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Establishing sustainable food production communities of practice: Nutrition gardening and pond fish farming in the Kolli Hills, India

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Abstract

This study describes the formation of nutrition gardening and pond fish farming communities of practice (CoPs) among small-scale farmers of the Malayalis tribe living in the Kolli Hills region of Tamil Nadu, India. We examine the factors that have shaped the formation of these CoPs, their purpose and function, who is involved, what activities hold these communities together, and their role in strengthening sustainable food production and consumption practices. Data were obtained through participatory rural appraisals (PRAs), key stakeholder interviews, and participant observations during four months of fieldwork. The primary motivations that led the nutrition gardeners and pond fish farmers to become part of CoPs were to improve the health and nutrition of their families and to obtain expert advice in sustainable

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food production practices. Both CoPs are in the early stages of development and differ not only in the types of food they produce and the skills and tools needed for their success, but also in their structure; nutrition gardening takes place at the individual and/or household level, whereas pond fish farming operates at the group and/or community level. The ways in which members experience being in a community also differs. Nutrition gardeners rely on open-ended conversations and community creation through relationship building; in contrast, fish farmers find that group meetings and maintaining transparent record-keeping are most important. Sustainability of these practices and the CoPs depended on factors internal to the communities (e.g., leadership, knowledge mobilization) as well as external factors (e.g., rainfall and market potential).

Keywords
Sustainable Food Production, Communities of Practice, Nutrition Gardening, Fish Farming, Participatory Rural Appraisal, Kolli Hills, India

Introduction
There is growing evidence that continued emphasis on agricultural industrialization, concentration of capital and resources, and globalized trade of a limited number of agricultural commodities is generating socio-economic disparities and ecological impacts that threaten global food security (Clapp, 2017; Foley et al., 2011; Garnett et al., 2013; Godfray, 2010; Thrupp, 2000). In India, where the negative impacts associated with these agricultural trends are compounded by climate change stressors (such as severe drought and intense flooding), food insecurity is especially high among poor and marginalized small-scale farmers (Shiva, 2016a; Singh, 2000). In 2009, a six-year interdisciplinary research program entitled "Alleviating Poverty and Malnutrition in Agrobiodiversity Hotspots" (APM) was initiated in three regions of rural India to improve food security among small-scale farmers through improved access to information and knowledge exchange about sustainable food production. This research was developed through collaboration between the University of Alberta's Faculty of Agriculture, Life and Environmental Sciences and the M.S. Swaminathan Research Foundation (MSSRF), which is based in Chennai, India (Raghu et al., 2013).

As part of the APM program, we examined CoPs that formed around two food production practices—nutrition gardening and pond fish farming—established through the APM project among small-scale farmers of the Malayalis tribe in the Kolli Hills region of Tamil Nadu. The introduction of each of these practices offered the opportunity for farmers to address nutrition deficiencies, save money by making fewer market purchases, and make money by selling excess produce. These practices were selected because they build upon traditional practices of forest gardening and river fishing and are low-technology interventions that could be continued by local villagers once the program ended. Consistent with MSSRF's mandate, a participatory, community-based approach was used in the introduction and development of these practices.

In this study, we investigate how the Malayali farmers learn from others and adopt new agricultural practices that can improve their food security. Although there are obvious environmental, political, and social constraints in raising awareness about and adoption of sustainable farming practices, we suggest that it may also include the current systems of knowledge mobilization among research centers, agricultural extension, and the farmers themselves. Improved knowledge-sharing among these parties may improve farmers' ability to assume more control over what they produce, reduce environmental externalities and the cost of production, enhance environmental quality through the promotion of practices that capture the regenerative processes of growing food, and increase access to nutritious food for families and communities. Greater understanding about CoPs that form to advance sustainable agriculture and improved nutrition can inform other efforts to work with small farmers as a community of farmers who routinely learn from each other and often from outsiders as well.

