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Characteristics, current relevance and retention of traditional knowledge in agriculture

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Introduction

Modern technological interventions have increased food production and created both negative and positive impact, especially on natural resources and their management. They are input intensive and have inevitably altered the ecological services of agro ecosystem. It has been reported that 60 per cent of ecosystem services are now degraded, contributing to a reversal in productivity gains (MA, 2005) that increases the vulnerability of farmers and farming systems. Studies indicate that scientific methods of intensive farming have reached only 30 per cent of resource-rich farmers, whereas the needs and priorities of nearly 70 per cent of the world's resource-poor farming communities were not adequately addressed (Nene, 2006).

There is a need for a paradigm shift in approach from higher productivity alone to integrated ecological, food and nutritional security to attain the goals of sustainability. This calls for an interdisciplinary and integrated agro-ecosystems approach to inclusive knowledge management encompassing traditional knowledge. The process of knowledge evolution and management commences with the advent of domestication of natural resources to meet subsistence goals. Traditional knowledge has been derived from the direct experience of labour process and empirically shaped by the social and physical environment (Kloppenburg, 1991) and passed to future generations (Braimoh, 2002) orally or by shared experiences and practices (Ohmagari and Berkes, 1997). Traditional

Traditional knowledge in policy and practice: Approaches to development and human well-being, Subramanian and Pisupati (eds), United Nations University Press, 2010, ISBN 978-92-808-1191-9

knowledge is defined as the knowledge of a people of a particular area based on their interactions and experiences within that area, built, experimented, adapted, and modified with the continuous utilitarian value which is holistic and largely transmitted orally (Boef et al., 1993).

The importance of traditional knowledge in agriculture was recognized during the nineteenth century when George Watt, a British botanist, documented traditional agricultural techniques in his book *Economic Products of India* between 1889 and 1893. Recently, at the global level there have been increasing research, dialogue, and attempts to revive interest in and practice of traditional agriculture, including livestock keeping, in the context of sustainable resource use. Also, biotechnological and pharmaceutical industries are increasingly looking for traditional knowledge. Many international development agencies, universities and research institutions have started focusing on traditional knowledge and they have incorporated it in their development perspectives. Large numbers of books, research articles, journals and newsletters have emerged during the last two decades on traditional knowledge.

Scholars have studied the varied dimensions of traditional agricultural knowledge and revealed its benefits. The application of folk biological principles in agriculture began with the study of ethnology of varietal taxa among several farming cultures, such as rice varieties among the Hanuoo (Conklin, 1957), potato names among the Aymara of Bolivia (LaBarre, 1947) and nomenclatural and classification systems (Berlin et al., 1973). However, only since 1970 has the theme of ethnobiological approaches emerged in the field of agricultural biodiversity (Orlove and Brush, 1996). Scholars reported its association with the environment (Ellen et al., 1996), agricultural practices (Brush, 1992), in situ conservation and management of genetic resources (Hammer et al., 1991), communal resource management institutions (Berkes, 1989), and tenure arrangements and resource allocation (Brookfield, 2001).

The United Nations Development Programme has recognized the contribution of traditional knowledge in achieving the Seventh Millennium Development Goal of "ensuring environmental sustainability." Traditional knowledge provides a basis for local level decision-making on issues of food security, human health, natural resource management (Gadgil and Berkes, 1991), livestock health, fodder sources, genetic improvement, range/grazing land management (ITDG, 1998), environmental assessment, and developmental planning (Warren et al., 1993). MOST and CIRAN (1999) and Kuramoto and Sagasti (2002) reported that traditional knowledge is crucial for survival and often contributes to improving the quality of life among poor populations. Agro-ecologists visualize traditional systems as unique opportunities to study the perspectives of stability and sustainability and to get ideas for agro-ecosystem management (Altieri and Merrick, 1987). In Nigeria indigenous soil taxonomy provides the base for agricultural decision-making (Warren and Rajasekaran, 1993) and folk biological taxonomy in plant genetic resource conservation, and in Guatemala and Peru forest conservation activities incorporate traditional sustainable harvesting methods (Nations, 1992 and Salick, 1992). Similarly, in Namibia the WWF has demonstrated the use of traditional knowledge in community based resource management, creating a win-win situation between economy and environment (AFROL, 2004).

Over the last two centuries, science and technology led development approaches have been used to enhance agricultural production. Such programmes provided purely technological solutions to economic, environmental, cultural, and social constraints. They followed the "transfer of technology" ("TOT") model or "trickle down approach," where traditional knowledge was ignored and rated as inefficient and inferior, and knowledge flow was unidirectional from researcher to farmer. Finally this approach led to disparity of development objectives, priorities, needs, and potentials of local communities (Altieri, 1990).

This chapter explores the manner in which traditional knowledge in agriculture is manifested, constructed, and managed within a socio-cultural context, its contemporary relevance for retention and integration with scientific knowledge systems, enabling policies, and transformational forms, and provides a way forward.

