FEATURES OF AGRICULTURAL EXTENSION SYSTEM AND IMPLICATION FOR CLOSING TECHNOLOGY GENDER GAP

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Synopsis

Agricultural sector in many developing countries is underperforming, in part because women who represent a crucial resource in agriculture and the rural economy through their roles as farmers, labourers and entrepreneurs face more severe constraints than men in access to productive resources almost everywhere. One of the reasons for the underrepresentation of women in agriculture has been their relatively low level of involvement in different technology development processes that have been introduced over the years. This paper discusses features of Agricultural Extension System and the Implications for closing Technology Gender Gap worldwide. Also, it discusses the needs for Agricultural Innovation Systems and Emerging Trends affecting gender roles in Agricultural Innovation.

Keywords: Innovation, Gender Gap, Technology, Women

1. Introduction

Agriculture is an important sector in the economic development and poverty alleviation drive of many countries. The role agriculture played in the industrial growth and development of most industrialized countries in the world cannot be over emphasized (Farshid 2011). The international development community has recognized that agriculture is an engine of growth and poverty reduction in countries where it is the main occupation of the poor (World Bank 2007).

Women make essential contributions to the agricultural and rural economies in all developing countries. Their roles vary considerably between and within regions and are changing rapidly in many parts of the world, where economic and social forces are transforming the agricultural sector. But the agricultural sector in many developing countries is underperforming, in part because women face more severe constraints than men in access to productive resources, despite the fact that they represent a crucial resource in agriculture and the rural economy through their roles as farmers, labourers and entrepreneurs (FAO 2011a).

Figure 1 shows the trend of weighted averages for the female share of total population economically active in agriculture in 5 major regions of the world. According to these data, women comprise just over 40 percent of the agricultural labour force in the developing world, a figure that has risen slightly since 1980 and ranges from about 20 percent in the Americas to almost 50 percent in Africa.

Women make up almost 50 percent of the agricultural labour force in sub-Saharan Africa since 1980 till 2010. The averages in Africa range from just over 40 percent in Southern Africa and 50 percent in Eastern Africa. These sub-regional averages have remained fairly stable since 1980, with the exception of Northern Africa, where the female share appears to have risen from 30 percent to almost 45 percent. Within Asia, the

sub-regional averages range from about 35 percent in South Asia to almost 50 percent in East and Southeast Asia. The global average is dominated by Asia. The developing countries of the Americas have much lower average female agricultural labour shares than the other developing country regions at just over 20 percent in 2010, slightly higher than in 1980 (FAO 2011a).

One of the reasons for the underrepresentation of women in agriculture has been their relatively low level of involvement in different technology development processes that have been introduced over the years. The different technology developments include; National Agricultural Research System (NARS), Agricultural Knowledge Information System (AKIS) and, more recently, Agricultural Innovation System (AIS).

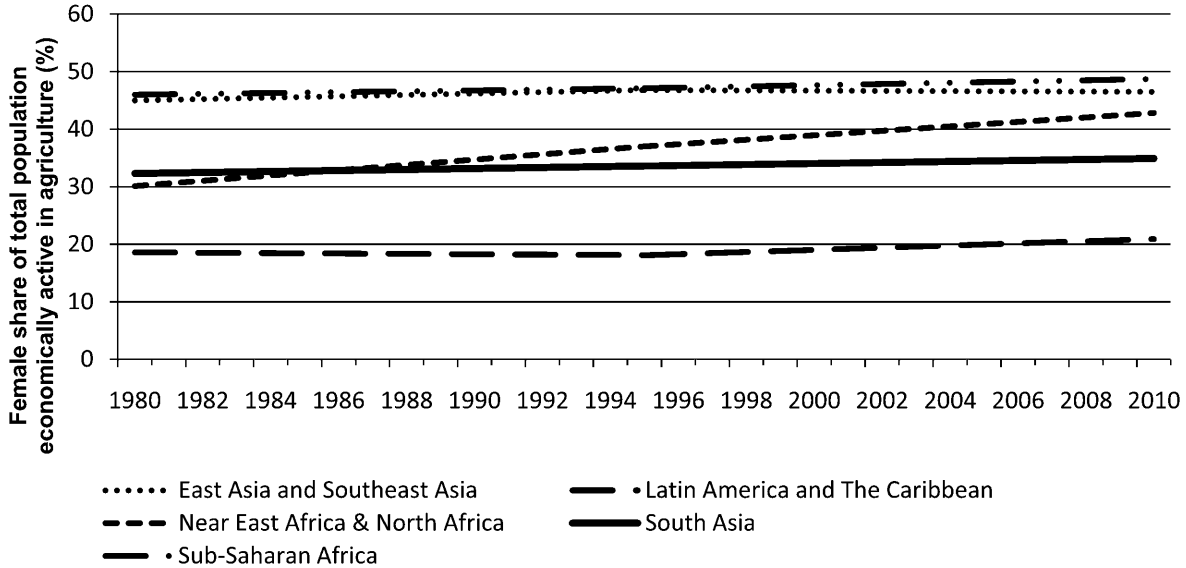
2. Technology Development Systems in Agricultural Sector

