of the mechanisms for water and watershed conservation, coastal protection, global climate changes services, and compensation to landowners – importantly, to both individuals and communities (Mayrand and Paquin, 2004).

Another variant of a PES scheme is the BioCarbon Fund established by the World Bank to buy certified emission reductions from land-use, land-use change, and forestry projects admissible under the Kyoto Protocol. The Fund is designed to target agricultural and forestry projects that enhance other ecosystem services, such as biodiversity and watershed protection, while improving the livelihoods of local people. Projects include conservation agriculture, such as shade-grown coffee, agroforestry to restore degraded areas, improved agricultural practices, such as shifting from subsistence farming to organic agriculture, and reforestation (Kumar, 2005).

7.2.6.2.1 Bioenergy and biofuels: subsidies and standards

Large direct and indirect subsidies, including tax credits for biofuels, have been used to build bioenergy production and markets. Fuel blending mandates and import restrictions, particularly tariffs on ethanol likewise have helped to build domestic markets (UN Energy, 2007). How the bioenergy value chain is structured is crucial for determining the development benefits of this sector. Policy options to support small and medium size enterprises in bioenergy should be considered because of studies showing the multiplier economic and development effects of local ownership in local economies (Morris, 2007; UN Energy, 2007).

7.2.6.2.2 First generation liquid biofuels: trade, subsidy and sustainability issues

When subsidies are granted to biofuels, they should be tied to objectively observable positive externalities. Biofuels policies set incentives for producers that directly affect the extent of externalities, the primary justification for granting the subsidies in the first place. In the case of current policies in most countries it is apparent that these incentives are rarely closely linked to the externalities they are allegedly supposed to provide. In fact, the majority of policies in OECD countries create incentives to maximize production of 1^{st} generation biofuels, irrespective of quality and quantity of externalities. Consequently, many biofuels are produced with intensive use of energy inputs, leading to low energy balances and GHG emission reductions while contributing to environmental problems.

Biofuels produced from agricultural feedstocks (first generation) are rarely competitive with other forms of energy and practically all producing countries support their biofuels industries through a complex set of federal and state-level policies. The most common forms of support are reductions on excise taxes that are designed to foster consumption by reducing the cost of biofuels relative to conventional fuels. On the supply side, these policies are often complemented with direct production support, e.g. payments of Euro 45 ha^{-1} for energy crops grown on non-set-aside land in the EU and subsidized credit for producers in Brazil and the U.S. In addition, biofuels also benefit indirectly from highly distorted agricultural markets in OECD countries, e.g. the U.S. maize sector, the primary ethanol feedstock in the country, received US$ 37.4 billion in subsidies between 1995-2003 (UNCTAD, 2006). In many countries, subsidies are accompanied by blending mandates, e.g. the E.U. set a voluntary 5.75% biofuels target for 2007, supported by several mandatory targets at the country level. The differential treatment of ethanol and biodiesel under international trade rules (ethanol is classified as an agricultural product, biodiesel is classified as a chemical/industrial product) has important implications on international market access and also affects how the fuels would be treated under a proposed WTO category of “environmental goods and services” (IEA, 2004; IEA, 2006; Kopolow, 2006; UNCTAD, 2006; USDA, 2006; Kojima et al., 2007).

Together, these forms of policy support generate substantial economic costs – reducing funds available for other policy goals, including energy conservation and support for other alternative energy generation technologies. Current levels of subsidies are considerable. For example, total annual subsidies to liquid biofuels in the US are estimated at US$5.1-6.8 billion, corresponding to US$0.38-0.49 and US$0.45-0.57 per liter of petroleum equivalent ethanol and biodiesel, respectively (Kopolow, 2006). Moreover, taxes on fuels represent a significant source of government income in many countries and reductions are often difficult to compensate. While blending mandates are attractive to policy makers because they do not directly affect government budgets, they too create considerable economic costs. In addition, blending mandates create inefficiencies by guaranteeing a market for biofuels producers irrespective of costs and limiting competition. This reduces incentives to develop more efficient and cheaper production – an effect that is reinforced by trade barriers.

Against these costs stand potential benefits in terms of rural development, climate change mitigation and energy security as well as possible negative effects on the environment and food prices. Consequently, decision makers need to carefully assess whether the full social costs of bioenergy and associated promotion policies are worth achievable benefits.

Policy options to reduce the social and environmental externalities of 1st generation biofuels production such as sustainability standards are widely noted in the literature, but developing effective standards that balance environmental and social interests with access to export markets for developing countries is a significant challenge. Given the potentially adverse social and environmental effects of large-scale increases in biofuels production (see Ch 4.3 and 6.2.5), the development of sustainability standards is being discussed in different private and government supported forums.

In the absence of universal regulations and enforcement, standards are viewed as key to limiting negative effects and improving benefits for small-scale farmers (O'Connell et al., 2005; Reijnders, 2006; WWF, 2006). In addition to disagreements on the definition of these standards, with large differences of opinion between industrialized and developing countries, uncertainty persists on how effective such standards can actually be. Given that biofuels are fungible export commodities, their effectiveness would depend on the participation of all major consumers and producers. Moreover, qualifying for standards and obtaining certification can be a considerable financial and institutional burden for poor producing countries. It is therefore essential that developing countries are included and supported in the process of the development of sustainability standards to ensure that environmental and social considerations are balanced with the broader needs of developing countries, including considerations about the needs of small-scale farmers, farmer cooperatives and access to the markets of industrialized countries.

Liberalization of biofuels trade would shift production to developing countries. There is significant question as to whether this would benefit small-scale farmers and in the absence of effective safeguards the resulting expansion of production in these countries could magnify social and environmental costs. Growing crops for biofuels could worsen water shortages; biofuel crop production in addition to food crops will add another new stress on water use and availability (de Fraiture et al., 2007b).

7.2.6.2.3 Second generation biofuels

The U.S. Department of Energy calculates that if all corn now grown in the US were converted to ethanol, it would satisfy only about 15% of the country's current transportation needs (DOE, 2006); others put that figure as low as 6% (ETC, 2007). A second approach is to produce ethanol from cellulose, which has the potential to obtain at least twice as much fuel from the same area of land as corn ethanol, because much more biomass is available per unit of land. Thus promoting research and development for second generation biofuels is an often noted policy option. Synthetic biology approaches to break down cellulose and lignin, crucial for second generation "cellolosic" biofuels production, are still years off but may be promising. Importantly, efforts are also needed to allow developing countries and small-scale farmers to profit from the resulting technologies (Diouf, 2007). While some countries have recently increased their support for research and development on 2nd generation biofuels, more public efforts international efforts are needed to focus on developing means by which 2nd generation biofuels may benefit small-scale farmers and developing countries. This includes tackling the high capital intensity of technologies, facilitating farmer cooperatives and dealing with intellectual property rights issues.

If any of the synthetic biology approaches are successful, the agricultural landscape could quickly be transformed as farmers plant more switchgrass or miscanthus as feedstock crops– not only in North America, but also across the global South. By removing biomass that might previously have been returned to the soil, fertility and soil structure would also be compromised. As presently envisioned, large-scale, export-oriented biofuel production in the global South could have significant negative impacts on soil, water, biodiversity, land tenure and the livelihoods of farmers and indigenous peoples (de Fraiture et al., 2007a).

7.2.6.2.4 Bioelectricity and bioheat

There is considerable potential for bioelectricity and bioheat to contribute to economic and social development (see Chapters 3 and 6) and a number of clear policy options to promote a better exploitation of this potential (Stassen, 1995; Bhattacharya, 2002; Kishore et al., 2004; Kartha et al., 2005; Ghosh et al., 2006). Promotion of R&D, development of technical standards as well as better access to information and finance are needed to better exploit the potential of bioelectricity and bioheat in developing countries.

Promoting research and development to improve the operational stability and reducing capital costs promises to improve the attractiveness of bioenergy, especially of small and medium-scale biogas digesters and thermo-chemical gasifiers, is important for the developing South. The development of product standards and dissemination of knowledge is also key. A long history of policy failures and a wide variety of locally produced generators with large differences in performance have led to considerable skepticism about bioenergy in many countries. The development of product standards as well as better knowledge dissemination can contribute to increase market transparency and improve consumer confidence.

Experience of various bioenergy promotion programs has shown that proper operation and maintenance are key to success and sustainability of low-cost and small-scale applications. Therefore, building local capacity, ensuring that local consumers are closely engaged in the development as well as the monitoring and maintenance of facilities, and increased access to finance for bioenergy are necessary. Compared to other off-grid energy solutions, bioenergy often exhibits higher initial capital costs but lower long-term feedstock costs. This cost structure often forces poor households and communities to forego investments in modern bioenergy, even when payback periods are very short. Improved access to finance can help to reduce these problems.

7.2.7 Enhancing governance of trade and technologies

Agricultural policymaking and AKST investment are affected by global governance issues that may apply in a number of economic sectors, including agriculture. This section addresses a suite of governance issues in trade and environmental decision-making, including the democratization of global trade regimes, as well as international competition policy to govern corporate power over commodity markets and promote more equitable distribution of agricultural rents that could help drive development and improve rural livelihoods. The section also reviews policy options for international instruments (agreements and intuitions) to assess the impact of proposed trade agreements and emerging technologies against the development and sustainability goals; these processes, including strategic impact assessments of proposed trade agreements and comparative technology assessments, could help educate policy makers and stakeholders, increase transparency, and assist in making decisions that would support development goals.

7.2.7.1 Governance of trade and environmental decision-making

If trade negotiation processes were made more transparent, social and environmental concerns would likely be better represented in the resulting agreements. The principles of good governance, such as representation, transparency, accountability, access to information and systematic conflict resolution should be fully internalized and implemented by international trade and environmental institutions (Stiglitz, 2006). Developing countries, which often lack personnel and institutional capacity to deal with the complexity of trade negotiations are at a distinct disadvantage negotiating for the interests of their rural sectors in these fora, and often lack resources to analyze important and highly complex issues, to develop negotiating positions and to respond quickly and effectively to their various negotiating teams. Civil society participation is limited from negotiations through dispute resolution process, much of which takes place behind closed doors.

Policies to strengthen developing country negotiating capacity in trade talks are important. Trade capacity development, as a part of “aid for trade” packages, are one option. Consideration may also be given to establishing national and regional teams of experts with the necessary authority to analyze the interests of their stakeholder groups and to establish appropriate negotiating positions.

Another option is to develop CSO consultative committees to support negotiators, giving farmer organizations, business and NGOs the opportunity to provide valuable input and support negotiators. A number of countries, for example Kenya, the Philippines and India, have created national consultative committees to the WTO (Murphy, 2006).

Without effective global environmental governance, nation-states, subject to the pressures of globalization, may drift towards a low-level environmental policy convergence that is insensitive to local ecological conditions and does not respect the diversity of preferences and priorities across and within nations (Zarsky, 1999). The creation of a United Nations Environmental Organization, perhaps modeled on the World Health Organization, has been proposed as one policy approach to address this significant global governance deficit and promote technologies and behaviors that respect ecosystems more effectively (Esty, 1994; Friends of the UNEO, 2007).

7.2.7.2 International competition policy and anti-trust: governing commodity markets to promote development goals

Vertical and horizontal concentration in global commodity markets is a primary cause of market distortion. Possible policy responses include an international review mechanism for proposed mergers and acquisitions among agribusiness companies that operate in a number of countries simultaneously (Stiglitz, 2006), the establishment of international competition policy, and the re-establishment of state trading enterprises.

One of the major anti-competitive effects of globalization has been a rapid concentration of market power away from producers into the hands of a limited number of trade and retail companies (Vorley et al., 2007). What looks like buying and trading between countries is often the redistribution of capital among subsidiaries of the same parent multinational corporation (Shand, 2005). As a result, the negotiating power within agricultural chains, over the past 20 years has moved rapidly away from the producer end of the market chain. The first level of consolidation was made at the wholesale level through a series of mergers, acquisitions and take-overs that reduced the number of international traders from hundreds of family based enterprises to a handful of international trade houses that dominate particular commodities, such as Archer Daniel Midland, Unilever and Cargill.