Social stratification of traditional knowledge

Variations in traditional knowledge in complex societies have not been adequately focused on. Most studies on such societies have looked at communities as a homogenous group; hence, the cognitive variations in classifying resources and knowledge generation have not received adequate attention; this is reflected in developmental interventions. Social stratification assumes importance in the social construction of knowledge since different groups may have different interpretive frameworks of experiences. Socialization and social heredity (the process of learning) take place within a particular socio-cultural realm, determined by class, gender and caste. The socially and culturally constructed differential tasks of men and women and disparity in power consequently lead to differential knowledge and skill in the community over time. Knowledge and information varies with socio-economic variables such as caste, class, gender and age that determine skills (Krishna, 1998; Vedavalli and Anilkumar, 1998; Banu and Thamizoli, 1998; Kelkar, 2007), knowledge networks (Ramdas et al., 2001; Howard, 2003), social relations of power (Agarwal, 1995), access to resources, education, employment, wages, household and community level decision-making and occupations. Access to resources, Box 7.1 Social construction of traditional knowledge on soil fertility management in an agricultural community, Tamil Nadu

A study was carried out to understand the social stratification of traditional knowledge on soil fertility management among women and men small farmers and agricultural labourers of Kannivadi village, Dindigul district, Tamil Nadu. It analysed the differential knowledge pattern between farmers and agricultural labourers, between men and women, and between higher caste and Dalit communities in south India. The findings show that though the indigenous knowledge of soil fertility management plays a crucial role in input investment, cropping patterns, and defining the value of the land, the differences in traditional knowledge are visible in terms of gender, class, and age. The women and the landless labourers seem to have more limited traditional knowledge of soil properties and management practices than farmers. Among farming households men possess deeper understanding and more knowledge of the soil properties than women. Of the men, the farmers who are forty years old and above have in-depth knowledge of soil properties and soil fertility management techniques. This is mainly due to the division of labour in which soil management is the sole activity and responsibility of men. Hence social norms define the experiences of individuals and groups and develop a framework for interpreting experiences. With regard to age, the introduction of modern technologies, access to external inputs, and government policies play an inevitable role in practising traditional knowledge. The study concluded that social stratification, the cultural norms, and access to resources influenced by production relations create conditions to exclude women and socially disadvantaged sections of the people in a village from sharing the traditional knowledge.

socialization, and processes of social heredity define knowledge acquirement within a given society.

Differentials in access influence the process of socialization and social heredity among different groups. Ludden (1996) put forth the idea that productive power relations and agro-ecological conditions in South India influence agricultural knowledge. Berlin (1992) has also described the cognitive variations in ethnobiological knowledge on the basis of sex, age or social status. In his study of Aguaruna's ethnobiology, he found that males have greater knowledge of rarely seen birds compared to females. Berlin attributes the social roles of males as hunters as a reason for the differences in knowledge. Similarly in India, men have specialized knowledge in the livestock sector, because women were historically denied access to animal healing due to the taboo associated with women (Ramdas et al., 2001), and the prevailing cultural norm where knowledge is transmitted from father to son. Berlin also highlights how knowledge networks are gendered, which influences the process of knowledge acquisition, processing, and sharing. Age also plays an important role in knowledge construction. Among the farmers in the semi-arid agro-ecosystem in Tamil Nadu, India, older people use more weather and seasonal climate predicting indicators with greater understanding of their reliability. The study shows that older men and women used more than twelve indicators for weather forecasting, whereas the middle-aged people (aged twenty-five to thirty-five) used only three to four indicators (Rengalakshmi, 2004). The case study in Box 7.1 clearly indicates how caste, class and gender form an important stratification system leading to differential knowledge and skills among farming and agricultural labour communities in a village in India. In addition to the social variables presented in Box 7.1, Ellen (1979) has added kinship affiliation, ideology, and literacy as additional variables influencing traditional knowledge in simple societies.

Gender relations and traditional knowledge

Experiential knowledge arises out of the experiences and routines of daily life, hence gendered knowledge also arises from gendered roles and responsibilities of men and women. In many parts of the world, women farmers are most knowledgeable about natural resources because of their constant close interaction with them (Berlin, 1992; Samal and Dhyani, 2006). Women farmers in resource-poor marginal farming systems have deep knowledge that includes ecological, agronomic and consumption characteristics about local landraces, crop improvement, agricultural practices, and the entire value chain and environment. It is argued that in traditional agricultural communities, this experiential knowledge gave women an important role in decision-making both at the family and community levels, consequently contributing to equitable power relations between genders (Rengalakshmi et al., 2006). The activity profile of millet cultivation requires women to stay for a long time in the fields, providing them with opportunities for closer observation that enable them to gain deep knowledge about the process of millet farming systems (see Box 7.2). The case study on the role of women in millet cultivation in the Kolli Hills among Malayali tribes brings out the manner in which knowledge becomes gendered and women become major decision-makers.