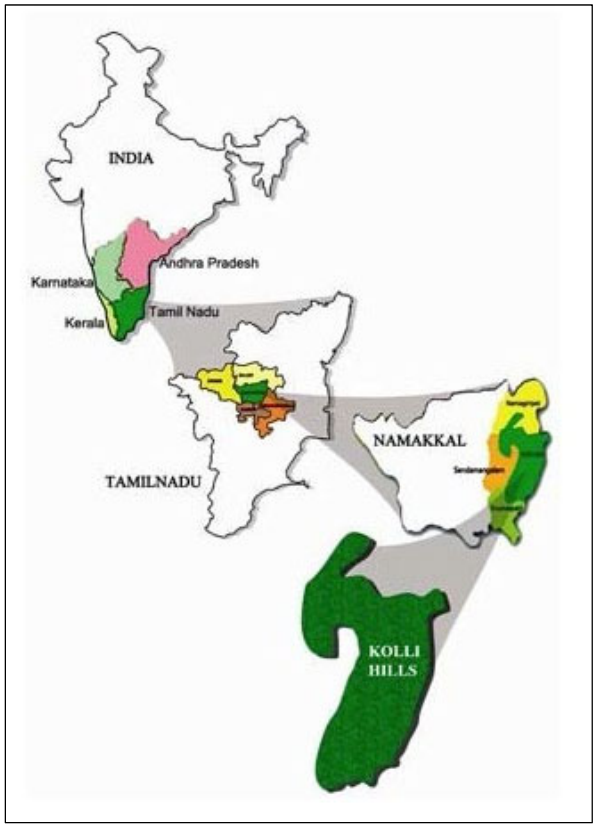
We begin with a brief description of the study site, followed by an overview of the literature pertaining to sustainable agriculture and communities of practice to provide a theoretical framing of this

study. This is followed by a description of the data collection methods. We then discuss the findings in relation to the development and maintenance of nutrition gardening and pond fish farming communities of practice. The conclusion provides summative remarks about the role of these communities of practice in fostering individual and collective learning about sustainable food production.

Context

The Kolli Hills are in the Western Ghats mountain range in the Namakkal District of the southwestern Indian province of Tamil Nadu (Figure 1). The study area lies between 11° 10' 54" and 1° 30' 00" N latitude and 78° 15' 00" and 78° 30' 00" E longitude. This hilly region ranges from 180 m (591') in the foothills, up to 1415 m (4,642 ft) at the plateau. Rainfall in this area is approximately 1300 mm (51") per year, most of which falls in the rainy months between May and December (Francis Xavier, Freeda Rose, & Dhivyaa, 2011).

Figure 1. Map Showing the Location of the Kolli Hills



Source: Sekar, Murugan, Pandikumar, Al-Sohaibani, & Ignacimuthu, 2016, p. 110.

Agriculture is the mainstay of the Kolli Hills, where 51% of the total area is under agriculture and the remainder is a protected reserve forest (Kumar-Range, 2001), but soil fertility and agricultural production output are relatively low (Raghu et al., 2013). Traditionally, there was a variety of locally produced foods such as rice, minor millet, bananas, jackfruit, tamarind, citrus, coffee, spices, and medicinal and aromatic plants, some of which were gathered through practices of forest gardening, as well as fish from river fishing (Raghu et al., 2013). In recent decades, malnutrition has been high in the region, with little to no household consumption of fruits and vegetables, and low protein intake. The introduction of cash crops, predominantly cassava, increasingly has displaced the production of nutritious varieties of small millet that have been grown in the region for centuries (Raghu et al., 2013).

Most of the 42,200 inhabitants of the Kolli Hill region are Tamil-speaking and belong to the Malayali population, one of India's Scheduled Tribes[1] whose members own small and marginal farm holdings or work as farm laborers (Kumar-Range, 2001; Raghu et al., 2013). The Malayalis are discriminated against as being considered a primitive culture, have limited political voice, and due to their relative isolation have poor access to markets, products, and services (Finnis, 2006). Aside from footpaths that connect the Kolli Hills to the surrounding plains, there is only one road suitable for vehicles (Kumar-Range, 2001).

[1] The Scheduled Tribes (ST) of India live in relative isolation in forested hilly/mountainous or desert regions. Members of a tribe are united by a common dialect, traditions, beliefs, and customs. Their livelihood is tied to their specific environment but generally centers on subsistence agriculture, hunting, and gathering. ST are among the most socio-economically disadvantaged groups in India, with high levels of poverty, illiteracy, and low access to resources. In recent decades the central and state governments have enacted legislation and provided funding for education and employment programs to improve their socio-economic status (Dragomir 2017; Naseer 2015;United Nations, n.d.).

Literature Review

From Food Security to Food Sovereignty

The Green Revolution transformed agriculture in India by replacing traditional farming practices and regional food diversity with an increasing reliance on external inputs and monocultures of cash crops (Patel, 2013; Shiva, 2016b). India's enrollment in the global agri-food system has resulted in greater state support for export-oriented crops, the overuse of chemical fertilizers and irrigation to increase productivity, increasing debt among farmers, and higher domestic food prices, none of which has contributed to national food security or put more cash in the hands of the poor (Carolan, 2012; Hazell, 2009; Sen, 1974; Shiva, 2016b). Among the small-scale farmers of the Kolli Hills region of Tamil Nadu, where subsistence farming of traditional varieties of small millets with high protein and mineral content has been replaced by large-scale production of less nutritious cassava, there is a high prevalence of iron, protein, and calcium deficiencies (Finnis, 2009).

