Network formation, learning and innovation in multi-stakeholder research projects

Experiences with Adaptive Research and Learning Alliances in rice farming communities in Southeast-Asia

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Thesis

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Chapter 1

General Introduction

1.1 Setting the scene

International agricultural research projects are increasingly required to use multi-stakeholder approaches, such as Adaptive Research (AR) and Learning Alliance (LA). These are types of research for development platforms, which aim to improve the contribution of science to policy and development by engaging various stakeholders (Boogard et al., 2013). Moreover, there is increasing external pressure on research organizations to achieve sustainable development outcomes from research (Kristjanson et al., 2014; Lundy, 2004). In this context, multi-stakeholder engagement is postulated to support innovation processes that stimulate the use of suitable technologies (practices and tools) from research. On top of this, research organizations face the challenge of implementing the approaches in ways that are effective and efficient (Waters-Bayer et al., 2015). This thesis contributes to understanding how multi-stakeholder approaches are used in research projects, how learning and change processes are enabled, and what outcomes emerge from it.

The thesis is about the enactment of the approaches as well as the effects of using these in projects that involve smallholder-farming communities. The core of this study is from fieldwork I carried out while involved, to varying degrees, in facilitation and monitoring of components of four projects led by the International Rice Research Institute (IRRI) in Indonesia, Cambodia, and Myanmar. In this chapter, I will provide context of the use of these approaches in research for development, particularly at the IRRI. I argue that while there is a rise in use of such approaches, systematic analysis is lacking on the dynamics generated during implementation, which create outcomes supporting innovation processes. After introducing the research questions of the thesis, I will describe the study design and main methods; concluding with an outline of the chapters.

1.1.1 Beginnings of Adaptive Research and Learning Alliance at IRRI

The Consultative Group for International Agricultural Research (CGIAR), is a consortium of research centers which aims to advance agri-food science for development worldwide (CGIAR, 2011). Fifteen CGIAR centers implement projects through partnerships. Traditionally, these partnerships were with national agricultural

research and extension systems (NARES), but more recently also with advanced research institutes, the private sector and development organisations (CGIAR, 2011). One CGIAR center, the IRRI, generates rice-related knowledge and technologies to contribute to development goals such as poverty reduction, improvement of health and environmental sustainability (IRRI, 2015). The IRRI implements research to develop and spread technologies with NARES in different countries.

Historically and still to a large extent, the IRRI operates in a 'develop-and-disseminate' approach. In the 1990s participation of farmers in research became a common principle guiding implementation and policies for research and development projects (Stiefel and Wolfe, 1994; Blackburn and Holland, 1998). This also spread in international centers such as the IRRI. The 1990s saw a rise of projects at IRRI using the AR approach (Fujisaka, 1992). The basic principle of the approach is to integrate scientific experimentation into the design, implementation, and monitoring of farm management by farming communities (Stankey et al., 2005). The approach thus gives space to the agency of farmers and other end-users in formulating their needs and wishes, as well as the capacity to adapt technologies. Various stakeholders are involved to support and implement findings from AR and results from this interactive research process inform policies and management response (Moore, 2009).

Despite successes in technological adaptation through research with farming communities, some limitations of the AR approach were the lack of follow-up support to sustain adoption, replication in other areas, and spread of results at wider scales (Smits et al., 2007, Lundy, 2004). Advances in innovation theory influenced the thinking for new approaches that could support learning to address these gaps. A new approach, termed Learning Alliance, was developed in the 2000s. This was supported by the idea that beyond technological adaptation, changes were needed in knowledge, and in formal and informal rules governing behaviour, so-called institutions (Proost and Leeuwis, 2007). The LA approach targeted wider involvement of stakeholders for widespread impact (Lundy, 2004). A LA explicitly involves a flexible, informal network of actors including those outside research and extension to generate and document outcomes and to inform public and private sector policy (Lundy et al., 2005). It is used to scale out research outputs in a way that wider stakeholders are involved in learning and change

processes. More recently, with the changing public sector management philosophy, multi-stakeholder engagement is recognized to achieve outcomes at wider scales (Mahroum et al., 2013; van de Kerkhof, 2006). This public policy has increased emphasis on multi-stakeholder engagement in research (Mahroum et al., 2013), including agricultural research. In this context, staff at the IRRI started using the LA approach in 2008.

Explicit in LA and prominent in AR is an emphasis on learning. In both approaches 'learning' is an assumed effect among all actors involved in the process. Learning as an effect of interaction is known as social learning or experiential learning (Kolb, 1984; Röling, 2002). The learning in AR and LA is centred on the introduction of technologies and improving the production, processing and marketing of crops. Moreover, AR and LA projects provide a medium for interaction between international research organizations, such as the IRRI, and national research and extension systems. In Indonesia, Cambodia, and Myanmar where rice holds economic and cultural importance, and comprises at least 70% of daily caloric intake, the IRRI has developed partnerships with governments aiming to increase production and/or export of rice (IRRI, 2009; Tun and Kang, 2015; Kean, 2012). These national systems also have specific targets and policies for rice, which drive support towards new technologies. There is an expectation that participatory approaches such as AR and LA could foster stronger partnerships between research and national stakeholders, and facilitate the uptake and spread of specific technologies. Moreover, the expectation is that with effective application of these approaches, projects could support communities in enabling innovations that would have positive impact for rice farming communities.

1.2 Problem statement: Issues on implementation and outcomes

The conceptual design of AR and LA assumes a specific learning process, a type of network engagement, and specifically targeted changes. Implementers of the approach however mediate this design of a straightforward, goal-oriented process. In other words, project actors translate the approach in communities through their activities, and do so in highly diverse contexts. The varying translations of these

approaches intertwine with the inherent complexity of research and development intervention processes. This makes these processes complex, unpredictable, and difficult to grasp. These affect the outcomes and the innovation process facilitated in communities. How development outcomes from research projects are achieved through approaches that engage multi-stakeholder networks is still largely unknown. A further understanding of the implementation of the AR and LA approaches is needed to know the consequences and outcomes especially at the community level. Such an improved understanding can inform research projects in applying multi-stakeholder approaches. Moreover, a better understanding of outcomes that can be expected from the approach is required to inform project monitoring.

1.2.1 Enactment of AR as a well-established approach

AR and its application as an approach in agricultural research have evolved since it was originally conceptualized. In general, participation by farmers is key to the AR process (Harwood, 2000). The approach has moved beyond field trials designed by researchers with support of farmers (Fujisaka, 1993). Instead, emphasis is placed on the experiential learning of farmers to adapt technologies that address their needs (Horne and Stür, 2003). Still, various projects translate this process differently. At one end of the gradient, involvement of farmers is only a consultative type of participation (Paris and Abedin, 2005). At the other end, involvement is experiential learning by farmers leading to their own decisions on combinations of tools and techniques, which farmers themselves evaluate resulting in an 'adapted' technology (e.g., Krupnik et al., 2012). In between these two, there are various gradients of involvement in AR activities. These combine a mix of context-dependent involvement by project partners and farmers. There is limited insight on the way AR is implemented and the extent to which it informs innovation.

Aside from varying dynamics of implementation, the idea that successful AR entails learning and adoption by farmers is still problematic when using a broad view on innovation. Innovation, in a narrow sense, is technology focused and typically looks at adoption or adaptation of agricultural inputs, tools or improved crop management. A broader perspective on innovation looks at technology as a practice and takes into account new knowledge and modes of thinking, changes in social institutions (formal

and informal rules) and forms of organisation (Smits, 2000; Leeuwis and Aarts, 2011). This implies that for farmers to use and benefit from new technologies through AR, there must be other simultaneous processes involving many stakeholders. This process is not investigated in AR projects. It is possible that projects deal with complexity but may be blind to some aspects of that complexity. It tackles the technical and biophysical, but pays little attention to the social component of negotiating rules, organizing users, or conflict management (Sayer and Campbell, 2001; Probst and Hagmann, 2003). Unpacking complex processes of learning regarding the social and technical aspects involved in AR is still needed to inform the implementation of the approach.

Notions regarding various outcomes from AR also have implications on the monitoring of AR projects. In many cases the outcomes are measured from the perspective of individual farmers: adoption, economic benefits, and changes in knowledge, attitude and practices (KAP) (e.g., Hu et al., 2007; Krupnik et al., 2012). Cognitive changes in knowledge, the outcomes on technical practices of farmers, and effects on the increased income from the farm are commonly studied. These however, do not show a complete picture of the outcomes. Farming is inherently complex activity where small changes in technique implicate associated changes in labour arrangements, seed sourcing, or management of communal irrigation, for example. If AR has indeed influenced change in technical practices, there must be other important changes happening which are not only at a cognitive aspect in individual farmers, but also affecting relations at collective level. These are missing in the studies on AR.

Moreover, AR may be influencing processes that are not adequately captured using these individual-focused, quantitative indicators (Launiala, 2009; Green, 2001). Awareness of what is happening in implementation has implications on furthering the methods used to capture socio-technical change in communities affected by AR. Doing so can improve implementation to make project efforts more effective in facilitating outcomes towards innovation.

1.2.2 Translation of LA as a new approach

The LA approach is developed with the assumption that by forming strategic partnerships impact from research will be realized faster and at wider scales (Denning, 2001; Lundy, 2004). The general idea is that implementation entails facilitating learning amongst a variety of network actors. The translation of LA as an approach is muddled with ideas from many similar terms and concepts including innovation platforms (Boogard et al., 2013), innovation networks (Pyka and Scharnhorst, 2009), and multi-stakeholder platforms (Adekunle and Fatunbi, 2012). This thesis does not aim to tease out the differences among them, but problematizes the process entailed in the translation of the LA approach considering its conceptual underpinnings.

Multi-stakeholder network processes similar to LA have been studied in terms of structure, connectivity and dynamism as an innovation network (Saviotti, 2009, Kilelu et al., 2013). The process of orchestration is also an area that has been looked into (Batterink et al., 2010). Studies have been conducted on how such networks operate through the formation of coalitions (Basu and Leeuwis, 2012), social learning in the network (de Mey et al., 2011; Eastwood et al., 2012) and varied network strategies such as deployment of innovation brokers (Klerkx et al., 2010, Kilelu et al., 2013). Moreover, monitoring models to capture what is happening in these networks have been suggested (Douthwaite et al., 2009).

In the literature specific to LA, there is coverage of how networks were started or facilitated (Moriarty et al., 2005; Stür et al., 2009). Partnerships within organizational networks have been described but with limited detail on community-level network dynamics (Ashley et al., 2012; Best et al., 2009). One study has quantified and mapped interaction patterns among farmers within alliances (Mashavave et al., 2013). Still, little research is done on the way LA networks, which involve various types of actors, affect innovation in farming communities. In some cases, outcomes on improving capacity of organizational members in the network and then adoption of specific technologies by farmers are studied (Stelling et al. 2009). What this misses is again the important process-related changes that are required to create an enabling environment for the technical change. Such processes do not only affect farmers or extension service providers, but also other community-level actors who create and implement formal and

informal arrangements that support the practice of farmers. This gap in knowledge about community-level processes brings out the question of whether LA can indeed support a different type of process at this level. It poses concerns on whether LA engages a network on paper, but the way it influences socio-technical change process is still largely passing on knowledge and tools from research to farmers. Implementation of LA therefore, merits closer examination because it is possible that projects engage the rhetoric but implement according to standard practices different from the approach as conceptually portrayed.

1.2.3 Outcomes in farming communities

Another issue regarding these approaches is on the outcomes of AR and LA, in particular the impact it has on farming communities. On one hand, AR has been used longer, resulting in a number of adoption and impact studies. Studies have examined results in terms of knowledge change (Escalada and Heong, 2004; Rejesus et al., 2009), adoption of technologies by farmers (Islam et al., 2007), and impacts on improved livelihoods of farmers (Ding et al., 2010; Rejesus et al., 2011). These studies notably focused on the effect of introduced knowledge or technologies on individuals rather than collectives. More specifically, the studies focus on farmers who are only one of the groups in the communities. They focus on farmers as individuals affected by or using technologies, but not actors relevant to this change by farmers. Limited studies examined the social, political and cultural mechanisms or other conditions external to but shaping individual farmers and farm environment (Palis, 2006; Palis et al., 2007; Sudarmaji et al., 2010). More details and references on studies of AR approach in research projects are provided in Chapter 2.

The standard monitoring approach appears to document adoption of technologies and results from adoption by farmers, while outcomes on the other stakeholders are rendered invisible. What is missing is insight on outcome-shaping factors that are outside the farm and farming households. Examples include change by intermediary actors such as service providers or new quality standards for the crop. These outcomes may have been affected by technological adaptation, or vice versa, are required to support technological change.

On the other hand, LA has been used only in recent years. Studies looking into its outcomes put forward more conceptual descriptions citing cases of where the process has been started (e.g. Lundy, 2004; Moriarty et al., 2005; Smits et al., 2007). Most of the literature focused on the build-up and facilitation of learning alliances at different levels including communities (Lundy et al., 2005; Penning de Vries, 2006; Prasad et al., 2007; Smits et al., 2007; Stür et al., 2009). Some experiences of involving diverse stakeholders and resulting initial technology adoption have been documented (Stelling et al., 2009; Best et al., 2009).

Although LA is postulated to affect institutional change, the extent and rate of scaling out, and stimulate socio-technical change, there is no systematic analysis of the resulting processes in communities. No studies have been done to trace the complex emergent outcomes when engaging learning alliances, especially at the level of farming communities. Therefore, the evidence on whether this approach can support adaptation processes, and lead to sustained adoption of suitable technologies by farmers is weak. Considering that this approach requires more effort and resources in network facilitation, project implementers who use or plan to use AR should critically examine the added value of the LA approach.

1.2.4. The overarching issues

In sum, the way AR and LA are implemented through research projects requires further examination because insights are missing on how these processes influence social, technical and institutional change. Second, the planned and emergent outcomes from AR or LA which are not only at individual but also happening in collectives require examination. These outcomes can be expected to occur at individual farm (including household), community, and higher levels. Therefore, depending on the network process facilitated through the approach, a flexible tracking of outcomes is required. Third, apart from surface differences, it is not known whether and how a new approach, LA, differs from an established one such as AR, and the associated added value it derives.

1.3 Concepts shaping the framework of the thesis

Implementers of AR and LA in research projects aim to facilitate learning in farming communities and spread technologies that work. Assumed within this aim are complex interactions between material objects, technical recommendations, organizing and coordination among actors, an environment that influences decisions, and networks of actors with their own interests and capacities. Analysis of how the approaches affect processes in communities entails a framework that explores a) the learning process, b) interactions in networks as influenced by the approach, and c) results of this learning process. The result of interest here relates to the aim of employing these approaches: change towards a functional material technology interlinked with working social and institutional changes.

On technology and innovation

An important result which implementers of AR and LA are interested in is whether there is change in the use of agricultural technologies. Technology is not simply a material object with functions but is shaped in a social context (Bijker et al., 1987; Garb and Friedlander, 2014). By implication, introduced technologies 'work' when the human capacity and institutional arrangements around it are also in place (Leeuwis, 2004). The type of change process aimed for by using AR or LA therefore, is inherently socio-technical.

To analyse this change process, an examination that engages the influence of material conditions is relevant. The analysis, as Bijker (1997) puts it, is not only on the 'social shaping of technology' but also on the 'technical shaping of society'. This means that specific material technologies entail change in structures for human actors; for example, a new tool does not only require new knowledge and skills for the user, but also different labour requirements, or new management routines that require coordination among users. Materiality (tools, composite objects, machines) is important in the analysis of the socio-technical learning process (Jaarsma et al, 2011).

Individuals who deal with material objects employ their improvisational capacities and manage their needs and goals along with the resources and conditions from their environment (Richards, 1989). This means that farmers, labourers, or millers adapt technology and knowledge to achieve specific goals. How they do this also requires unpacking; in particular, how their adaptive capacity, as shaped by interactions with the agro-ecological context, informs the reworking of technology. At the same time, these individuals also adapt to the social and institutional conditions in their environment. As an example, farmers may choose to employ labourers to manually harvest parts of their field, but also use machines for some part with specific varieties that millers prefer to buy fresh.

On networks and interactions

Implementers of AR and LA aim to influence the socio-technical change process by engaging networks. The underlying assumption is that by facilitating network interactions, a process of collective learning amongst varied actors would be facilitated (Lundy and Gottret, 2007). In this process, individuals such as farmers are dependent on a network of actors in an innovation system, which includes various stakeholders, or actors with specific interest. The Innovation Systems perspective posits that varied actors 'demand and supply knowledge and technologies' (World Bank, 2006, p.5). There are policies, rules and mechanisms that affect the way different agents interact to share, access, exchange, and use knowledge; these are necessary to support innovation (World Bank, 2006). Coordination among networks of actors as well as supporting institutions in terms of rules, policies or ways of working specific to the context is therefore required (Hall, 2006; Leeuwis, 2004). This further implies that alignment of technological change with associated institutional changes is necessary to facilitate the innovation process (Rip, 1995).

To capture the change process, it is important to examine network building through newly created and sustained connections between actors; not only those coordinated by the project but also the associated informal networks in communities. The network, and the process it affects, is examined in this thesis not only by looking at stakeholders but also the tools and materials they use or encounter in the environment. This is because a complex network of materials and meanings created by the actors with

respect to the environment shapes the way actors behave (Latour, 2005; Law, 1999). This perspective entails a focus of analysis on process rather than pre-defined outcomes, and also on network actors and the material entities they engage.