According to Riikka et al (2008), the last 40 years have witnessed substantial debate over the best way for science and technology (S&T) to foster innovation. The first view to emerge regarded scientific research as the main driver of innovation; research created new knowledge and technology that could be transferred and adapted to different situations, this view is usually termed the "linear" or "transfer of technology" model. The second and later view was termed the "agricultural knowledge and information system" (AKIS) concept in the 1990s and (more recently) the "agricultural innovation systems" (AIS) concept. Although it acknowledges the importance of research and technology transfer, the second view explicitly recognizes innovation as an interactive process.

2-1. The National Agricultural Research System (NARS)

The National Agricultural Research System (NARS) perspective recognizes the public good nature of agricultural research and the absence of market access or purchasing power among many agrarian agents, and thus places necessary emphasis on the role of the state in fostering technological change. Yet the NARS approach tends toward linearity in so far as the movement of knowledge is described as originating from some known source (the scientific researcher) and flowing to some end user (the farmer), with

FIGURE 1: FEMALE SHARE OF AGRICULTURAL LABOUR FORCE



Note: The female share of the agricultural labour force is calculated as the total number of women economically active in agriculture divided by the total population economically active in agriculture. Regional averages are weighted by population.

Adapted from FAO 2011a

the assumption that social and economic institutions in which this process occurs are largely exogenous and unchanging (Spielman, 2005).

NARS was developed to guide investments in agricultural development. Development activities based on the NARS concept generally focused on strengthening research supply by providing infrastructure, capacity, management, and policy support at the national level.

The NARS framework has been effective in creating agricultural science capacity and in making improved varieties of major food staples available, particularly in Asia, where its use has transformed food production but research is not explicitly linked to technology users and other actors in the sector. As a result, NARS priorities are slow to reflect clients' needs and changing circumstances in the sector. The NARS framework is poorly suited for responding to rapidly changing market conditions and for providing necessary technologies for producers (who are mainly women) to supply emerging, high-value niche markets. By emphasizing the development of the capacity of the research system, the NARS framework tends to limit attention to other factors that enable new technologies to be used (World Bank 2007).

2-2. Agricultural Knowledge Innovation System (AKIS)

AKIS is defined as "a set of agricultural organizations and/or persons, and the links and interactions between them, engaged in such processes as the generation, transformation, transmission, storage, retrieval, integration, diffusion and utilization of knowledge and information, with the purpose of working synergistically to support decision making, problem solving and innovation in a given country's agriculture or domain thereof" (Röling 1990).

The AKIS incorporate important concepts from the study of information and knowledge economics. The AKIS perspective highlights the linkages between research, education, and extension in generating knowledge and fostering technological change (Nagel, 1979; Röling, 1986, 1988). More importantly, by focusing on the dynamics of dissemination through extension, the approach rectifies some of the conceptual gaps that had impeded analyses of how knowledge moves between researchers and end users.

The AKIS perspective, embedded as it is in the study of how knowledge flows between and among agents, is less linear than the NARS approach. Yet it may be argued that the perspective is limited in its ability to conduct analysis beyond the nexus of public sector research, university research, and extension services and to consider heterogeneity among agents, the institutional and historical context that conditions their behaviors, and the learning processes that determine their capacity to change and innovate (Spielman 2005).

Agricultural knowledge and information systems link people and organizations to promote mutual learning and to generate, share, and use agriculture-related technology, knowledge, and information. An AKIS integrates farmers, agricultural educators, researchers, and extension staff to harness knowledge and information from various sources for improved livelihoods. Farmers are at the heart of the knowledge triangle formed by education, research, and extension (FAO and World Bank 2000).

The AKIS concept recognizes that multiple sources of knowledge contribute to agricultural innovation and gives attention to developing channels of communication between them. The emphasis on innovation as a social process of learning broadens the scope of agricultural research and extension to include developing local capacities. The addition of educators to the framework is notable. The AKIS framework clearly recognizes that education improves farmers' ability to engage in innovation processes but the focus is restricted to actors and processes in the rural environment, and the framework pays limited attention to the role of markets

(especially input and output markets), the private sector, the enabling policy environment, and other disciplines/sectors. The AKIS framework recognizes the importance of transferring information from farmers to research systems but tends to suggest that most technologies will be transferred from researchers down to farmers which women mostly do not have access to as their male counterparts (World Bank, 2006).