In response to the legacy of agricultural modernization efforts, development agencies and nongovernmental organizations like MSSRF have shifted from a linear and top-down transfer of technology (ToT) model toward extension models that place farmers and their needs first (Chambers & Ghildyal, 1985; Cullen, Tucker, Snyder, Lema & Duncan, 2014; Scoones & Thompson, 1994; 2009). The concept of food sovereignty—the right of farmers to maintain and develop their capacity to produce basic food crops and maintain cultural diversity—has reinforced the emphasis on farmers' traditional knowledge and its mobilization through farmer-to-farmer networks (Altieri, 2009; Claeys & Lambek, 2014; Desmarais, 2012; Wald & Hill, 2016). Traditional knowledge related to seed saving, food preservation, and the use of ecologically based fertilizers and pesticides has been shown to be key to the success of diversified, small-scale farms (Altieri, 2009; Sinha, 1997; Thrupp, 1989), which are estimated to produce over 80% of the food consumed in a large part of the developing world (International Fund for Agricultural Development [IFAD], 2013). While the role of smallholders in addressing food security and poverty in local contexts is acknowledged by the International Fund for Agricultural Development as important (IFAD, 2013), a debate has emerged about how best to address global food security given the world's growing population, which is expected to reach more than 9.6 billion by 2050. Some contend that increasing productivity through agricultural intensification is essential to securing global food security (Garnett et al., 2013; Tilman, Balzar, Hill & Befort, 2011). Food security, however, is not only about increasing food volume; it is equally about nutrition (Freedman, 2015), food access, and improved food sovereignty. Our study examines CoPs formed around two small-scale farming practices in the Kolli Hills region (nutrition gardening and pond fish farming), which were introduced to increase farmers' capacity to grow more nutritious and diverse food for local consumption, as opposed to the monocultures of cash crops grown for global markets. These CoPs revolve around social learning for sustainable food production and healthier food consumption as farmers create and exchange knowledge within their communities.

Nutrition Gardening

Nutrition gardening, often in the form of home or community gardening, has played an essential role in improving food self-sufficiency, particularly in countries of the Global South during times of crisis (Galhena, Freed & Maredia, 2013; Marsh, 1998). Examples include the development of urban agriculture in Cuba during the "Special Period" that was triggered by the collapse of the Soviet Union, their major trading partner (Buchmann, 2009; Premat, 2009), and the proliferation of home gardens in Sri Lanka as a post-tsunami and post-war strategy for agri-food resilience (Galhena et al., 2013). This form of small-scale food production has been proven to meet nutritional needs without negatively affecting the resource base and, in fact, often improves it (Torquebiau, 1992). The benefits for small-scale farmers are widespread and include improved food and nutrition security, monetary gain (either through reduced expenditures or profits from marketing), improved human capacity, the empowerment of women, and the preservation of indigenous knowledge and culture (Mitchell &

Hanstad, 2004). Although similarities exist among home gardens in different settings, they are unique in structure, functionality, composition, and appearance (based on the environment within which they are situated), as well as family members' preferences, skills, and access to resources (Galhena et al., 2013). Despite many examples of the benefits and success of home gardening, the literature also provides examples of failures resulting from environmental, cultural, and/or economic factors (e.g., Corzo Márquez & Schwartz, 2008).

Pond Fish Farming

According to the Food and Agriculture Organization of the United Nations (FAO), large-scale aquaculture is recognized as the fastest-growing food industry in the world, but small-scale aquaculture also has an important role to play for sustainable food production and food security (Kawarazuka & Béné, 2010; Townsey, 2013). Fish are rich in essential nutrients, such as vitamin A, calcium, iron, and zinc, and fish consumption can significantly improve diet. In Mexico, a study by Mitchell (2015) showed that participation in the production and sale of fish not only improved farm family diets, but also elevated women's economic status and significantly reduced household food expenditures. In Asia, where aquaculture has shown steady growth in recent decades, there is also clear evidence of associated household income and nutritional benefits (Ahmed & Lorica, 2002; Yamamoto, 2013). However, Ahmed and Lorica (2002) conclude that in order for aquaculture to more effectively address food security and poverty among small-scale and subsistence-level farmers in Asia, there is a need for better institutional and infrastructure support. In Eastern Africa, Mwanja and Nyandat (2013) also identified poor infrastructure and poor knowledge mobilization as factors influencing the failure of local fish farming initiatives, as well as the quality of fish fingerlings, the lack of fish food, lack of traditional experience, gender inequality in control of resources, and land tenure insecurity.