Furthermore, the network that is relevant and requires examination is not only the assemblage coordinated by project facilitators, but also groups that exist and emerge around specific farming operations. These groups may form around specific tasks, specialize on specific skills and interests, and have varied forms of organization (McFeat, 1974). These groups experiment with technologies and the social-institutional re-configurations around these. In the dynamics they initiate, these small groups stimulate and drive culture change (McFeat, 1974).

On learning facilitated by the approach

Lastly, learning is an important process that the two approaches aim to achieve. The approaches entail varied learning processes happening at different focal points. One point is among individuals learning about new techniques and tools. Another is in multi-stakeholder networks learning to influence systemic change. Yet another focal point for learning is groups that learn to coordinate socio-technical re-configurations. Analysis of learning in this thesis therefore needs to shift between various focal points to capture learning processes. The AR and LA approaches include an indirect notion of learning, meaning that cognitive changes are not observed or tested in individuals directly but are inferred from observable practices, activities, and interactions of individuals in groups and within networks.

Besides learning as a cognitive process, there is also learning of skills, perceived as a combination of cognitive and bodily capacity that results from day-to-day practices of individuals. Skills and skill formation are crucial in experimentation and adaptation by individuals in farming and similar processes where people interact with the natural and man-made physical and biological environment (Richards, 1989). The process in which individuals learn skills is also known as experiential learning (Kolb, 1984). The analysis presented in this thesis aims to capture the observable changes in the practices of various individuals and groups in how they deal with technical challenges created by

the newly introduced inputs, tools and methods embedded within task groups and the wider socio-technical networks.

Where different networks are engaged, there is also a different learning process that requires examination. To examine broad multi-stakeholder networks, the idea of translation (Akrich, 2000) and theories of action (Argyris and Schön, 1974) allow for comparisons of assumptions and design with concrete processes, actions, and outcomes. These provide an analytical lens with which connections are formed in network processes during the implementation of an approach.

Furthermore, in the examination of learning in this study, a focus on simultaneous learning with others about interconnected aspects that support change in technology is important, referring to learning in innovation systems. Such focus is supported by the concept of social learning. Social learning that happens in interactions lead individuals and groups to reflect on, and change perspectives or actions collectively (Keen et al., 2005). Social learning can be viewed as the process by which people with shared interest (communities of practice) interact, share ideas, discuss or come up with novel solutions (Lave and Wenger, 1991). This means it is not only learning coming from research into farming communities but learning through interaction within stakeholder groups. From interaction, individuals may develop shared or complementary goals, insights and interests moving towards more collective cognition (Röling, 2002; Leeuwis, 2004). In this view of social learning, interaction allows individuals and groups with separate understanding of an issue to form overlapping or shared understanding.

Social learning is essential in light of how farmers are dependent on other actors in an innovation system where technological, social, economic, and institutional aspects of agriculture are interlinked (Leeuwis, 2004; Ashby, 2009; Klerkx et al., 2012). Within networks, groups who deepen their knowledge and expertise by interacting on an on-going basis are shaped (Wenger et al., 2002). When farmers, or specific groups learn about new technologies, they also require simultaneous learning with others about connected changes in the wider setting such as institutions or ‘social rules of the game’ (World Bank, 2006). Learning in this study is not only transfer of technical information

processed through individual experience, but rather on the interactive construction of meaning and knowledge. That knowledge is acquired from interaction directs analysis on units beyond the individual where mechanisms for change are located such as in small groups within a wider network.

In this thesis, combinations of these concepts on learning become relevant for the aspect studied with regards to implementation and outcomes from LA or AR. In chapter 2 for example, cognitive changes to knowledge of farmers was examined vis-a-vis the learning of actors in the innovation system. In Chapter 3, action theories concerning assumptions and the interactions of human and material aspects in the network are examined. In Chapter 4, social learning in task groups from connections with a wider network is examined. As a final example, Chapter 6 employed a comparison of learning models where one is on experiential learning on technologies and another is a combination of experiential learning with social learning amongst innovation system actors.

1.4 Research aims and questions

The aim of the thesis is two-fold. The first is to examine how AR or LA are translated through projects, to bring about insights regarding the process to influence innovation by engaging multiple stakeholders. Second, to obtain evidence of the planned and emergent outcomes from the approaches in the networks engaged as well as the farming communities involved.

The overall research question is: How and to what extent do Adaptive Research and Learning Alliance approaches influence socio-technical innovation in rice farming communities? In relation to this research question, the thesis addresses several sub-questions focusing on:

1. The process of implementation of AR and LA approaches

   Who are involved; what events, activities, and interactions happened within the network; and how these affect socio-technical change for specific rice farming activities?

2. Learning among community level actors and the outcomes of the process

   What socio-technical processes are triggered by the approach, and what changes (if any) in technologies (tools and techniques), institutions, knowledge, policies and market conditions can be observed in the sites where networks engaged with individuals and groups in communities?

3. The wider multi-stakeholder network

   How are connections with higher-level actors made; what are the feedback mechanisms in projects; how do LA projects compare with AR projects?

1.5 Research design

1.5.1 Varied case studies to cover a range of contextual factors that affect implementation

This thesis uses multiple case studies of projects coordinated by the IRRI, which implemented the two approaches. Case studies help capture complexities and nuances in the practice of implementing the approach. To do this, diverse contextual factors affecting implementation had to be considered requiring an optimal mix of types of implemented projects from the IRRI (Table 1.1). The cases chosen for the thesis were representative of current interests from scientists at the IRRI who are involved in so-called 'downstream' projects. These projects are geared towards benchmarking research approaches in the field and then extending the resulting technologies and approaches. These interests developed as research projects progressed from adapting integrated technologies, to engaging wider dissemination networks, and then exploring differences and added value of engaging these networks.

The cases were selected primarily because they used AR or LA approaches (Table 1.1). Case studies of on-going projects provided the possibility to observe and analyse learning processes within the network and communities. Cases of completed projects were useful to trace the process over the duration of the project, track the outcomes and identify plausible links between process and outcomes at the community level.

The scope of the networks and level of network activities also were covered in the cases (Table 1.1). I examined the types of partnerships and breadth of stakeholders involved in the network. The studies covered national level networks as well as those formed at community level. These networks were formed around various technologies of interest in the project.

Table 1.1: Contextual factors in implementation covered by the case studies in this thesis

Case Study	Approach	Scope of network*	Level of network activities	Initial technologies of interest	Duration	Data collection in project timeline	Country
1	AR	A	community	Basket of options**	2008-11	Up to the end	Indonesia
2	LA	B	national + community	Hermetic storage and Dryers	2008-12	Up to the end	Cambodia
3	AR vs. AR + LA	A vs. B	community	Basket of options	2012-16	Start to middle	Myanmar
4	LA	B	community	Dryers	2012-15	Start to middle	Myanmar

*A = few government research and extension partners, B = Diverse stakeholders; ** varied technology options for rice production and post-production

The research sites for this thesis were those where the projects were implemented (Figure 1.1). Indonesia, Cambodia and Myanmar are rice-producing and consuming countries. For all three, there is interest at a national level on rice and technologies to improve production as well as livelihoods of smallholder farmers (IBRD, 2015; Okamoto, 2007; UNDP, 2001). Details on features of the study sites are provided in Section 1.5.4.

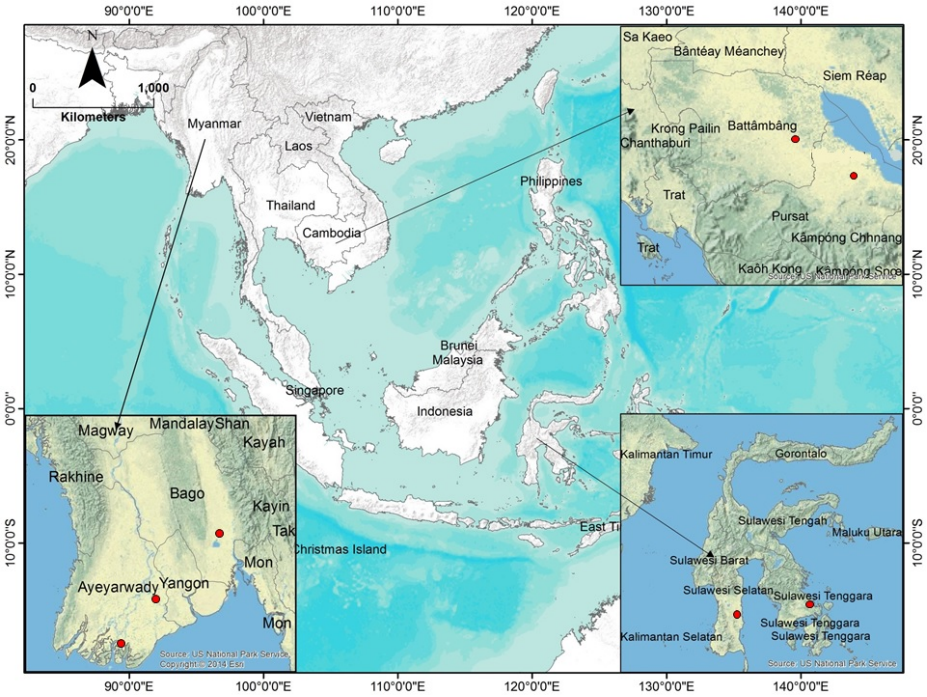


Figure 1.1: Map of study sites in Indonesia, Cambodia and Myanmar

1.5.2 Main methods used for data collection

Involvement in project monitoring and evaluation provided unique opportunities to employ mixed quantitative and qualitative methods for this study. Existing quantitative data from adoption and impact survey implemented by the author in Indonesia before the start of the thesis were complemented with observational and interview data for the first case study. Although these were done prior to the start of the thesis research, the analysis employed a suitable framework allowing for comparison with the other cases.

The other case studies involved the collection of primary data during field work carried out intermittently over 2.5 years. Data gathering in Cambodia was done between 2012 and 2013. Aside from qualitative data gathering during project-organized events, two phases of fieldwork were carried out covering two consecutive rice post-harvest seasons. Each phase lasted 1-2 months. For the two cases in Myanmar, I helped facilitate

and monitor multi-stakeholder activities of the project. Similarly, two phases of fieldwork were implemented in 2014-2015 covering two post-harvest seasons in sites of the two case studies.

In each case, I carried out interviews to investigate who is part of the network engaged in the approach and what activities were implemented with project support or as spin-off activities. I also interviewed network members located in the communities (e.g. NGOs, extension staff, manufacturers, cooperative leaders, service providers, key farmers) and tracked community-level actors with whom they were linked. For cases involving LA, network mapping was done. Moreover, I interviewed a sample of farmers, service providers and millers in the village sites to understand how network activities affected community-level actors. Finally, I did participant observation of farming activities, primarily related to post-harvest as it was a key focus of the projects in the cases studied. Observation of what is happening in the communities entailed mobility and capacity to interrogate levels including national, provincial, to village and farms.

The purpose in choice of the methods was to 'cover a network of sites that encompasses a process' (Marcus and Fischer, 1986). Data from these multiple sources allowed for triangulation of findings, ensuring that not only project implementers' perspectives were analyzed in the case studies (Yin, 2003). Further details on the methods are provided in the chapters covering each of the case studies.

1.5.3 Data analysis

Social network analysis was done through consolidation of data derived from stakeholder mapping. Project participants in a facilitated workshop format, did the mapping exercises. The maps they produced were converted into a database for analysis using UCINet and Netdraw. The consolidated maps were compared over time, and also complemented with interviews of network actors. Additional qualitative data allowed for triangulation of insights regarding interaction and involvement.

Data from interviews of farmers were consolidated in Excel, and were analysed through SPSS 22. The method was aimed at surfacing insights regarding changes in on-farm knowledge and practices, as well as involvement in project-initiated activities. The different characteristics of farm environments managed by farmers also were factored into the analyses.

Qualitative data, including observation notes were analysed through ATLAS.ti 7. These and other secondary data from the projects were used to bring out insights on process dynamics across different groups and analyse events in timelines. Qualitative data provided depth for understanding networks, practices and interactions. The analysis re-constructed implementation of the approaches. Analysis of the progression of activities and learning agenda merged this reconstruction of the implementation with insights from farmers interviewed. Details are provided in the chapters.

1.5.4 Key features of the study sites: rice-producing areas with varied extension context

The three sites of this thesis research shown in Figure 1.1 are in Asia, which produces 88% of the global harvest of rice, the staple food for more than half of the world's population (Redfern et al., 2012). Most of the rice farmers in Asia are smallholders; 58% of all farms are below 1 hectare, and 85% are below 2 hectares (FAO, 2010). Rice is a crop that intersects with various social concerns because roughly 900 million of the world's poor (less than 1.25USD/day income) depend on rice as producers or consumers (Pandey et al., 2010). In this intersection, there is an intricate tapestry of contexts involved such as ecological factors affecting rice production, political and historical context, and a setting around extension. While the thesis does not aim to provide a comprehensive understanding of contexts surrounding rice, a short description of these can provide clarity on the circumstances that affected research and development projects in the sites.

Indonesia

The IRRI project, in the first case studied, aimed to improve production in Sulawesi, Indonesia. The project had two sites, South Sulawesi (119° 55' 40.8" E and 4° 4' 33.6" S) and Southeast Sulawesi (121° 52' 12" E and 3° 44' 34.8" S).

Indonesia has the largest irrigated rice area in Southeast Asia, with 6 million hectares (Mutert and Fairhurst, 2002). Sulawesi is one such irrigated rice area. Farmers in Sulawesi produce roughly 2.3 million tons of rice, and have an average yield of 4.5 tons per hectare (Makarim, 2000). With this production, a large yield gap existed considering ecological conditions in the area. Yield increases between 1.8-2.5 tons/ha were possible (Makarim, 2000). Hence, there is an interest to increase rice production in Sulawesi. This interest is fuelled by the fact that Indonesia is one of the top importers of rice in Southeast Asia (Dawe, 2014).

According to Röling and van de Fliert (1994), Indonesia had a history of largely top-down policy for technology dissemination, but also extension specialists have been exposed to participatory methods for more than two decades. In the period of political turmoil and famine in the 1960s officials implemented a coercive nature of introducing technologies. In 1989 however, Indonesia started a national program that 'capacitates farmers to make sound decisions'. In this program, non-formal education was the basis for the training approach. Farmers in organized groups go through a field school where lecturing was no longer the standard practice. Rather, observation was the source of knowledge for the groups, with extension staff as facilitators. With programs like this, the national extension system had considerable exposure to participatory methods for working with farmers and farmer groups.

Cambodia

The second case study is of an IRRI project on rice-postharvest in Cambodia. The project involved diverse actors from different regions in the country. Of the six province sites of the project, two sites were selected for this research: Battambang (13°06'54.3"N and 103°12'52.2"E) and Pursat (12°26'11.2"N and 103°54'48.9"E).

Cambodia does not have a large rice area compared with Indonesia or with its neighbouring countries, Thailand and Vietnam. Farmers in Cambodia have a lower mean yield of 2.75 tons per hectare (Kleinhenz et al., 2013). Battambang is among the top rice-producing provinces, while Pursat is among the lowest. The country however, has moved out of deficit into surplus rice production allowing it to aim towards recovering its former status as major rice exporter (Kean, 2012). The Cambodian

Government has focused efforts on rice export since rice contributes 10% of the country's total export value (IMF, 2009). In 2009, Cambodia exported16 thousand tons of rice (Kean, 2012; World Bank 2015). In 2010, the government raised the export target to at least 1 million tons by 2015. Part of the policy was a push for support in the rice processing sector as well as for mechanization in rice agriculture, which resulted in a steady increase of machines used for harvesting, drying, and milling rice (MAFF, 2011, 2012; Kleinhenz, 2013).

Agricultural extension services were non-existent in the colonial period, and weak in the years after independence (Nesbitt, 1997). The long record of political conflict and the legacy of genocide and state-sponsored destruction of capital exacerbated this (van Acker, 1999). The opening of the country to a market economy following this period has started a move to strengthen agricultural research system, although it is still largely driven by international donors (World Bank, 2005). Thavat (2010) documented a resurgence of commodity chain approaches wherein private sector orientation in development projects in Cambodia were starting. Such cases may not be widespread, but it shows how international development thrusts affected the exposure towards a value chain orientation for extension.

Myanmar

Two of the cases studied in this thesis are in Lower Myanmar. In one case, the project had two sites: Daik Oo (17°37'49.5"N and 96°34'29.1"E) in Bago Region and Maubin (16°41'20.6"N and 95°39'49.7"E) in Ayeyarwaddy Region. In the other case, the project was located in the Lower Ayeyarwaddy Region, deep in the delta at the borders of Bogale and Mawlamyinegyun townships (16°23'55.5"N and 95°22'49.2"E).

Rice is an important crop in Myanmar. The Ayeyarwady, Yangon and Bago Regions constitute the main rice bowl of the country because of its agro-ecological situation (Naing et al., 2008; Weber et al., 2015). These areas are naturally fertile floodplains that receive abundant monsoon rainfall (Naing et al., 2008). The country produces roughly 31 million tonnes, of which the three rice producing regions contribute 47% (Aung, 2011; MoAI, 2013). Farmers in Myanmar on the average produce 3 tons per hectare (Naing et al., 2008).