Changes in the agricultural production systems across different agro-ecosystems have led to consequent changes in gender roles, responsibilities, and knowledge. The loss of traditional production systems has displaced women's knowledge and expertise. It has affected women's access, control, and decision-making in resource management. The shift to

Box 7.2 Specialized knowledge of women in small millet cultivation and utilization

Knowledge of soil: Despite the complementary roles of men and women in small millet cultivation, women contribute up to 80 per cent of the labour in cultivation and perform specialized tasks in production, processing and utilization. Close interaction and responsibility help them to gain a deeper understanding of the growing environment, particularly soil and its interaction with rainfall. Women have greater knowledge than men about soil texture, fertility status, and suitability for millet cultivation, though men do the ploughing. A quote from one of the Focus Group Discussions (FGD) with men and women farmers "Often men plough but it is women who touch, feel and work in the soil" further supports this fact. Women's intimate relationship with the soil is reflected through their statements made in FGDs. Local category *pallakadu* (black clay soil) retains moisture for seven to ten days after the first rain, but the *sudumannkadu* (red gravelly soil) absolutely lacks any moisture holding capacity after the first rain. The third category of soil, *kassanku kadu* (red laterite soil), becomes hard and crust forms on the surface after the first rain. Irrespective of soil type, women ensure the soil moisture is, as they say, *thavittu irram*, which means the right state of moisture in the soil for ploughing and sowing. This knowledge helps them to take a lead in decision-making for ploughing, sowing or weeding on the basis of rainfall received and soil types. It indicates a deeper understanding of soil profile characteristics and ability to correlate quantum of rainfall and field conditions.

Knowledge of crops and different landraces: Women not only differ in expertise, but also in opinions from their counterparts with regard to value of landraces. The crop selection criteria of women, compared to men, consist of multiple interests or concerns. Stability and productivity are the major concerns in landrace selection for men, whereas women consider meal quality, resource availability, ease in processing, and multiple uses of the crop. Men prefer early maturing landrace *Malliasamai*, while the women choose *Vellaperumsamai/Perumsamai* because of their meal quality. Women, being responsible for cooking, explain that they value *Vellaperumsamai/Perumsamai* because of its taste and consistency. Women say that, among all the little millet landraces, *Kottapattisamai* is the most beautiful, as stated in a local language (Tamil: *samaikku azhaku kottapattisamai*), and prefer this landrace due to ease in processing, productivity, meal quality, and adaptation to diverse agro-ecosystems. Women rate the landraces according to meal quality and taste. In Italian millet the meal quality is in the

Box 7.2 (cont.)

order of *Perumthinai* followed by *Palanthiani*, *Senthinai*, *Mukkanthinai*, *Koranthinai*. Also, women classify little millet landraces based on bran to edible portion ratio and prefer landraces that are lower in bran proportion. Based on pounding intensity, they assess bran ratio and prioritize landraces for cultivation. Women rate landraces based on pounding intensity as *Vellaperumsamai* > *Kattavettisamai* > *Karumperumsamai* > *Kottapattisamai*. The responsibility and involvement in the pounding process help them to gain knowledge about the grain characteristics in milling, although sometimes men also pound the grain.

Source: Rengalakshmi, 2004

modern agriculture has restricted women's role as providers of labour and denied access to information, knowledge, and skill regarding new technology.

Today, the fate of global food security is linked to the performance of less than ten crops out of nearly 7,000 edible species (MSSRF, 1999). The disappearance of agro-biodiversity results in loss of local knowledge on the management and conservation of local resources (Knabe and Nkoyok, 2006). Most importantly, gender issues of roles, access, control, and decision-making, and related local knowledge systems have undergone changes, and marginalized women's knowledge and status (Zwelfel, 1996) and decision-making power (Ramdas et al., 2004). Ramdas et al. (2001) reported that changes in the cropping pattern from food crops to cash crops changed women's participation and decision-making in cultural practices of local food crops. The value of women's specialized knowledge, based on use and demand for such knowledge, would clearly be linked to the rise or fall of production of the particular crop. If small millets continue to fade away, or vanish, in the Kolli Hills, knowledge about them would no longer be valuable or needed by the community, and that would affect women's status adversely (Rengalakshmi et al., 2006).

Culture and traditional knowledge and their contemporary relevance

Traditional knowledge is based on interaction with the environment to cope with agro-ecological and socio-economic environments. Knowledge is structured by a system of classification, sets of empirical observations about the local ecosystems and systems of self-management to guide the resource use. Hyndman (1994) demonstrated a strong interdependent cultural and biological diversity through self-determination among indigenous peoples in Central America. It is important to focus on the cultural aspects of traditional natural resource management in order to understand the manner in which culture influences use and management of natural resources by men and women. Johnson (1974) observed: "Analyses of the shared cognitive aspects of human ecological systems must increasingly take into account behaviour which connects a people's idea to the external environment in which they attempt to survive." Such knowledge and practices are preserved and transmitted to the subsequent generations either orally (folk songs/folk tales) or through shared experiences (rituals and religious ceremonies). Nietschmann (1992) reported that "where there are indigenous peoples with a homeland there are still biologically-rich environments."