This situation means that even when farmers organize and aggregate, produce quality goods, and sell collectively, they have insufficient volumes of sale to negotiate effectively with four to five giant corporations. There is increasing concern that lack of competition in the marketplace is having seriously negative social effects on agricultural producers; the most vulnerable are the poorly organized, resource poor farmers in developing nations (Fig. 7.7).

[Insert Figure 7.7]

One approach to address this imbalance in trade relationships is the establishment of international competition policy in the form of multilateral rules on restrictive business practices. A potential model for this approach is the French law (*Loi Galland*) that prohibits selling at a loss and "excessively low prices."

Another policy option that is widely noted is the reintroduction of price bands as a means of cushioning the impact of world price instability. For example Chile's Free Trade Agreements with EU and Canada allowed it to keep its agricultural price band which was designed to stabilize import costs of agricultural staples (including wheat, sugar, oil) through adjustment to tariffs on such with the objective of allowing a fair rate of return to Chilean farmers even if they were competing with heavily subsidized US farmers. In contrast the US-Chile Free Trade Agreement committed Chile to phase out its agricultural price band system. An international competition policy framework might also include creation of an independent UN agency to address some of the issues that UN Center for Transnational Corporations used to address.

7.2.7.3 Strategic impact assessment and comparative technology assessment

There is often a dearth of information on the potential social and economic benefits and risks of proposed trade agreements and emerging technologies alike. Policy tools to allow developing countries to better analyze benefits, risks and tradeoffs of proposed trade agreements and the introduction of new technologies are needed. Policy approaches to redress this issue include Strategic Impact Assessment (SIA) of trade agreements and Comparative Technology Assessment for emerging technologies. Additionally, increased research and more sensitive trade policy stimulations tailored to countries at different stages of development with different characteristics to their agricultural sectors may be helpful to inform policy choices to address development and sustainability goals (Morrison and Sarris, 2007).

SIAs have provided early warnings as well as research evidence that failing to mitigate negative environmental effects can substantially reduce net economic and welfare gains from trade. In this way, these assessments can provide critical information to governments and stakeholders allowing them to consider whether or not to reject or mitigate a trade policy proposal that is likely to worsen poverty, inequity or environmental degradation in certain sectors.

Strategic impact assessment of trade agreements that have been undertaken for regional agreements, such as NAFTA and multiple EU trade agreements, aim to give negotiators a fuller understanding of potential environmental impacts in their own countries, such that they may be taken into account alongside the economic and social considerations on which trade negotiations have traditionally been based. The fuller information on environmental issues enables negotiators to make more reliable tradeoffs, in those cases where the effects do not provide win-win outcomes for national and international economic, social and environmental concerns.

The European Commission for example has defined the goal of SIA as generating information to integrate sustainability into European trade policy by assessing a proposed trade agreement's potential impacts on sustainable development. SIAs, which are public documents, inform negotiators and interested stakeholders of the possible social, environmental, and economic consequences of a trade agreement; provide analysis that will help maximize benefits of the agreement through better management of environmental, social and economic resources; and inform the design of policy options, including capacity building and international regulation, that may maximize the benefits and reduce the negative impacts of the proposed trade agreement (George and Kirkpatrick, 2003).

Another noted policy option to increase information and transparency is the establishment of an intergovernmental framework for the comparative assessment of new technologies as they evolve from initial scientific discovery through to possible commercialization. For example, observers have noted that rapid developments in nanotechnologies and nano-material production may out-compete developing countries' primary commodities in international markets in the near and mid-term (ETC Group, 2005). All stakeholders, perhaps especially including developing country governments that are negotiating market access for their agricultural commodities and raw materials in various multilateral, regional and bilateral agreements, could be provided with information on how future technology development may affect them and the markets that are essential for their economies.

The potential benefits and risks of nanotechnologies present an example of the benefits for the realization of development and sustainability goals that a technology assessment agreement or agency might afford. There has been considerable reporting and analysis of the potential benefits of nano-scale technologies for developing countries, particularly with regard to water and energy. The potential health and environmental risks of this new technology platform, as well as nanotechnology's potential impacts on commodity markets and the social and economic disruption that may cause, are less well studied. Nanotechnologies are still very new; nonetheless if a new engineered nano-material outperforms a conventional material, including for example cotton textiles, copper or rubber, that are key commodities for developing country economies, significant economic dislocation may result (ETC Group, 2005).

Emerging technologies, including nano-scale technologies, require scientific, socioeconomic and societal evaluation in order for governments to make informed decisions about heir risks and benefits. Rather than approaching technology assessment in a piecemeal, technology-by-technology fashion, governments and the international community could consider longer term strategies to address technology introduction on an ongoing basis. One option for the international community is to consider an independent body that is dedicated to assessing major new technologies and providing an early warning and early listening system. Comparative technology assessment could help policy makers and stakeholders monitor and assess the introduction of new technologies and their potential socioeconomic, health and environmental impacts.

One policy approach might be to reinvigorate the capacity of the UN System to Conduct Technology Assessment for Development. The UN Commission on Science and Technology for Development has become a subsidiary body of the Economic and Social Council, where it operates with greatly reduced staff and funding. This commission could be strengthened, or another specialized UN agency could be given the mandate to both conduct technology assessments and build capacity in developing countries to assess technologies, with the goals of promoting poverty reduction, health and environmental protection, and sustainable development (ETC Group, 2005).

Another policy option could be the establishment of a legally-binding multilateral agreement on comparative technology assessment, potentially negotiated through a specialized agency such as UNCTAD, the ILO, or ECOSOC's Commission on Sustainable Development. The objective of such a convention would be to provide an early warning and assessment framework capable of monitoring and assessing emerging technologies in transparent processes and their potential benefits as well as costs and risks for human health, the environment, and poverty reduction and development. At the same time, such an agreement might help to generate information that would help educate citizens and stakeholder groups, via participatory and transparent processes, support broader societal understanding of emerging technologies, encourage scientific innovation, and facilitate equitable benefit and risk-sharing. Alternatively, a specialized Technology Assessment Agency could be created, within the UN system to conduct comparative technology assessments of new and emerging technologies.

7.3 Food Safety, Animal and Plant Health

The management of food safety, animal and plant health issues along the farm to fork continuum requires a level of coordination and integration that often is not provided by the current international policy and regulatory framework for agriculture. Instead, these three issues are largely addressed in terms of international standards elaboration through parallel programs developed by the Codex Alimentarius Commission, World Animal Health Organization (OIE) and the International Plant Protection Convention (IPPC) for food safety, animal health and plant health respectively. These standards and related sanitary and phytosanitary (SPS) measures are implemented and enforced to a greater or lesser degree through an array of often uncoordinated national initiatives variously managed by ministries such as agriculture, health, environment, forestry, fisheries, trade, commerce and international affairs. Related to this lack of coordination, or perhaps because of it, alternative regulatory mechanisms such as third party standard and certification systems mandated by private sector retailers, in response to increased consumer demand for improved food safety and food quality, have been implemented. Much of the cost burden for meeting these private regulatory requirements is borne by primary producers.

The increasing internationally traded volume and variety of food, food ingredients, feed, animals and plants poses many challenges for private quality assurance programs and government SPS programs. SPS system failures affect both exporting and importing countries. For example, recent U.S. imports of contaminated pet food from China resulted not only in the deaths and illnesses of an unknown number of pets and the closing of 180 processing plants in China, but a U.S. Congressional proposal for reorganization of US food import inspection. Yet proposals to equip SPS authorities and private establishments with adequate personnel and technology to enforce standards sometimes encounter not only bureaucratic resistance and/or opposition from industry segments of the supply chain, but broader resistance based on credible threats of trade retaliation in non-food and agriculture sectors (Barboza, 2007; Clayton, 2007; Weiss 2007). Whether or not food and agriculture trade expands to the extent projected by FAO for 2030 (FAO, 2006c), the cost-benefit framed tension between measures to protect human, animal and plant health and broader trade pressures is likely to remain.

7.3.1. Food safety

7.3.1.1 Surveillance challenges

The lack of reliable data or data that are comparable between countries on the prevalence and severity of foodborne disease, despite several WHO initiatives to develop global and regional surveillance and outbreak reporting systems, continues to impede the development of evidence-based food safety interventions in many WHO member countries (WHO, 2002a, 2004). For example, the EU has undertaken a fully harmonized baseline surveillance study for *Salmonella* in poultry production which is the basis of targeted interventions to manage the prevalence of this foodborne pathogen (EFSA, 2006a).

Epidemiological uncertainty about the origin, prevalence and severity of much foodborne illness makes it difficult to target resources and do comprehensive and pro-active food safety control planning. More than 200 known diseases are transmitted by food, however under-reporting, illnesses caused by unknown pathogens and other factors, such as water sanitation, obscure the origin of foodborne illness. The confluence of these factors impedes estimates to characterize the burden of existing foodborne illness, much less the evolution of future pathogens.

Pathogens featured in today's headlines, such as *Listeria monocytogenes* or *E. coli* O157:H7, were not identified as major causes of foodborne illness 20 years ago (Mead et al., 1999). However, for most foodborne infections effective preventive interventions can be taken despite a lack of exact epidemiological knowledge. Furthermore, the majority of foodborne infections in most countries are caused by a few pathogens e.g., in the EU, *Salmonella* and *Campylobacter* accounted for about 96% of reported zoonoses cases in 2005 (EFSA, 2006a). In developing countries, actions such as water sanitation and heat treatment of food in combination with measures for basic sanitary and hygienic routines would have significant health benefits, even without immediate support of detailed surveillance data. Diarrhea is the leading causes of illness and death in less developed countries, killing an estimated 1.9 million people annually worldwide and almost all deaths are caused by food or waterborne microbial pathogens (Schlundt et al., 2004). This incidence of morbidity and mortality is consequent to the fact that globally > 1 billon people, and in sub-Saharan Africa > 40%, lack access to clean drinkable water and 2.4 billion do not have basic sanitation (CA, 2007). In practice, this means that these people have to drink water with fecal contamination from humans and animals and their intestinally excreted pathogens.

For countries with weak surveillance and outbreak detection systems, estimating the burden of foodborne illness is even a more daunting challenge, despite the assistance provided by WHO's Global Salm-Serv, Global Outbreak and Response Network (GOARN), International Food Safety

Authorities Network (INFOSAN) and the FAO/OIE/WHO Global Early Warning System and Response for zoonotic disease surveillance (Flint et al., 2005). Further complicating the future of foodborne disease surveillance is the likelihood that as a result of climate change, new pathogens will emerge, particularly in fish and shellfish raised in water whose quality is degraded or contaminated (Rose et al., 2001).

The timeliness and efficacy of preventative or prophylactic food safety interventions depend on accurate, comprehensive and timely surveillance information. The factors of uncertainty in calculating the burden of foodborne illness are compounded by weak national surveillance systems upon which the international systems depend. Many governments, particularly in least developed countries, are unable to finance the development of such surveillance systems as part of national health system planning.

Since welfare benefits from agricultural trade are expected to increase for only a few developing countries as a result of the WTO Doha Round of negotiations (Bouet et al., 2004; Anderson and Martin, 2005; Polaski, 2006), it is unlikely that non-benefiting countries will be able to pay the costs of foodborne disease surveillance systems and SPS interventions from trade revenues. Therefore, in what follows we assume that some form of public finance and donor assistance will be required for capacity building in surveillance and other food safety activities. Furthermore, public finance may be involved in helping to insure against global foodborne illnesses risks that are not and perhaps cannot be insured by private firms.