The socialist government in Myanmar created a comprehensive system wherein rice production, procurement and rationing for consumers were controlled by the state (Okamoto, 2007). The extension approach wherein the extension staff and village extension managers provide demonstration of technologies such as variety or fertilizer, is historically common (Win 1991). In recent decades, despite the opening of the economy, extension remained a prerogative of the government which still operates largely on centralized control and planning (Cho, 2013). Government extension services are centralized through the Department of Agriculture (DOA). The agency provides trainings, collects statistical data, enforces standards, and controls distribution of seeds, equipment, fertilizers and insecticides (Cho, 2013).

1.6 Roadmap of the chapters

This thesis is structured around seven chapters (Figure 1.2). The chapters are linked with the case studies, which as mentioned earlier in this chapter, were informed by the interest from the projects using AR and LA approaches. The presentation of the chapters follow the chronological set-up of the cases as implemented in projects at the IRRI.

Chapter 2 is on the case of adaptive research in Indonesia. In this chapter, I traced the historical background of the AR approach at IRRI; with particular attention on how it had been monitored. The chapter functions as a context-setting chapter to examine how AR was implemented and monitored with respect to innovation processes. This chapter shows the focus of AR on learning about agronomic aspects while missing the simultaneous, emergent changes in the social aspect related to new technologies. The paper highlights how current monitoring is blind to what is happening in the wider environment affecting innovations.

Chapter 3 is on the case of learning alliance in Cambodia. It functions to provide a more comprehensive context regarding LA approach and its conceptual assumptions from literature. Focusing on the network involved in LA, the chapter is a comparison of the conceptual assumptions, assumptions made by project implementers, and the

implemented network in communities. This chapter shows that while some assumptions matched implementation such as expansion of the network or inclusion of diverse actors, there were also mismatches. There were emergent outcomes such as activities of small informal networks, change in roles, or disengagement of actors but these were not noted during implementation.

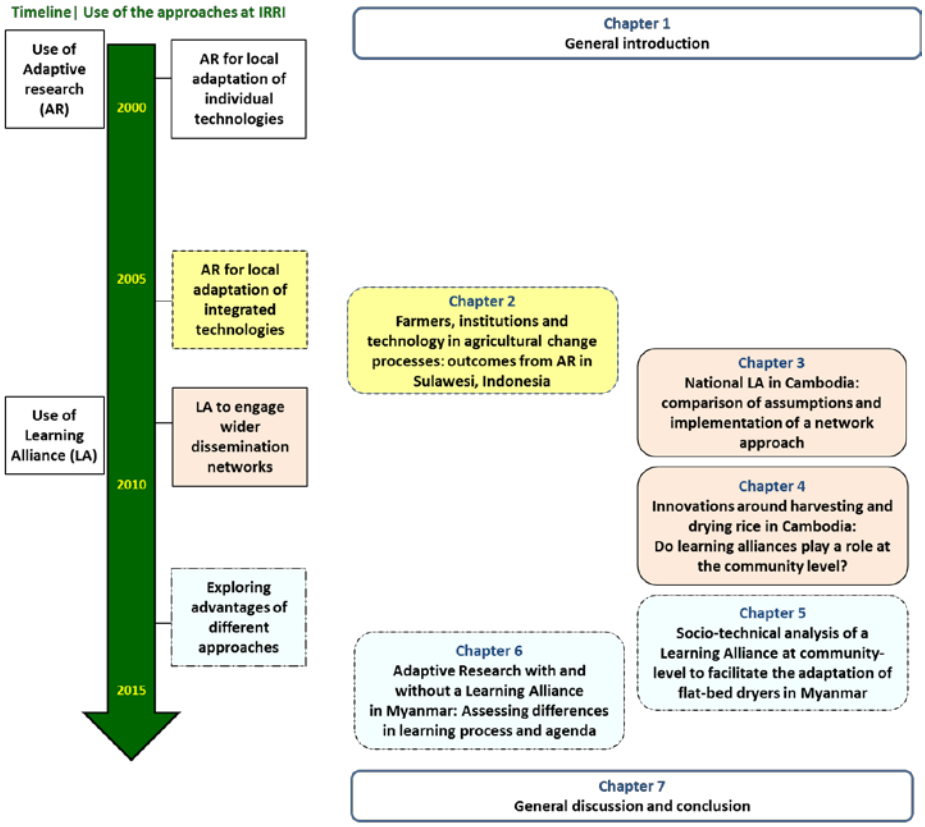


Figure 1.2: Thesis overview in the context of using Adaptive Research (AR) and Learning Alliance (LA) at IRRI

Chapter 4 delves into the processes at the community-level where a national-level LA network aimed to shape innovations for producing higher quality rice through mechanized harvesting and drying. This chapter shows the assessment of how LA members from a broad national network engaged with groups in communities that

shaped innovation processes. An important contribution of the chapter is an examination of small groups in communities as a way to monitor the innovation processes affected by LA.

Chapter 5 is another ethnographic study of a LA, but this case was of a LA formed at the village-level. The chapter is an analysis of processes where involvement of development organizations and the private sector in community level networks targeted socio-technical adaptation around flatbed dryers. The chapter is anchored with the history of flatbed dryer technology, which has successfully spread in one country but not in others. Emphasis in literature points to a conjecture that the use of a LA can support learning for the adaptation of the technology. The chapter provides an examination of the activities to spread and sustain the use of flatbed dryer and adaptation and adoption outcomes. I showed how LA orchestrated a self-organized learning process for socio-technical change.

Chapter 6 is a comparative study where a project used AR with and without LA, expecting that the involvement of a wider network through LA affects learning process of farmers. I first examined how the project translated the approaches through the progression of agenda or 'learning topics' over time. I also compared the actors involved in both approaches and traced relevant interactions facilitated to support learning. I found a translation of AR wherein brokering by local researchers and extension staff facilitated a research-led mode of learning. The inclusion of LA provided a broader network, which expanded the agenda thereby facilitating ownership in learning activities.

The last chapter is the general discussion, comparing the cases and ultimately the two approaches as implemented. This concluding chapter synthesizes findings regarding AR and LA as practised and the innovation outcomes they facilitated. It closes with theoretical implications of the findings regarding multi-stakeholder approaches in research and development organizations as well as practical implications to improve implementation and monitoring.

Chapter 2

Farmers, institutions and technology in agricultural change processes: outcomes from adaptive research on rice production in Sulawesi, Indonesia[1]

[1] Published as Flor R.J., Singleton G., Casimero M., Abidin Z., Razak N., Maat H., and Leeuwis C. 2015. Farmers, institutions and technology in agricultural change processes: outcomes from Adaptive Research on rice production in Sulawesi, Indonesia. International Journal of Agricultural Sustainability (Online first, DOI: 10.1080/14735903.2015.1066976)

2.1 Introduction

International agricultural research centers have taken up participatory approaches in projects aimed at the introduction of technologies that enhance agricultural production and rural development (Gonzalves et al., 2005; Lilja and Bellon, 2008). Many of these projects involve research, for example on testing various technologies under field conditions or evaluation studies addressing adoption of introduced technologies. Participatory methods enhance the inclusion of farmers in project activities, thereby acknowledging the role of farmers as key players in making any technology effective for agricultural production. Likewise, farmers have become an important source of information in studies that focus on distribution and adoption patterns of introduced technologies. Participatory methods thus intend to strengthen linkages between farmers, national research and extension institutes, and international development partners (Consultative Group for International Agricultural Research [CGIAR], 2013; Global Rice Science Program [GRiSP], 2010; Rejesus et al., 2014).

A major implication of using participatory methods is the shift from traditional ideas of technology dissemination in which farmers are considered passive recipients of a technology. Instead, participatory methods recognize farmers as decision makers and knowledgeable practitioners, who assess the benefits of new technologies to their farming system by trying things out on their farms.

Participatory methods also imply a different perception of technology or the innovation process. Rather than considering seeds, tools, improved methods or other innovation as independent factors which the farming community responds to, the innovation process becomes a complex set of interactions between a variety of actors, the agro-ecology and the knowledge and techniques introduced by a project. Participatory approaches in agriculture such as Participatory Action Research (Masters, 1995), Participatory Rural Appraisal (Chambers, 1994), Adaptive Research (Horne and Stür, 2003), or Farmer Research Committee (Ashby et al., 2000) are all aimed at creating effective linkages between farmers' practices, introduced technologies and the wider environment such as policy, manufacturers and service providers. This paper

starts from the assumption that these types of projects need a different type of approach for monitoring.

In contrast, studies on monitoring and evaluation in international agricultural research centres typically employ methods aimed at isolating certain factors or indicators and measure effects with the help of statistical analysis. The advantage of this approach is that it can deal with large samples that produce reliable outcomes about the effect of the measured variables. Such evaluations however, do not capture the many other factors that come into play at the farm level as well as the role of other actors and institutions in the innovation process. Technological change is disconnected from wider interactions amongst various actors and the norms and rules governing their actions. Moreover, it disregards how collective action and social interaction affect interpretations and adjustments of the introduced technologies (Douthwaite et al., 2007; McAllister, 2001).

Qualitative research that assesses and analyses the creation of new relationships and connections between a variety of social actors and introduced innovations, can help to fill that gap. Rather than dismissing one method and privileging the other, we argue for an integrated qualitative and quantitative approach for monitoring and evaluation studies. Such integrated approach can capture complex interactions between farming decisions, changing market or policy conditions, structural arrangements that affect interaction and other innovation processes (Spielman et al., 2009).

We develop our argument by looking at a participatory project on rice production in South and Southeast Sulawesi, Indonesia. In Sulawesi, an adaptive research project was established with farming communities to increase rice production. Researchers introduced a range of best practice technologies found to be effective elsewhere in Southeast Asia (Singleton et al., 2011). The end goal was to support local innovation whereby communities evaluate technology options and make adaptations to suit their context. This participatory project provides an opportunity to empirically examine project outcomes of an impact study with results from focus group discussions and assessment of the constraints posed by actors in the broader environment.

We revisit the result from these monitoring studies to address three questions: 1) what is the background of the participatory research approach employed in the Sulawesi project?; 2) what insights does the analysis of results from monitoring studies reveal, in particular about how farmers responded to the project activities?; and 3) what is the role of actors not directly involved in farm activities, in enabling or constraining the innovation process? These actors form part of the socio-technical environment which influences how new tools and practices are established as innovations. In the Sulawesi project, we want to understand how they shape the institutional environments which influence farmers.

To address these questions we first sketch the historical context of adaptive research approaches for increasing rice production at an international agricultural research and development institute, the International Rice Research Institute (IRRI). We explain the implications in terms of conceptualisation of the role of farmers, technology, and the innovation process. The overview also provides the theoretical perspective from which we examine how adaptive research projects in general and the Sulawesi project in particular were monitored. We then revisit the results from monitoring of the project wherein data was collected between 2008 and 2011, before the current study. In the last section we discuss the implications of our work and present our conclusions.

2.2 Adaptive research at IRRI

Adaptive research (AR) can be traced to 'adaptive management', developed in the 1970's for scientific research to inform policy choices in ecosystems management (McAllister, 2001; Holling, 1978; Walters, 2007). Modified into a type of participatory action research, where scientists develop solutions along with farmers (Horne et al., 2000, Horne and Stür, 2003), it is used by IRRI in projects involving rural communities.

In the 1970s, Farming Systems Research (FSR) was the major approach at IRRI by which connections between rice-related technologies and other crops and farming activities were studied. Research addressed concerns about impacts and on-farm relevance of new technologies (Fujisaka, 1993). FSR encouraged participation by

farmers (Harwood, 2000) mainly through field trials designed by researchers and managed with the support of farmers (Fujisaka, 1993). With external concerns on sustainability, equity, and other issues, IRRI shifted from FSR to a "farmer-first" approach in the mid-1980s (Paris and Abedin, 2005). Adaptive research was used in the farmer-first stage recognizing contributions of farming communities to technology development. Multiple technology options and multi-disciplinary work complemented the consultative-collaborative type of participation (Fujisaka, 1993; Probst and Hagmann, 2003).

Multi-disciplinary groups, in the late 1990s, furthered adaptive research through established consortia working on specific rice environments. The Irrigated Rice Research Consortium (IRRC), for example, facilitated partnerships between national agricultural research and extension systems (NARES) and IRRI scientists, for work in irrigated ecosystems (Rejesus et al., 2013). When the IRRC started in 1997, it aimed to conduct region-wide multidisciplinary work on nutrient and pest management (Dobermann et al., 2004a).

In succeeding phases efforts were increased to integrate different technologies across disciplines and to strengthen research-extension partnerships. The Consortium evolved for over 16 years into an international platform for adaptive research to achieve impact, defined as improvements in the lives and livelihoods of rice farmers and consumers (Palis et al., 2010, Rejesus et al., 2013). Where much of these projects worked with pre-set technological options, the perspective was further broadened at the start of year 2000.

First of all, projects further extended the involvement of farmers in analysing and defining bottlenecks and key problems. Needs assessment surveys are conducted through focus group discussions with farmers. Out of the problem inventory and prioritization of key needs, researchers initiate baseline field assessments and a series of research trials in the fields of farmers, presenting technologies that could address the needs. The results of these trials are discussed with farmer groups at the completion of each crop. After that, farmers are invited to implement their own trials on a portion of

their land. Extension specialists provide advice during the first season but the farmers are responsible for managing all aspects of rice production.

Monitoring adaptive research at IRRI targets different themes (Table 2.1). Studies address needs in project decision-making, evaluating technology performance in fields of farmers, monitoring adoption, informing extension activities or assessing impacts and returns of research investments.

Survey methods are commonly used in these studies to examine what happens after technologies are tried. The methods strongly focus on capturing data from individual farmers, such as knowledge and belief indices, practices and associated costs, characteristics that determine practice, technical and cost efficiency of technologies when used by farmers, and effects on crop yield. These survey methods were used in the late 1990s (Dobermann et al., 2004b; Escalada and Heong, 1997). Data collected were strongly linked with the technology being studied. For example, work on nutrient management emphasized inputs and yield data, whereas pest management focused more on knowledge, attitudes and practices (KAP) of farmers (Morin et al., 2001).

Later on, monitoring studies incorporated qualitative methods to complement surveys. Participatory action research, FGDs and interviews were used to explore social, political and cultural mechanisms involved in practices, tools, and conditions under which farming communities deal with new technologies (Palis, 2006; Palis et al., 2007; Sudarmaji et al., 2010). The studies related farming practices with conditions external to individual farmers, as well as some of the more complicating factors of farming such as unavailability of services at land preparation which resulted in asynchronous planting. This practice in turn constrained the implementation of a rodent management technology (Sudarmaji et al., 2010). Such external conditions are important because they affect individual decisions. Project activities may include reaching policymakers, research partners, extension staff and many others. Yet, monitoring how these actors and the institutional arrangements governing their interactions support change processes at different levels is largely missing.

Table 2.1: Themes in monitoring studies of adaptive research by IRRI scientists and national collaborators in Asia

Theme	**Indicators**	**Examples**
Participatory diagnosis of problems	change in management practices of individual farmers, technologies used, factors affecting socio-economic changes, farmers' assessment of interventions	Can *et al.*, 2010
Technology evaluations	reduction of inputs (seeds, fertilizers, pesticides, labor) and associated costs; effects on yield and income	Huan *et al.*, 2005, Hu *et al.*, 2007, Malabayabas *et al.*, 2013
Decision-making and adoption		
- Economic determinants of adoption	use of technology by individual farmers from intervention and non-interventions sites; time-pattern of adoption; regression on determinants (cultivated area, age of farmer, schooling, irrigation etc.); inputs and yields; economic benefits	Islam *et al.*, 2007
- Beliefs, attitudes and norms affecting adoption	belief scores, management decisions, perceived and calculated losses in yield and associated costs	Heong and Escalada 1999
- Communication avenues that influence adoption decisions	belief index, media exposure, efficiency index, effects of campaign type on knowledge and practice (ex. pesticide use patterns; management actions)	Escalada and Heong 2004, Rejesus *et al.*, 2009, Flor & Singleton, 2011
Impact studies	Awareness and adoption, regression on determinants for adoption, changes in input use and yield, cost efficiency, technical efficiency	Huelgas *et al.*, 2008, Nga *et al.*, 2010, Ding *et al.*, 2010, Rejesus *et al.*, 2011
Meta-impact (investment returns)	economic surplus, poverty indices, adoption estimates, returns of research investment, environmental benefits	Renkow and Byerlee 2010, Rejesus *et al.*, 2014

2.3 A conceptual framework to broaden monitoring

One of the central notions behind participatory approaches is that farmers are knowledgeable actors who operate in decision-making environments composed of a combination of agro-ecological, socio-economic and cultural spheres (Nazarea-Sandoval, 1995). Beyond mere application of accumulated knowledge and skills, or simple acceptance of a tool through adoption, farmers typically adjust their actions based on what they know and can do. These insights imply that what is commonly referred to as adoption of technology is in fact the establishment of effective connections between farmers' knowledge and skills, introduced tools or methods and the conditions around farming. Moreover, such connections are not fixed and finished but require reworking and maintenance from season to season as conditions may vary.