The nature of "coexistence of indigenous people and the natural environment" was demonstrated in Central America, where six million indigenous peoples are geographically coterminous with the region's surviving biodiversity (Chapin, 1992). Tengo and Hammer (2003) emphasize that knowledge is "stored" and manifested in management practices and institutions for resource use. The examples cited in Boxes 7.3 and 7.4 highlight the knowledge of plant genetic resource management encoded in rituals and cultural practices and how it was institutionalized among the Malayali tribal communities in the Kolli Hills, South India. Practices like these effectively manage the socio-ecological context through promoting and managing cultivation of small millets and maintain wide inter- and intra-crop diversity. Some of these customary practices manage small millet resources and natural resources effectively at the field level and ensure their utilization at the household level.

Once the conceptual and empirical basis of people's interactions with their environment is understood, a connection is made between culture and behaviour, structure and event by formulating rules to cope with local environmental variables. In the Kolli Hills small millet landraces are cultivated under a rainfed system and adapted to local climatic and edaphic conditions. Malayali farmers understood the environment and crop genetic resources and evolved a local system to ensure its availability.

The dependence on traditional knowledge and cultural aspects was ignored when the productive capacity of the land was thought to be infinite (Hyndman, 1992). Also, it was increasingly believed that intensifying capitalist relations of production is possible with the support of modern science and technology. Under the changing social, economic, and political systems the degree of interdependence between knowledge and culture #

Box 7.3 Rituals and cultural practices associated with small millet diversity management in Kolli Hills among Malayali tribals

Small millets with considerable intra-specific diversity have been cultivated in Kolli Hills, where sowing customarily commences when the village leader defines the time of sowing and pattern of cropping through a festival called "erecting the golden yoke" (*Poonerukattuthal*). He consults the elders on the onset of rainfall and defines the sowing date, which mostly coincides with the first week of June. Through this ritual the message of the onset of rain is communicated to the entire community. The elders use the same occasion to informally educate the younger generation about the traditional rain classification and appropriate cropping practices. The practice also shows deep environmental and crop improvement knowledge. As the breeding system of the species used is autogamy, in order to reduce inbreeding depression and loss of genetic erosion the Malayalis have been ensuring uniform sowing dates. By this practice farmers indirectly make adjustments in the flowering dates, which is most relevant for geneflow between different landraces in the neighbouring plots. In addition, seed flow is facilitated through informal horizontal seed exchange networks, gifts to a daughter's family at the time of marriage, or to relatives, and sometimes in exchange for labour. These processes indirectly promote and maintain varietal diffusion, diversity management and widening the genetic basis by conserving different types of alleles.

Another tradition among Malayalis is to offer more diversified grains to the goddess during the annual festival, which necessarily includes all small millets cultivated in the hills. The social status of the household increases when it manages to offer diversified grains. Thus most of the households used to cultivate and manage most small millet species in their respective fields. Also, during marriages it was customary to give five measures of little millet as a part of *parisam* (bride price). These practices ensured the continuous cultivation of small millets in the marginal hilly environment and maintain the locally adapted seed resources.

Source: Rengalakshmi, 2004

has been altered and its relevance is diminishing among agrarian societies.

Around the globe preservation of traditional agricultural practices is challenged under the changing socio-political systems. Subsistence

Box 7.4 Institutionalization of traditional knowledge and practices about seeds

In addition to farmers' own source of seeds, the community have evolved an informal seed network for local seed exchange that ensures availability of small millet seeds. Horizontal seed networking among farmers is a traditional practice that is primarily based on kinship and neighborhood evolved to facilitate and ensure the availability of seed to farmers. It operates through an informal network governed by local ethics and norms. Exchange takes place without cash transaction. Some of the norms evolved and practised by the Malayali community include:

- The borrower is required to return one-and-a-half or two times the quantity of seed borrowed.
- The transaction is exchange of seeds and never in cash.
- Seeds have to be returned; otherwise, support in future is not ensured.
- Delay in returning seed after a crop harvest has the penalty of double the quantity borrowed.
- If the quantity is not returned, the village *panchayat* meetings are used to resolve the matter.
- The lender ensures seed quality and "neighborhood certification." If the quality is poor, with inert dust particles and chaff, the lender cleans it before transaction.
- Materials are exchanged for products having equal value. For example, little millet and Italian millet are exchanged, but not for paddy because paddy gives only just under 60 per cent of the edible part after threshing. Little millet and Italian millet give around 75 per cent of the edible portion, leaving the husk.