Communities of Practice

CoPs reflect the fundamentally social nature of human learning. They are those "groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" (Wenger-Trayner & Wenger-Trayner, 2015, p. 1). Wenger-Trayner and Wenger-Trayner (2015) distinguish a CoP from other groups and communities by three elements. First, there is a shared *domain* of interest and a commitment to that domain, where members share information and learn from each other. Second, the *community* is created in the pursuance of their common interest through joint activities and discussions. Third, the *practice* itself takes time and sustained interaction, whereby members develop shared resources, experiences, stories, tools, and ways of addressing problems. Interventions that can facilitate knowledge exchange and relationship-building can help these groups gain their full potential (Li, Grimshaw, Nielsen, Judd, Coyote, & Graham, 2009). The strength of a CoP lies in the continuous learning and active participation of its members. Participation in a CoP is not always equal, however, as power relations can emerge within and outside the community. One of the benefits of using the CoP approach to research is that one can observe different levels of participation, group dynamics, and knowledge exchange among multiple stakeholders to solve problems and innovate (Cullen et al., 2014).

Within a CoP analysis, Wenger, White, and Smith (2009) refer to *orientations* of CoPs as the typical patterns of activities and connections through which members experience being a community. Communities may rely on meetings, open-ended conversations, or may organize themselves around common projects. They may also focus on the creation and sharing of content, rely on expert advice, relationship building, community cultivation, or serving a common cause in a specific context. These orientations are described in Table 1 in further detail.

Methods

This study takes a qualitative research approach to examine how CoPs are formed and maintained around sustainable food production. Qualitative data were obtained in the field with CoP members through participatory rural appraisal (PRA) (Table 2), semistructured interviews (Table 3), and

Table 1. Orientations of Communities of Practice

Orientation	Description
Meetings	Members engage in shared activities for a specific time. Regular face-to-face, well-attended meetings, with enthusiasm to participate, connection to others, and useful outcomes to ensure the communities' existence.
Open-ended Conversations	Members rarely meet formally, but instead maintain ongoing conversations as their primary way of learning.
Projects	Organized around a particular project; members participate in activities together.
Content	Interest in creating, sharing, and providing access to documents, tools, and other content. Valuable and well-organized content is useful for members to attract new members and makes it possible to offer a community's expertise to others.
Access to Expertise	Reliance on expertise (internal or external) to answer questions, fulfill requests for advice, or to engage in collaborative, just-in-time problem-solving.
Relationships	Emphasis on the interpersonal aspect of learning together. Involves networking, trust-building, and mutual discovery.
Individual Participation	Individuals experience learning through participation, personalized exchange, and individual development.
Community Cultivation	Need to reflect on the effectiveness and health of the communities to make things better. Activities are well planned, reference materials are well produced and organized, and members find that someone is always responsive to their requests, contributions, and changing needs.
Serving a Context	Outward-facing mission as a key driver of community evolution.

Adapted from Wenger, White, & Smith, 2009, pp. 69–100.

participant observation. Participant observation included events such as a children's summer computer class, videoconferencing of health information, cooking demonstrations, training for coffee farmers, and a fish harvest demonstration, as well as a farmer research group meeting for paddy variety trials. Fieldwork consisted of the first author spending two and a half months (April to July 2013) and the third author spending two weeks (April 2013) in the Kolli Hills region. Participants in this research were recruited using purposive intermediary snowball sampling. MSSRF served as the intermediary in this process as it had good knowledge of existing relationships with most of the farmers in the project area.

The PRA method was used so that community members could be involved actively in the research process. The continuous critical (and self-) reflection that this method requires can empower local people to actively analyze their own living conditions, problems, and potentials for change (FAO, 1999). PRA activities and the location and number of male and female participants are presented in Table 2. The PRA activities that were inspired by Wenger, White, and Smith's (2009) orientations (Table 2, # 11 and 12) were of particular value for this study. Both fish farmers and nutrition gardeners were asked to place a circle on a diagram showing the relevance of each orientation along a continuum, from least important to most important. This rating system allowed for open dialogue among practitioners as they decided what was most relevant for their particular CoP.