This process of repeated adjustments and alterations is what Richards (1989) has termed 'agriculture as a performance,' highlighting the improvisational capacity of farmers mediated by factors that are beyond individual control. Such factors may relate to erratic rainfall, variable soil conditions or pest pressure. It may also refer to social and economic factors within the direct household and community or wider society such as unexpected reduction of labour, price fluctuations, or availability of agricultural services that affects farm operations.

The factors from wider society influencing the performance of agricultural production are central in the policies and activities of agricultural ministries, research institutes, private companies and other organisations. The whole spectrum of actors responsible for changes in the technological, social, economic and institutional nature of agriculture is generally referred to as the 'agricultural innovation system' (Leeuwis, 2004; Klerkx et al., 2012).

In essence, the innovation systems framework proposes that on their own, farmers cannot drive technological change but are dependent on a network of actors (Leeuwis, 2004). It also posits that technological change requires changes in the broader environment involving the network. This includes changes in institutions or the social 'rules of the game' (World Bank, 2006). Such institutions may be in the form of rules,

policies or land tenure arrangements, which shape the interactions between farmers and the wider network around farming. Therefore, alignment of technological change with associated institutional changes is necessary to facilitate the innovation process (Rip, 1995). Hence, the innovation systems framework opens up questions about the ways in which actors align and coordinate their activities, leading to incremental changes and mutually interlinked trajectories affecting agricultural production (Hall, 2003; Leeuwis, 2004; Smits and Kuhlman, 2004). The framework directs analysis to a more institutional and collective focus in looking at what is happening with farmers and their use of technologies.

The concept of farming as performance and the innovation systems perspective together points out how practices of individuals are negotiated. Farmers and users of technology can take action, have resources and knowledge to employ decisions in agricultural activities; this is performance in the sense of dealing with emergent and possibly unpredictable conditions (Richards, 1989; Klerkx et al., 2010).

There are also collective features that influence action; for example around the farming enterprise, policy system, or general rules governing interaction (Edwards, 2000; Moriss et al., 2006). These collective features cover not only farmers but other actors around them (Klerkx et al., 2010). Therefore, farmers negotiate their practice to employ their own knowledge and skills, while accounting for these external conditions. Conversely, some agreed-upon actions or collective decisions could emerge. These decisions also require translation and negotiation in individual practice. This focus on negotiating change brings up new questions for monitoring and evaluating participatory projects. Rather than looking at impact at the farm level, it expands the scope of analysis to linkages and interactions with institutions and organisations. It examines how these connections support innovation. In other words, monitoring participatory projects involves analysis at different levels of the innovation system.

The concept of farming as performance and the innovation systems perspective comprise the framework with which we examine adaptive research project in Sulawesi. We look at how farmers responded to the introduced innovations as well as how actors in innovation systems responded to the changes set in motion by the project. To answer

the research questions, we revisit previously collected data to examine the space or capacity for farmers to adjust their decisions on new technologies or practices, to know whether linkages are made or not made by project actors with the innovation system, and to understand the involvement of other actors in establishing an agricultural practice.

2.4 Research methods and study area

From 2008 -2011, IRRI staff implemented monitoring and evaluation. Data from the monitoring activities were revisited in light of questions regarding socio-technical and actor-network change processes. For the case study, the sites are villages, Ujung Tanah and Awolagading in South Sulawesi (119° 55' 40.8" E and 4° 4' 33.6" S) and, Bendewuta and Karandu in Southeast Sulawesi (121° 52' 12" E and 3° 44' 34.8" S). Fieldwork was carried out intermittently at key points during the project (Table 2.2).

In 2008, FGDs were undertaken at the beginning of the study to document the socio-economic conditions, current practices, and perceived constraints. We interviewed an average of 18 men and women farmer representatives and local leaders per village (range of 10-28 participants).

Table 2.2: Monitoring activities, villages covered and farmers interviewed in study sites from 2008-2011

Year	Month	Method	Villages covered	No. of farmers
2008	Apr	FGDs	11	195
	Nov	Survey (baseline)	8*	240 (149 from project sites)
2009	Sep	FGDs and interviews	8*	51
2010	Nov-Dec	Survey (end of project)	8*	253 (154 from project sites)
2011	Jan	FGDs and interviews	4**	40

*4 villages each in project and control sites, **project sites only

In 2009 and 2011, we conducted FGDs to monitor the experiences of farmers (men, women, co-operators and non co-operators) in different farm activities and the situation in the village related to the new technologies. These meetings often led to farmers showing us their fields or tools, which allowed observations of their practices in their fields.

Two surveys were implemented to compare socio-economic and knowledge variables for with- and without intervention, as well as before and after intervention. The surveys captured knowledge, attitudes and practices (KAP) of farmers around specific technologies, practices and associated costs, and yields across two seasons. Respondents (n=240) were randomly chosen and represented at least 30% of households per village. Sampling was done in two project- and two control sites of similar socio-economic characteristics, in each province.

Essentially the same farmers were interviewed for both surveys except for respondents who no longer lived in the village. A sample of co-operators (farmers who volunteered to try technologies to compare with their current practice) was included in 2010; since their participation could not be anticipated at the start. Only survey data from the four project villages (n=154) are used in this study to focus on what happened at project sites (co-operators n=48 and others n=106).

The survey covered practices where there were new technologies introduced: crop establishment, fertilizer, water and pest management, and postharvest. For analyses which required comparison of before and after data, only respondents who were interviewed in both surveys were included. Chi-squared, Fisher's Exact, and Wilcoxon's Signed Rank tests were used in the analyses.

The current method diverges from the standard where qualitative monitoring data fed into project management and reports while quantified survey data comprises the bulk of impact studies. We merged data from FGDs and interviews with key results from surveys exploring these with an integrated perspective. The focus is not only farmers and adoption of technology but also actors in the network around introduced technologies.

2.4.1 Description of farmers in the study

Village sites were 70 to 130 km from the capital of each province and within 3 km from main roads. Markets were accessible, although one village is 33 km from town. All respondents from South Sulawesi were of Bugis ethnicity, while those in the Southeast were mixed Bugis (67%), Tolaki (15%), Javanese (15%) and some Mandar, Muna, Sundanese and Poso. Farmers in the Southeast were part of the transmigration, a government migration program that relocated people from Java out of densely populated areas. All sites are under the local extension office, but only one village per province was part of a program to support farmer groups with microfinance, capacity-building, and technical assistance.

Rice is the main source of income. To supplement income, farmers from South Sulawesi had garden vegetables and livestock, while those in Southeast had pepper, cocoa, maize, mung bean, cassava and livestock. Farming conditions in the two provinces are different. There were fewer land-owners in the South (77%) than in the Southeast (90%). Farmers in South Sulawesi cultivated a mean area of 0.8 ha in the wet season (WS) and 0.9 ha in the dry season (DS), while those in the Southeast had 1.8 ha in WS and 1.4 ha in DS. Farmers used pumps in the South, while those in the Southeast have an irrigation system, with access to supplementary irrigation. In the South, farmers are dependent on rain but pump water from the river during DS. Due to the expense and dependence on service providers, some farmers do not use pumps during WS. Hence, they may cultivate less land area, leaving water-scarce areas fallow. Lastly, Ciherang, Way Apo Buru and IR66 were rice varieties planted by farmers in the South, while Mekongga, S33 and Cisantana were planted in the Southeast.

Farmers plant two rice crops per year, while some grow cash crops in smaller areas in their farms. In other villages farmers have tried different cropping patterns such as rice-soybean-rice, or rice-maize-fallow. Key farming constraints in 2008 were periodic water scarcity, high cost of fertilizer inputs, and pest problems from rats, stem borers or snails, which typically resulted in 10-15% loss, and occasionally complete yield loss.

2.5 Outcomes from multi-level monitoring of adaptive research in Sulawesi

2.5.1 Review of the adaptive research process

The adaptive research project was implemented through the IRRC at a time when the Consortium had experience with integrated technologies and multi-stakeholder partnerships. The project involved a process with planned and adaptive activities, various actors and different technologies that were tried and integrated in a suite of management options for different contexts (Figure 2.1).

Co-operators, staff from the Assessment Institute for Agricultural Technologies (AIAT), local extension office staff and researchers from IRRI were the key actors in adaptive trials. Notably, the group comprises research and extension actors as well as farmers.

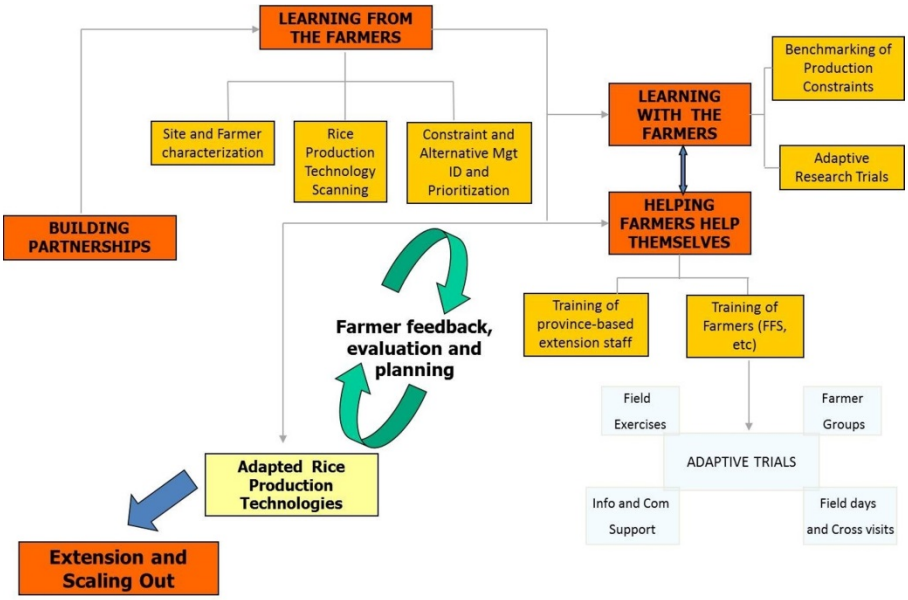


Figure 2.1: Adaptive management process of the project in Sulawesi

After learning about farming constraints, researchers and a few co-operators did benchmark trials (scientist-managed plots). Co-operators then tried a technology in small plots, using an experimental frame comparing ‘farmer’s practice’ and ‘with new

technology'. Key actors and non co-operators gathered at the close of each season to discuss results, review their main needs or constraints, and plan for the next season. In 2009-2010, co-operators decided to integrate technology options and then evaluate the results. A farmer field school (FFS) was held as a season-long learning activity for interested farmers, including women. Field days during harvest season also were held, inviting local officials up to the provincial level, staff from research and extension agencies, and other community members.

A range of communication activities were undertaken at the national, provincial and district levels to facilitate wider spread of knowledge from adaptive research and obtain support from other actors (Table 2.3).

2.5.2 Technology options introduced by the project

Technology options included alternate wetting and drying (AWD) (Bouman et al. 2007), integrated pest management (IPM) (Way and Heong, 1994), direct seeding using a drum seeder, appropriate weed management (Mazid and Johnson, 2010), ecologically based rodent management (Singleton et al., 2005), and fertilizer management. Fertilizer recommendations that were based on soil test kit (locally, PuTS), or on computer-generated recommendations from responses to 10 basic questions (PuPS) (Santoso et al., 2010) were also tried. Based on the main constraints described by farmers in the village, the group tried a technology option aimed to address the constraint. While not all technologies were recommended for farmer trials at all the sites, all technologies were included in field schools and other training activities. Farmers in the Sulawesi sites were not involved during the technology-design phase. Rather, at the start of the project, involvement was through consultative type of participation (Biggs 1989; Leeuwis 2004). Then at the adaptive phase, it became a more collaborative process as farmers decided on the options to implement at a wider area or to integrate with other options.

Table 2.3: Number of communication activities in the Sulawesi Project from 2009-2011

Activity	No.	Activity	No.
Communication with Policymakers:		*Media outreach:*	
Presentations to national government agencies (IAARD, ICFORD, ICATAD, AIAT, and ICRR)	3	International publications (magazines)	4
Briefing for Minister and Donor representatives	2	Radio (local)	1
Meetings with local level policy-makers	4	Television (local)	3
Policy briefs or notes	2	Print (local)	
Curriculum guide/modules (for ICM-FFS)	1	News articles	6
Communication with research partners:		Posters	4500 copies
Presentations	12	Leaflets	5000 copies
Papers	3	Training CDs	100 copies
Communication with national extension staff:		Video	100 copies
Served as resource persons	8		
Trainings/seminars	3		

Source: Singleton et al., 2011

2.5.3 Use of technologies and participatory process

Co-operator farmers tested different options initially in less than a fifth of their cropland but expanded in subsequent seasons. This is in line with the adaptive learning process. They also influenced other co-operators and farmers to try new options. In 2008, there were ten co-operators in South Sulawesi and eight in Southeast. In 2010, there were 37 in the South and 32 in the Southeast. At that last adaptive-trial season, 51 co-operators integrated at least two technologies proven suitable for their fields. The choices varied; based on their assessment of the outcomes from previous season as well as perceived needs of the farmer. For example, 29% of the co-operators integrated four options. Mostly they chose to integrate AWD, PuPS, weed management and IPM.

Also, 41% integrated two options. Some chose AWD and PuPS, drum seeder and PuPS, or IPM and PuPS. The co-operators observed increases in yield and income (Singleton et al., 2011), which influenced their decision-making to continue using the new technology. In FGDs, co-operators said they had developed more confidence in talking about their new management practices to others. They also reported an ease in making adjustments to managing their farm when integrating different options.

After seeing results from co-operators, staff from the AIATs implemented adaptive research process at other sites. Researchers from IRRI and AIATs also had links with government institutes such as the Indonesian Center for Food Crops Research and Development (ICFORD), the Indonesian Center for Rice Research (ICRR), and the Indonesian Center for Agricultural Technology Assessment and Development (ICATAD). These actors became champions who promoted the technologies and process at the national level, and supported extension activities of the AIAT partners.

This established a different interaction pattern at the research-extension side; partners brought learning from both the participatory process to work with farmers and the technology assessments, into other programs of national agencies. It was not only the technologies but also the methods or participatory process that was brought out.

A key outcome was sharing the modified field school curriculum with national partners implementing the rollout of P2BN, the national rice production program. The adaptive research process was new to AIAT staff and they started to adopt it in 2011 and used the approach in their work with rice farmers in other sites. The Director of ICFORD commissioned and circulated a report to directors of other national agencies furthering support to the activities (H. Sembiring, *personal communication*). In this case, network expansion to target spread of knowledge and practitioners of the adaptive process was targeted.

2.5.4 Outcomes in the farming communities

By 2010, technologies were used not only by co-operators but also by those who were not directly involved or non co-operator farmers (Table 2.4). These changes in practice resulted in a 1.1 t/ha mean increase in yield (43% increase from 2008) for

farmers in South Sulawesi and 0.6 t/ha mean increase in yield (19% increase from 2008) for those in Southeast Sulawesi. Co-operator farmers obtained an increase in net income of 68 USD/ha in South Sulawesi and 45 USD/ha in the Southeast.

The succeeding subsections discuss changes in farm activities related to uptake of new technologies. We also discuss supporting and constraining conditions in relation to embedding a 'novelty' or new technology and practice within an innovation system.

Crop establishment

Direct seeding was not a new approach in Indonesia, however, there was a marked increase from 2008 to 2010 of non co-operator farmers who did direct seeding in Southeast Sulawesi (Table 2.4). Farmers in the Southeast experienced labor scarcity at the start of the season which encouraged use of alternative crop establishment methods. Farmers said they were familiar with direct seeding and drum seeders. A few used drum seeders in 2010, whereas none did in 2008. Co-operators who used drum seeders in 2010 had modified the tool and integrated it with other farming practices. On one hand, some farmers interviewed had not tried the drum seeders but expressed interest.

On the other hand, farmers who had tried the drum seeder commented that dragging the 6-drum tool was too heavy. In 2012, farmers had developed a modified 4-drum tool and were showing it to other farmers. A participatory video by co-operators discussed the modified drum seeder, fitting their legowo planting system (Irrigated Rice Research Consortium [IRRC], 2012). By 2012, farmers had made adjustments in their crop establishment practice, linked this planting system with weed management, and modified their tool to make it lighter. This shows farmers had developed skills to integrate different new technologies in a way that addressed their needs.

