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On-farm/*In Situ* Conservation of Tropical Fruit Tree Diversity: Emerging Concepts and Practices[1]

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The Convention on Biological Diversity (CBD) defined *in situ* conservation as "the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated and cultivated species, in the surroundings where they have developed their distinctive properties" (CBD, 1992). Defining *in situ* and on-farm conservation of agricultural biodiversity was an important step; the main dilemma over the past two decades has been its practical implementation in conservation practices that fit into the context of the sustainable livelihoods of smallholder and poor farmers (Jarvis *et al*., 2011; Sthapit *et al*., 2012; Bellon *et al.*, 2014). While *ex situ* conservation poses largely technical challenges, *in situ* and on-farm conservation needs additionally to consider several social parameters involving farming communities and the knowledge they hold. It is impossible to undertake on-farm conservation of 'nature' without considering people, their rights, their needs, their values and their relationships. Despite the threat of rapidly shrinking biodiversity in farmers' fields with associated loss of evolutionary options for the future, appropriate community-driven methods for the on-farm conservation of agricultural biodiversity continue to be meagre.

Research carried out to date has remained quite academic and descriptive, so government organizations have difficulty in translating the theory into practice on the ground and garnering support from policy makers and communities. Many theories of on-farm conservation of agricultural biodiversity have been put forward in literature (Bellon *et al*., 1997; Brush, 2000; Bellon, 2004; De Boef *et al.,* 2013) but few studies have been conducted long-term research to assess the impact of on-farm conservation projects in developing countries (Bellon *et al.*, 2014). We asked basic research questions to assess whether: i) empowering communities improve use and safe-guard traditional genetic resources for improved livelihood strategies and people well-being, and ii) supporting roles of custodian farmers and their local organisations support the evolutionary process of on-farm conservation of biodiversity. We aim to deepen our understanding of farmer management of diversity to determine when, where and how such strategies can be further developed to improve the resilience of such systems and farmer well-being.

Methodology

We employed Community Biodiversity Management (CBM) method (Sthapit *et al*., 2016). The CBM approach originally emerged from the experience of on-farm conservation projects carried out in Nepal from 1998 to 2004 during a period of civil conflict (Sthapit *et al.,* 2012a; Subedi *et al.,* 2013) and further evolved by diverse actors in several other countries where biodiversity assets are high but other resources are low. CBM is a

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community-driven participatory approach that empowers farmers and communities to organise themselves and develop strategies that support the on-farm management of agricultural biodiversity for the improvement of their livelihoods. The CBM approach integrates knowledge and practices with social systems, institutions and regulations that support conservation and development goals set by participating communities.

We tested this approach in 36 communities of GEF project, "Conservation and sustainable use of wild and tropical fruit tree diversity in India, Indonesia, Malaysia and Thailand" to: i) understand characteristics of farmers that are maintaining fruit tree diversity despite pressure of globalization, and ii) assess whether empowering diversity-rich farmers and community and local institutions helps to realise the dual goals of on-farm conservation and development, and (iii) discuss key principles and practices that empower community.

Discussions

Conceptual Framework

The goal of the CBM approach is to realize conservation and sustainable use of tropical fruit tree diversity for present and future generation in farmers' fields, home gardens and orchards, and also in the wild. If crop genetic diversity is going to be conserved on-farm, it must happen as an integral part of farmers' production and livelihood strategies. This means conservation efforts must be carried out within the framework of farmers' livelihood and income-generating systems (Sthapit *et al*., 2012a; Bellon *et al*., 2014).

The CBM concept aims to that three specific outcomes to achieve the overarching on-farm conservation goal: i) community empowerment ii) livelihood development and iii) biodiversity conservation. These outcomes can be achieved if an enabling environment is created for the men and women of the community to enhance their: i) knowledge, ii) practices and iii) institutions. Communities, after initial community awareness, usually easily agree that the three outcomes are mutually supportive and needed for sustainable agriculture. However, they often lack the confidence, skills and strategies to achieve these objectives in a synergistic manner. The success of the CBM approach hinges on its ability to build the community's commitment, confidence and problem-solving skills to achieve these widely accepted outcomes.