PRA gatherings and interviews took place early in the morning or in the evening, as to not interfere with farmers' daily work, in locations convenient for participants, such as a village meeting area (see Figures 2 and 3). There was no financial incentive offered for participation, although refreshments were served at each PRA meeting and small gifts

Table 2. Participatory Rural Appraisal (PRA) Activities

#	Name of PRA	No. of Participants		Location
		Men	Women	
1	Seasonal Cycle of Millet, Cassava, and Rice	3	1	Thurapallam
2	Timeline for Nutrition Garden Cycle	3	1	Thurapallam
3	Times for Fish Farming Cycle	1	0	Semmedu
4	Training Aspirations Spider Diagram #1	17	0	Oyankulipatty
5	Training Aspirations Spider Diagram #2	0	9	Oyankulipatty
6	Training Aspirations Spider Diagram #3	11	0	Odakatupatty
7	Training Aspiration Spider Diagram #4	0	12	Odakatupaty
8	Orientations PRA with Nutrition Gardeners	0	4	Oyankulipatty
9	Orientations PRA with Fish Farmers	4	2	Asakattupatty
10	Knowledge about Nutrition Gardening #1	0	14	Puduvalavu
11	Knowledge about Nutrition Gardening #2	1	13	Manjalpatty
12	Knowledge about Pond Fish Farming #1	4	1	Ththandipatty
13	Knowledge about Pond Fish Farming #2	4	3	Thurapallam
14	Conversation PRA with Nutrition Gardeners #1	3	6	Asakattupatty
15	Conversation PRA with Nutrition Gardeners #2	6	10	Odakatupatty
16	ICT PRA: Women Most Common VKC Users	0	7	Alavadipatty
17	ICT PRA: Men Most Common VKC Users	6	0	Asakattupatty
18	Technology Use Timeline	5	12	Oyankulipatty
19	Media Footprint Diagram	2	6	Oyankulipatty
20	Media Footprint Diagram	4	6	Oyankulipatty

were given to those we interviewed individually. We conducted individual interviews with 20 men and women community leaders to further substantiate findings from the PRAs and gain a more in-depth understanding of food production activities that took place in the Kolli Hills, and of the inner workings and relationships that exist within CoPs. A translator was used for data collection and transcription.

Figure 2. Participatory Rural Appraisal (PRA) to Characterize Knowledge About Nutrition Gardening

Findings

In this research we examined CoPs that formed around nutrition gardeners and pond fish farmers in order to understand how each emerged, how the characteristics of members differed, what qualities leaders within each community had, and what factors allowed the CoP to maintain itself. We were mindful of the development of the *shared domain*, *community*, and *practice* of each, which are the essen-

Figure 3. Participatory Rural Appraisal (PRA) with Fish Farmers in Thathandipatti

tial components of a CoP, as well as the various orientations—patterns of activities and connections—utilized by each CoP (Wenger-Trayner & Wenger-Trayner, 2015). The following section summarizes the findings for each of the CoPs.

Nutrition Gardening

Nutrition gardeners placed equal importance on six orientations they identified as most relevant to this practice: individual participation; access to expertise; open-ended conversation; community relationships; community cultivation; and serving a context (Figure 4). Group meetings were considered to be more important in the initial stages of formation, whereas creating and sharing written content on how to do the practice and being part of group projects were not seen to be central to this community. In the following paragraphs, we examine these orientations and how they related to both CoPs.

Nutrition gardening is a household-level practice whereby individuals and families (mostly women) take on a maximum of 15 minutes of daily responsibilities, such as seeding, weeding, watering, and harvesting. Individual participation was therefore noted as essential. Although MSSRF provided initial training and inputs for gardening, each household ultimately took responsibility for its own garden, from land preparation, to seed selection, to harvest, and to preparing food. As reported by farmers, men took part in some of the more strenuous activities, particularly in preparing the plot for planting between harvests (which required a few hours of work, up to four times per year), whereas women (mostly between the ages of 20 and 60) and children participated in daily gardening activities, and women cooked the food. Households with the lowest income were likely to be most interested in nutrition gardening, as it reduced the amount of money spent in the market on fresh produce.

Access to expertise was important to nutrition gardeners, even though uncontained gardening has existed for generations in the Kolli Hills. MSSRF staff provided agronomic advice (i.e., plot placement, crop rotation within the garden, intercropping for purposes of integrated pest management, and vermicomposting) and demonstrated food preservation (drying, pickling) and cooking techniques. Village volunteers (both men and women) were also recruited to support the development of these CoPs and serve as liaisons between the community and the project staff. These volunteers had to have a minimum of 10th standard education, which generally compares to the completion of a high school diploma in North America; basic knowledge about computers (as they also ran the village knowledge centers[2]); and strong links to their communities. Initial training lasted one to two

Figure 4. Orientations Participatory Rural Appraisal (PRA) Diagram with Nutrition Gardeners in Oyangulipatti

[2] Village knowledge centers were set up by MSSRF as resource hubs for community members to access and share agricultural information, gain skills training (e.g., computer classes), and serve as venues for community meetings.