7.3.1.2 Financing a public good

The globalization of the food and feed trade enables a broader and more rapid transmission of foodborne illness, particularly from high-risk microbial pathogens of animal origin (OIE, 2006). Development of surveillance data often becomes a priority only if a food contamination incident or zoonosis threatens trade, e.g., BSE and avian influenza. Such threats to trade usually focus only on emerging diseases and less on those that are prevalent and perennially cause major problems. Yet the costs of foodborne illness far exceed those that can be recovered from inspection fees or other forms of trade related SPS financing, even when the origin of an illness can be traced back to a specific source. Whereas the costs of food safety measures can be internalized to some extent in the cost of a product, there is no adequate mechanism for financing the public health costs resulting from transborder foodborne illness. FAO and WHO recognize that "[f]ood safety is an essential public health issue for all countries," but the normative framework and technical assistance planning for food safety in developing countries is largely a function of trade policy, or more broadly of the economics of private markets. Donor interest in and exporting country demand for SPS related assistance tends to be triggered by the threat of trade disruption or to ensure that food imports are safe (World Bank, 2005).

Although food safety is characterized as a global public good, economic analysis of food safety interventions often is framed largely in cost/benefit terms of market failures, in this case, the failure to internalize such negative cross border externalities as foodborne illness. Attempts to mitigate these externalities on an *ad hoc* emergency basis "is a costly and unsustainable form of assistance" (World Bank, 2005). The role of public food safety management is defined in terms of serving the market, without, however, an adequate financing mechanism designed to enable the development of food safety as a public good and taking into consideration the full and considerable cost for foodborne infection *e.g.* loss of labor time and cost for medical care. New proposed public finance mechanism (*e.g.* Kaul and Conceição, 2006) could be adapted to the provision of food safety, both on a global and regional basis, as a global public good. A World Bank study has argued cogently for a more proactive and preventative supply and demand approach to providing capacity building for food safety to facilitate trade (World Bank, 2005) but such capacity building need not be limited to trade facilitation.

7.3.1.3 Implementing food safety standards for domestic public health benefits

In theory, trade related food safety standards and control measures may also be applied readily to domestic food safety programs. In practice, according to developing country official respondents to survey input into the FAO/WHO Food Standards Programme Evaluation, developing countries adopt few international food standards into domestic legislation because they lack the resources and technical capacity to implement and enforce the standards (CAC, 2002).

The unmet challenge remains, how to apply food safety measures not only for internationally traded products but for the great share of global food production that is not traded internationally. Of particular concern is the implementation of standards and other guidance to prevent foodborne illness resulting from new foodborne pathogens in domestically produced and consumed foods or from existing pathogens whose prevalence or severity has increased. The challenge of applying standards domestically for public health benefits is even greater in countries where food safety control systems are not integrated into the public health system but are instead largely confined to export establishments and import inspection. Policy options, outlined below, to meet this challenge should take into account capacity building challenges.

Despite the proliferation of international public and private standards, compliance with which is required for market entry, there are relatively few public studies of sanitary/phytosanitary (SPS) compliance costs for developing country agricultural exports (Pay, 2005). These few quantified studies indicate that existing levels and kinds of trade related technical assistance are far from providing the necessary facilities, such as accredited laboratories for measuring pesticide residue levels, to enable SPS standards implementation and enforcement (*e.g.*, Larcher Carvalho, 2005). However, in some developing countries, qualitative needs assessments should suffice to demonstrate the desirability of donor financing of basic SPS infrastructure and training. Notwithstanding the technical capacity shortfall to implement the SPS requirements of trade agreements, the view that “aid for trade” should be a binding, scheduled and enforceable part of trade negotiations for least developed countries (WTO, 2004; Stiglitz and Charlton, 2006) has not received support from developed country WTO members. While “best endeavor” capacity building can be helpful, the trade-off in depending largely on private sector SPS infrastructure investment is that WTO members not integrated into transnational corporate food supply chains likely will be unable to ensure that their agricultural exports meet SPS requirements.

In the absence of adequate funding, proliferation of unfunded negotiating mandates may result in attempts to avoid SPS rule compliance. Furthermore, domestic adoption of international standards will not be enhanced by a simple increase in current capacity building initiatives, since there is a considerable disjuncture between the sanitary-phytosanitary technical assistance requested by developing countries, particularly for SPS infrastructure, the assistance provided by donors that is often limited to training to understand SPS rules (CAC, 2002).

7.3.2 Animal health

Internationally, policies aimed at managing infectious animal diseases, including emerging or re-emerging human diseases caused by animal-borne pathogens (Taylor et al., 2001), have been directed to improving preparedness. Methods of controlling and responding to zoonoses have been proposed, through developing and strengthening surveillance systems and identifying risks, including the economic, sociological and political implications and the need for intersectoral collaboration (e.g., WHO, 2004). It is particularly challenging for developing countries to try to meet internationally defined or driven regulations and policies for the animal health sector as these are continuously shifting in response to the increasing needs and ambitions of developed countries. This is assessed below in relation to the major groups of infectious animal diseases and the current principles for their control and regulatory support (Fig. 7.8).

[Insert Figure 7.8]

7.3.2.1 Major epizootic diseases and impact on trade and developing countries

The effectiveness of current policies (eradication and SPS standards for maintaining disease free status) successfully applied in developed countries to prevent outbreaks of the major epizootic diseases (Leforban and Gerbier, 2002; DG SANCO, 2007) means that many developing countries will continue to be excluded from accessing the high-value international markets. This is generally because the conflict between free trade and the protection of health status and, more specifically, because eradication of important epizoootic diseases, a core principle of the OIE who determine the animal health standards within the SPS Agreement, is not considered achievable in developing countries in the next decades because it requires significant efforts and investments in surveillance and veterinary service to meet eradication and control policies (Scoones and Wolmer, 2006). The magnitude of the challenges involved is demonstrated by the fact that an estimated 200 million poultry producers in Asia are on small holdings (e.g. 97% in Thailand and 75% in Cambodia (FAO, 2004a; Gilbert et al., 2006).

International debate on this dilemma has focused on an increased implementation in developing countries of other policies such as using a risk- and commodity-based approach that allows an alternative to the total restriction in trade of animals and animal products (Brückner, 2004; Thomson et al., 2004; Perry et al., 2005; Thomson et al., 2006). The concept is that different commodities pose very different risks for the spread of pathogens. For example, deboned meat has a reduced risk in relation to whole carcasses and is applied by certain countries to facilitate import from certain foot and mouth disease infected countries (Sabirovic et al., 2005). Similarly, policies that limit import restrictions to certain export producing areas (regions) instead of restrictions on whole countries or continents are also recommended. Such regionalization is considered as a useful additional tool in maintaining trade flow by limiting import restrictions in the case of new outbreaks of animal diseases, and also allowing import from individual countries or regions based on their improvement of the animal health status food products (DG SANCO, 2006). However, these policies require a reliable and independent system of certification based on international standards (Thomson et al., 2006).

Instead of focusing on achieving high value exports from African countries to Europe and the U.S, bilateral agreements between developing countries that protect exporting countries and producers could be promoted (Scoones and Wolmer, 2006). A third alternative *e.g.* for African countries, is to initially focus on local trade and markets to supply the growing local and regional demand for meat (Kulibaba, 1997; Diao et al., 2005; Scoones and Wolmer, 2006). These alternative policies for developing countries emphasize benefits to their producers by using food safety and animal health standards needed for the local and regional market.

In addition to the introduction of advanced and new methods for improved and more cost effective disease and outbreak control (*e.g.*, DIVA vaccines), the recent pandemic of highly pathogenic avian influenza virus demonstrated the importance of providing international support to developing countries when coordinated interventions are required to manage international emergencies, and also that sustained improvements in national disease control systems are required so that countries view such activities as investments rather than internationally imposed costs (Lokuge and Lokuge, 2005).

7.3.2.2 Zoonoses as foodborne infections - policies for integrated approach

The BSE crisis, the avian influenza pandemic and the threat of global warming with vectors and diseases moving into new areas has highlighted the importance of the animal- human link via the food chain and the need for capacity building for surveillance and control of zoonotic diseases (FAO, 2006d). In addition to these and other emerging zoonotic diseases, as highlighted above, there is also a basic need for effective policies for the prevention of the majority of the foodborne outbreaks that in most part of the world are caused by agents like *Salmonella* and *Campylobacter*.

In the US it is estimated that *Campylobacter* causes 2 million cases of foodborne infections annually and *Salmonella* is estimated to cause another 1.4 million infections, the latter at a total estimated annual cost of US$ 3 billion annually (Mead et al., 1999; USDA, 2007). In developing countries the situation is likely to be at least of the same magnitude. The vast majority of these infections primarily originate from animal production so the overriding aim for the animal health sector is safe food and consumer protection (Schlundt et al., 2004). A problem is that these infections usually cause no or very limited economic losses to animal production. Thus, efforts are needed to implement policies with economic incentives for producers to improve hygiene in their animal production in order to decrease the input of potential pathogens to the food chain. The need for integrated approaches is emphasized when interventions are needed along the whole food chain. Of particular interest are challenges posed by the increasing global demand for protein as animal feed, in response to the increasing global demand for meat (Morgan and Prakash, 2006). To meet that demand soybean production has increased *e.g.*, in Brazil, which has resulted in deforestation and monoculture followed by environmental degradation from high pesticide use and significant problems with pesticide residues in the soy products produced (Klink and Machado, 2005). In addition, many countries have experienced an increased risk of *Salmonella* contamination in soy meal, which constitutes an important route for introducing *Salmonella* into animal production when used as animal feed (Hald et al., 2006; EFSA, 2006b). A pandemic spread of *Salmonella* occurred when contaminated fishmeal from South America was exported to the U.S. and Europe, causing more than one million human cases in the U.S. alone

(Clark et al., 1973; Crump, Griffin and Angulo, 2002). *Salmonella* contamination has become a significant challenge to the global marketing of animal feed and food products (Plym-Forshell and Wierup, 2006).

7.3.2.3 Endemic diseases – the major challenge and potential

Categorization of livestock diseases is critical for the determination of public intervention, as highlighted in the recent assessment of the EU animal health policy (DG SANCO, 2006). International and national policy and legislation focuses on the control of the major epizootic diseases and, increasingly, on the foodborne zoonotic diseases. Economic compensation in case of outbreaks, surveillance and other measures are generally limited to these, so-called, listed diseases (Table 7.1) (WHO, 2006).

[Insert Table 7.1]

Endemic diseases comprise the majority of animal diseases and, in developed countries, continuous implementation of disease prevention measures directed against these endemic diseases is necessary for efficient production. The economic importance of endemic diseases is recognized and in many developed countries a number of the endemic diseases have been successfully eradicated or controlled (e.g. Aujeszky´s disease in pigs, infectious bovine respiratory disease and bovine virus diarrhea in cattle). Such programs have been found to be very cost effective (e.g. Valle et al., 2005). The increasing focus on reducing antibiotic use to prevent resistance and on animal welfare further emphasizes the importance of control and/or eradication of animal diseases (Wierup, 2000; Angulu et al., 2004).

Control of animal diseases and the promotion and protection of animal health are essential components of any effective animal breeding and production program (FAO, 1991). However, despite remarkable technical advances in the diagnosis, prevention and control of animal diseases, the condition of animal health through the developing world remains generally poor, causing substantial economic losses and hindering any improvement in livestock productivity (FAO, 1991; FAO, 2002). Consequently, in addition to efforts to minimize the negative effects of the major epizootic and foodborne diseases, policy could also focus on the prevention and control of endemic diseases, even though the producer is generally considered to bear the responsibility for production losses caused by this group of diseases. However, such actions could also have a direct strengthening effect on food safety and food security and, in this respect it has been emphasized that a focus on safe food in the context of strengthening export capacities of developing countries should come second to the primary objective of improving food safety for local consumption (Byrne, 2004).