CBM Process for Strengthening Farmer and CBOs Capacity

There are eight generic steps (Fig. 1) in the CBM process that enrich farmers' knowledge with scientific knowledge. It is assumed that the process will facilitate local innovation at each step and thereby current farmer practice will evolve and improve with changing challenges and contexts. Each of the steps is guided by the principles of CBM approach, as described above. A range of methods and tools are available for each step (Sthapit *et al*., 2016) and can be customized in the CBM process to suit practitioners' preferences and specific purposes. Complex GEF project activities were implemented using the same steps and allowing community to develop own community action plans. An empowered community tends to demonstrate good capability in: i) situation analysis, ii) critical thinking about what is good for the environment rather than focusing on short-term gains or external resources, and iii) appropriate decision making that considers community well-being. This is only possible if local government creates an enabling environment and institutional platforms for social learning and promotes community level action plans.

Custodian Farmers and Local Innovations

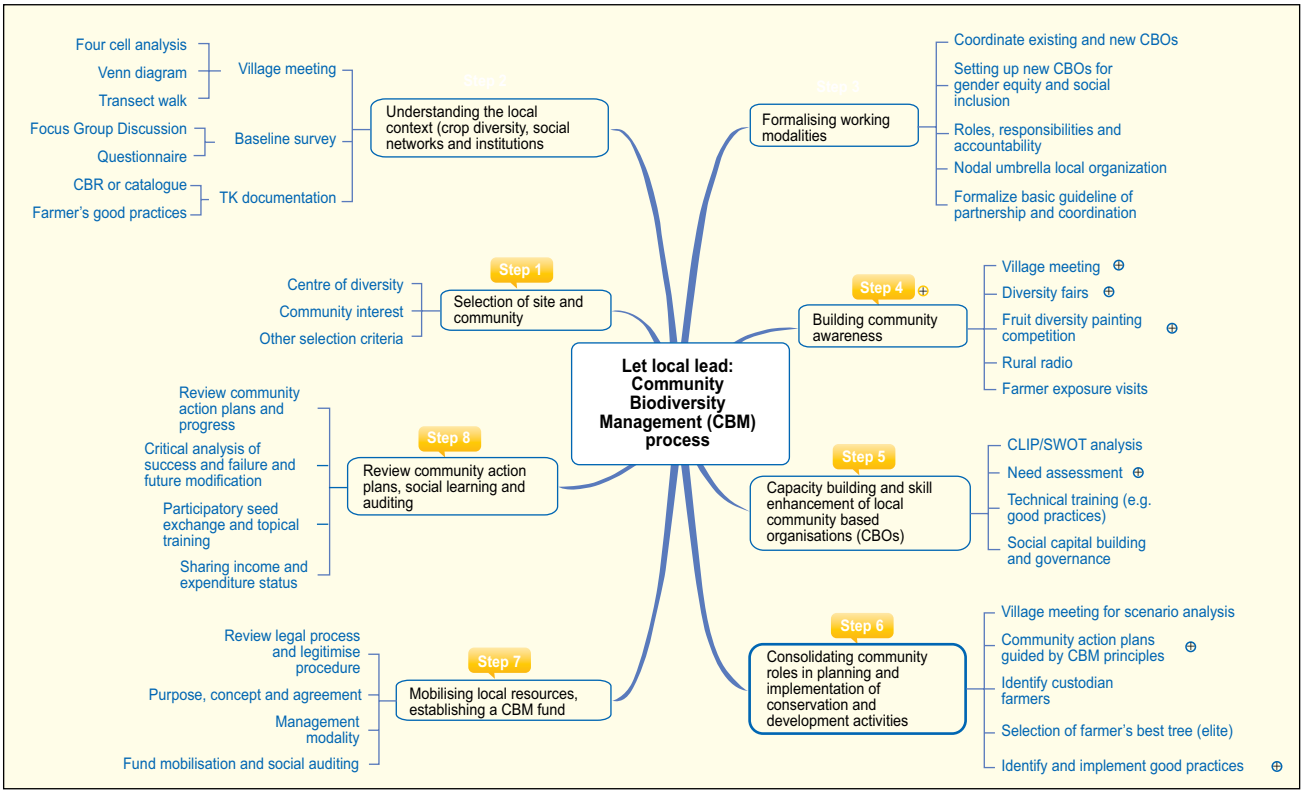
Whilst searching for good practices of tropical fruit management, researchers identified what they have called 'custodian farmers' (Sthapit *et al.,* 2013; 2016). These are farmers who maintain portfolios of diverse crop species and varietal diversity of agricultural biodiversity. Three features characterise these farmers: i) they maintain high richness of agricultural biodiversity, ii) they adapt or select available diversity, and iii) they disseminate materials and knowledge on a wider scale in the community. These farmers select varieties adapted to local conditions and promote the use and conservation of local diversity among their friends and neighbours, even in the absence of any extrinsic incentives. Despite commercialisation and global biodiversity loss, a few such farmers can be found in every country. These individuals can be an entry point for any community biodiversity management initiative as they are often knowledge and material holders without whom knowledge is lost. In five years, 95 elite varieties of *Mangifera*, 32 of *Citrus*, 5 of *Garcinia* and 2 of *Nephelium* were identified, characterised and documented using farmer fruit tree catalogues from four countries. Of these, a total of 75