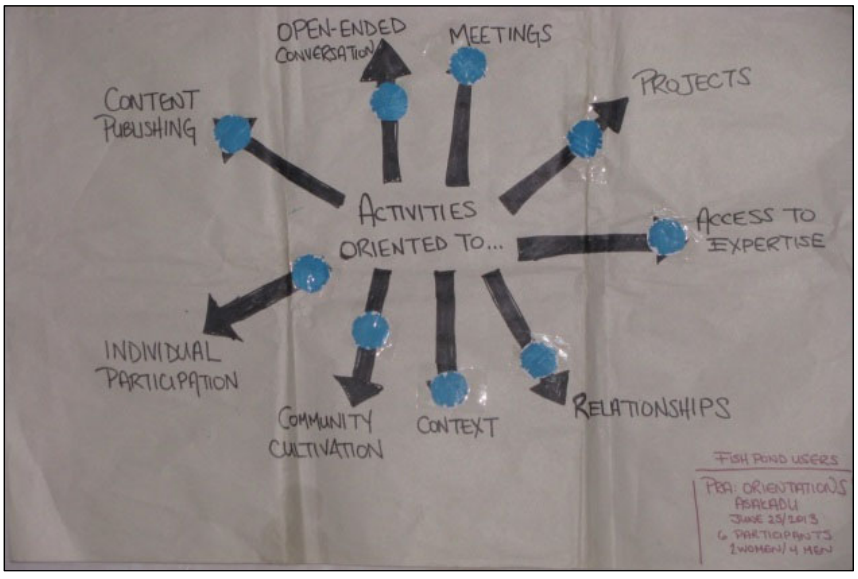
days, but there were ongoing learning opportunities throughout the year about nutrition, agricultural practices, and government schemes to provide financial aid to farmers. Villagers could contact village volunteers to access supplies for their gardens and gain advice on pest management and irrigation. Volunteers explained that they enjoyed the opportunities for learning, being of service to others, and the small monthly honorarium provided by APM.

Community members identified *meetings* as somewhat important for the initial introduction of gardening techniques and for the regular cooking demonstrations, which were attended by both men and women. After several regular face-to-face visits from community volunteers and MSSRF field staff members, formal public meetings became less necessary. Most participants commented that they only accessed MSSRF staff when they needed more seeds or other supplies.

Gardeners placed importance on learning from each other through *open-ended conversations*, which aided in the formation and maintenance of *community relationships*, both of which were key to exchanging information and learning from each other's experiences. Discussion about fertilizer use, pest control, and the lack of water (due to drought) were common conversation topics at the household and community level. Nutrition gardeners, especially women, often shared recipes and excess produce with family and neighbors. These verbal and material exchanges took place most commonly in the workplace, in the market, in villages in the evenings, and at the numerous religious festivals that take place throughout the year. These exchanges bolster relationships of reciprocity and mutual trust (Miller, Van Esterik & Van Esterik, 2009). Similar to what Torquebiau (1992) found, nutrition gardeners emphasized the importance of *community cultivation*—working together to empower their communities to become more food secure. Community teamwork was evident as they prepared food together at festivals.

Community members agreed that participation in nutrition gardening was beneficial because it served a specific *common context.* Similar to other case studies on nutrition gardening, the most significant benefit identified was improvements to general family health and nutrition (Mitchell & Hanstad, 2004). The second most important benefit, also identified by Mitchell and Hanstad (2004), was the opportunity to save money due to reduced spending on food at the market. Families in the Kolli Hills with gardens saved an average of 200 rupees (approximately CA$3.70 or US$2.82) per week. Due to the small size of the gardens, production volume was relatively low; and hence, selling surplus produce in the marketplace was not a viable option during the time of the fieldwork.

Figure 5. Orientations Participatory Rural Appraisal (PRA) Diagram with Fish Farmers in Oyangulipatti



Pond Fish Farming

Group fish farmers placed the greatest importance on access to expertise, serving a context, group meetings, and content publishing (Figure 5). Open-ended conversations, projects, relationship-building, and community cultivation were identified as being slightly less important, whereas individual participation was considered least important to the way that this CoP functioned.