The global burden of animal diseases when including also the cost for public health and loss of labor is also estimated to be dominated by the endemic diseases, in contrast to the public focus on the control of the epizootic diseases.

7.3.2.4 Animal welfare

The protection of animal welfare and the demand for a sustainable animal production system, which is increasingly being considered in animal health policies and in SPS- associated regulations, can be an additional constraint for developing countries trying to access international markets. However, sustainable extensive livestock production practices in developing countries that promote animal welfare could open niche market opportunities in developed countries. This is in contrast to intensive livestock production in many sectors of the industrialized world where in the short term the implementation of systems for improved animal welfare often are associated with increased cost of production (OIE, 2005a; Kyprianou, 2006).

The veterinary services of developing and transition countries are in urgent need of the necessary resources and capacities that will enable their countries to benefit more fully from market access opportunities in trade agreements, while at the same time providing greater protection for human and animal health, animal welfare and reducing the risks linked to zoonoses (OIE, 2004; Thomson et al., 2006). It is of utmost importance that the ongoing initiatives from OIE and others to support veterinary services, in particular in developing countries, continue. OIE emphasizes the need for veterinary services to support access of animals and their products into national markets, indicating the importance of animal health control in a safe and secure food supply. A challenging factor is the limited availability of veterinarians trained in veterinary public health (WHO, 2002b), which in developing countries has opened discussions on the need of para-professionals such as community animal health workers (Scoones and Wolmer, 2006).

7.3.2.5 Priority setting for disease control technologies

Historically significant resources have been directed towards tools to implement eradication policies and research often focuses on the production of a vaccine that simply should be the key to success. These resources are also often directed to diseases that gain special attention in relation to international trade but that might be of less economic importance in an endemic situation in a developing country (Scoones and Wolmer 2006). However, effective vaccines are available only for a limited number of infections and therefore preventive actions need to come into focus. Many important diseases have been successfully controlled through the application of simple, preventive hygienic methods; a “bottom-up” approach to priority setting can therefore be recommended (Scoones and Wolmer, 2006). Recommending that milk be boiled prior to consumption in South Africa could more simply and cheaply limit human health risks due to *Brucellosis* than a comprehensive vaccination control program in a cattle population where the disease caused relatively limited production losses (Mokaila, 2005).

7.3.3 Plant health

Food availability depends in the first instance on the actual production of food, which is influenced by agroecological production potential as well as by available production technologies and input and output markets (FAO, 2005b). Plant pests are key constraints to achieving the true yield potential of food and fiber crops, particularly in tropical and subtropical regions where conditions necessary for the reproduction of pests may be present year-round (FAO, 2005c). In addition to their direct and deleterious effect on the yield and quality of plant products, plant pests can also pose an absolute barrier to imports when countries apply phytosanitary measures to regulate the entry or plants, plant products or others materials capable of harboring plant pests.

7.3.3.1. The challenge of international phytosanitary standards

International phytosanitary standards recognized as authoritative by the SPS Agreement can be a positive driver in developing countries. When applied to high value food products, these have played a beneficial role in stimulating improvements to existing regulatory systems and the adoption of safer and more sustainable production practices (World Bank, 2005). More commonly, however, international phytosanitary standards are considered as barriers to trade that particularly discriminate against developing country stakeholders who can neither afford to meet the high costs of compliance associated with these nor participate effectively in their development by international standard setting bodies like the International Plant Protection Convention (IPPC) (e.g., Simeon, 2006). Governments, institutions and farmers may respond to such standards in a number of ways: support or participate in programs that will address the management of the pest problem; find alternative foreign markets for nationally produced goods; focus on increasing domestic demand for trade-prohibited plants and products; or exit production, with or without compensation and/or incentives to promote diversification into other crops.

Governments generally divide resources applied to address phytosanitary considerations in two ways: (1) to meet the phytosanitary requirements of importing countries (export certification); and (2) to meet domestic phytosanitary requirements, including those applied to imported agricultural products. In both developed and developing countries these regulatory tasks are typically addressed through an array of plant protection and quarantine (PPQ) programs. Core services of traditional PPQ programs include activities such as: detection and control or management of plant pests of quarantine or economic significance; undertaking pest risk analyses; and managing import, export and/or domestic certification programs. These programs are being challenged by increases in the volume and kinds of agricultural products being traded internationally, the number of countries exporting such products, and international travel which creates more opportunities for the rapid introduction and spread of new pest species (FAO, 2003).

7.3.3.2. Opportunities through regionalism

For some countries, particularly those with limited resources applied to national PPQ programs, regional or sub-regional programs may be a workable alternative. Regional initiatives to harmonize standards where trade between the participating member countries for specific plant products is significant and where an international standard is not needed (i.e., a different, less restrictive or less economically punitive standard will suffice). Regional pooling of scientific resources (human and institutional) to collectively manage plant pests and implement surveillance programs can enable developing countries to meet the surveillance and pest risk assessments required for compliance with import requirements. Surveillance data is important to ensure that domestic phytosanitary measures are equivalent to those applied to imported commodities so that discrimination against imports based on pest exclusion is not supported. Efforts to collect these data for key pests that affect movement of plant material from or within a specific region may be best addressed by establishing harmonized protocols for data collection and then pooling resources to acquire the necessary information to demonstrate pest-free status. Initiatives to promote meaningful, results-based regional cooperation to address plant health issues will require incentives to promote cooperation both within and between national agricultural systems. Where regional regulatory programs may be government to government, these should also actively encourage the inclusion of other stakeholders, especially the private sector and producer groups.

7.3.3.3 Biosafety and plant protection

With the ratification of the Cartagena Protocol on Biosafety, many governments are in the process of developing or implementing national biosafety regulatory programs (GEF, 2006). With the rapid adoption and global trade of transgenic maize, soybean, cotton and canola the primary focus of these new programs is typically the regulation of transgenic crops. National, bilateral and international support for the establishment of biosafety regulatory programs has favored the creation of new regulatory entities under ministries other than agriculture. Given the shared nature of many of the regulatory functions of PPQ and biosafety programs (e.g., risk assessment, monitoring and inspection activities) and the inclusion of Living Modified Organisms in ISPM No. 11 (Pest Risk Analysis for Quarantine Pests, Including Analysis of Environmental Risks and Living Modified Organisms), there exists an opportunity to apply new resources available for biosafety regulatory capacity building to strengthen existing PPQ programs so that the objectives of both can be achieved without building redundant administrative services. This could be achieved under the umbrella of “plant biosecurity” to include plant health, plant biosafety and also invasive alien plant species. Inputs for programs related to plant biosafety or, more broadly, plant biosecurity should be actively sought from, if not led by, ministries of agriculture.

7.3.3.4 Meeting the plant health needs of small-scale farmers

Control of plant pests that are important from a trade perspective may be of little or no significance to small-scale farmers who are not exporting their plant products. Instead, their priorities are likely to be management of local pests that will have a direct impact on their harvested or post-harvest yield. Policy makers could ensure that the small-scale farmer, whose fields may be an inoculum source of a trade-prohibited pest, is provided with incentives to assist in the management of such pests so that export certification of the commodity in question can still be achieved. This could come in the form of support that links breeding or pest management programs designed to address the priorities of the small farmer with activities that will also assist in the management of the prohibited plant pest. Similarly, a government could strengthen the capacity of regulators to enforce compliance with internationally relevant phytosanitary standards but couple this with direct support for the primary producer where production practices may have to be modified so that pest exclusion goals can be attained.

An alternative policy option is to realign public sector AKST funding to support research explicitly directed to improving small-scale, diversified farming practices that promote improved yields and enhanced food quality through sustainable pest management practices. These could variously include IPM, organic farming, and improved plant breeding programs, including the development of pest resistant varieties through marker assisted selection or recombinant DNA techniques. National prioritization of the needs of resource-poor farmers may be more important in the future as scientific and agricultural technology spillovers from developed countries that are adapted by developing countries may be less available (Alston et al., 2006).

7.3.3.5 The private sector and third party certification

The private sector has responded to enhanced consumer awareness and concern about food safety by developing their own phytosanitary (and sanitary) standards, enforced through third party certification (Hatanaka et al., 2005). This means that participating primary producers have to meet an array of requirements that go beyond those mandated in government regulations, such as implementing traceability programs or participating in accreditation programs that add expense and complexity to more traditional production systems. While there are examples of developing country farmers who have benefited from third party certification (Hatanaka et al., 2005), arguably these private sector standards discriminate against resource poor farmers who cannot afford the high costs of participation. In response, governments may decide to align their public sector investment to ensure that AKST is applied to assisting producers to meet only statutory phytosanitary standards, through agricultural research, extension and/or education systems. Individual farmers or commodity-specific producer associations would have to use their own resources to meet additional private-sector requirements. Alternatively, governments could strategically invest in AKST that will promote the participation of small-scale farmers in third party certification, through the provision of education programs and technical assistance. This may also provide a stimulus for the development of off-farm employment opportunities through the provision of services such as third-party accreditation of farms or production systems. Internationally, the private sector in developed countries, which is driving third party certification, should promote the harmonization of private sector standards and streamline accreditation, especially where these apply to plant products produced in developing countries (Jaffee, 2005).

7.3.3.6 Climate change and plant health

A significant consideration for policy makers tasked with addressing plant health issues is the impact that climate change will have on plant production. Climate change can affect plant health by: modifying the encounter rate between host and pest by changing the ranges of the two species; introducing new hosts, vectors and/or pests; causing social changes such as shifts in agricultural labor; and shifting land use patterns that will alter the potential for populations of plants and pests to migrate to fragmented landscapes (Garrett et al., 2006). In response to this, policy makers will be challenged to decide if investments in development and deployment of AKST will be proactive (*e.g.*, inclusion of climate prediction in forecasting models of plant disease) or reactive (*e.g.*, deployment of resistant varieties after the emergence of a new plant disease). Action to mitigate the impacts of climate change on crop production will require integrated strategies developed and implemented in a participatory fashion that emphasizes the need to include non-traditional players in agricultural research. Coherent policies could be developed cooperatively through multi-disciplinary partnerships within government (*e.g.*, Ministries of Agriculture, Energy, Trade, Health and Commerce) and with significant guidance from academic, agricultural, nongovernmental and private sector players.

7.3.4 Ways forward

Recognizing that food safety, animal health and plant health are global public goods, new mechanisms to support the development and, most importantly, implementation of proactive and preventative policies and programs to facilitate compliance with SPS standards could be explored. Internationally, donor support could be targeted to specifically assist those countries that cannot adequately finance SPS standard implementation nationally but attention could also be paid to ensuring that trade facilitation is not the only driver of SPS program delivery. The application of AKST to address yield and quality losses associated with pests or pathogens that are of domestic, but not international, importance may have more impact on reducing hunger and poverty, and improving nutrition and health, particularly in the least developed countries, than applying these resources exclusively to accessing international markets. For small developing countries, the possibility of regional food safety "trusts" to provide a continuous funding source for shared SPS related surveillance programs, infrastructure and personnel should be considered. An international SPS insurance mechanism that would supplement or replace current *ad hoc* funding to detect and mitigate transborder food contamination incidents, zoonoses and plant health contagion should also be considered.

Given the globalization of agriculture and trade, the institutional separation of Codex, OIE and IPPC may be of limited relevance in the future. The traditional mandates of these international organizations are already challenged by the emergence of alternative regulatory mechanisms that integrate food safety, animal and plant health related standards and production practices *e.g.*, Good Agricultural Practices, Good Manufacturing Practices, on-farm HACCP plans and other retailer-driven certification programs. Revising SPS-related policy and regulatory measures within an explicitly coordinated biosecurity framework may be one option for promoting cross-sectoral interventions. Internationally, policy and regulation related to food safety, plant and animal health could be better integrated if the mandates of Codex, OIE and IPPC were recast to remove areas of duplication, identify sources of conflict and promote opportunities for policy and program coordination to more effectively utilize the limited resources that are applied to SPS issues.