Table 2.4: Percentage of co-operators (coop) and non co-operators (non coop) using the technologies in South and Southeast Sulawesi, 2008 and 2010. Sample size in brackets; P = probability from chi-squared analyses

Technology	Adoption by farmers (%) in South Sulawesi						Adoption by farmers (%) in Southeast Sulawesi					
	2008			2010			2008			2010		
	Coop (8)	Non Coop (86)	*p*	Coop (23)	Non Coop (58)	*p*	Coop (9)	Non Coop (45)	*p*	Coop (25)	Non Coop (48)	*P*
Direct seeding	12.5	61.6	*	34.8	58.6	*	11.1	17.8	*	64	52.1	*
Drum seeder	0	0	na	8.7	5.2	ns	0	0	na	24	10.4	**
Nutrient management:												
PuPS	0	0	na	43.5	5.2	*	0	0	na	60	27.1	*
PuTS	0	0	na				0	0	na	56	12.5	*
LCC	12.5	2.3	**	78.3	20.7	*	11.1	6.7	ns	76	45.8	*
AWD	0	0	na	56.5	12.1	*	0	0	na	56	52.1	**
TBS	0	0	na	78.3	56.9	**	0	0	na	12	18.8	ns

P Values: * = <0.05, ** = <0.001; ns = not significant; na = not applicable

Although farmers were able to modify the tool and local manufacture was possible, production was limited and there were no local-level actors who invested on making and marketing them. Many of the co-operators had no access to a drum seeder. Those who expressed interest said they could not borrow from the few who had them. The farmers' lack of access to drum seeders (market supply) limited their use despite levels of interest, knowledge and technical adaptation. In summary, adaptive research was strong on the technical and extension side, and was successful in helping farmers harness their creative capacity to adjust a technology to suit their needs. However, the innovation system actors for market and distribution were not present to support the change process.

Photo 1.1: Modified drum seeders
Farmers from Southeast Sulawesi modified the IRRI drum seeder (top). Some farmers made changes by keeping the 6-drum structure, but leaving space in between two rows (middle). The farmers explained this adjustment fits their preferred planting system, and that it makes weeding easier and promotes higher yields. Other farmers own units that have only four drums (bottom). Photo: www.knowledgebank.irri.org (top); R.Flor (middle); T.Mendoza (bottom)

Nutrient management

The introduced technologies encouraged farmers to adjust the amount and timing of application of fertilizers to fit local conditions. More farmers used new nutrient management technologies in 2010 after their introduction in 2008. For both South and Southeast Sulawesi, the increase in number of farmers adopting PuPS, PuTS and LCC is significant (Table 2.4) and adopters significantly reduced their chemical fertilizer inputs by 22% in 2010 compared with 2008 (t_{83} = 2.91, $p<0.01$). Co-operators applied less inputs by about two bags/ha (108 kg/ha) compared with non co-operators. The difference is not statistically significant, but it did lead to important cost savings for an individual farmer.

Similarly, from 2008 to 2010, the number of farmers who had heard of the technologies increased (Table 2.5). Nutrient management technologies not known in 2008 were known in 2010. Also, the number of farmers who had heard of LCC significantly increased at project sites (Fisher's exact test, $p<0.01$).

Table 2.5: Percentage of non co-operator farmers who heard and used nutrient management technologies at project sites in 2008 (before) and 2010 (after); n= sample size

		Farmers (%) in South Sulawesi		Farmers (%) in Southeast Sulawesi	
Technology	Heard and used	2008 (n=86)	2010 (n=58)	2008 (n=45)	2010 (n=48)
LCC	Heard	7	41.4	17.8	75
	Used	2.3	20.7	6.7	45.8
PuPS	Heard	0	29.3	0	45.8
	Used	0	5.2	0	27.1
PuTS	Heard	na	Na	0	39.6
	Used	na	Na	0	12.5

na = not applicable

Farmers had problems getting needed fertilizers at the right time; this is connected with the national policy on fertilizer subsidies. Chemical fertilizers are subsidized in Indonesia (FAO, 2005). Extension officers collect the type and amount of fertilizers every season from farmers, and then submit the data to a national system for

allocation. Farmers and extension staff said fertilizers ‘often arrive late’ or ‘those that are available are not the type [they] need’. For farmers in the project sites, there was a disconnect between their knowledge to adjust type, timing, number of splits, and amount of fertilizer; and their situation of waiting for subsidized fertilizers. Changes to the institutional mechanisms that would allow timely access by farmers to fertilizers were not part of the adaptive research activities.

There is evidence that farmers have the knowledge of recommended best practices (e.g use not only nitrogen or Urea but also other types as needed by the soil, timing of application at specific crop stage, split of total amount needed), yet they decided on fertilizer amount based on ‘what they are used to’ (52%). Others follow what is advised by technicians (37%). Technologies to aid decisions on how much to apply based on location-specific needs were considered only by 11% of farmers. They explained that this is the case 'because it is available and affordable'.

Farmers could adjust the type of fertilizer and split their application, but encounter difficulties to apply at the recommended timing. For example farmers could add Phonska fertilizer (15%N-15%P-15%K) to Urea. Others even added SP36 or KCl fertilizers, but obtaining these at the timing they should be applied was difficult. Other farmers just used Urea. Hence, in the case of nutrient management technologies, the knowledge spread in farming communities but the market situation, availability of fertilizers, and the policy context, led to limited use of new options for nutrient management.

Pest management

Synchrony of cropping was promoted at all sites as a basis for improved pest management. Some 93% of farmers (n = 81) in South Sulawesi and 88% in the Southeast (n = 73) said they planted within 2-4 weeks of their neighbouring farmers. There were signals, such as the start of flow of water in irrigation canals, or religious rituals that open the season which encouraged synchronous planting. The knowledge was also supported by instructions from village extension officers at the start of the season.

In the case of rodent management, farmers were encouraged to do community action early in the cropping season, and implement other rat control methods as needed. Among the key messages emphasized were to work together as a community in management actions and to time management action within 2 weeks after rice is transplanted or within 4 weeks if the rice is direct seeded.

Farmers recognized the potential benefits of these actions but only a few farmers (3%) did small-group control, and none said they did community action. A new control method adopted was a linear trap barrier system (TBS), which consisted of a plastic fence with multiple-capture traps in place set in a line between refuge habitats for rats and the newly planted rice crop. The traps were checked daily and action was coordinated by a group of farmers. In South Sulawesi, many co-operators and non co-operators said they used the linear TBS (Table 2.4), but this was not the case in Southeast Sulawesi. Farmers also said the TBS was expensive.

Comparing knowledge scores for 2008 and 2010 using a Likert scale on questions pertaining to rodent management, South Sulawesi farmers obtained significantly higher mean scores in 2010 (Table 2.6, $p<0.001$, Wilcoxon Signed Rank Test). Knowledge scores in Southeast Sulawesi decreased in 2010, although the difference is not significant.

Table 2.6: Mean scores for rodent management knowledge comparing 2008 and 2010
P value from Wilcoxon signed rank test; n= sample size

Site		**2008**	**2010**	***p***
South Sulawesi (n=41)	Mean score	4.3	4.6	
	S.E. Mean	0.04	0.05	0.003
Southeast Sulawesi (n=18)	Mean score	4.3	4.1	
	S.E. Mean	0.07	0.08	0.511

Knowledge among farmers Southeast Sulawesi may be linked with a negative experience in attempting to adapt community rodent management. Project partners and co-operator farmers introduced community-level management, after villages experienced rodent problems in 2009-2010. Farmers decided to do community action at the start of the 2010 wet season, but experienced conflicts. They were thus not able to organize and work together at the right time, which was at the start of the season. The root of the issue, according to farmers in Karandu, was that a ritual needed to signal the start of the rice cropping season. A religious leader had to be invited to lead the ritual in the field, but because villagers could not agree on details of the event, their plans for community action were affected. Rather than control rodent populations in their rice fields, farmers shifted to corn for the succeeding season or left their fields uncultivated. Others used zinc phosphide or did nothing to control rats. Local extension staff or project partners did not follow-up to coordinate community-wide activities.

In 2012, to manage insect pests farmers implemented more monitoring rather than immediate application of pesticide. Thus they reduced the amount of insecticide used by 32% (t_{40} = 0.92, $p<0.01$). This may be related to better use of knowledge in identifying insects and monitoring methods using locally available materials. Farmers said they saw insects but would not spray right away, unlike before. Synchronous planting was widely recognized as a necessary management action related to pest control. Co-operators said they monitored more because they could not tell if adult insects or larvae were present if they observed only in one day, so they had to continuously check over five days to confirm.

In 2010, farmers in project sites increased their herbicide use by 5% (t_{48} = 0.24, $p>0.1$). This adjustment in their weed management can be related to shift in using the drum seeder or implementing AWD. Labor days for hand weeding decreased significantly by 16%, from 11.2 days in 2008 to 9.4 in 2010. Women, who are usually labourers for hand weeding, were recognized to have increased knowledge on weeds after attending training activities. Labour-days associated with hand weeding increased by 12% for women, but decreased by 32% for men.

In general, pest management actions that farmers could implement individually such as applying pesticides or hand weeding changed along with changes in knowledge. Aside from synchronous planting, however, options that required coordination and collective decisions, such as TBS or community-action, had less uptake. While coordination was encouraged through activities to introduce new management methods, enabling coordination required more orchestration than lead farmers and extension staff could provide. Effective pest management in this culture also required behavioural change for actors such as village leaders, religious leaders, service provider groups, and labourers. The current project had not developed strong connections with these other set of actors.

Water management

Farmers have knowledge on alternate wetting and drying (AWD). Ninety-three percent of farmers in South Sulawesi and 88% of farmers in the Southeast, said they allowed their fields to have no standing water at intervals during the growing season of rice. A lower percentage of farmers in the South than in the Southeast said they used AWD (Table 2.4).

There is a marked difference in arrangements for water management which affects irrigation practices in the two provinces, which in turn affects whether farmers could implement AWD. Farmers from South Sulawesi sites hired service providers to irrigate their rice crops via pumps, whereas those in the Southeast managed their own fields through gravity irrigation. Farmers in the South paid 20% of their yields to service providers for labor, pumping, rent and fuel. They do not get involved directly in irrigation activities. In comparison, farmers in the Southeast had to carry out the task and deal personally with scarcity of water in the irrigation system.

Service providers in both provinces were not were not introduced to AWD or reducing water use. There was no change in the arrangement of service providers for irrigation for South Sulawesi farmers between 2008 and 2010. Payment was the same whether they pumped more or less water, but the service providers could be blamed if the rice plants did not receive enough water. Irrigation managers in the Southeast also were not oriented with AWD. Only individual farmers who can control their own

irrigation did some monitoring. Co-operators mentioned they used bamboo perch tubes, as recommended, to observe below-ground water levels and then irrigate when needed. They said it was time-consuming to check the tubes every two days, but also that AWD is important for 'when there is water scarcity.' In the end, there was some adjustment in frequency of monitoring tubes for water levels once farmers, who irrigate by themselves, knew when there was low moisture in the subsoil. Otherwise, the usual practice was done by service providers. Here again is an outcome whereby farmers learned about a new technology but application was constrained by the 'disconnect' with the practice of wider network actors.

2.6 Discussion

At the community level, adaptive research changed some practices of co-operator and non co-operator farmers, showing how a participatory approach helped to fast-track technical adaptations of suitable technologies (within a two-year time frame). There were marked increases in farmers using some technologies, not so much with others. There were changes in yield and income associated with some of the technical innovations (see Singleton et al., 2011 for details). Farmers started to manufacture tools and had knowledge to modify and integrate technologies, demonstrating improvisational capacities to deal with change. At the level of organizations reached by the adaptive research, we found consolidation of support and use of the outcomes from the on-the-ground trials.

Water, fertilizer management and pest management were among the top three constraints farmers mentioned during the needs assessment. Technologies which targeted these: AWD, PuPS and IPM, were preferred by co-operators among the varied options introduced. Adaptation of these technology options was not a straightforward application of new knowledge about discrete technological elements but rather the development of a set of negotiated practices. In the case of pest management for example, there was merging of existing knowledge on pest identification and new monitoring methods. Interviewed farmers appreciated the use of new monitoring methods through pheromone traps, soap and water; or golden apple snails, chicken dung

and paste from soy beans. Monitoring options helped them reduce insecticide use or do nothing even when insect pests were present.

Moreover, farmers had to balance their actions as they integrated different options. Farmers, for example, said fertilizer application had to be side by side with water management, which meant changed timing of application when they did AWD. At the same time, they also had to adjust weed management when they practiced AWD; which could mean increasing their use of herbicides. Co-operators also mentioned they learned about types of herbicides which 'could be used before the weeds were grown.' Indeed, adapting the practices meant that the farmers were monitoring the interactions and the consequences.

Notably, while researchers and extension staff supported monitoring activities by farmers, none stepped in to help resolve conflicts and co-ordinate the organization of collective action. An example was the lack of coordination in hunting rats and maintaining clean farms. This highlights that project monitoring could capture bottlenecks but deemed the socio-institutional constraint to be outside the sphere of intervention. The experiences on integration and adjustment have strong implications on the interdependence of technological decisions as well as negotiating with conditions beyond individual and farm levels.

Change in technologies used, yields, inputs, costs and knowledge monitored in Sulawesi are outcomes commonly tracked in monitoring studies of adaptive research (Table 2.2); these are important indicators. The Sulawesi case however, shows that there are more angles to examine of the complex process of knowledge integration and stakeholder interactions involved in this type of research. Adaptive research processes were not limited to research-with-farmers; of particular importance were ways to expand the network of partners and generate support for embedding innovations. The pattern of interaction where researchers and extension staff worked closely with farmers and built networks of political support was essential in this process. The composition of key actors and the interaction pattern may be an effect of how IRRI scientists historically work with national partners. Indeed, engaging networks of support beyond knowledge links at different levels has been found to support diffusion (Basu and Leeuwis, 2012).

Outcomes regarding what key partners, as intermediaries, took out of the project aside from the technologies introduced may be captured in monitoring but these often do not emerge in impact studies. Policy outcomes are mentioned but how such policy changes did or did not emerge in relation to activities of key partners is not explained. Although the benefits of partnerships and participatory processes are widely accepted, the process in which these actors influence change is largely left implicit (Hall et al., 2001, 2003). This case shows such changes can be documented.

The activities of the project focused on agronomic and technical adaptations. For some technologies there was limited effect in some aspects of the innovation system. Constraints in markets or access to equipment, cultural factors facilitating cooperation in communities, inclusion of other actors such as service providers, local leaders or policy agencies on input subsidy could be targeted to support change processes. Indeed, although some technologies are found promising after field evaluations, there are still social and institutional conditions that affect adoption outcomes (Pircher et al., 2013). The lag between what is known of social as opposed to technical adaptations may be related to the involvement of communities only after the technological-design phase. Our findings concur with Roep et al. (2003) that the simultaneous redesign of technical and institutional changes is needed. These findings also highlight the importance of the process in which a new technology starts to become connected to a configuration of aspects in the innovation system, a process which Elzen et al. (2012) termed as anchoring. Sustaining the uptake of novelties trialled in the project requires connections with a much wider set of actors, in ways that fit together a set of tools, tasks and mechanisms governing interaction. Doing so can support the decisions of farmers regarding practice.

Framing user practices not only as a function of individual decisions but also as part of collective processes showed both the constraining and enabling conditions of technological change. This framing allows complex socio-technical issues to surface, which are often gaps in technology adoption and impact studies. For example, in what ways do farmers modify technologies or integrate component technologies to address their location-specific needs and demands from external conditions. In another example, external conditions that affect farmers such as labour scarcity, input subsidies and the

institutional context around farming may sometimes be presented as backdrop within which individual decisions are made. This way, factors affecting technological change are ascribed to 'other' actors beyond the scope of participatory projects.

Lastly, a focus on collective processes may also highlight how non-farmer actors in the wider network take up aspects of a technology to aid access for farmers. By these we mean service providers of irrigation or local manufacturers of drum seeders in Sulawesi. It may be implied in monitoring of adaptive research that once farmers have knowledge and 'proven' technologies to work in the farms, the necessary tools and social mechanisms would also be present. Farmers are part of a network of actors relevant for co-evolutionary change and their decisions are mediated by external conditions (Rip, 1995; Smits, 2002). Recognizing this implies the need to broaden the scope of monitoring to include what is happening to the wider network and the institutional environment affecting farming practices.

In addition, the inclusion of methods that consider socio-economic stratification would allow projects also to monitor subsets of actors (e.g poor, landless, women) who experience the impact of innovations for sustainable development, while reaching those who can influence change. A broader approach could address some critical assessments of outcomes from adaptive projects as well as questions on the inclusiveness of the innovations (Gilbert, 1999; Connell et al., 2007; van de Fliert et al., 2010).

2.7 Conclusion

We have shown how farmers adjusted their practices and how actors involved linked (or not) with others in the innovation system. We also demonstrated how institutions such as local policies, payment schemes, or religious rituals posed conditions that affect practices aligned with introduced technologies.

The current emphases on quantifying outcomes of adaptive projects in terms of adoption at farm level, however, does not expound on broader processes that provide enabling conditions around new technologies. Instead, we provide evidence that using a broader perspective in monitoring can uncover important additional insights on the factors which shape outcomes in farming communities. More rigorous use of this approach in monitoring outcomes is likely to enhance adaptive research programmes.

The study also has implications for adaptive research itself. Technological change was an emergent process in the Sulawesi case study and was intricately linked to the conditions in the social environment. Therefore, in order to expand outcomes from adaptive research, we recommend a move beyond experimentation on the agronomic aspect or design of new technologies. This means that adaptive research projects should also pay attention to designing and testing new institutional arrangements that create enabling conditions for agricultural innovation.

Chapter 3

Rice post-harvest Learning Alliance in Cambodia: comparison of assumptions and implementation of a network approach[2]

[2] This chapter is under review for journal publication as:
Flor, R.J., Leeuwis, C., Maat, H., Gummert, M. Rice post-harvest Learning Alliance in Cambodia: comparison of assumptions and implementation of a network approach.