Source: Rengalakshmi, 2004

arrangements can no longer regulate the major articulation between the human population and the ecosystem (Ellen, 1983). The loss of self-sufficiency therefore leads to loss of the possibility of regulatory autonomy. Knobl et al. (1999) observed the changes among Alpine communities where the practice of managing agro-ecosystems through social structures is weakened today, and values are eroding with a threat to social cohesion and whole farming systems.

The shift from subsistence and semi-commercial systems to commercial systems led to erosion of crop genetic resources across the globe. The spread of new global culture threatens traditional agriculture. Another significant factor threatening diversity of agriculture crops is growing globalization of food market systems and tastes (FAO, 1998). The change in the food system globally has resulted in marginalizing the small-scale food production system that conserves farmers' varieties of crops (FAO, 1998). Most importantly, the advances in enhancing the productivity of major crops like wheat, rice, and maize, introduction of new crop species, and government policies have resulted in the replacement of numerous minor cereals and millets, legumes, tubers, oilseeds, and vegetables. Examples are the disappearance of several small millet landraces in the Kolli Hills and the consequent reduction in the area under millets; from 1799 ha during 1970–71 to 766 ha during 2003–04 (Rengalakshmi, 2004), traditional paddy landraces from Jeypore tract of Orissa from 1745 landraces during 1955–60 to 256 during 1995–96 (Smita et al., 2005). Over time the loss is also associated with changes in the local culture and dietary habits.

Also, it is important to mention the negative implications of genetic erosion for knowledge systems and traditional practices. Synnevag et al. (1999) reported that threats to locally available food and seed supply systems affect the associated practices, knowledge, and social relations which are used in promoting in situ conservation activities. For example, in the Philippines the commoditization of rice production eroded the cultural dance pattern and labour sharing practice which helped the cultivation of long duration *wagwag* rice landraces. The Hopi Indians of the US lost traditional blue corn varieties mainly due to lack of skills in seed saving (Anonymous, 1993). Similarly in the livestock sector, Raika communities in Western India acquired innovative and specialized knowledge on sheep rearing and followed internal control practices on sustainable resource utilization. But changes in the ecological and institutional landscapes in Rajasthan marginalized the availability of grazing land, which largely affected their pastoralist lifestyle and forced them to sell animals and take up low-paid labour in towns. Hence their knowledge is irrelevant and thus the changes in their livelihood led to the disappearance of valuable breeds and associated knowledge (Practical Action, 2009).

Promoting a strategy of linking biodiversity with human cultural, ethical, and utilitarian requirements is a need (Reid, 2002). For example, farmers in semi-arid parts of South Tamil Nadu use ploughs made of neem tree timber (*Azadracta indica*) as one of the integrated methods to control *Cyperus*, a notorious weed in cropped fields. Currently ploughing is carried out using tractors and thus the traditional knowledge of using neem ploughs has become obsolete and its relevance is limited under the changing production practices.

An associated loss is the institutional mechanisms developed such as seed networks, local resource sharing, and control mechanisms. In the

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Kolli Hills the reduction in small millet diversity reduced informal seed network and community labour sharing measures for farming, social, and cultural activities (Range, 2001). The cultural value placed on crop diversity and local selection techniques is also declining in many areas and the skills that contributed to evolution of landraces are slowly disappearing, as in the case of specific culture in the Philippines mentioned earlier. Changing socio-cultural practices make the knowledge irrelevant and reduce sharing and communication at the community level and into the next generation. Dying traditional wisdom and loss of traditional knowledge have received attention from the academic institutions, which have made efforts to document some of them. For example, in India the National Agriculture Innovation Programme launched nationwide documentation on Indigenous Traditional Knowledge across different sectors.

Retention and integration of traditional knowledge

In the changing context of commercial agriculture and national and international trade, neither the traditional nor the scientific knowledge systems can work in isolation to promote sustainable farming strategies and livelihoods. The importance of the integration of traditional and scientific knowledge systems as prerequisites to achieve sustainable development was highlighted by Icamina (1993); Warren et al. (1995) and MA (2003). International organizations like the IUCN and the WCDE (WCDE, 1987 and Johnson, 1992) also accentuated that ecological security could only be achieved by creating a technological base that includes both traditional and modern approaches to problem solving. In such a situation, the challenge is in bringing together traditional knowledge and modern science without substituting one for the other, but respecting these two sets of values, and building on their respective strengths to address the contemporary developmental challenges. Altieri (2002) stated that hyperbolic growth of agricultural production due to modern science and technologies is built on foundations nurtured by the farmers over a long period through traditional knowledge. However, the dichotomy between traditional knowledge and scientific knowledge is reported as a cause for underdevelopment. Participatory research and farmer-back-to-farmer models of technology transfer (Amanor et al., 1993) are examples of the attempts towards establishing such a bridge. Similarly, disciplines such as ethnobiology have sought to build bridges between indigenous knowledge and modern science.