2-3. Agricultural Innovation System

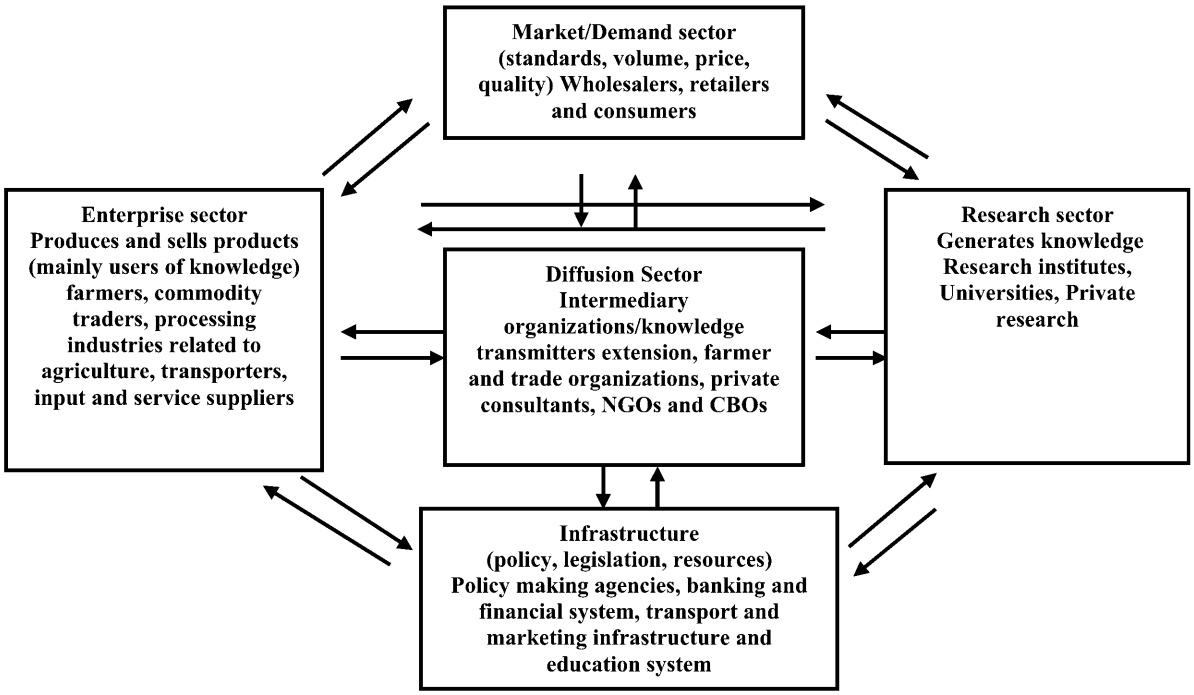
An innovation system can be defined as the network of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into economic use, together with the institutions and policies that affect the system's behavior and performance (World Bank 2006).

Adapting the various definitions of innovation system, agricultural innovation system is defined as a set of agents that jointly and/or individually contribute to the development, diffusion and use of agriculture-related new technologies and that directly and/or indirectly influence the process of technological change in agriculture (Tugrul and Ajit, 2002).

The AIS concept, which has been tested widely in the industrial sector, offers a holistic way of strengthening the capacity to create, diffuse, and use knowledge. Aside from knowledge and skills, capacity development includes the attitudes and practices that influence the way organizations deal with knowledge, learning, and innovation and the patterns of relationships and interactions that exist between different organizations. The concept strongly links innovation and investment needs but this remains largely untested in the agricultural sector. It is difficult to diagnose the interactions and institutional dimensions of innovation capacity from analysis of published data sources, as these not routinely tracked in industry and national statistics (World Bank 2006).

The AIS framework considers women to be critical actors in an innovation system. From this perspective, innovation is viewed as a social and economic process that draws on discovery and invention but recognizes that the most important role that these innovations have is to improve the livelihoods of all people, especially those of women and other vulnerable groups (World Bank 2009). From the perspective of the AIS framework, the

FIGURE 2: POSSIBLE ACTORS IN THE AGRICULTURAL INNOVATION SYSTEM



Adapted from CABI/CTA/KIT/VRLIE/WUR (2006)

active engagement of women is no longer only a right but is an imperative to future farming, processing, and marketing systems that can improve livelihoods and agribusiness development. This framework proposes that innovation involves not only new actors but also new roles and many relationships that can sustain knowledge generation and learning if technical and economic successes, together with social and environmental sustainability, are to be achieved (Spielman and Birner 2008).

Although the AIS framework focuses on equality in access to technology, inputs, services and markets, as well as on opportunities for participation, leadership and equal representation as a means of influencing policy-making processes, it does not make visible farmer types based on diverse asset portfolios, levels of education, and networks. So although there is a visible space for all types of actors in the system, small-scale, women, and indigenous farmers will continue to be left behind unless they receive effective support to build the organizational, technological, management, and investment capacity they will need to engage (World Bank 2009)

Figure 2 shows the possible linkages and relationships among diverse actors in an agricultural innovation system. The agricultural innovation system (AIS) comprises of a far broader set of actors than the traditional agricultural research, extension and education agencies. Innovation takes place throughout the whole economy, and not all innovations have their origin in formal S & T nor are they all exclusively technical. This new perspective places more emphasis on the role of farmers, input suppliers, transporters, processors and markets in the innovation process. While each of the three system concepts has its own strengths and weaknesses, they can be seen as interlinked and cumulative: NARS focuses on the generation of knowledge, AKIS on the generation and diffusion of knowledge, and AIS on the generation, diffusion, and application of knowledge.