MSSRF initiated village-level meetings to inform farmers about pond fish farming and the potential benefits. MSSRF identified four usable community ponds (which were otherwise used for bathing, washing clothes, and as drinking water for cattle), eight individual fish ponds in the project area, and 50 group ponds outside the project area. Although river fishing existed historically among the Malayali people, pond fish farming as an enterprise and communal activity was a novel practice introduced by MSSRF. Therefore *access to expertise* was named as an essential community orientation, particularly since most of the groups had only experienced one harvest at the time of this research. The fish farmers used the expertise of the MSSRF fish scientist to establish and maintain the community fish ponds, obtain the necessary permits from the government, access inputs such as fishlings and nets for harvest, and learn about cleaning and cooking the fish.

The APM project initiated community pond fish farming primarily as a way to address nutritional deficiencies prevalent among farmers in the Kolli Hills, and also for potential income generation. The farmers believed that *serving a context*—for the health and nutrition of their families—was one of the most important reasons to participate in the practice. They learned about the nutritional benefits of consuming fish to address the protein and iron deficiencies that are prevalent in the population and are linked to certain diseases. Participants also learned that fish farming has the potential to generate income through the selling of surplus product in the marketplace. As this was a new practice, fish production at the time of data collection only provided enough fish for the participating families' own consumption. People were eager to increase yields so that they could sell excess fish and were also interested in starting hatcheries in order to produce fishlings locally, as many had died during transport.

Involvement in pond fish farming was voluntary, but the APM project attempted to address gender equality by encouraging equal membership of men and women. Each group consisted of six men and six women and had a formal self-governing structure whereby monthly *group meetings* were held to collect the monthly fee, maintain records, decide what investments needed to be made, and create schedules for fish feeding. Meetings were also open to outsiders who were able to listen or ask questions. Most decision-making happened in this formal meeting context, but *open-ended conversations* were identified as relatively important for ensuring that all members took care of their allocated responsibilities throughout the month, dealing with potential problems such as drought or pest control, and monitoring accountability of members' investments. All members contributed 100 rupees (approximately CA$1.85 or US$1.41 USD) per month, most of which was used to purchase ingredients for making the fish feed. Two group members worked approximately one hour each day to feed the fish, and the responsibilities ran in two-week cycles. The only reason for a member to leave the group was if they had to temporarily move for work away from the Kolli Hills.

Leadership roles (president, secretary, and treasurer) within the group were determined by consensus. Roles could change after every harvest to allow new members to learn different responsibilities. A common quality of the leaders was that they had relatively higher levels of education than the other members, and one group explained that they also ensured that an elder with experience took on one of the leadership roles. All leadership roles within the fish farming groups were occupied by men during the data collection period, although one group had nominated a woman to be its next president. When asked about personal motivations for taking on leadership roles, farmers explained that it created good learning opportunities with regard to banking, teamwork, and nurturing a personal interest in fish ponds, but improving the health of their families surpassed these. Consistent with the fish farming studies by Ahmed and Lorica (2002) and Yamamoto (2013), the nutritional contributions to diet garnered by fish farming was the strongest motivator for participation.

The importance of *community cultivation* (the well-being of the community as a whole) and *relationship building* (through teamwork needed for this type of joint venture) were also viewed as important. Care of the ponds was a new skill for most members, and they relied on each other to

maintain the ponds and share the responsibility of dealing with problems, which is why farmers rated the *projects* orientation (members participating in activities together) as relatively important. Cleaning the pond, preparing food for the fish, controlling pests, preventing thefts, harvesting, and preparing fish are all projects that were essential to the maintenance of this food production practice and were carried out by all members; however, women's roles were mostly limited to preparing fish and cooking the fish after harvest. The entire group agreed upon all labor divisions and other decisions. In this CoP, there was little focus on the individual, which is why *individual participation* was placed at the bottom of the spectrum, save for the individual group members who cleaned and cooked fish after the harvest.

Discussion and Conclusion

Having presented the data in relation to the CoP *orientations*, we now return to the three elements of CoPs in relation to the social practices of nutrition gardening and fish farming: a shared *domain* of interest, whereby members are competent in contributing to it as they share information and learn from each other; *community* is created as members engage in activities and discussion in order to pursue their interests; and *practice* develops from sustained interaction among the members as they develop shared resources, experiences, stories, tools, and ways of addressing problems (Wegner-Trayner & Wenger-Trayner, 2015).

The *domain* of interest for the members of each of the CoPs examined here is reflected in their common goals and commitment to achieving them through the practice in which they participate. Improving the health and nutrition of their families was identified by both nutrition gardeners and pond fish farmers as their primary goal for participating in these practices, but the financial benefits (e.g., decreased spending on food purchases and potential income generation) were also identified as important. These findings are consistent with other studies of home gardening and small-scale aquaculture that identify the contribution of these practices to food security and improved economic status for the participants (e.g., Galhena et al., 2013; Townsey, 2013).