Linking the different knowledge systems provides scope to increase the amount and quality of the information available about a particular environmental or agricultural developmental problem. Of late, there is a

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Box 7.5 Harmonizing traditional and scientific knowledge systems in rainfall prediction and utilization: The experience of a farming community, Tamil Nadu

> The amount of rainfall and the period of onset are the most significant variables for the farmers to make decisions in agricultural activities. An attempt has been made to link traditional forecasting knowledge and skill with scientific methods through appropriating the scale with the technical support of the National Centre for Medium Range Forecasting, New Delhi and Tamil Nadu Agricultural University, Coimbatore, India through Village Knowledge Centres at the village level. The scientific forecast provides a probability distribution for the quantity of seasonal rainfall (three to six months in advance) and does not provide information on the likely onset and its distribution. On the other hand, traditional knowledge is able to help the farmers in terms of the possible onset of rainfall using indicators such as direction and intensity of the wind during the summer season, position of the moon on the third day and traditional calendars (including other supportive indicators). An attempt was made to establish a continuum between scientific and traditional forecasts, which combines the scale and period of onset of rainfall. The result of combining these two knowledge systems indicated that although the reliability of the traditional indicators varies, they do help the farmer to prepare for the timing and distribution of rain, while a scientific forecast might help them to prepare for the amount.

Source: Rengalakshmi, 2006

shift in direction in agricultural technology development and there is an increasing appreciation of farmers' knowledge and experiences. Experiences show that an intensive dialogue between scientific knowledge providers and user groups helps to define strategies for bridging these two knowledge systems in developing reliable weather and seasonal forecast systems in south India. The different strengths of the two systems, when combined, provide farmers with more valuable information than either system provides in isolation (see Box 7.5).

As a strategy, participatory research and dialogue has been effective in building bridges between two different knowledge systems. Participatory research in the context of crop improvement is a familiar example that essentially means exchange of knowledge of farmers on local crop improvement and the scientific approaches of researchers. Participatory Plant Breeding (PPB) bridges farmers' traditional knowledge and skills #

Box 7.6 Participatory plant breeding in traditional paddy landraces, Orissa, India

The Jeypore tract of Orissa in India is a secondary centre of origin of rice and used to be endowed with more than 1745 landraces of rice. Low productivity due to the sub-optimal agronomic practices, erosion of varietal heterogeneity and the genetic purity of land races are the major constraints. Hence efforts have been made since 1998 to conserve and enhance productivity through improved agronomic practices and participatory purification of selected landraces. Participatory field trials were carried out using twenty-six landraces across upland, medium land, and lowland agro-ecosystems. Effort has been focused on improving farmers' own natural resources by bringing genetic purity and selecting for a number of traits desired by the farmers. These combined methods helped to enhance the productivity of landraces by up to 4.5 tonnes per hectare and improved the skill and capacity of farmers on the process of purification. For example, the rice landrace *Kalajeera* was genetically purified and further developed by local farmers to commercial scale and named *Kalinga Kalajeera*.

on crop improvement using modern breeding concepts based on the laws of inheritance. The case study of paddy landraces improvement through PPB by Arunachalam et al. (2008), illustrates its potential (see Box 7.6).

Bridging knowledge systems empowers the user communities by involving them in the process of assessment, integration, testing and evaluation (Ammann, 2007). Such a process takes time, typically of the order of ten years (Berkes, 2002) to build mutual trust and respect, which are slow to build and are preconditions for linking knowledge systems (Preety and Ward, 2001). Cash and Moser (2000) and Rengalakshmi (2006) reported the need for the boundary organizations to mediate the relationship of science to traditional knowledge and stimulate integration (refer case 4, Village knowledge centre as a boundary organization at the village level). Berkes et al. (2006) point out that bridging needs a combination of communication modes such as scenarios and graphics and group deliberations.

Though integration of knowledge systems is necessary, indeed vital, one needs to acknowledge the barriers to bridging, such as power dynamics. Nadasdy (1999) states that bridging takes traditional knowledge out of its cultural context, aggravates power imbalances and disempowers local communities. Other barriers are scientists' common lack of respect for local and traditional knowledge (Berkes et al., 2006), lack of common "language" and means of verifying the veracity of knowledge (Ericksen et al., 2005). Finally, a most important trend observed during field visits and observation is the lack of interest and appreciation for traditional knowledge among younger generations, which results in their not inheriting the knowledge from elders.

New trends: Organic farming, LEISA, and ecoagriculture

Studies indicate that traditional systems and their underlying agro-ecological principles are highly productive and sustainable (Gliessman et al., 1998). The recently promoted farming system approach of Low External Input Sustainable Agriculture (LEISA) and organic farming are built on agro-ecological principles of traditional systems. The cardinal principles of traditional systems such as diversity, integration and recycling are widely promoted to improve agro-ecological services.