AIS evolved directly from the concept of national innovation systems with the sectoral level as the unit of analysis. The organizations include research institutes, training and education institutions, credit institutions, policy and regulatory bodies, private consultants/NGOs, farmers, farmers' associations and public services delivery organizations. It emphasizes agricultural innovations and goes beyond previous knowledge system concepts by incorporating the goals of current reform measures, such as political decentralization, public sector alliances with the private sector, enabling private sector participation in advancing consensus approach to development and promoting demand-driven services. Besides, it captures the intricate relationships between diverse actors, processes of institutional learning and change, market and non-market institutions, public policy, poverty reduction and socioeconomic development.

3. Characteristics of NARS, AKIS AND AIS frameworks

The main characteristics of these frameworks are described, followed by a discussion of their major similarities and differences (summarized in table 1).

A NARS comprises all of the entities within a country that are responsible for organizing, coordinating, or executing research that contributes explicitly to the development of its agriculture and the maintenance of its natural resource base (ISNAR 1992). The NARS framework has been the mainstay of agricultural development planning for the past 40 years or so. The underlying idea is classically linear agricultural research, through technology transfer, leads to technology adoption and growth in productivity. The capacity to achieve this goal lies within the agricultural research, training, and extension organizations of the public sector. Capacity is developed by investing in scientific infrastructure, equipping human resources with up-to-date skills, setting research priorities, and providing the operational funds to implement

Table 1: Defining Features of the NARS and AKIS Frameworks in Relation to Agricultural Innovation Systems

Defining feature	NARS	AKIS	Agricultural innovation system
Purpose	Planning capacity for agricultural research, technology development, and technology transfer	Strengthening communication and knowledge delivery services to people in the rural sector	Strengthening the capacity to innovate throughout the agricultural production and marketing system
Actors	National agricultural research organizations, agricultural universities or faculties of agriculture, extension services, and farmers	National agricultural research organizations, agricultural universities or faculties of agriculture, extension services, farmers, NGOs, and entrepreneurs in rural areas	Potentially all actors in the public and private sectors involved in the creation, diffusion, adaptation, and use of all types of knowledge relevant to agricultural production and marketing
Outcome	Technology invention and technology transfer	Technology adoption and innovation in agricultural production	Combinations of technical and institutional innovations throughout the production, marketing, policy research, and enterprise domains
Organizing principle	Using science to create inventions	Accessing agricultural knowledge	Finding new uses of knowledge for social and economic change
Mechanism for innovation	Transfer of technology	Interactive learning	Interactive learning
Degree of market integration	None	Low	High
Role of policy	Resource allocation, priority setting	Enabling framework	Integrated component and enabling framework
Nature of capacity strengthening	Infrastructure and human resource development	Strengthening of communication between actors in rural areas	Strengthening of interactions between actors; institutional development and change to support interaction, learning, and innovation; creating an enabling environment

Source: FAO and World Bank 2000; ISNAR 1992

those priorities. This model proved very effective in areas where technological solutions with wide potential applicability were required (for example, to overcome the food shortages in South Asia in the 1970s). The emphasis on setting priorities by agricultural commodity implies that small and nascent activities tend to be neglected until they have reached significant economic importance. The NARS framework highlights the research base that leads to improved production technology, although the adoption of these research results in farmers' fields was often encouraged by separate output and input (especially fertilizer) pricing policies.

The AKIS framework has its origins in the analysis of agricultural extension arrangements. It has a strong focus on how information and ideas are communicated between the various actors in rural areas and how this knowledge can be harnessed for rural livelihoods. AKIS recognizes learning and innovation as an interactive process. The AKIS framework has been promoted strongly by FAO and tackles many of the shortcomings of conventional agricultural research and extension systems, particularly their limited opportunities for interaction between the users and producers of knowledge.

The AIS concept values the capacities and processes emphasized in the NARS and AKIS frameworks, including channels that give farmers access to information, and well-resourced and up-to-date scientific research and training organizations. It also goes further in recognizing a broader range of actors and disciplines/sectors involved in innovation, particularly the private sector in its many guises along the value chain. Innovation systems analysis recognizes that creating an enabling environment to support the use of knowledge is as important as making that knowledge available through research and dissemination mechanisms.