farmer varieties of *Mangifera*, 16 of *Citrus*, 5 varieties of *Garcinia*, and 2 of *Nephelium* were registered by the respective competent authority of the government. These elite farmer materials are potentially valuable natural assets developed by farmer innovation that help income and livelihoods of farmers. In this way selected unique elite material in the name of the farmer or community can be registered with the appropriate Government Authority, according Farmers' Rights (http://www.planttreaty.org/content/farmers-rights) and making the information available for public and private nurseries. This is important strategy in neglected and under-utilized crops where plant breeding is long-term investment and international and national research investment is also meagre compared to arable crops and commercial vegetables. Consolidating roles of custodian farmers in the identification, piloting and mainstreaming of GPDs within a community biodiversity management approach might be one way forward.

One low-cost, efficient strategy to strengthen community biodiversity management is to work with custodian farmers (Sthapit *et al.,* 2013) to identify elite materials, which are the best trees ('plus trees') available in the community, characterise and evaluate them and further multiply them for community benefits.

Conclusion

On-farm conservation efforts are sustainable only when local efforts are embedded within a wider context of government policies and programmes at national and local level. Mainstreaming on-farm/*in situ* conservation into the agroecosystem is grounded in a vision that firmly links research on the species and genetic diversity assessment, access to and value of crop genetic diversity to farmers with the benefits obtained by the farming community from the sustainable use of this diversity. Considerable gaps in knowledge exist as to how to consolidate local and individual efforts on the ground and with regard to local and wider contexts and requisite supportive policies and institutions. We found that community empowerment is the key driver to achieving both conservation and development. We have shown that this can be achieved by the process of community-based biodiversity management (CBM) approach – a set of principles and practices- by which communities enhance knowledge of local inter- and intraspecific diversity and improve traditional practices through continued engagement in platforms of social learning led by community organizations. These platforms may use a set of good practices (adapted to local context), tools and methods that engage both men and women, poor and rich



in collective planning and learning and practising. Here we illustrate some of those good practices that support participatory fruit tree improvement (though simple selection and propagation) for improving livelihoods, promote *in situ*/*ex situ* linkage and safeguarding fruit tree genetic resources. Roles of farmers, especially those of custodian farmers, as user, conserver, innovator and promoter are considered important for supporting on-farm management of tropical fruit tree diversity. We suggest that tree selection from farmers' orchards is the best approach for under-researched fruit crops. We put forward CBM as a key strategy to promote community resilience contributing to the on-farm/*in situ* conservation of plant genetic resources in general and tropical fruit genetic resources in particular.

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