The International Federation of Organic Agriculture Movements (IFOAM) defines organic agriculture as a production system that sustains soils, ecosystem services, and people and combines tradition, innovation, and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved. It promotes the use of agro-ecosystem principles like diversification, integration, and recycling and improves ecosystem services. Organic farming pursues a way to encourage the powers of self-regulation and resistance, which plants and animals possess naturally (Lindenthal et al., 1995). Organic agriculture promotes the use of local resources, thus scope and opportunity is gaining momentum on traditional knowledge since it is holistic, contextual, and adaptive (Blaikie et al., 1997). Recent studies substantiate the view that indigenous/traditional knowledge and experiences of farmers were the base for sustainable and organic agriculture (Vogl et al., 2005). Currently, millions of small farmers across the globe practise organic farming without this being certified as traditional farming or agro-ecological movements (Altieri, 2000) and 31 million ha were under certified organic farming during 2008. The principles and practices (crop rotation, organic fertilization, mixed cropping, use of legumes in cropping systems and so on) followed in traditional agriculture have been promoted in contemporary organic agriculture and included in its standards (Vogl et al., 2005).

Certified organic farming gained importance in the context of the shift from subsistence to market oriented agricultural systems by integrating traditional agro-ecological principles and scientific knowledge systems. In other words, organic farming practices that have strong roots in traditional agricultural knowledge provide scope to bridge with scientific knowledge systems (see Box 7.7).

Box 7.7 Integrating scientific and traditional knowledge in coffee berry borer management under an organic farming system in Tamil Nadu

> Coffee has been cultivated in the Lower Palani Hills of south India under a traditional system without external inputs. The major weakness in such systems is productivity and product quality, which could be addressed through harmonizing scientific and traditional knowledge systems. Due to considerations of market advantage, it was decided to certified organic products, and the process was initiated with the support of IMO Control Private Limited in 2003. In 2004, when it reached the market as an "under conversion" product, it was rejected due to high incidence of the coffee berry borer pest. A Focus Group Discussion was carried out with knowledgeable men and women farmers with field visits to identify traditional control measures. Later the matter was discussed with experts from the Coffee Board on the scientific methods of management along with local farmers. These participatory discussions helped to evolve complementary strategies to harmonize traditional as well as scientific knowledge systems. Steps have been taken to control the pest incidence using the traditional method of pruning to arrest the excess vegetation as well as the scientific method of use of biological predators (Mexican beetle: *Hypothenemus hampei*) as well as simple traps using ethanol and methanol mixtures as attractants. This practice has been continued at the community level for two years. During 2006–7 when the coffee bean was tested, damage was reduced by 80 per cent and presently the product is reaching the market with an organic label.

At the same time, the standards promoted under the certified organic farming approach may lead to the risk of homogenization of practices, which affect farmers' initiatives and innovation to adapt to local conditions. The prescribed standards become mandatory and the inspection and certification regime does not match with the local socio economic and cultural context of farmers. The standards are being set by the promoting organizations and government agencies, which almost lead to a situation where organic farmers have little or no power over them (Vogl et al., 2005). In this context, these authors suggest that regulations and all activities to monitor must respect cultural diversity and promote regional definitions, local identification and innovations.

Thus the organic farming approach needs to be improved further to address the key challenges of the future: maintaining the power of innovation, empowering small and marginal land holding women and men farmers, enhancing food security and safety, ensuring ecological services and farm resilience, facilitating and supporting traditional knowledge through use, and bridging with scientific knowledge systems.

LEISA (Low External Input Sustainable Agriculture) is seen as a viable alternative to conventional external input based farming. The main objective of LEISA is to enhance farm productivity, ecological sustainability and social justness and humaneness (Reijntjes et al., 1992). The study of Graves et al. (2004) states that compatible socio-economic conditions of the farmer are most crucial requirement for the practice of LEISA. Strengthening and promoting such a low input based farming approach requires incorporating the element of "farmer participation" as a central theme. In the process, development workers stimulate and facilitate the participatory learning and development to strengthen farmers' knowledge, skill and decision-making capacities. The approach helps to value their traditional knowledge and build horizontal networks for knowledge and resource sharing. The studies indicate that complementary investments are needed to promote farmer-to-farmer diffusion, innovation and networking in order to promote LEISA among small and marginal farmers (Tripp, 2006). Farmer Field School, Participatory Technology Development, Participatory Plant Breeding and others are such initiatives acknowledging and integrating traditional knowledge. In order to promote the LEISA practices, networking has been done through the Centre for Information on Low External Input and Sustainable Agriculture, which promotes documentation and exchange of information for small-scale farmers in the south.