Policy options

- For smaller and contiguous developing countries, strengthening or starting regional foodborne, animal and plant health surveillance systems may be a viable option, particularly where dietary patterns, agricultural practices, and natural resources for agriculture are similar.
- Consideration should be given to establishment of national or regional food safety trust funds invested to ensure a continuous funding mechanism to gradually build the national or regional surveillance systems upon which effective food safety interventions depend. The trusts could be financed from an increase in ODA and from an increase in agrifood corporate taxes. Alternatively, governments can continue to respond *ad hoc* to food safety emergencies or SPS related threats to trade, financed by voluntary funds for each purpose.
- Governments should consider expanding current “aid for trade” commitments to include the financing of specific SPS infrastructure requested by WTO members with documented incapacity to finance that infrastructure from domestic sources. Since it is unlikely that governments will support binding and enforceable "aid for trade"

commitments, governments should consider developing a model contract for expedited needs assessment that is not tied to import of SPS technology or training from any one donor.

- Considering that SPS standards are largely implemented in developing countries for the purpose of trade facilitation, often with little benefit to local consumers of domestically produced food, policies that focus on domestic food production and domestic priorities for animal and plant health, food safety and public health could receive greater attention.
- Weak national SPS surveillance systems could be strengthened to improve the timeliness and efficacy of preventative or prophylactic food safety, animal and plant health interventions. Even where there is an absence of detailed epidemiological or surveillance data, foodborne infections and animal and plant diseases could be better managed through policies that promote simple, workable SPS programs implemented at the farm or community level. Capacity building could be re-directed from training to understand SPS rules to technical support needed to operationalize such programs.
- Eradication of the major epizootic animal diseases is unlikely to be achieved in the foreseeable future in many developing countries in spite of significant investment and effort to do so. An alternative, commodity based approach could instead be used as a tool to promote access to international markets which would also allow resources to be allocated for the prevention of losses caused by other animal and zoonotic diseases.
- Governments could align their public sector investment to ensure that AKST is applied to assisting producers to meet only statutory SPS standards, through agricultural research, extension and/or education systems.
- Governments could strategically invest in AKST to promote the participation of small-scale farmers in third party certification, through the provision of education programs and technical assistance.
- The ongoing initiatives from OIE and others to support veterinary services in developing countries could continue as a means to support access of animals and their products into national and international markets and to improve food safety and secure food supply. Policies that recognize and support the training of para-professionals such as community animal health workers could be promoted to compensate for the limited availability of veterinarians trained in veterinary public.
- Policies could support the provision of international support to developing countries when coordinated interventions are required to manage international emergencies (*e.g* highly pathogenic avian influenza virus) and sustained improvements in national disease control systems could be viewed as investments rather than internationally imposed costs.
- FAO, WHO and OIE could consider establishing a joint task force to examine what those agencies and their member governments might do to prepare their SPS surveillance and

intervention systems to identify SPS risks and hazards that may result from anticipated effects of climate change on food and agriculture production and distribution.

7.4 Knowledge and Knowledge Management - Property Rights

The generation, dissemination and maintenance of AKST increasingly depend on property rights, placing AKST in private, community, and public domains. As opportunities to protect AKST increase and access to innovations, local knowledge and genetic resources become restricted through different regulatory systems. Public research may result in privately controlled knowledge, either as a result of institutional policies or of public-private partnerships. IPRs have multiple objectives, ranging from stimulating investments in R&D, facilitating technology transfer and bringing knowledge to the public domain through publication and setting time limits to any exclusive rights. However, the validity of these in a LIC and development context of low technical capacity is contested. Nevertheless, public research institutions have to decide how to deal with these developments and how far to go in developing capacities to manage proprietary knowledge and materials (Egelyng, 2005).

Opportunities to legally protect knowledge can be analyzed in terms of the likely impact on the generation of and access to such knowledge for development purposes. This analysis refers to both the strength of intellectual property rights in general and to the policies towards the use of the protection systems by public (research) organizations. IPRs fit in a paradigm of market-led development which is essentially different from both the concept of sharing ideas that characterize most farming communities (and which is essentially different from medicinal knowledge in many communities) and from the public goods paradigm which dominated the agricultural research for development policies for over 50 years. Strong intellectual property rights may support commercial investments in research, but may not be effective in stimulating research for non-market uses to serve the need of the poor.

Changes in property rights systems impact the roles of the stakeholders in AKST. National policies, such as the Bayh-Dole Act in the USA, promoting "protection" of IP by public universities, led to new commercialization strategies for publicly developed AKST, including exclusive licensing of IP to companies in exchange for follow-up university research contracts and product commercialization. Reduced public expenditure on agricultural research in a number of countries, and the expansion of public-private partnerships in agricultural research also tend to stimulate the protection of knowledge by public research institutions in order to generate income (Louwaars et al., 2006). An analysis of the impact of the Bayh-Dole Act in the USA (Rosenberg and Nelson, 1994) indicates that as a result of the high costs of managing IP, very few schools make a net profit on their R&D investment.

The design of systems of rights and the forms in which these are implemented are examples of interactions between various levels of organization ranging from international conventions and commitments to local forms of interpretation with or without the filter of national policy and legal systems. If different rights systems do not specify how results produced by AKST system are used, exploited and disseminated those knowledge products and technologies may be unused by the intended AKST beneficiary. If the public sector is stimulated to use the rights to create a flow of revenue, public sector researchers are likely to change their programming away from the needs of the poor (World Bank, 2006).

7.4.1 Public research and the generation of public goods

The status and nature of AKST as "public/private good" is critical for its value in development. Anthropologists and sociologists (Fuller, 1993; Callon, 1994) hold that science is a public good. Innovation, a change in order to solve a constraining situation, is both a key for human development and a tool for competitiveness. The report of a Commission initiated by the British government to look at how IPR might work better for poor people and developing countries remains a most important analysis of this challenge (Commission on Intellectual Property Rights, 2002).

Both the international priorities for the production of global public goods in global schemes (e.g. in the CGIAR), and national innovation programs can to be viewed in this changing perspective when they are to deal with multiple development objectives. The introduction of private, community and national rights creates a wide range of challenges for public research.

Realization of environmental objectives are very appropriate areas of inquiry for publicly funded AKST: research towards fulfilling these objectives can frame natural resources as public goods requiring collective management, such as climate, air quality, water, landscapes. Knowledge can help private stakeholders, like farmers, forest owners, rural factories, to develop environmentally friendly practices even in those areas that are privately owned.

7.4.2 Multilateral negotiations on rights systems

Attempts to import concepts from one multilateral agreement to another to enhance their mutual compatibility have met with strong opposition.[2] For example, the proposal to make the CBD's

[2] How to protect and license the use of intellectual property (IP) and traditional knowledge (TK) continues to be fiercely debated in World Intellectual Property Organization (WIPO), the WTO negotiations to amend the Agreement on Trade Related Aspects of Intellectual Property (TRIPs) and in various civil society forums. The implementation of national sovereignty over genetic resources (GR) and arrangements for Access and Benefit Sharing (ABS) as debated within the Convention on Biological Diversity (CBD) and the International

Prior Informed Consent in the use of traditional knowledge and genetic resources a substantive requirement of patentability in TRIPS has not prospered (Visser, 2004).

WIPO and WTO. Proposed binding WIPO norms to protect traditional knowledge and genetic resources from unauthorized and unremunerated misappropriation (i.e. "biopiracy") have been rejected as a threat to WTO IP rules (e.g. paragraph 211 - WIPO, 2006a). The nature of the threat is, however, not specified, but likely relate to the collective stewardship of traditional knowledge, which from a classical IP viewpoint would represent an undermining of the individual status of patent ownership (Finger, 2004). It remains an option to further explore a developing country proposal to amend TRIPs Article 29 to require disclosure in patent applications of traditional knowledge and genetic resources used in the development of patented products (WTO, 2006a).[3] Proponents of disclosure argue that disclosure would improve patent quality (Article 27.1), prevent abuse of the patent system and promote the public interest (Article 8), provide social and economic benefits to WTO members (Article 7) and make TRIPs supportive of the CBD, particularly its ABS provisions (Articles 1 and 15). Opponents of disclosure opponents contend that ABS is best implemented through contracts that offer a cash payment or other benefits in exchange for the rights to patent products developed from an agreed number of genetic resource samples (WTO, 2006b).

Intellectual property regimes alone, no matter how comprehensive, fully implemented, and mutually supportive of other multilateral treaties, are insufficient to enable development of the seed systems needed to fulfill goals, and poorly designed and implemented regimes can be detrimental to achieving these objectives (World Bank, 2006).

Genetic resources in agriculture. Challenges to bringing the private rights of IPRs in harmony with the collective rights over traditional knowledge and local genetic resources are further complicated by the rights based on national sovereignty over the physical genetic resources, as established in the CBD. Apart from conceptual and legal challenges, this complication has led in the past years to practical problems in the exchange of genetic resources, which affects the agricultural use of genetic resources in plant and animal breeding more that any other type of use. Important steps have been taken in the sharing of benefits derived from the use of these resources in a multilateral way through the IT PGRFA 's conclusion of the Standard Material

Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) also link with the protection of IP and TK.

[3] The information embedded in the genetics of the seed and the associated farmers' and scientific knowledge comprise a significant part of AKST. The value of TK appropriated for use in patented agricultural and medical products would represent at least $5 billion annually in royalties to developing countries, if TK were protected and licensed as patents are (McLeod, 2001). Just half of such a sum, if invested for the *in situ* conservation of agrobiodiversity and if distributed effectively to the often collective and indigenous stewards of that biodiversity, could help realize development and sustainability goals.

Transfer Agreement The IT PGRFA confirms the Farmers' Right of protection of TK, which established a link with the debate in WIPO, the right of benefit sharing linking it further to the CBD, and the right to participate in decision making at the national level on matters related to the conservation and sustainable use of plant genetic resources for food and agriculture. The IT PGRFA refers the implementation of these rights to the national level (Article 9.2C)). However, it may prove difficult for national policy makers to implement these Farmers' Rights while avoiding conflicts among IPR, biodiversity and seed regulations with the right of farmers to save, use, exchange and see farm-saved seed.

Traditional knowledge (TK) and genetic resources. A review of technical papers in support of the WIPO negotiations has proposed that an "international enforcement pyramid" be constructed from existing practices to enable developing countries to control and sustainable use traditional knowledge and genetic resources (Drahos, 2006). The "enforcement pyramid" would integrate indigenous and national government practices and would be coordinated by a Global BioCollecting Society under the aegis of WIPO, FAO and the CBD. Complicating the construction of an effective enforcement mechanism for traditional knowledge and genetic resources are differences between indigenous customary law and governance, and national government jurisdiction, particularly where indigenous territories cross national boundaries (IIED, 2006).

WIPO negotiations for a Substantive Patent Law Treaty (SPLT) present a framework for IP protection and enforcement very different from an enforcement pyramid based on national and indigenous group enforcement practices for traditional knowledge and genetic resources protection. The SPLT is part of a Patent Agenda to create and enforce a "global patent" with mechanisms far more specific and powerful than the TRIPs enforcement provisions (Article 41), and reduced transaction costs (WIPO, 2001). The U.S., EU and Japan are the main SPLT advocates and cooperate in patent matters. Some IP scholars are concerned that the SPLT could negatively affect public AKST and access to publicly held genetic resources, particularly in countries where rules on plant variety protection do not yet limit farmers' rights to save or exchange seed (e.g. Tvedt, 2005). The SPLT may also limit developing countries ability to shape their patent laws to their own specific needs, taking into account the development stage that they are in. SPLT is thus seen as supporting only a trade agenda rather than supporting a Development Agenda (WIPO, 2004). The debate is ongoing.