In the same way, an innovation system encompasses a wider set of activities that are likely to support innovation by including such processes as the creative adaptation and financing of innovation. Like AKIS, the AIS concept places greater emphasis on the interaction between actors, but encompasses a wider set of relationships that can potentially foster innovation because it includes this broader set of relationships between actors and contexts, it potentially offers a framework for embedding innovation capacities in the rapidly changing market, technological, social, and political environment of contemporary agriculture.

4. The Need for Agricultural Innovation System

Like other economic sectors, agriculture today is evolving in an environment of rapid changes in technology, markets, policies, demography and natural environments (e.g. climate change, desertification). Although partly due to globalisation and world-wide trends, the challenges that these changes pose to national agricultural sectors or local communities are context-specific and complex. These challenges are putting new demands on all actors in and around the agricultural sector to innovate and develop new ways of collaborating to generate knowledge and put it into use at the required pace. This includes 'co-innovation' between different companies and users of their products, between private and public research, between farmers, agro-industries and retailers (e.g. to develop new convenience foods requiring new crop varieties), between farmers, policy makers and research (e.g. to develop ways of complying with new food safety or environmental regulations), etc. Making knowledge work and scaling up innovation also requires collaboration between actors who can promote those markets, policies, financial and business support services which are adequate and mutually reinforcing the large scale use of knowledge for change. (Jon Daane 2010)

5. Gender Roles and Constraints

In the realm of national and international agricultural research, women continue to be underrepresented and underserved, and their contributions are not fully tapped (Ruth et al 2011). This "gender gap" hinders their productivity and reduces their contributions to the agricultural sector and to the achievement of broader economic and social development goals (FAO 2011a).

According to Ruth et al (2011), despite the important role women play in agricultural production, they remain disadvantaged in numerous respects. On one hand, women have limited access to a wide range of agricultural inputs including seed and fertilizer, technological resources, equipment, land, and so forth. On the other hand, women often lack the capacity needed to deploy these resources. For example, women may have access to land but lack access to the fertilizer needed to farm the land productively or lack the knowledge of how to properly apply fertilizer. Furthermore, many nontangible assets, such as social capital, human capital, rights, and decision making power, are more difficult for women to access. Although gender inequality involves comparisons between women and men, in most (but not all) cases the gender gap penalizes women. These gaps in assets and inputs are a hindrance to agricultural productivity and poverty reduction.

Although the AKIS approaches promote the farming systems perspective that considered intra-household gender relations and differences with regards to roles and responsibilities in agricultural production, they failed to reconcile the power relations pertaining to decision making. For example, men, as heads of households, make most of the decisions, thus cutting out the contribution of women as key stakeholders and actors in agricultural production (World Bank, FAO and IFAD, 2009).

Many agricultural policy and project documents still fail to consider basic questions about the differences in the resources available to men and women, their roles and the constraints they face and how these differences might be relevant to the proposed intervention. As a result, it is often assumed that interventions in areas such as technology, infrastructure and market access have the same impacts on men and women, when in fact they may not. At the same time, building a gender perspective into agricultural policies and projects has been made to seem more difficult and complex than it need be. The agriculture sector is becoming more technologically sophisticated, commercially oriented and globally integrated; at the same time, migration patterns and climate variability are changing the rural landscape across the developing world. These forces pose challenges and present opportunities for all agricultural producers, but women face additional legal and social barriers that limit their ability to adapt to and benefit from change (FAO 2011a).

Good and timely information on new technologies and techniques is essential for farmers when deciding whether or not to adopt an innovation. Although private extension services are playing an increasing role in some countries, public extension services remain the key source of information on new technologies for farmers in most developing countries. Extension services encompass the wide range of services provided by experts in the areas of agriculture, agribusiness, health and others and are designed to improve productivity and the overall wellbeing of rural populations. The provision of agricultural extension can lead to significant yield increases. Yet, extension provision in developing economies remains low for both women and men, and women tend to make less use of extension services than men (Meinzen-Dick et al 2010).

According to a 1988-89 FAO survey of extension organizations covering 97 countries with sex disaggregated data (the most comprehensive study available), only 5 percent of all extension resources were directed at women. Moreover, only 15 percent of the extension

personnel were female (FAO, 1993). In social contexts where meetings between women and men from outside the family nucleus are restricted, a lack of female extension agents effectively bars women from participating. The preference for female extension agents varies by country and marital status. However, even when women have access to extension services, the benefits may not be obvious. Extension service agents tend to approach male farmers more often than female farmers because of the general misperception that women do not farm and that extension advice will eventually "trickle down" from the male household head to all other household members. Extension services are often directed towards farmers who are more likely to adopt modern innovations, for example farmers with sufficient resources in well-established areas. Women are less likely to access resources and may therefore be bypassed by extension service providers (Meinzen-Dick *et al.*, 2010).