Apart from this, ecoagriculture, which is a blend of conservation and rural development strategy promoted by Ecoagriculture Partners, has been promoted as an alternative to conventional agriculture; the underlying principle is "farming with nature," meaning farming in a way that builds on natural processes, maintains a healthy environment and supports livelihoods at the local level (McNeely and Scherr, 2003). Ecoagricultural concepts aim to interlink enhancing production, improving biodiversity, and promoting viable local livelihoods as key themes. It recognizes the traditional knowledge of the producers and integrates and promotes the utilization of the same in isolation or in integration with scientific knowledge.

Retention of traditional knowledge: role of state policies

Globalization and intellectual property rights are issues threatening traditional knowledge systems. The limitations of intellectual property rights in recognizing traditional knowledge have led to strong reactions, such as "The perception that intellectual property is only recognizable when produced in laboratories by men in lab coats is fundamentally a racist view of scientific development" (Mooney, 1988). WIPO has established a system to study traditional knowledge and the possibilities of including it in a digital, searchable database. The Doha Agenda Ministerial Declaration explicitly endorsed the issue of traditional knowledge as a subject for negotiation (WTO, 2001). A study by Ammann (2007) stated that policy makers recognize traditional knowledge affects the legitimacy of the multilateral trading system as well as modern agricultural and environmental policies. The Convention of Biological Diversity provided space to recognize traditional knowledge under Article 8 (j). Indian National laws like Plant Variety Protection and Farmers Rights Act 2001 (PVPFR), and The Biodiversity Act 2002, incorporated the same. The PVPFR Act recognizes farmers' planting materials and knowledge and promotes management of traditional varieties and landraces. The Act recently recognized communities and conferred a "genome saviour award" for their role in conservation and enhancement of traditional paddy landraces in Jeypore tract of Orissa, India, which is the secondary centre of origin of paddy (MSSRF 2008). The Biodiversity Act promotes the documentation of traditional knowledge and practices through People's Biodiversity Registers at the village level.

Concluding remarks

In the context of climate change, it is increasingly felt necessary to enhance the resilience of farming systems (including livestock), for which traditional knowledge and learning are fundamental elements. Carpenter and others (2001) defined resilience as the "capacity to buffer change, to reorganize and to adapt." The capacity for adaptation and learning is the characteristic of the traditional knowledge based farming which is gaining attention at the global level.

The changing socio, economic and political systems in the agricultural domain influence the relevance of traditional knowledge, widen the gap between culture and traditional knowledge, and make the knowledge less relevant to the context. Loss of traditional knowledge has implications for gender relations; women's contribution to resource management has not been widely utilized and the lack of documentation on such knowledge systems has denied access to such knowledge, which altered the gender relations in many societies. At the same time, it is mandatory to acknowledge and recognize the differential knowledge in the community while reviving interest in traditional knowledge. The vertical and horizontal stratification operating in a given society defines the access to various resources including cultural and natural resources. The social stratification, the cultural norms and access to resources influenced by the production relations, create conditions to exclude certain sections of the community from sharing the indigenous knowledge.

Increasing recognition of bridging knowledge systems provides scope to harness the benefits of the respective systems through innovative participatory delivery strategy and communication modes. The approaches of organic farming and LEISA are potential alternative systems and more environment friendly forms of agriculture, which provides scope to create links between traditional and scientific knowledge systems. The promotion of organic farming and its standards needs to respect the traditional ecosystems and knowledge of the farmers. It is important to assimilate strategies that combine traditional knowledge and modern science based practices to achieve sustainable and equitable use and development. Such changes would require a shift in research and development approaches towards farmer/user led participatory development, which is right now being practiced among developmental agencies. Also need based exchange, dialogue and consultations need to be promoted and institutionalized among local communities, researchers/scientists, policymakers, officials and others to facilitate the integration between two knowledge systems.

Finally, the international and national policies recognize the need and promote the documentation, integration and upscaling of the traditional knowledge links in promoting sustainable development. Currently, the interaction between traditional and scientific knowledge provides scope to facilitate the development of more appropriate agrarian strategies, which are more sensitive to the complexity of agro-ecological processes. Such strategies promote an agro-ecosystem based approach, which is more in tune with nature, and thus minimize the environmental problems associated with conventional, industrial agriculture. Towards this, it is essential to promote policies among developmental and academic insitutions for aggressive international and national donor support to carryout micro-level model building efforts with multi-stakeholder partnerships. In order to promote such an approach, mapping of the successful case studies and lessons learned are to be documented to translate the knowledge and facilitate cross learning.

Acknowledgements

The author expresses her deep sense of gratitude to Dr Thamizoli and Dr Arivudai Nambi for critically reviewing the paper at various stages and constructive comments on the first draft of this paper. She is grateful to Prof. M. S. Swaminathan, Chairman, Dr. Ajay Parida, Executive Director and Dr Sudha Nair, Director, JRD Tata Ecotechnology Center for their encouragement. The author appreciates the cooperation and help rendered by men and women farmers, who constantly shared their time and experiences.

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