Nevertheless, elements of the draft SPLT are being carried forward in Bilateral Investment Treaties (BITs) and so-called "TRIPs plus" provisions in bilateral Free Trade Agreements

(FTAs)[4]. BITs with many of these parties define IP and genetic resources in ABS agreements as "investments" and allow a very broadly defined "investor" to sue states for non-enforcement or inadequate enforcement of investor rights, no matter how resource constrained the developing countries parties may be (Correa, 2004).

IP and TK economics. Desegregated data on agricultural IP costs[5] could help policy makers make more informed decisions about whether to assume the costs and legal obligations of specific patented agricultural products. The cost is difficult to justify in light of the aggregate 53% price drop in agricultural export commodities from 1997 to 2001 (FAO, 2005a), nor from the expected 2.8% price increase resulting from WTO Doha Round (Bouët et al., 2004). In our assessment, the terms of trade rationale for investment in patented AKST becomes weaker still when taking into account the costs of state liability for non-enforcement of IP as "investment" in BITs and individual producer liability for violating patent holder rights, e.g. of agricultural biotechnology firms.

There is no agreed methodology for estimating the economic value of traditional and local knowledge and genetic resources, for the purpose of licensing its use in specific patented products (Drahos, 2006). Agreement on such a methodology might be derived on the basis of experience with studies estimating the value of traditional knowledge and genetic resources used in specific patent products. A royalty or licensing fee system based on the value in the seed market is incorporated in national laws in some countries (e.g. the gene fund in India) and in the IT PGRFA that will be used to fund genetic resource conservation. Seed sales royalty funding therefore remains a policy option.[6]

The global costs of withholding access to genetic resources due to national access regimes are insufficiently researched. Given the interdependence of countries on genetic resources (Flores-

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[4] "TRIPS plus" agreements assert TRIPS as a foundation but add some provisions that arguably conflict with TRIPS provisions. Recent FTAs require the patenting of biological resources, thus overriding the patenting exemption in TRIPs Article 27.3, and require countries to become member of the Union for the Protection of new Varieties of Plants (UPOV), thus closing the door for alternative breeder's rights protection systems, including earlier versions of the UPOV Act that are more compatible with farmers' seed systems (World Bank, 2006). These FTAs also prohibit parties from citing resource constraints as a legal defense for non-enforcement of IP obligations (Fink and Reichenmiller, 2005).

[5] One estimate suggests that developing country TRIPs commitments in the Uruguay Round amounted to $60 billion annually in implementation costs, licensing fees and royalties (Finger, 2004).

[6] As part of a project to measure genetic resource erosion and to suggest how royalties be paid to source countries of genetic resources might provide incentives for conservation, it was estimated that a 1% royalty on sales of patented seeds incorporating traditional knowledge and genetic resources would return about $150 million per annum to the source countries, most of them developing countries (FAO, 1998). However, with the creation of the Global Crop Diversity Trust in 2004, FAO's erstwhile interest in using royalties to pay for protection and enhancement of crop diversity has diminished. The Trust Fund has shifted away from FAO's prior dependence on annual donor government contributions towards funding Trust activities from an endowment supplemented by foundation grants. Nevertheless, the Trust states that there are many crop diversity conservation activities that it cannot and will not finance.

Palacios, 1997) and the fact that exchange of agricultural genetic resources among developing countries is much more frequent than transfer from South to North (Fowler et al., 2001), such costs are likely to be borne to a large extent by developing countries. Providing financing mechanisms to facilitate genetic resource access and transfer from agrobiodiverse rich developing countries to agrobiodiverse poor developing countries is one option for remedying this situation.

Other policy options regarding intellectual property and traditional knowledge include:
1) Insofar as traditional knowledge and genetic resources may form part of the prior art of a patented AKST product, adoption of a disclosure amendment in TRIPS could serve to enhance patent quality and might be a disincentive of misappropriation. Information so disclosed could be part of the legal basis for any licensing agreement on traditional knowledge and genetic resources used in a patented product. WTO members might also wish to consider adopting a weaker interim standard of TK protection, such as a Declaration on Trade and Traditional Knowledge (Gervais, 2005).

2) Given the impasse at the WTO over disclosure, developing country members are seeking to protect traditional knowledge and genetic resources with strong norms in WIPO negotiations. However, in the absence of the capacity to enforce such norms, members could agree on the design of mechanisms for and the financing of an "enforcement pyramid" (Drahos, 2006) for any norms that are agreed, preferably under the coordination of a joint agency under CBD, FAO and WIPO. This could ensure that local and indigenous stewards of agrobiodiversity would participate in member government decisions on the licensing of traditional knowledge and genetic resources, as called for in Article 9 of the ITPGRFA.

3) Both multilateral IP negotiations and implementation discussion lack ex ante and ex post economic analysis of the cost and benefits of adopting IP commitments and patented AKST. Analysis of, not rhetorical claims about, IP benefits for developing countries, could inform bilateral agreements and national government IP policy and legislation (Park and Lippoldt, 2004). Multilateral and technical assistance could include financing for IP economic analysis.

4) A methodology for valuing the ex-post contribution of traditional knowledge and genetic resources in patented AKST option to agree, as a pre-requisite for any agreement on how to license traditional knowledge and genetic resources in patented products. Decision makers may consider ex-post studies of traditional knowledge and genetic resources valuation in existing patented products to better delineate the elements for an agreed methodology.

5) Facilitating access to and sustainable use of traditional knowledge and genetic resources among developing countries, particularly for the benefit of agrobiodiverse poor developing countries may be a an issue that policy makers may wish to move higher in the priorities of the multilateral AKST agenda, Both for food security and agroenvironmental sustainability reasons, it remains an option for policy makers to consider developing guidelines for a specific facility for the benefit of agrobiodiverse poor developing countries.

7.4.3 Effects of rights on AKST at the national and institutional levels

IPRs on products and processes that are relevant to agricultural development in the widest sense create novel conditions for the use of AKST at different levels. The trend towards privatization of AKST is particularly felt in the sphere of plant breeding and biotechnology.

Stimulating private investments in research. IPRs are meant to stimulate private investment in research, but even though evidence of such effects in various industries may be available, it is very weak in the agricultural sector, notably plant breeding (Pray, 1991; Alston and Venner, 2000). IPRs protected in LDCs with a limited research capacity are more likely to improve access to proprietary technologies from abroad (e.g. Bt cotton). There are claims of positive effects of protection of breeder's rights for a selective number of cases; however, without taking into account alternative explanations for the observed effects and without providing data for other crops in the same case study countries (UPOV, 2005). Other studies show inconclusive results of the value of IP protection for the plant breeding sector in LDCs. Based on evidence in five developing countries, IPRs may support the development of a private seed industry, but only when this sector has reached a certain level of maturity; IP protection is not a major stimulus for initial investments in the sector (World Bank, 2006).

Public-private partnerships in research. In a market system, IPRs provide a way to share benefits among the different chain partners through the transfer of technology fees (royalties). They are the basis for negotiating partnerships in research between private and public partners, notably private IPR-holders and public research institutions in accessing technologies in a certain country. However, the reliance on negotiated license agreements also introduces prospects for unequal sharing of benefits based on differences in negotiating capabilities and power of the partners.

Financial support to the public research systems through IPRs. Even though IPRs fit in a commercial approach to innovation, it is in many countries the public sector research institutions that promote the introduction of IPRs in agriculture. This promotion is based primarily on a perception that these institutes may obtain significant revenue when their inventions (e.g. plant varieties) may be protected. This revenue is welcomed when there is under-investment in public research (common in many countries since the 1990s), but may be viewed differently if such benefits can only be obtained in commercial markets (e.g. seed markets). Reliance on IPR based revenues is likely to lead to a change in public research priorities, in some cases to commercial crops like maize and oil crops to the detriment of research on small grains and pulses, and to benign ecologies and market oriented farmers, to the detriment of a small-scale farmer focus (Fischer and Byerlee, 2002). Such research shifts may fit in market orientation priorities of national development strategies, but may at the same time challenge to some extent the public tasks of contributing to poverty alleviation and household nutrition security (Louwaars et al., 2006).

The most common alternative strategy for a public research institute may be to publish its innovations, i.e. place in the public domain. This strategy reduces opportunities to obtain financial revenue and may limit public-private partnerships.

Challenges to technology transfer – thickets of rights. Even though license agreements may promote technology transfer by clarifying roles and responsibilities, IPRs may also pose serious limitations to research and the use of technologies in development. Particularly in advanced research, so called thickets of rights lead to the tragedy of the anti-commons leading to underinvestment and under-utilization of technologies (Heller and Eisenberg, 1998). Property rights on research tools, processes and products create very complex situations for researchers and their institutions, potentially leading to under-utilization of technologies. Research institutes have to learn how to establish and negotiate their freedom to operate on these technologies. The quality and enforceability of the claims of a patent may significantly differ between jurisdictions; negotiating access to a technology can be very difficult when unequal partners are involved; so-called humanitarian use licenses (license on a technology for R&D for development with ‘soft’ conditions) may be granted when the use of a technology is unlikely to challenge the commercial interests of the rights holder, but the ‘small print’ license details can create significant obligations for the recipient.

These are new policy challenges for most developing countries, the actual impact of which cannot be readily assessed yet (World Bank, 2006). The rights on enabling technologies create challenges for producing public goods, which has been the main focus of public research, and more specifically for the centers of the Consultative Group on International Agricultural Research. When more and more technologies are protected by IPRs in their target countries, producing international public goods may become more and more difficult (Fischer and Byerlee, 2002). Currently, these centers are venturing in license strategies on their protected technologies that provide a public good status for the purpose of poverty alleviation and food security in developing countries, while maintaining ownership in commercial markets both in developing and industrialized countries.

Costs of compliance. Compliance with the rights of IPR-holders requires public and private research institutions alike to invest in capacities that they had not required in the past, notably legal and commercial specialists. There are already commercial seed companies that spend far more on legal services than on research. This preponderance of legal over research expense in fighting through the patent thicket may be a 'warning' to public research institutions that emulating commercial plant breeding practices to produce public goods may be a less an optimal production pathway. Legal advice is not only needed to channel the use of research results in development oriented and commercial markets through contracts that need to be negotiated and concluded and court and settling disputes. Legal considerations are also more and more influencing the research itself. Scientists may be required to use old (free or cheap) technologies instead of effective ones which may be costly or not available.

Scientists frequently feel stifled by the legal advisors who have to make sure that third party IP rights of contributive technologies are respected and that the IP produced by the scientists can be protected, by putting restrictions on scientific communication before a patent application is filed. Another compliance cost is the need to transfer obligations derived from contracts downstream, i.e. a research institute working in plant breeding with genetic materials that have been obtained through contracts may have to require farmers involved in local testing of potential new varieties to sign contracts restricting their use of the varieties that they obtained (e.g., farmers participating in rice research in the Philippines).

Humanitarian use licenses on individual parts of AKST can reduce these transaction costs to a limited extent since the negotiations that lead to such licenses may be lengthy. One policy option is more generic approaches that limit such costs have been initiated by international consortiums of research institutions forming the "Generation Challenge Program" (Barry and Louwaars, 2005), and those collaborating in PIPRA (Public Intellectual Property Resource for Agriculture). Application of open-source approaches to genetic technologies (www.bios.net) is a policy option for providing more sustainable solutions to the emerging patent thicket, but its impact is yet limited.