3.1 Introduction

New approaches for research projects have emerged, which involve local stakeholders to realise innovation in rural areas. These approaches are based on a perception of innovation as a process to re-order technical, social and institutional elements, affected by relations in networks (Leeuwis and Aarts, 2011). There is however, scepticism that approaches based on multi-stakeholder networks remain paper tigers and that in practice technology-push strategies and top-down instructions prevail (Leeuwis, 2010; Schut and Sherwood, 2007). It is thus important to manage expectations of what multi-stakeholder networks are and what role they play in innovation systems (Trott and Hartmann, 2009). The current study examines a multi-stakeholder network approach called Learning Alliance (LA) to understand how it is translated in practice. We trace what happened in a project in Cambodia with respect to (dis)connections between assumptions from project implementers, conceptual rationale of LAs and how it worked out in practice. We found that the innovation network is reassembled after an innovation is introduced. Smaller clusters of the network move the innovation forward and should be seen as the real innovation network.

LA is a concept for research and development projects in which a variety of local, national and international stakeholders are involved. Such projects work with objectives envisioned to be achieved in specific ways, formulated as a so-called theory of change (ToC). The ToC comprises the assumptions and guiding principles for project activities and spell out its impact on the medium and long term. The ToC is thus an important source to understand how projects accommodate (or not) ideas about innovation through LAs.

In the LA literature, network processes are not well elaborated. There is coverage for example of how networks are started or facilitated (Moriarty et al., 2005; Stür et al., 2009); or impacts on organisations and farmers (Lundy et al., 2012; Stelling et al., 2009). There are also descriptions of organizational networks with emphasis on partnerships, but with limited explanation of what partnership means (Ashley et al., 2012; Best et al., 2009). Studies have quantified and mapped interaction patterns among farmers in alliances (Mashavave et al., 2013), but little research is done on how LA

networks operate on the ground or the mechanisms for its effectiveness. This paper is a first step to fill this gap.

In the early 2000s, the International Centre for Tropical Agriculture (CIAT) first used LA approach in an international agricultural research project (Lundy et al., 2005). The case analysed here is a Rice Postharvest LA in Cambodia initiated by the International Rice Research Institute (IRRI) and implemented between 2008 and 2012. LA approach was used to bring together various stakeholders to reduce losses and improve the quality of harvested rice.

We compare conceptual design of LAs, and the assumptions from the research project, with the networks and outcomes created during implementation. In subsequent sections, we present analytical concepts which we use to compare these three and describe our methods to collect and analyse data. We then present the case of the Postharvest LA leading into a discussion of the (dis)connections between conceptual design, assumptions from the project, and the case in Cambodia.

3.2 Translating a network approach: connections between assumption and implementation

The assumptions about what a network is or is supposed to do in LAs can be observed as conceptual design from literature and as design formulated in project documents. These 'blueprints' are negotiated between different stakeholders, who make adjustments and compromises during implementation. This process can be conceptualised as a series of translations, a notion derived from actor-network theory (ANT) (Akrich 2000; Law and Callon 1988). ANT emphasizes that distinctions between theory and practice, design and implementation become obsolete when looking at it as a series of translations. Since distinction between formulated (design) and achieved (implementation) targets plays an important role in projects, we introduce the combined notions Espoused Theory and Theory-in-Use as developed by Argyris and Schön (1974).

3.2.1 Conceptual assumptions from LA literature: Three key concepts

The LA fits in a variety of approaches and concepts that advocate the creation of stakeholder networks for rural innovation. A functioning network is also referred to as an innovation system (Hall et al., 2003; World Bank, 2006). The common idea is that actors jointly identify, share and adapt proven agricultural practices in specific contexts (Lundy, 2004; Lundy et al., 2005; Stelling et al., 2009). Actors include a variety of organizations and individuals, at national, regional or community level, together shaping the innovation and creating the required knowledge to make the innovation work (Best et al., 2009; Douthwaite et al., 2009; Lundy et al., 2005; Penning de Vries, 2006; Prasad et al., 2007; Verhagen et al., 2008). Network-building activities imply the inclusion of new stakeholders or strengthened connections through increased interactions (Adolph, 2005; Best et al., 2009). How networks are created, who is involved and the nature of the interactions are important questions to examine implementation.

Furthermore, LAs are considered to result in a more effective innovation process (Proost and Leeuwis, 2007). The technical components of an innovation can only work through the activities of involved actors. This implies complex processes of coordination in co-evolutionary change that include unpredictable developments and possible conflicts (Leeuwis and Aarts, 2011; van Woerkum et al., 2007). Actors negotiate institutional agenda, catalyse new linkages and strengthen coalitions between actors (Hall, 2006; Leeuwis, 2004; Lundy and Gottret, 2007; Stür et al., 2009). LAs also engage intermediaries--actors who provide bridging, brokering or knowledge-transfer support, to reach other actors (Douthwaite et al., 2009; Moriarty et al., 2005; Stür et al., 2009). Finally, LA networks are thought to foster reflection and learning (Morrison and Mezentseff, 1997). How this process evolves is a second question that guides our analysis.

LAs align with the current view of innovation that focuses on successful combinations of technical devices, modes of thinking and social organisation or ‘mutual co-innovation’ (Ferris, 2005; Leeuwis, 2004, 2010). Rather than spreading specific research products, LAs facilitate social learning in an area of interest to understand key elements required for innovation (Morrison and Mezentseff, 1997). This thinking

highlights that alliances develop local knowledge to support local solutions while accounting for local realities; thus it focuses on the enabling environment needed to maintain the innovation (Moriarty et al., 2005). This leads to a third component of the analysis: how are social interaction formed by the technical requirements and vice versa.

Our review of conceptual assumptions revealed three interrelated concepts assumed in the network approach: the composition of actors, process of innovation, and the combined social and technical nature of innovation.

3.2.2 Network assumptions and implementation

Actors within projects have a ToC which orients project-related activities. This comprises assumptions of what the stakeholder network would be like, what it will do and how it will accomplish project goals. The ToC then contains what Argyris and Schön (1974) call an espoused theory, expressing the assumptions about how actors are supposed to behave in order to make the preconceived innovation work. Argyris (1976) described Espoused Theory as the theory which people use to design their action. It comes together with a Theory-in-Use, the theory used (wittingly or unwittingly) to carry out their actions. Analysing (mis)matches between espoused and theory-in-use helps to understand why certain connections in the network turn out differently and why some linkages may be facilitated or not. Project implementers have this espoused theory as a design for how actors would make network processes unfold. Yet the actions may be carried out differently from the design, requiring implementers to move back and forth between what they assumed and what is actually happening (Akrich, 2000).

3.2.3 Merging and broadening the concepts for analysis of implementation

Considering that the social and technical do not evolve in mutually-exclusive paths (Law and Callon, 1988), analysis of the role of the material in networks is also needed. ANT captures and broadens our concepts from assumptions and directs attention on processes, performance and relations between heterogeneous human and material actors (Latour, 2005; Law, 1999). It pushes for exploration of patterns created through interactions between agro-ecology, specific tools and techniques, and people's activities during implementation. We will investigate the network on-the-ground to make plausible links between actions, relationships and outcomes.

We will use actor composition, network process and nature of innovation; and merge these with a relational analysis through ANT. We also recognize that project actors make collective assumptions of how this network unfolds on the ground. From these, we build our understanding of LA, making connections across conceptual literature, project theory of change and implementation.

3.3 Methodology

To investigate the assumptions, implementation and outcomes in the LA, several strategies for data collection and analyses were used.

3.3.1 Data from alliance members: interviews, documents and network maps

In 2012 and 2013, the first author obtained data from all active members of the LA located in Phnom Penh, Battambang or Pursat. These are listed in the appendix. Aside from organizations, individuals who were part of the LA were also interviewed including millers, leaders of cooperatives, manufacturers, service-providers, and farmers. Questions were on alliance-related activities, actors they worked or interacted with, and outcomes from these. For interviewees at village level, the same key questions were asked but follow-up questions on their activities emerged during observations in the field.

Alliance meetings, project events and monitoring also provided opportunities for participant observation and secondary data gathering. Project documents were examined for implemented activities, assumptions and targets.

To track the types of actors involved, and whether this changed over time, data from network maps were used. In 2008 (start of the alliance) and 2011 (monitoring), two of the authors facilitated mapping by representative members of the alliance. Members listed the people with whom they interact and how they were linked. For the 2011 mapping, members from six province sites made maps to analyse who were involved in their province. Data from the six maps were consolidated. The maps were digitized, creating a database in Excel. Data were analyzed using UCINet6, with consolidated

network maps produced from NetDraw. The network maps were further analysed in complement with coded interview data (through ATLAS.ti) to examine network composition and processes.

3.3.2 Interviews in farming communities

Interviews with farmers and town-level actors who were not members of the alliance were done in two sites each in Battambang and Pursat. These are sites where members had activities. Farmers were selected randomly based on a list. Other respondents were either target groups of alliance activities, or involved in post-harvest tasks: millers, service providers for drying and harvesting, local extension staff, finance groups, manufacturers, cooperatives, non-government organizations (NGOs), and traders. The interviews focused on postharvest activities to understand innovation processes mentioned by alliance members and to clarify cases where members made connections at community level.

The overall analytical focus was on how the network was articulated in comparison with conceptual assumptions. We separately analysed what this network entailed as envisioned by project proponents and implementers, and as a translation of multi-stakeholder actors operating at different levels in Cambodia.

3.4 The Cambodian Post-harvest LA

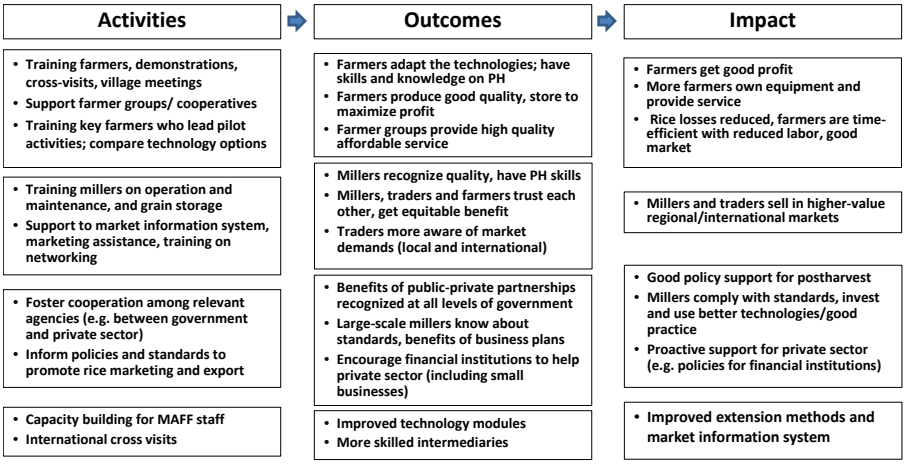
We first explore how the network was viewed through objectives of the research project and translated by LA members into a ToC. Then we show the evolving network as the LA was implemented.

3.4.1 The network as envisioned by project actors

The aim of the project was to reduce post-harvest losses, strengthen existing extension services and increase the income of rice farmers in three Asian countries. It had a wider aim of creating a policy dialogue about postharvest. It targeted five LogFrame outputs: postharvest technologies, extension methods, business models, trainings and national LAs. Defined activities included piloting dryer and hermetic

storage; collaboration agreements with partners; creating business models for equipment; and supporting national extension systems. The long-term impact targets were 0.5% poverty reduction in 2015 compared with 2008, at least 300,000 farmers adopting piloted technologies, and postharvest losses reduced by 5% with the value of rice increased by 10%.

The LA was both means and end. Once the alliance was functioning, it could help to achieve additional goals. In Cambodia the LA was formed in 2008 through a participatory impact pathways analysis workshop (Douthwaite et al., 2007). In the workshop representatives from farmer groups, government agencies, millers, NGOs and researchers explicated the ToC (Figure 3.1).



Source: Participatory Impact Pathways Analysis Report (Dec 2008)

Figure 3.1: Theory of change (ToC) outlined by learning alliance members, 2008

The ToC shows assumptions of change emerging from different extents of influence particularly, farmers, millers, traders, government organizations, and private-sector. The changes targeted were not only in technologies and practices but also policies. Technology and extension were prominent in the activities as well as target results. The ToC espoused a network where connections are initiated and facilitated through organizations. It also captured best-bet technology products from research,

which would be piloted, adapted and spread; specifically, spread of technical knowledge to farmers and millers. Moreover, the ToC recognized institutional change related to markets, funding and other capacity-building needs.

3.4.2 Implemented LA network

Of the implemented network, we first examine network composition. Secondly, we look into processes shaping the network such as inclusion, change in roles, coordination between levels, and scaling out. Lastly, we analyze socio-technical learning and adjustments.

Network composition and expansion

In 2008, alliance members mapped their post-harvest network. The resulting map represented eight stakeholder categories including research, funding agencies, local manufacturers, millers, service providers, extension agencies, policy agencies and farmers. Research and extension agencies were prominent at the start of the alliance, with a few private sector representatives. About 60% of 22 initial LA members were from government agencies and mostly based at national offices in Phnom Penh. Initial members were not only organizations but also individuals such as local manufacturers.

The network expanded to 22 stakeholder categories in 2011 from eight represented at the start in 2008 (Figure 3.2). Some LA members had links with community-level stakeholders. The members (red and blue nodes in Figure 3.2) included NGOs, projects, universities, key farmers, and service providers in addition to stakeholders initially identified. They included individuals who acted separate from their group or organization.

In 2012, similar stakeholder categories as those in 2011 surfaced in the interviews, except that there were eight actors not mapped by alliance members in 2011. These actors were formally involved since 2008, but mostly operating at national level and were hence not known at province level. Some actors had ceased activities in the alliance and were not mapped. Other actors mentioned as important links in 2012 and providing services such as hauling, coordination for harvesting or manual labour were also not specified in 2011. Conversely, a link to local media was not mentioned in

interviews but emerged in the 2011 map. The mapping exercise thus shows there is considerable dynamics and learning regarding the network. It also shows actors recognize network members, particularly when they are visibly active at local level.

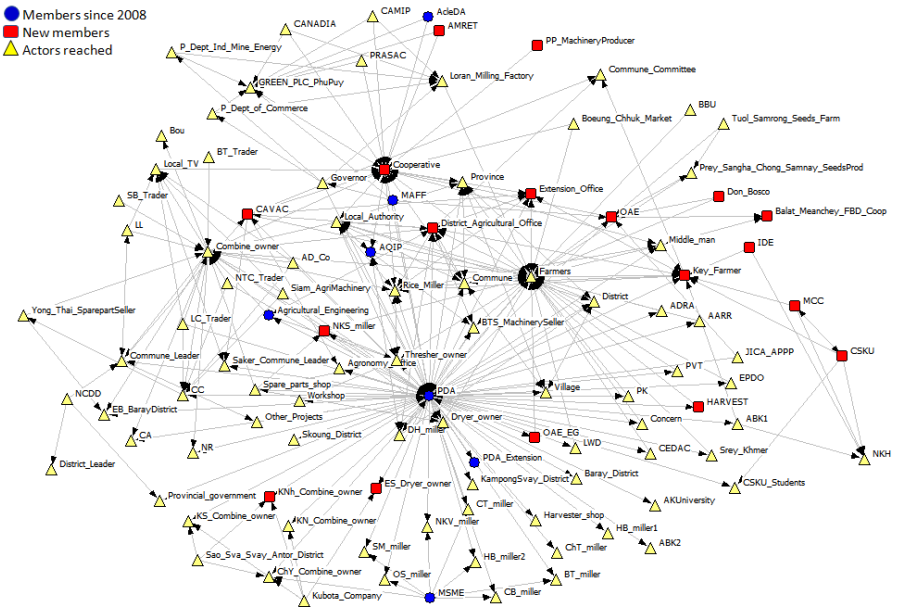


Figure 3.2: Network map of the Cambodian Postharvest LA in 2011showing original alliance members (in blue nodes), new members (red) and other actors reached (yellow);

Process dynamics

The network approach resonated in engaging stakeholders with a common problem definition, defined by facilitators as the 'need for better rice post-production practices throughout the value chain' (PIPA Report, 2008). Engaging new members in the alliance also implies widening knowledge of specific actors. Interviewed extension staff indicated not knowing at the start in 2008 about other actors, such as millers and how to involve them. Millers were initially categorized as a homogenous group, represented by the association of millers (Figure 1). There are variations of millers however, as they produce for different trading channels, or aim for different quality of rice for export, regional markets or local markets. Alliance members found out about these differences as they moved along, therewith shaping the network in a particular way. Another

example is the involvement of NGOs. An interviewed government extension staff, for example, did not know there were NGOs active in the same area. Discovering these organisations resulted in the involvement of two NGOs in the alliance.

As the network widened, some actors were no longer actively informed or invited; nor did they share their activities with the alliance. Reasons given for disengagement included conflicts between actors (e.g. leadership decisions, monopoly of benefits), differing access to resources, and turn-over of staff in organizations. Furthermore, not all activities are facilitated by the local coordinating team, resulting in separate activities in different places without exchanges between various locations. The open and informal set-up of the network was conducive for such situations.