Finally, the way in which extension services are delivered can constrain women farmers in receiving information on innovations. Women tend to have lower levels of education than men, which may limit their active participation in training that uses a lot of written material. Time constraints and cultural reservations may hinder women from participating in extension activities, such as field days, outside their village or within mixed groups (Meinzen-Dick *et al.* 2010).

Several new and participatory extension approaches have been developed and tested in the past decade in an effort to move away from a top-down model of extension service provision to more farmer driven services. These approaches can target women effectively and increase their uptake of innovations (Davis et al 2009). Participatory approaches that encourage communication between farmers and researchers can also lead to positive feedback loops that allow researchers to adjust innovations to local needs.

Modern information and communication technologies (ICTs) such as radio, mobile phones, computers and Internet services can also play an important role in transferring information. ICTs offer opportunities for accessing and sharing information faster, networking, the mobilization of resources and educational purposes (ITU, 2010). These technologies may be beneficial for rural women whose ability to travel to distant markets is restricted. Rural women may face barriers in accessing ICTs because of their limited education, financial and time constraints (Best and Maier, 2007).

Access to new technology is crucial in maintaining and improving agricultural productivity. Gender gaps exist for a wide range of agricultural technologies, including machines and tools, improved plant varieties and animal breeds, fertilizers, pest control measures and management techniques. A number of constraints, lead to gender inequalities in access to and adoption of new technologies, as well as in the use of purchased inputs and existing technologies. The use of purchased inputs depends on the availability of complementary assets such as land, credit, education and labour, all of which tend to be more constrained for female-headed households than for male-headed households (FAO 2011a).

The adoption of improved technologies is positively correlated with education but is also dependent on time constraints (Blackden *et al.*, 2006). In an activity with long turnaround periods such as agriculture, working capital is required for purchasing inputs such as fertilizers and improved seeds; however, women face more obstacles relative to men in their access to credit (FAO 2011a).

6. Emerging Trends Affecting Gender Roles in Agricultural Innovation

Several emerging trends are affecting the gender-responsiveness of agricultural innovations, including policies, social processes, information and communication technologies, learning and education, formal and informal organizations, and monitoring and evaluating progress.

Gender-responsive agricultural policies have contributed to overcoming asymmetries in gender power relations, especially where they provided frameworks and mechanisms for improving women's access to assets including information, training, land, and technology. From the perspective of AIS, an increase in women's capacity to manage different aspects of a given system will enhance the capacity of that system to innovate and sustain itself as climate changes, market opportunities, and the need for alliances and networks become more and more demanding.

Agricultural and social policy can enable or hinder the participation of women whether they work on farms or require education, or if they are scientists in national and international research organizations. Policies regarding farm and related labour practices, trade, and food safety, to name a few, influence gender relations far beyond the local level and throughout the system. Increased participation of women in research and extension organizations can contribute to the development of gender-sensitive policies and practices. The most important policy that affects the participation of professional women in the agricultural sciences and extension is probably one that explicitly makes their contributions in national, regional, and local organizations visible. If the professional women in agriculture are not visible in newspapers, on radio and television, and in research organizations and extension offices, it is doubtful that primary- and secondary-school students will become inspired to prepare for careers in agriculture, let alone in agricultural research.

Women extensionists need extra support throughout their scientific careers from colleagues who have "been through it" or are empathetic with them. It is not enough to motivate women to prepare for and take up positions in extension; more is needed if women are to stay involved. We require additional steps to engage women in informal networks, working groups, and teams so that they will not only be competitive but also be visible and recognized. Overcoming the hurdles women scientists face cannot be left to the individuals alone, and it will not happen with written rules alone. An effective mentoring system needs to be put into place so that women scientists can become more effective in leveraging opportunities for advancement and conditions that will make the workplace more friendly to and acceptable for them (World Bank 2009).

Other emerging trends affecting gender roles in agricultural innovation according to World Bank 2009 are as follow;

Informal organizations and women's access to information and services; social processes of communication and information exchange; practices that increase the commitment and empowerment of women; innovation platforms for learning, communication, and alliance building; investment in diverse forms of research and advisory services; strategies that engage women in agricultural innovation; recognition for organizations that pay attention to representation by women; monitoring progress of multi-stakeholder involvement.

7. An example of how AIS closed Gender Gap; a case study of Papa Andina in Peru

One major example of the implementation of AIS is the Papa Andina project. Papa Andina works through a range of strategic local partners in each country: the PROINPA Foundation (Bolivia) ; the National Potato Program, INIAP (Ecuador) ; and the INCOPA Project (Peru). It was financed by Swiss Agency for Development and Cooperation; also New Zealand Aid Programme, McKnight Foundation and implemented by Partnership Program hosted by the International Potato Center (CIP).