Private, community and national rights. It is not only the private rights (primarily IPRs) that affect the organization of agricultural research for development. Community rights, such as those based on traditional knowledge, and sovereign national rights (on genetic resources based on the CBD) affect research institutions in a similar way. Transaction costs are increased through the need to negotiate access and terms, the opportunities to use the best available inputs in research are reduced, and the use of the research results may be restricted (Safrin, 2004; Louwaars, 2006). Research institutions need to trace all the knowledge, technologies and genetic materials in the various research programs and may have to check at the start of every program or experiment whether third party rights may interfere with their program or experimental design. These institutions may have to consult with legal advisor regarding these rights at every step of making their new technologies available to farmers. One policy option is to expand and strengthen the International Treaty on Plant Genetic resources for Food and Agriculture, the implementation of which is likely to reduce the transaction costs at least for the use of genetic resources of the major field crops and pasture species covered by the Standard Material Transfer Agreement.

Challenges for public research and policy options. Whether or not public research organizations intend to obtain revenue through protecting their own intellectual property, they need to develop institutional policies how to deal with such rights. Such policies need to be supported at the national level of policy and regulation.

Option to strengthen awareness of the issues and professional capacity in IP-strategy and marketing (Erbisch and Fischer, 1998) can focus on three different levels: scientists, research managers and policy makers (Cohen et al., 1999), which often requires the establishment of specialized technology transfer offices (Maredia and Erbisch, 1999).

Above all, national policy makers responsible for agricultural development and the national agricultural research systems need to be aware of the challenges that new rights regimes on intellectual property, traditional knowledge and genetic resources pose in the public research institutes and their relation with an emerging private sector. Policies that reduce public expenditure, that promote the use of IPRs by public research institutions or that restrict access to genetic resources and traditional agricultural knowledge could be based on a thorough understanding of the role of public research in the arena of access, development and use of AKST in development.

Policy options at the national level to make sure that thickets of rights do not develop in technologies and materials that are important for development and sustainability goals particularly include mechanisms to exempt the use of knowledge and materials for use for these goals when these are protected by private, community and national rights

7.4.4 Rights systems on natural resources: from simple ownership to bundle of rights

Scientific knowledge takes into account the frames through which the real world is perceived by stakeholders, such as scientists (fundamental and applied), local innovators, policy makers, businessmen, negotiators in international arenas. The knowledge on local management systems of natural resources and the theories to which this knowledge refers are the basis upon which decisions and agreements are made. Appropriate AKST can contribute to the improvement of the understanding of what is relevant at the field level and with local situations.

There are a wide variety of rights and management systems for natural resources. For example, one may own the land but not the subsoil resources, or the trees in a forest. A participant in a common property regime may have guaranteed exclusive use of a parcel she has cleared, or that parcel may be subject to re-assignment by a tribal elder. An untitled farmer at the agricultural frontier may have what is commonly considered 'ownership' of the 'improvement' to the land, which may not be *de jure*, but sufficiently enshrined in a *de facto* sense that those improvements can be bought and sold in the market. Some common property regimes have proven to be far more sustainable than individual property regimes. Commons are open access resources the property of which is not allocated to individuals but supposedly owned in common. Commons are not excludable and are *in se* not rivalrous. (Kaul et al., 1999; Wouters and de Meester, 2003). Strengthening the focus on new rules and international agreements that take into account more complex situations in regard of property rights and regimes is an option.[7]

This issue is raised without further details in Article 10c of the CBD (Sustainable Use of Components of Biological Diversity): "protect and encourage customary use of resources in accordance with traditional cultural practices that are compatible with conservation or sustainable use requirements." This Article is now in legal tribunals by native populations experiencing difficulties with norms they feel are being imposed on them (Goldman, 2004). Such rules may lead to confusion about ownership or accountability of 'resources' that have meaning and values at the local as well as at the global levels or aggravate the situation of those who are marginalized by the negotiated rules (Allier, 1997, 2002).

Studies on local management systems can contribute to designing new systems that better fit to evolving and dynamic conditions. Conceptual analyses has greatly benefited from scientific research since the late 1980s (Schlager and Ostrom, 1992; Sandberg, 1994; Le Roy, 1996; Chauveau, 1998; Lavigne Delville, 1998; Karsenty, 2003). Taking into account the different forms

[7] There are many examples of successful management 'in common', based on a variety of rights which are used to regulate access to, usage, exploitation, ownership, alienation, exclusion, etc. of such resources. Even though land is a rival and excludable good, many traditional societies maintain non exclusive grazing and hunting grounds. And some communities effectively manage as commons such natural resources as land, forests, water and plant and animal species (Demsetz, 1967; Bromley, 1990; Barzel, 1997), thus reconfirming that excludable resources do not necessarily have to be made private or exclusive. Doing so is a policy choice.

of knowledge involved, e.g., ‘explicit’ and ‘incorporated,’ can lead to a more complex view of what is at stake in a range of situations (Box 7.1).

[Insert Box 7.1]

The principle of legal plurality facilitates operational understanding of two coexisting legal worlds These normative productions were defined as “*droits de la pratique*”, i.e. rights based on practice, as a “plural set based on different ages and particular stakes, actors and formalisms”, specifying what is commonly designated as the ‘law of the land’.

A piece of land may be viewed as a “good” while the resources may be seen as “things” free of access or as an “having” (as defined above) open to harvesting by people other than the owner with his/her authorization. All these management practices may be subject to seasonal variation depending on the types of resources to be taken (grass, crops, berries, mushrooms, game, fish, etc.). The “right to hand over” (Chauveau, 1998) between the right of exclusion and of alienation, as hybrid forms of access to land, such as buying land for migrants, which gives them the right to pass it on to their heirs, but not the right to sell it. This traditional order may evolve with time. This system commonly falls within the more general social norms, and follows an intrinsic evolution as a result of overall change in the customary order, and of interactions with the positive law implemented by the modern state. The trend towards commoditization of land and resources will challenge the authority of these different modes and is likely to lead to individual property and ownership as understood by capitalist economy and modern law.

However when the excess capacity of common goods is limited, congestion may turn the consumption of the good as rival, i.e. when an additional unit of the good consumed by one member negatively affects other members’ satisfaction of the public good. An example of this situation is the fish-stock in oceans. Over-fishing depletes the world’s fish-stock and threatens endangered species with extinction (Wouters and de Meester, 2003). Thus a complex set of laws and agreements have completed the UN Convention on the Law of the Sea (1982), which introduced two fundamental principles: (1) the territorial sea, providing a coastal state with the right to control a narrow band of sea as an extension of its sovereignty offshore; and (2) freedom of the high seas, meaning the freedoms of navigation and fishing in the high sea beyond that offshore coastal area (Joyner, 2000).

The first principle relies on the co-management between states and coastal communities in planning, regulating, and conducting resource management (Borgese, 1999). One of the main issues is the obligation for states to maintain or restore populations of harvested fish at levels that produce a 'maximum sustainable yield'. 'Non-exploitive users', i.e. the rest of society's citizens, also have a right of access to the Exclusive Economic Zone for other functions, which include permission to locate aquaculture installations, mineral mining, shipping access, etc. decisions on which remain with government (Caddy, 1999).

On the second principle, a UN Agreement for the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks has been adopted in 1995, mandating states to establish sub-regional and regional conventions and organizations to facilitate conservation and management of living resources, and an International Seabed Authority for the deep ocean floor and non living marine resources. Except for sedentary species of the sea floor, international fisheries agreements do not speak in terms of ownership of resources but of access rights. This distinction raises the fine point as to the timing of the access and even whether this right could be extended to include the progeny of the resource share in future rights. A corpus of international law has evolved around the 1982 Law of the Sea Convention for protecting and managing the world's oceans (Joyner, 2000), which will likely be extended in the future (Caddy, 1999). Assessments such as the MA, point out that these arrangements are insufficient to avoid a decline of populations of harvested fisheries and 25% of the oceans are over-fished, creating problems for both the fish species and the fishermen depending on them. The setting of fishing quotas doesn't take in account the effects of the withdrawal of one species on the functioning of the whole marine ecosystem: it alters not only the targeted fish population but also the other trophic levels concerned by this species as prey or predator. In most situations there is insufficient knowledge on the functioning of marine complex ecosystems to design better management rules.

Challenges for public research and policy options. Scientific knowledge has to help to understand the complexity of such situations, in the oceans as well as on the continents to formalize these different sets of right regimes and also to design new ways for collective action for the fair implementation of such rights reach optimally sustainable management of renewable natural resources. Such knowledge has to guide the design of laws, incentives, contracts, taxes, quotas, permits and licenses that take in account the diversity of situations and that avoid blueprint solutions.

Natural Resources Management Policies: Since state appropriation of NRM based on positive law may co-exist with the modalities of local rights systems, which distinguish access to, usage, exploitation, ownership, alienation, exclusion, of "common" goods at a collective level, one option is to recognize that the 'law of the land' may further involve land tenure systems that cannot be reduced to individual ownership. Collective ownership and management of natural resources is protected in Article 10c of the CBD (Sustainable Use of Components of Biological Diversity). Indigenous groups have referenced this Article to help defend their collective rights and NRM practices against governments that would ignore these rights in fulfilling commitments to protect 'global' resources. New instruments for collective action have to make explicit and feasible the fair implementation of collective rights and NRM practices in order to obtain the best and sustainable management of renewable natural resources. Formal institutions have to take in account this diversity of NRM knowledge and avoid conforming only to a concept of individual ownership and rights.

7.5 Pro-Poor Agricultural Innovation

7.5.1 Technology supply push and the global agricultural treadmill

The dominant policy model for promoting innovation is called the linear model (Kline and Rosenberg, 1986), or the transfer of technology model (Chambers and Jiggins, 1987; Ch 2). Also known as "technology supply push," this approach relies on the agricultural treadmill (Cochrane, 1958) i.e. market-propelled waves of technological change that squeeze farm-gate prices, stimulate farmers to capture economies of scale, deliver high internal rates of return to investments in agricultural research (Evenson et al., 1979), but also encourage externalization of significant social and environmental costs (Lal et al., 2005; Mukherjee and Kathuria, 2006).

While the technology push model provided the basis for the positive impacts of the Green Revolution in favorable areas (Castillo, 1998) and under defined conditions that typically included high subsidies on fertilizers and pesticides (Pontius et al., 2002), it has not served nearly as well as resource-poor areas that are highly diverse, rain fed, and risk prone, and that currently hold most of the world's poor (Anderson et al., 1991; Biggs and Farrington, 1991; Vanlauwe et al., 2006).

The market-propelled diffusion of innovations called 'the agricultural treadmill' (Cochrane, 1958) has been ongoing in developed market economies for 50 years or more. The literature observing the process for hybrid maize in the American mid-West goes back to 1943 (Ryan and Gross, 1943). During these 50 years, farmers in those economies have been able to capture significant economies of scale. The treadmill process in those economies has been heavily supported in terms of public funding of agricultural research, education and extension, credit subsidies, land and irrigation development, supportive legislation, access to inputs, services and markets, and the evolution of farmers' organizations and their lobbies that represent farmers' interests at state and federal or EU levels. One can now speak of a 'global treadmill' that allows farmers in developed economies to export their (sometimes subsidized) products to developing countries and compete with local small-scale farmers.

Value added per agricultural worker in 2003 (constant 2000 US$) in developed market economies was 23,081 with a growth over 1992-2003 of 4.4% (FAO, 2005b). For sub-Saharan Africa the figures are 327 and 1.4%, respectively. As long as the global treadmill is operating, even with all OECD subsidies removed, efforts to uplift rural poverty will remain severely handicapped and it will continue to be difficult to enlist the vast arable lands in developing countries that are now underperforming and degrading for purposes of global food security. In these circumstances, to continue with a technology-supply push conception of innovation seems inappropriate. The rural poor are not on the global treadmill; instead the global treadmill prevents them from development. Required are institutional framework conditions that provide realistic opportunities to subsistence farmers to become small-scale commercial farmers.

In imperfect markets the benefits are uneven and do not always reach the poor. Policy responses of proven historical efficacy to addressing unevenness in competitiveness and opportunity include institutional framework conditions within which AKST can play a more positive role, i.e. by stimulating targeted investment in creating small farmers' access to market opportunities, inputs, alternative employment and to creating value-adding enterprises and by temporary market protection to infant agro-industries. The contemporary and future challenge is to achieve positive policy outcomes in ways that internalize the environmental and social costs as well.