Remarkably, traders were not actively linked to the alliance the way millers were. Although farmers wanted better interaction with traders, staff from a government research agency expressed traders were 'not positive to changing the situation of farmers producing good quality' rice. Accordingly, it goes against their competitive advantage in selling to millers. Therefore, to maximize benefit for farmers who can keep profit margins for themselves, alliance members thought it could be a useful strategy to bypass traders. Traders however were important to farmers for other reasons, most prominently providing credit. Nevertheless, traders were deliberately not included in alliance activities.

Another process dynamic was a change of roles of alliance members (Table 3.1). Actors discovered new opportunities and learned new skills that changed or expanded their activities in the network. One example is a cooperative providing drying services to farmers decided to produce flatbed dryers. They 'learned from a manufacturer [member of the alliance]…when they were involved in construction of their own dryer' (interview with cooperative leader, 2012). The cooperative successfully obtained contracts to set-up flatbed dryers in the province. There was also a miller who started making recirculating dryers for other millers after getting some training and support from alliance members. There were changes in government agencies as well, for example the creation of a post-harvest section in a government research institute. Another is the involvement of an alliance member in the newly-established national standards

committee for grains. This committee creates the regulations on grain quality for national and export markets, affecting set standards by millers and traders.

Table 3.1: LA Members with changed roles, shown with their link to the LA, the change in roles regarding rice post-harvest (PH) from 2008 and 2012, and the level where they operate

Institute/Org Type	Link with LA and project activities	Change	Level
DAM	Trained on PH; research on machines	New PH Section at government agency on agricultural machinery formed, LA member appointed head of section	National
Miller, Owner of combine harvester; Head of Millers' Assoc.	Involved with combine and dryer demo, link to millers' association, trained on next-generation dryer (recirculating dryer)	Uses flatbed dryer in own mill; manufacture and sells recirculating dryers; Demonstrates how to use combines to farmers and operators	Local
PDA (Pursat and Battambang)	Extension partner	Have new projects including PH (funded by IFAD, JICA and IMF); Started to implement trainings on PH for these 2 projects (40 trainings, 25 farmers each) in other locations	Local
RUA	Attended training; Coordinated training for teachers	Teach PH in RUA; Promote and use Rice Knowledge Bank; Appointed member of the National Quality Standards Committee for export and local market	National
Cooperative/dryer operator	Trained on dryers, former project key farmer	Contracted by ABK Seed Co. and other seed producers for drying; manufactures dryers	Local
Combine operator	Cross visit to VN for combine event	DAM contact for demo activities in Battambang, Provides repair/support service to combine operators	Local
Don Bosco (NGO)	Business model case, Demonstration dryer unit for services	Provides drying service to farmers; extension activities to students and farmers; Linked with government to obtain milling unit	Local
Key farmer (Pursat)	Key farmer	Coordinates harvest and bulk selling (paid by trader)	Local
Key farmer, dryer operator, Cooperative leader	Key farmer, dryer operator for demo unit in Battambang	Trains dryer operators; shared knowledge to miller customers who also set up their own dryers	Local
Micro-finance institutes; bank	Joined business fora	With Harvest and USAID, increased its agricultural business products (previous amount was only for machine spare parts); plan to open loan products for combine harvesters	Local
Key farmer, Chrey Veal Village	Key farmer; joined combine demo	First in the village to invite and hire combine harvester in 2009 (in 2010 there were 18 combines operating in the village)	Local
PDA Pursat	Training extension staff	Implement new projects on rice post-harvest	Local
Coordination team	Coordinate and implement project activities	PH Publications adapting e-learning materials; Other project links; Consultancy work on post-harvest, Provide training to millers, NGO and farmers	National

Socio-technical network building

Most changes were not outcomes of deliberate action from the alliance but evolved out of the joint focus on postharvest techniques. Indeed, it seems that the stronger and lasting connections developed around particular tools or technique used by a small number of actors, who are furthering their own networks. Two cases are presented of individual members at the community level, in the process of linking with other post-harvest actors.

Case 1: Alliance member from a cooperative (Kim: dryer operator, cooperative leader)

Kim (a pseudonym) operates a flatbed dryer (FBD) and leads a cooperative. His post-harvest network (Figure 3.3) involved farmers (in square nodes), millers (diamond), manufacturers (circle) and external actors (triangle). Through a demonstration unit operated as a business of the cooperative, he was given technical support to manage the drying-service operation. He was also a 'key farmer' who taught other farmers on post-harvest techniques, organized meetings or cross-visits, and coordinated the use of communal equipment.

Of the farmers in Kim's network, two said they did not want 'to wait or compete with other users to dry their grains' (interview notes, 2013). They had their own FBD installed in 2012, from which they started to provide drying services to other farmers in the village.

Millers were among the customers of the drying services. The interaction with millers and their experience of 'getting good quality rice, with good milling output' spurred millers to invest in dryers. Kim linked some millers to a manufacturer LA-member, while others contracted different manufacturers for installation. In total, five millers in Kim's network installed their own dryers. Of these millers, three asked Kim for training on dryer management and sent their operators to apprentice with Kim. Four of the millers used dryers for their own business, but one provides service to farmers when not used for their own purpose.

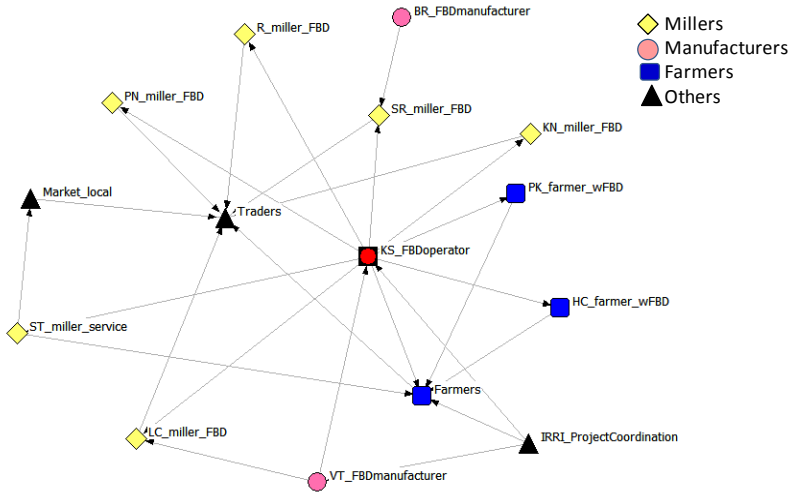


Figure 3.3: Network of dryer-operator LA member, showing links with farmers (in square nodes), millers (diamond), manufacturers (circle) and others (triangle)

Millers learned quality and amount of milled rice is different if grains were mechanically-dried. Thus their standards changed. As one miller, who did not have a dryer expressed: 'if a miller does not have a dryer at this time, he can no longer compete in the business' (interview notes, 2012). Since he could not afford a dryer, he decided instead to focus on providing milling service for villagers (household consumption) and supplying rice husk to dryer operators.

Case 2: Alliance member from service sector (Nuon: Combine-harvesting service provider)

Nuon (a pseudonym) developed a network around combine harvesters that he hires out to farmers (Figure 3.4). He was a thresher-manufacturer who observed a demonstration of combine-harvesters by an IRRI-project in 2007, and was among the first combine-harvester owners in the area. Another link with the alliance was through a cross-learning trip to Vietnam. He was then involved in research trials on combine harvesting and other machines.

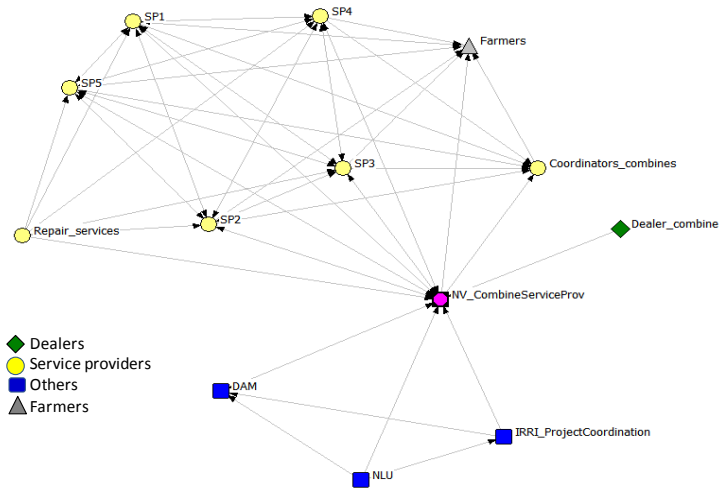


Figure 3.4: Network of combine service-provider LA member, showing links with dealers (in diamond nodes), combine service providers (circle), farmers (triangle), and others (square)

Nuon's network involves service providers for mechanized harvesting (circle nodes in Figure 3.4). The small group of service providers consults with him and learns from each other discussing machine operation and modifications. He supported the others through training, repairs and trouble shooting, referrals of customers, and discussion about machines. The group shares at least one harvesting coordinator in each village to find farmers and schedule harvesting. This contracting service is paid 5USD per hectare which they pay out of the harvesting service fee from farmers.

The two cases show how alliance members who interact more at community level are involved in emerging changes to relevant institutions that support the shift in harvesting and drying. Firstly, the emergence of service-providers, who provide drying service or coordinate harvesting, changes the way in which options are made available for farmers. Secondly, some of these connected actors set standards which affected farmers in the area. For example, millers influence what varieties and paddy type (wet or

dry) would be bought. As one trader said, the ‘rules for buying are slowly changing’ (interview with trader 2012). With more millers being aware of higher milling recovery from machine-dried paddy, there was increased demand for dried paddy or machine-harvested paddy which millers themselves dry. Thirdly, there is local investment and cost-sharing. Resources used in the interactions, for example payments for coordinators or training of new operators were provided locally.

Socio-technical learning at community level also affected processes facilitated by the wider network. The alliance had reflection cycles covering technical and social aspects of post-harvest. One was assessments of tools that were useful and those that did not work. The project initially focused on storage and drying technologies; but simple tools to help farmers negotiate with traders were found needed partly to ensure market incentives for quality. One simple tool, the scale was seen to be important. Key farmers then managed one communally-owned weighing scale in each village. Farmers borrowed the calibrated ‘project scale’ when selling. This created a different selling practice where the exchange was not only dependent on traders. Farmers noticed ‘traders now use the project scale’ (interview with farmer, 2013) which for them meant less cheating on weight of paddy. It provided an equalizing effect in negotiations between farmers and traders.

Another tool, moisture meters, did not work initially because they were easily broken. The tool helps farmers assess moisture content themselves rather than be told and given low price by traders. Finding more reliable moisture meters was done, and key farmers explored payment schemes to generate maintenance funds to sustain its use. Some farmers mentioned that telling the miller precise moisture content aids decision-making to buy the grains immediately. LA members also furthered local development of dryers into re-circulating batch dryers, of which units were locally produced by 2012.

Furthermore, socio-technical learning led to adjustments in activities targeting institutional change. In trying different tools, alliance members recognized difficulties regarding sustainable financing and getting more people to invest on new equipment. It was difficult to attract additional resources or understand requirements from funding agencies. Thus one national and two province-based business fora were held, facilitating

discussions among bank and microfinance representatives, millers, farmers, and manufacturers. The fora shifted focus from technology to the rules governing how farmers interact with funding agencies.

On another concern, feedback that operators rush to complete harvesting, resulting in more losses, emerged after users had tried combine harvesters. Members found while competition among many service providers helps with quality, it was becoming a barrier to reducing losses. Operators, paid according to area harvested rather than per day, do not operate the machines effectively. To address this, LA members explored certification for combine-harvester operators. Members from the government proposed to regulate service-providers and set standards for operators. This was tried but the pilot activity failed to bring it to a level of sustained interest for changes in local policy. Service providers who attended remembered it as a 'training activity on machine operation'. A reflection from one member was that farmers themselves have to 'know what is good [harvesting service] and make the operator meet standards.' No organized activities from the LA followed-up on this attempt to certify operators.

Adjustments in the theory of change (ToC)

We previously discussed the assumptions made by project implementers as espoused theory from defined Logframe objectives. These espoused theories are tweaked and redefined over time as the implementers observe what is happening and question the theory-in-use. Over time the ToC was modified, expanding the agenda. The targets were negotiated to assimilate new targets such as technologies being tried. The changes in project agenda detailed in previous section show how developments within the network also affected project processes and targets.

For one, the project supported LA as an output but also an independent process generating other outcomes. Having a multi-stakeholder platform had perceived advantages from a project manager's perspective,

> "First, it allowed for flexibility in the composition of stakeholders, ensuring that not only traditional partners lead activities. Some may take less central roles but continue being informed. Doing so balanced political interests and managed possible barriers from

> influential stakeholders. Second, it encouraged members to mobilize additional resources through co-funded activities. Third, it helped the project act flexibly to needs of stakeholders which were not expected at planning phase. Fourth, it promoted 'talk plus action' or reflection with implementation rather than discussion only. Lastly, informal linkages at different levels generated learning for recommendations into the Cambodian Rice Strategy, even without the project dedicating an activity to influence policy." (Reflection from project leader, 2014)

In comparison, scaling out was an important focus of many network activities. This assumption changed little over time. LA members were involved in outreach activities that introduced technologies of interest to the project, such as trainings or distribution of extension materials. Of 1930 copies distributed, 64% was sent to 24 provincial extension offices, 23% to six government research agencies, 7% to seven universities around project sites, and 4% to trainees and key farmers. These extension activities were one-way knowledge links that created temporary ties to spread information.

The tweaking in the extension aspect was trying various options outside the government extension system. One option was linking with an NGO through a farm business-advisor program. Through the alliance, the NGO linked with a manufacturer for hermetic storage options. The intent was to assign trained NGO staff in the villages, providing paid extension services through a business model for sustainable extension. Although the link with the manufacturer was successful, the necessary steps after training were not yet taken by 2013.

Another option tried was farmer-led extension services where two key farmers were chosen in each project village. They were trained on post-harvest, attended cross-visits and meetings, and were provided technical support from alliance members particularly from government extension. They also managed communally-owned equipment for use by farmers. The key farmers link alliance members with village-level actors through monthly meetings, and other village-level activities. The various

activities to reach farmers and extension partners with technical knowledge exemplify the project's assumptions about extension and scaling out.

3.5 Comparison of the LA case: conceptual claims, assumptions from project and implementation

The theory of change of the project and conceptual literature (constituting the espoused theory) and the implemented LA network (theory-in-use) can be seen as interlocking elements that create overlaps as visualised in Figure 3.5. We also found differences and dis-connections. We tease out the disconnect starting with how the project's ToC compared with conceptual assumptions. We then expound on the disconnect between the implemented network and its blueprints from the project and conceptual literature.

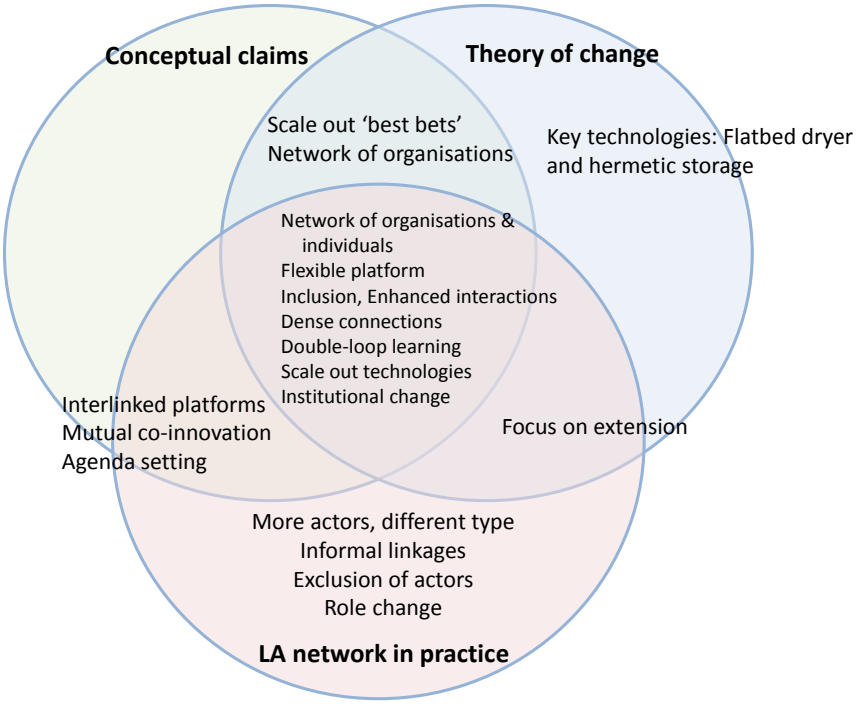


Figure 3.5: Overlaps between learning alliance in practice, conceptual claims, and theory of change (ToC)

3.5.1 Disconnect between project theory of change and conceptual assumptions

The project's first translation of the network is linked to ideas posited in literature regarding the approach. Referring to conceptual assumptions explained earlier, we now zoom-in on diverging strands within the literature (Table 3.2).

We find salient aspects in the project that aligned with one strand in the conceptual literature but contrasted with another. Regarding network composition for example, one thread in literature emphasizes partnership of research and development organizations, thereby involving a core group of actors. In contrast, another strand emphasizes a network of organisations and individuals with shared interest on knowledge creation and innovation.

This assumes a much broader involvement of actors which can be pictured as interlinked platforms. The Cambodia project initially focused on partnerships between organisations and representatives of formal groups and much less on variation in groups and individuals. The latter was important in activating innovation through informal network formation. These smaller informal networks were then linked to the wider network including formal organisations.