Across the Andean region, small-scale farmers face the challenge of gaining access to dynamic new markets for high value produce while remaining resilient amid the forces of climate change and globalization. The Papa Andina regional initiative, anchored in the International Potato Center (CIP), promotes innovation that

leads to the development of market niches and value addition, particularly for the native potatoes grown by poor smallholders in Bolivia, Ecuador, and Peru. The assessment of gender issues plays a critical role in Papa Andina's two principal approaches to engage market chain actors: the Participatory Market Chain Approach (PMCA) and stakeholder platforms.

The PMCA is based on the participatory approach to stakeholder collaboration in agricultural R&D known as Rapid Appraisal of Agricultural Knowledge Systems (RAAKS) (Engel and Salomon 2003). The PMCA fosters commercial, technological, and institutional innovation through a three-step process that builds interest, trust, and collaboration among participants, improves farmers' links to markets, and stimulates pro-poor innovation.

Stakeholder platforms are spaces and events where public and private stakeholders interact, share reciprocal interests, build trust, and join in common initiatives. Often such platforms are developed as a result of PMCA and continue after the approach has been implemented; in other cases, the PMCA works through platforms that already exist.

Both the PMCA and stakeholder platforms facilitate the articulation of demand and supply for innovation-linked services and reduce transaction costs in marketing the produce of many small farmers (Bernet et al. 2008). In the Andes, PMCA has been validated in two complete cycles, both in Peru and Bolivia (2003–04). The method has been shared with other organizations in these countries, which has led to further testing. In Peru, the Intermediate Technology Development Group, an international NGO, subsequently used the method in the cheese, coffee, and cacao subsectors. Starting in 2005, PMCA was introduced and tested in potato, sweet potato, and vegetable commodity chains in Uganda.

7-1. Objectives and Description

A key feature of Papa Andina is that it brings together many participants in the AIS, including smallholders, market agents, and agricultural service providers, many of whom did not know one another or who actively distrusted one another, and helps to identify new opportunities for all of these stakeholders to collaborate and innovate. Papa Andina recognizes that gender analysis and female farmers' active involvement in assessing innovation processes and systems are central to developing sustainable, profitable agricultural market chains that are well integrated into the wider innovation system. In turn, this system-level integration is important for gender equality and the empowerment of resource-poor women and their families. Each phase of the PMCA incorporates specific gender related assessments and activities. Flexibility in the duration of each phase and in the use of specific tools (quantitative surveys, focus groups, and so forth) is necessary (Bernet et al. 2008).

7-2. Innovative Elements

From a gender perspective, Papa Andina has three innovative elements. *The first innovative element* is that the PMCA and stakeholder platforms enable women to share their findings and customs with other members of the AIS through events and activities that highlight women's knowledge of genetic diversity. When women participate in events such as family competitions, their roles in the farming household, the wider community, the market chain, and the AIS are recognized and reinforced. The *second innovative element* is that the empowerment of women farmers has resulted in systemic changes. Through the PMCA, women's involvement and the involvement of different groups of women are systematized in the following ways:

Representation: Smallholders, female and male representing their communities at events return to their communities and share their findings and innovative ideas.

Replication: Initial farmers, now acting as representative farmers, work with R&D partners to replicate knowledge-sharing events and

activities with more farmers in their area who grow native potatoes. For example, a woman farmer in Puno shared information with representatives of 12 communities in the Lake Titicaca basin. In this way, innovative ideas for making coffee from dried potato and adding value to freeze dried potato products spread to at least 10,000 farmers in those areas.

Communication and recognition: Native potato product ideas and technologies were also shared between women farmers in Peru and women's groups and R&D institutions in Uganda, Bolivia, and Ecuador (Horton 2008; Kaganzi et al. 2009).

The *third innovative element* is that Papa Andina purposefully demonstrated the value of women's involvement in the AIS. The initiative showed that it is possible to involve resource-poor women farmers as key stakeholders in the potato value chain; the participating R&D institutions demonstrated the value added by gender analysis and investing in women's innovation; and the donor agencies played an important role in establishing the need for gender assessment and the integrated involvement of women farmers in R&D as key stakeholders.

7-3. Benefits, Impacts and Experience

A number of gender-related benefits, impacts, and experiences are linked to each of the three phases of the PCMA and to the stakeholder platforms. In *phases 1 and 2*, experiences with gender assessment and gender-related activities in organizing the PMCA and stakeholder platforms have shown how to foster the organization of female and male farmer groups based on common interests and resources. Organizing enables farmer groups to consider the economic feasibility of production and marketing issues beyond the household level. The groups can build their human and social capital to access platforms where support is available from R&D and government institutions as well as NGOs. This support can also entail technology transfer to farmers and opportunities to fine-tune technologies to specific conditions.

In *phases 2 and 3*, thematic groups use communication and collaboration to address and break down traditional gender roles, divisions of labor, and power relations. Recognizing women's role in the selective breeding of native potato varieties in different ecosystems and their detailed knowledge of different potato phenotypes helps to counteract gender bias. Communication activities, including the innovation fairs, focus on how Andean women have cultivated native potatoes. These activities enable women to bring their large store of knowledge to bear on the innovation process for native potato.