7.5.2 Brokered long-term contractual arrangements

Brokered long-term contractual arrangements (BLCA; a term used here to designate a suite of modern contractual arrangements) have proven effective in improving the livelihoods of poor farmers and fostering rural innovation (Little and Watts, 1994; Key and Runsten, 1999). However, the set of conditions required for this policy option to be attractive are rather restrictive. BLCAs were initiated to use the good aspects of state trading enterprises (STEs) because STEs proved sensitive to corruption, rent seeking, gender discrimination and externalization of costs to farmers (Hobart, 1994; Dorward et al., 1998). A major challenge facing expanded use of BLCA´s as a policy option is to avoid repetition of the historical record that provides ample evidence of the misuse and abuse of nationalized BLCA-like (STE) schemes.

BLCAs, under favorable social conditions with transparency and strong farmer organization, provide a policy option for public sectors to invest in the creation of opportunities for poor farmers. Synergies between long term contractual arrangements and the organic and fair trade markets increase when such types of contractual arrangements are coupled with group certification of small-scale organic producers. Policy options include retooling abolished STEs and creating legal, financial and technical support for emerging new BLCAs that are pro-poor.

7.5.3 Endogenous development and traditional knowledge

Endogenous development draws mainly on locally available resources, local knowledge, culture and leadership, with an openness that allows for integration of outside knowledge and practices' (Haverkort et al., 2002; Millar, 2005).

Traditional knowledge can be effective and reliable (Brammer, 1980; Warren et al. 1991; Reij et al., 1996; Brammer, 2000; Balasubramanian and Devi, 2005) with respect to: (1) knowledge about the agroecosystem and seasonality in which the farmers operate; (2) information about what local people need, want and have capacity for in terms of resources, access to markets; (3) locally adapted technical knowledge and practices and (4) a system view based on having to live by the results.

Farmers may innovate at the system level. For example, farmers on the very densely inhabited Adja Plateau in Benin have developed an 'oil palm fallow' rotation that allows them to suppress *Imperata cylindrica*, restore soil fertility for annual crops, and make money from distilling palm wine once the palms are cut down (Brouwers, 1993). But traditional knowledge may have weaknesses such as attributing plant disease to rain and thus foregoing useful management measures (Almekinder and Louwaars, 1999) or an inability to respond to rapidly changing circumstances, e.g., climate change. Experience with multi-agent approaches suggests that mobilizing the intelligence of a great many actors to address a new and complex problem can be an effective and efficient way to solve such systemic complexity (Funtowicz and Ravetz, 1993; Gilbert and Troitzsch, 1999).

Policy options for promoting endogenous development include decentralization; use of rapid rural appraisals and participatory approaches; empowerment initiatives; multistakeholder processes; and strengthening farmer organizations. Decentralization as in India or Uganda, however, may strengthen and widen the base for democratic participation in agricultural research decision making, open new opportunities for collaboration in agroenterprise innovations and service delivery, address specific local development problems, and improve responsiveness to the needs of the poor (e.g., SNV and CEDELO, 2004).

Rapid rural appraisal (RRA) and participatory approaches may supply more accurate or insightful information than questionnaire surveys or more relevant or better adapted technologies than the experiments of scientists conducted in conditions and places remote from the fields (e.g., Collinson, 2000). Participation has long been dominant in pro-poor development approaches and may range from simple consultation to support for autonomous decision-making (e.g., Pretty, 1994; Biggs, 1995). RRA and participatory approaches may be poorly performed and insufficient, however, for addressing the multiple scales of policy intervention required (Biggs, 1978; Biggs, 1995; Cleaver, 2001; Cooke and Kothari, 2001). The challenge in meeting development and sustainability goals is to create complementarity that draws on best practice across the range of pro-poor approaches and policies (Biggs, 1982; Biggs, 1989; Bunders, 2001; Ceccarelli et al., 2002; Chema et al., 2003).

Participatory Technology Development (PTD) (Jiggins and De Zeeuw, 1992) is a concrete approach to the design of complementary action that is relevant for achieving development and sustainability goals but has some negatives associated with it. With very small windows of opportunity, it is not easy to reduce poverty by enhancing productivity at the farm level, even through PTD. The challenge is to *stretch* those windows through access to markets, better prices, the development of services, and the removal of extractive practices and patrimonial networks. Given opportunities, West African farmers have time and again considerably increased their production without major technical change. Technology becomes important once framework conditions begin to improve (Box 7.2).

[Insert Box 7.2]

Empowerment. The corollary of recognizing resource-poor farmers as partners in complementary and collaborative approaches to development is to accept their empowerment. It can be more efficient to increase farmers' countervailing power than to increase an agency's intervention power through investing in more vehicles, agent training or budget support. Farmer Field Schools (FFS) (Box 7.3) is an option that warrants further empirical research to determine the conditions under which this may be so and the kinds of policy environment that best enable empowerment strategies to be effective in meeting development and sustainability goals. (Van den Berg and Jiggins, 2007, for a review and assessment of IPM FFS literature).

[Insert Box 7.3]

Multistakeholder processes. A special participatory approach is the facilitation of multi-stakeholder processes (Leeuwis and Pyburn, 2002; Wals, 2007). Especially in resource dilemmas, where different categories of interdependent stakeholders make competing claims on common pool resources, sustainable solutions cannot come from regulation, technology or market interventions only. The way forward is a facilitated process of negotiation, shared (social) learning, and agreement on concerted action, based on trust, fairness and reciprocity. There is increasing evidence that humans are capable of agreeing on sustainable solutions and of creating institutional conditions that support he implementation of such solutions if drawn into appropriate knowledge processes (e.g., Ostrom et al., 1992; Blackmore et al., 2007). Multistakeholder processes increasingly are important with respect to climate change adaptation, when agreements have to be reached to avoid crisis or when loss of ecosystem services becomes a key cause of poverty.

The Chain-Linked Model. Commercial innovation studies give a central place to the entrepreneur who sees a possibility to capture an opportunity by mobilizing resources, including knowledge (Kline and Rosenberg, 1986). The driver of innovation in these situations typically is the entrepreneur spotting or creating market-related or social organizational opportunity. Policy support to innovation in these cases is provided by helping entrepreneurs to access specialized sources of knowledge, services and skills (Coehoorn, 1994; Crul, 2003). International experience of supporting innovation in small and medium enterprises in non-farming sectors can be useful in guiding pro-poor agricultural enterprise development.

Strengthening farmer organizations. Investing in people's organizations is a policy option (Toulmin, 2005) with a long history. The experience of the USA and Europe shows that strong farmers' organizations can be a necessary condition for commercially efficient agricultural development (Bigg and Satterthwaite, 2006). An African example is provided by ROPPA in West Africa (Koning and Jongeneel, 2006; ROPPA, 2006). Organizations such as AGRITERRA in The Netherlands attempt to strengthen farmers' organizations in developing countries through training, delegating research funds to farmers' organizations, and building farmers' capacities as effective partners in the negotiation of contracts as well as in research-priority setting. Since farmers' organizations need allies in other sectors or at other levels if they are to become strong and act effectively in collaborative AKST partnerships (Wennink and Heemskerk, 2006) it is a useful a policy option to invest in 'platforms' (or organized social arenas) where farmers and researchers can meet on a level playing field. The inclusion of small farmers' representatives on such platforms (as in the PRODUCE foundations in Mexico) may require special effort but may still end up favoring those with sufficient assets to seize commercial opportunity.

One of the persistent experiences in agricultural development is that while it can be relatively easy to promote pro-poor endogenous development, collaborative AKST partnerships and the mobilization of indigenous knowledge in pilot projects, the prevailing governance conditions make it difficult to scale up and embed successful pilot experiences in routine institutional behaviors The difficulty in part lies in social realities that position power and opportunity as highly contested zero-sum contests. In 1986, when Java's rice fields were devastated by resurgent waves of Brown Plant Hoppers (BPH) resistant to pesticides destroyed the natural enemies or predators of the BHP, it took considerable time for the government to respond. The problem was a principle called 'asal bapak senang' that may be translated as 'as long as father is happy' (with the sense of 'to avoid upsetting your boss with negative information'). At each level in the hierarchy, the bad news about the devastation in the rice fields was watered down. It was only when the people from his own village came to the President directly to ask for help that he learned that something was seriously amiss. In our assessment, policy initiatives that aim at empowerment and endogenous development would be most accepted where democratic forms of government and a strong civil society exist; most poor people live in countries where these conditions are not present.

7.5.4 Innovation systems (IS)

Innovation is the emergent property of the interaction among organizations and people who make the complementary contributions required for innovation to take place (Röling and Engel, 1991; Bawden and Packam, 1993). The configuration of actors is not fixed (Engel and Salomon, 1997). The empirical research of successful and innovative economies that stimulated the recent interest in innovation Systems has found that 'the essential determinant of innovation appeared to be that the suppliers of new knowledge were intimately engaged with the users of that knowledge' (Barnett, 2006).

Older traditions of systems thinking and practice (e.g. Checkland, 1981; Checkland with Scholes, 1990) drew attention to linkages, relationships, interfaces, conflicts, convergence, and reciprocity in innovation processes. The application of such thinking and practice to pro-poor development in agriculture has been stimulated also by the evidence that it appears to be suited to dealing with the kind of institutional development that The New Institutional Economics (North, 2005) sees as a precursor to growth.

The 'innovation systems' approach in recent years has become an ex-ante policy model (World Bank, 2007a) that draws on the aforementioned traditions as well as on empirical research on the emergence of Asian economies. Such models are an increasingly important tool for stimulating innovation at the interface of agriculture, sustainable natural resource management and economic growth, for instance in the context of the EU's Water Framework Directive (e.g., Blackmore et al., 2007) and Land Care and more recently Catchment Management Authorities in Australia (Campbell, 1994). These experiences also show up the weakness of the IS approach: absent appropriate enabling policy frameworks and economic drivers at higher system scales, successful lower scale innovations can peter out or become frustrated. The lessons may be linked to the widespread confidence that rational choice theory offers an appropriate foundation for policy designed to support innovation; the empirical evidence suggests to the contrary that, given the public good character of development and sustainability goals, policies based on an understanding of the role of collective management in innovation processes may be more appropriate (Ostrom et al., 1993; Gunderson et al., 1995).

Conditions under which the policy options may be conducive to meeting development and sustainability goals: The following concrete steps have been proposed to make an innovation systems approach work in resource-poor environments (see Tripp, 2006; McCann et al., 2006; Van Huis and Houkonnou, 2007):

- Public, private and civil society agencies identify a number of priority themes based on national plans, or poverty reduction strategies;
- For each theme, rapid appraisal of agricultural knowledge systems (RAAKS) (Engel and Salomon, 1997) or other methods are used to identify configurations of stakeholders (including researchers, farmer organizations, etc.) that constitute promising innovation systems. Such configurations include actors at the both the national and the decentralized local government level;
- Key representatives of these stakeholders are facilitated to form a 'Community of Practice' (COPs) (Wenger, 1998) at decentralized (e.g., district) and national levels, where the national level has the power and ability to create conducive institutional framework conditions for the concrete activities at the decentralized level. An IS approach thus requires trained facilitators who operate within a national mandate that recognizes the importance of IS;
- For each COP, diagnostic studies identify concrete opportunities that can be realized through concerted action by the stakeholders;
- Each COP submits proposals to a national fund set up for this purpose;
- Each COP is monitored to allow national learning about the IS approach as a basis for staff training and increasing management effectiveness.

The IS approach assumes considerable political will and an understanding of processes that cannot be captured by hierarchy and market since creating windows of opportunity for small-scale producers will require new kinds of institutional innovation (Egelyng, 2000).