The *community* of nutrition gardeners was created as members regularly attended cooking demonstrations, cooked together at local festivals, exchanged recipes, and shared excess produce. They also compared yields and shared information about establishing and maintaining a garden through fertilizing, crop rotation, and pest control. *Serving a context*, *individual participation*, *access to expertise*, *community cultivation*, *relationships*, and *open-ended conversations* were identified as the most important orientations by nutrition gardeners. In contrast, the orientations relevant to fish farmers as they build their community were *serving a context*, *group meetings*, *content publishing*, and *access to expertise*. The *community* of fish farmers was supported more formally, as members learned how to collectively take part in pond fish farming, invest money equally, maintain books and records, do banking, create a system for selecting people for leadership roles, and participate in regular and democratically run meetings.

The *practice* of gardening involved individual households, and although a CoP was developing during the time this fieldwork took place, the long-term implementation of this practice failed. The authors learned subsequently from MSSRF staff that nutrition gardening has been unsuccessful due to a prolonged drought, limited access to seeds, and a lack of technical support following the end of the APM project. Although home gardens in other areas have had long-term success in improving food and nutritional security for small-scale farmers (Buchmann, 2009; Torquebiau, 1992), the contexts in which they exist (environmental conditions, access to resources) and the preferences and skills of practitioners influence the sustainability of the practice (Galhena et al., 2013; Márquez & Schwartz, 2008). Nutrition gardening in the Kolli Hills has not proven to be a sustainable practice, but many gardeners indicated that learning about these practices was useful and meaningful, particularly as they related to developing an understanding of the nutritional benefits of fresh produce.

By contrast, pond fish farming has become a sustained *practice* in the Kolli Hills, but like nutrition gardening, there have been challenges, including one pond failing due to drought. Participation is a challenge for members of the group fish ponds who must travel a distance from surrounding

villages to take part. Women involved with one of the collective fish ponds located near to a temple also face challenges in participating, as Hindu tradition does not allow women who are menstruating to approach the area. The costs of transporting fishlings to the Kolli Hills are high, and there is also a significant loss of fishlings during transport. The hope of creating hatcheries in the area failed because of the lack of water; however, farmers have identified other fish hatcheries in the region and regularly access them on their own. Furthermore, after getting help from professional fishermen from the surrounding plains during initial harvests, pond fish farmers now have the skills to carry out their own harvests.

Despite these explanations provided to us regarding the ongoing sustainability of one food production practice and the discontinuation of the other practice, the question remains as to why this outcome occurred, given that both CoPs experienced the prolonged drought and the termination of access to inputs and expertise provided by the APM project. Perhaps the answer lies in the predominantly gendered nature of these two practices and the higher potential of fish farming for income generation. The novelty of fish farming collectives as a more formal and structured initiative with viable income and employment opportunities, and the prevalence of men in leadership and other key roles, may have drawn higher community value than the household and individual nature of nutrition gardening, which was primarily women and children's work. Furthermore, being part of a fish farming collective provides access to new market channels and distributes the associated costs and risks among participants (Yamamoto, 2013).

Both nutrition gardening and pond fish farming were selected to be introduced by the APM project because they built upon traditional practices of uncontained gardening and river fishing. The APM project provided resources to help improve upon these traditional practices through the development of CoPs. The sustainability of these practices and the CoPs depended on factors internal to the communities (e.g., leadership and knowledge mobilization) as well as external factors (e.g., rainfall and market potential). Most importantly, what makes a CoP succeed depends on both the individual interests and resources of the members, and the goals and objectives of the community as a whole. Wenger (2000) reminds us that a successful CoP is dynamic, involving open dialogue within and outside the community, and with oscillations in the level of participation. If a CoP maintains a focus on shared values and creates excitement about the communal learning that exists, the group can weather difficulties (Wenger, McDermott, & Snyder, 2002).

The contribution of small-scale agriculture to food security is undeniable. In order to ensure that this practice continues to thrive, it is essential that farmers have access to relevant information as well as social spaces and opportunities in which their accumulated knowledge can be mobilized. The CoP approach allows researchers to understand how farmers come together to learn and mobilize knowledge for sustainable food production. Researchers and development workers need to be aware of the importance of knowledge co-creation and sharing and the fluidity and adaptability of a learning community, and be sensitive to changing physical and social contexts in different communities.

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