In recent years, women farmers in some regions of Peru have established profitable businesses supplying native potatoes to national and/or international markets. Messages about women's advancement in marketing chains and innovations have been highlighted in public-private R&D partnerships and corporate social responsibility commitments involving such companies as Pepsi-Co and its subsidiary, Frito Lay. New products marketed by some companies have used the image of an award-winning female farmer. These examples have been reported as motivating female producers to participate in the native potato market chain.

7-4. Lessons and Issues for wider Application

Several gender-related lessons have emerged from Papa Andina. Donor priorities were an important contextual consideration for incorporating gender assessment in the native potato innovation system. Donor agencies' initial proposal development and planning criteria for gender, empowerment, and working with NGOs stimulated the requirements for gender assessment and the integrated involvement of women farmers in R&D as key stakeholders. As a result, "researchers and NGOs that have worked with Papa Andina are more aware of gender issues and the need to achieve impact at farmer level" (Devaux et al. 2010).

In some cases, the benefits of traditional and newly developed innovations generated by the

stakeholder platforms remain highly localized. For example, with support from USAID, one farming community sold a local variety of potato known as "Capiro" to Frito Lay to produce potato chips for the domestic market (the company had previously imported potatoes from Colombia). Farmers earned more than US$1.6 million in sales, but this success cannot be replicated easily because the domestic market for snack foods is limited. Farmers are also cautioned not to regard this success story as an inducement to grow just one variety of potato. The maintenance of potato diversity remains central to the innovation system and its stakeholder platforms. Although female farmers, especially indigenous women farmers, have brought a wealth of experience to market chains and agricultural innovation, women farmers often struggle to ensure that their knowledge benefits themselves, their families, and their communities. Investment strategies that establish networks of information and knowledge sharing can increase the impact of locally developed and innovative practices and strengthen the abilities of women and their communities to meet their agricultural and economic needs in a culturally appropriate and environmentally sensitive manner.

Despite women's critical role in the potato market chain, subsistence production, in which women are usually involved, receives less institutional support than cash crop production. The number of female extension officers in public extension systems is very limited (although the only NGO working in the high Andes, Fovida, provides a few female agents). As a result, resource-poor women farmers are less likely than their male counterparts to receive agricultural extension services. Forming links to NGOs within phases 2 and 3 of the PMCA is important to strengthening the innovation system in this regard.

Papa Andina illustrates the centrality of gender issues in sustainable and inclusive agricultural development and the effectiveness of the AIS as a whole. Gender assessment and strategies to ensure the participation of women in value chains are important tools to identify the strengths and diversity of actors in innovation systems. R&D institutions play an especially important role in ensuring that innovation benefits small-scale male and female farmers (Silvia 2012).

Conclusion

Carefully designed policies, strategies and projects can work within existing cultural norms, through the public and private sectors, in ways that benefit both women and men. Policy interventions can help close the gender gap in agriculture and rural labour markets. Priority areas for reform include: eliminating discrimination against women in access to agricultural resources, education, extension and financial services, and labour markets; investing in labour-saving and productivity-enhancing technologies and infrastructure to free women's time for more productive activities; and facilitating the participation of women in flexible, efficient and fair rural labour markets. This would produce significant gains for society by increasing agricultural productivity, reducing poverty and hunger, and promoting economic growth.

If women had the same access to productive resources as men, they could increase yields on their farms by 20–30 percent. This could raise total agricultural output in developing countries by 2.5–4 percent. Production gains of this magnitude could reduce the number of hungry people in the world by 12–17 percent. The potential gains would vary by region depending on how many women are currently engaged in agriculture, how much production or land they control, and how wide a gender gap they face. These potential productivity gains are just the first round of social benefits that would come from closing the gender gap. When women control additional income, they spend more of it than men do on food, health, clothing and education for their children. This has positive implications for immediate well-being as well as

long-run human capital formation and economic growth (FAO, 2011b).

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農業普及と農業技術におけるジェンダー・ギャップ

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要　約

多くの途上国では，いまなお農業がその潜在力を十分に発揮できていない。この事態は部分的には，女性が農民として，あるいは労働者としてまた企業者として農業や農村経済で重要な役割を担っているのに，生産要素へのアクセスが男性よりも制限されていることによって引き起こされている。農業技術は過去何年にもわたってさまざまの形で導入されてきたが，その開発過程では女性の役割を十分に考慮してこなかった点に，その理由の一端を求めることができる。本稿では３つの農業普及システムの特徴を論じ，農業技術におけるジェンダー・ギャップをどのようにして埋めていけるのかを検討する。そのために，AIS（Agricultural Innovation Systems）と呼ばれる農業普及システムの必要性と農業の技術革新におけるジェンダーの役割に影響する最近の動向を明らかにする。