Regarding the way innovations were established, there is emphasis in conceptual literature on LA as mechanism for out-scaling research results (Table 3.2). Activities involved separate phases of research and scaling out, starting with 'best bet' technologies or practices (Douthwaite et al., 2009). In contrast, another strand describes 'mutual co-innovation' (Ferris, 2005), highlighting the development of local knowledge to support local solutions while accounting for local realities (Moriarty et al., 2005). Rather than starting with a specific research output that is distributed through the network, LAs facilitate the creation of networks around introduced tools and methods. However, no introduced innovation works just like that. Making effective connections between the social and technical is a key element to making it work.

Table 3.2: Features of Learning Alliance from literature in terms of network, process and nature of innovation

Concept	Features	Literature
Network	Partnership of organisations	Douthwaite et al., 2009; Lundy et al., 2005; Prasad et al., 2007; Stelling et al., 2009
	Organisations and individuals with shared interest in innovation	Batchelor and Butterworth, 2008; Penning de Vries, 2006
	Interdependent multi-stakeholder platforms; flexible; communities of practice	Adolph, 2005; Douthwaite et al., 2009; Lundy and Gottret, 2004; Lundy et al., 2005; Prasad et al., 2007; Verhagen et al., 2008;
	Inclusion	Adolph, 2005
	Enhanced interactions, dense connections	Lundy and Gottret, 2007; Mashavave et al., 2013
Process	Institutional change	Best et al., 2009; Lundy, 2004; Stur et al., 2009
	Identify, share, and adapt good research, development, and business practices	Best et al., 2009; Lundy et al., 2005; Smits et al., 2007;
	Iterative, double-loop learning	Best et al., 2009; Gottret, 2006; Lundy et al., 2012
	Share knowledge, build trust and create shared language	Prasad et al., 2007
	Synergy	Lundy et al., 2005; Stelling et al., 2009
	Dialogue for agenda setting	Lundy et al., 2012
Nature of innovation:		
A. Scaling (adapt and redesign)	R&D outputs as inputs; Scale out proven technologies or 'best bet'; wide-scale impact	Lundy, 2002; Douthwaite et al., 2009; Lundy and Gottret, 2007; Lundy et al., 2012; Stür et al., 2009
	Learning selection of technologies	Douthwaite, 2002; Lundy, 2004
	From technology to capacity to learn, adapt and adopt	Stelling et al., 2009
B. Changes in multiple elements	Mutual co-innovation	Ferris, 2005
	Effective learning in enabling environment	Lundy and Gottret, 2007; Moriarty et al., 2005; Morrison and Mezentssef, 1997;
	Local knowledge, solutions, and realities	Moriarty et al., 2005

Learning is topically seen as a cognitive or social process but situations where technical tools and methods are important, learning is also about interaction with materials (Jaarsma et al., 2011). LAs thus not only focus on research products but rather on the enabling environment needed to maintain an innovation (Lundy and Gottret, 2007; Moriarty et al., 2005). The project initially focused more on the first strand, scaling out and starting with best-bet technological products, flatbed dryer and hermetic storage. It initially emphasized extension in the ToC. But later on, lessons from what happened in practice were taken on board and other technological needs were subsequently considered.

3.5.2 Disconnect between the network in practice and assumptions from project and literature

There are compounding factors which differentiates LA in practice from its design and assumptions at the start (espoused theory). While assumptions inform practice, human and material actors interact, creating emergent outcomes (Law and Callon, 1988).

Implemented network and assumptions from the project

As earlier mentioned, the network did not turn out as collaborative partnerships between formal organisations. The connections were mostly through informal linkages. Moreover, the project outlined key actors as mainly farmers, traders, government agencies and millers, but others became involved, for example universities, banks, and service providers.

The project assumed a linear flow from deliberate action, which affected tracking of outcomes and impact. A revisit of the project targets compared with indications of outcomes is presented in Figure 3.6. Outcomes emerged from a non-linear process where changes were occurring at various levels. The project assumed networks for scaling out research products. Use of some tools spread, but changing standards, affecting policies and creating enabling conditions for its use was happening at the same time. There were materials important not only for quality rice or reduced losses, but also for mediating interactions between farmers and traders or millers.

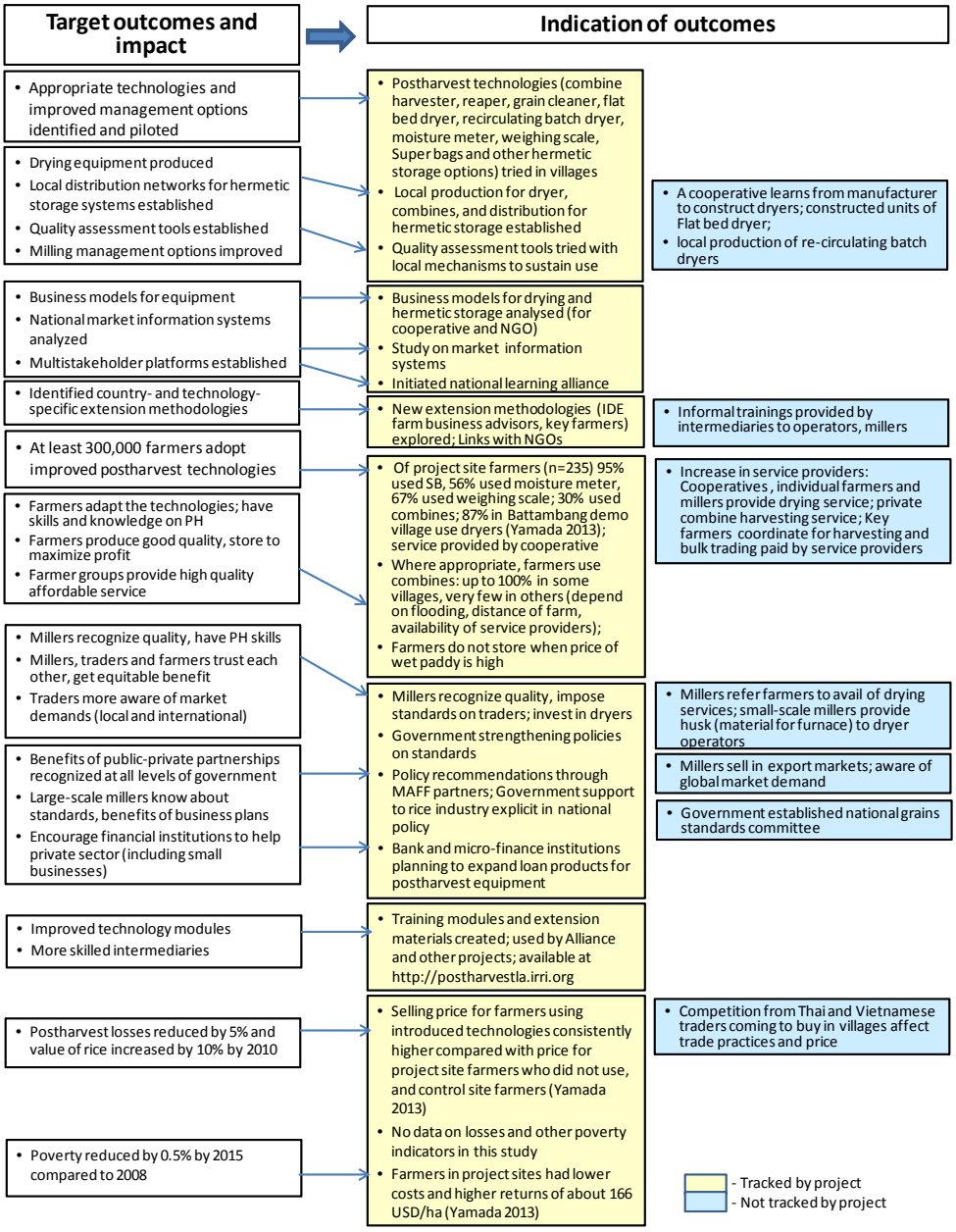


Figure 3.6: Comparison of targets from impact pathways of the Cambodia Posthatvest project and indicators of outcome including those tracked and not tracked in project monitoring

In connection, the key technologies which the project started with shifted. Some technologies like ‘improved granaries’ were modified from existing material technologies within the communities. Moreover, while farmers, millers and traders were important, the increasing number of service providers was also important to expand access to equipment. These indications of outcomes in comparison with targets show how the project shifted between espoused and theory-in-use of project actors and acted upon the learning. Indeed, there were outcomes that emerged only after interviews (Figure 3.6), these were from activities not known or supported by the project.

Lastly, on the objective of the project to affect economic benefits to farmers: although there are indications of a possible benefit from higher prices, this is intertwined with trading practices and national policies regarding cross-border trade. Hence, the changes in price may not be a direct result of the ‘improvements’ through intervention. This was not covered in the project monitoring which focused on where the project influenced change in technology, and measurements of difference emerging from use of introduced technologies. This consequently implies the network may have missed opportunities regarding market conditions that could benefit farmers.

Implemented network and conceptual literature

In practice the alliance was operated as interlinked small networks. Our findings highlight the importance of informal linkages in LAs. The Cambodia case showed a network where individual members had links to small dense pockets. The members were effectively enabling institutional changes in these pockets. While intermediaries that support legitimacy or those already trusted by communities are important (Suchman 1995), LAs can also take advantage of informal networks. This would be limited if LAs are conceived as partnerships between organisations. Then again, such network dynamics pose limitations in coordination and steering for national-level alliances such as in Cambodia. Klerkx et al. (2010) similarly found limitations in the steering of innovation networks owing to the complexities with which they engage.

Opening space for inclusion is emphasized about LAs (Best et al. 2009), but the process is not explained in conceptual literature. In implementation various strategies supported inclusion; for example framing of a shared concern, refining knowledge about actors, and visibility of actors. Disengagement and exclusion of actors were not mentioned in conceptual assumptions but nevertheless happened in implementation. Disengagement was either not known or taken for granted.

Another disconnect pertains to change in roles of different network actors, which was an important unintended outcome in the Cambodia case. Improved capacity of an actor allowed it to change roles and move beyond its own mandate or ways of doing things, thereby consolidating interest. This may be explained as synergy from interaction (Stür et al., 2009), negotiating institutional agenda (Lundy and Gottret, 2007), or social learning (Proost and Leeuwis 2007). Related studies on multi-stakeholder platforms have highlighted roles of brokers and intermediaries (Kilelu et al. 2013; Klerkx et al., 2010). The importance of change in roles is not explicit in conceptual literature of LAs. Considering outcomes from role changes at national and local levels in Table 1, alliances can indeed target change not only in technologies but also institutions.

3.6 Conclusion

We argued for an examination of the LA network approach as it was implemented in communities to clarify what it entailed in terms of innovation processes and outcomes. We compared the implemented case of the Post-harvest LA in Cambodia, the assumptions by project actors, and conceptual design of the approach.

The network expanded from 2008-2011 including actors from different stakeholder groups, but disengagement also occurred. Regarding network process, change in roles among actors in the alliance and linkages with small network pockets which affected institutional change were important. These were not emphasized in conceptual assumptions. Regarding socio-technical adjustments, there was more flexibility on material technologies and agenda (e.g. certification, interaction with banks), even if not

intended or foreseen. Learning was not only on material or technical but rather on enabling conditions in the social domain.

Emergent dynamics from network interactions, which are not elaborated in LA literature and not always known to project implementers, could lead to missed opportunities. The Cambodia case demonstrates monitoring small informal networks, change in roles, or disengagement could enhance learning in the network. Espoused theories on LA can thus be expanded with more emphasis on emergent actor-network dynamics.

The LA espouses diverging strands of conceptual assumptions, creating blurred lines which can affect translation of the approach in projects. The current project inclined towards linear extension, aligning with the conceptual idea of LA as 'vehicle for scaling out' technologies which are outputs of research. There was evidence on use of introduced technologies, but the network in the end also promoted other technologies. Emphasis on scaling out, rather than mutual co-innovation may mislead expectations and direct project efforts away from interrelated processes that enable socio-technical change. Nonetheless, the dynamic interaction and iterative learning on what works on-the-ground resulted in self-organisation and correcting mechanisms which influenced flexibility of project agenda. The LA approach can promote actor-network processes which target social, technical, and institutional re-ordering, as shown in the Cambodia case.

Chapter 4

Innovations around harvesting and drying rice in Cambodia: Do learning alliances play a role at the community level?[3]

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4.1 Introduction

The Learning Alliance (LA) approach is a means to facilitate the development and spread of technologies in farming communities through a multi-stakeholder platform (MSP). Although the involvement of stakeholders is considered to increase effectiveness of innovations, the process of change is deemed messy, unpredictable, and steerable only to an extent (Klerkx et al., 2010; Leeuwis & Aarts, 2011; Aarts et al., 2011). Moreover, what should be perceived as the result of the approach, and hence monitored for its effects, differs. Some projects consider the realisation of a network of collaborating organizations to be the main result; while what counts for others is the adoption of technologies by farmers (Stür et al., 2009; Stelling et al., 2009; Mashavave et al., 2013). Nevertheless, little attention is paid on how changes in the LA network relate to the way farmers adopt new tools and techniques. In this paper, we examine how a Learning Alliance influences innovation at the community level.

The combined reconfiguration of social changes and technical components can provide a better understanding of how innovation processes work (Smits and Kuhlman, 2004; Leeuwis 2013). What we propose here is that innovation processes in farming communities are characterised by small group dynamics at community level. The paper shows that these group dynamics emerge partly because of the introduced innovation. We argue that within and between these smaller groups in communities, we can observe the way social and the technical jointly co-evolve in a negotiation space (Law and Callon, 1988).

Our findings have implications for the way LA and similar multi-stakeholder approaches are implemented. What appropriate networks will look like and which stakeholders become important in realising innovations is not fully predictable from the outset. Networks are forged and adjusted as part of the innovation process, requiring continuous monitoring by development agencies.

4.1.1 Learning Alliance on rice postharvest in Cambodia

We examine a rice post-harvest LA, established in 2008 in Cambodia. The LA operated at a national-level and aimed to change practices and conditions pertaining to rice harvesting, drying, storage, and marketing. Involved stakeholders were government agencies on policy and extension, research institutes and universities, non-government organizations (NGOs), banks and micro-finance organisations, manufacturers, millers, farmers and service providers. The LA aligned its goals with the policy of the Government of Cambodia to support the introduction of new post-harvest technologies for rice (Gummert et al., 2010).

Rice has become Cambodia's most important agricultural export product in recent years, contributing 10% of the country's total export value (IMF, 2009). In 2004, the government set a target to produce 7.5 million tons by 2010 (Yu and Diao, 2011). Cambodia achieved its production target in 2009, and exported16 thousand tons (Kean, 2012). In 2010, the government raised the export target to at least 1 million tons by 2015. Part of the policy was a push for mechanized harvesting and drying resulting in a steady increase of machines used in harvesting and drying (MAFF, 2011, 2012; Hien, 2010). The shift towards mechanized harvesting and drying in Cambodia implied considerable changes at the community level. Interactions between farmers, traders, millers and other community actors are at play. The post-harvest LA in Cambodia aimed to facilitate these changes, particularly by addressing post-harvest losses.

After explaining the conceptual framework and methodology underlying this paper, we present the results from analysis of two cases where the learning alliance engaged with small groups in communities. We show how small groups in the community were linked to the alliance and what happened in these groups in terms of socio-technical changes relating to mechanized harvesting and drying. In the final section, we present our conclusions regarding the way network pockets engage at a community-level to influence socio-technical change, and discuss the implications of our work.

4.2 Conceptual framework: Tracing how learning alliances affect change in communities through small groups

4.2.1 Learning about technologies among actors

The LA approach is based on concepts of 'social learning' and 'innovation systems' (Lundy and Gottrett, 2007). An alliance is formed by a network of interdependent stakeholders, each with its own knowledge base. The stakeholders learn simultaneously and share this learning. To arrive at coherent practices for innovations, these groups need to coordinate with each other, with overlapping or shared understanding (Leeuwis, 2004).

Technology in this process is socially embedded, implying that all stakeholders have an interest in the technology or the process enabled by the technology. In the case of rice post-harvest technology, this means that "the farmer, the miller and the people in their social networks have their own learning cycles; with these, they create conditions for the recombination of differing observations and experiences that can lead to further adaptation" (Douthwaite and Gummert, 2010). The social networks in an LA are broadly defined. These involve public and private supporting agencies, for example, agricultural extension services and companies buying agricultural products or selling inputs and machinery. However, the different roles of actors in the network imply different involvement with the technology. At the community level, the frequent and direct involvement of actors with an introduced technology results in dense patterns of interactions crucial for the technology to function. These local-level clusters in socio-technical networks operate as task-groups.

4.2.2 Dynamics in small groups regarding socio-technical change

McFeat's (1974) idea of small-group cultures aids the empirical analysis of how socio-technical change is happening in communities. Small groups form and negotiate the behavioural space between individuals and the structures enforced by institutions (Fine and Hallett, 2014). According to McFeat (1974) small groups, rather than individuals or wider collectives, are the locus of culture change. Small groups adjust to new members, share important agenda, and organize or cooperate to solve problems. In this process, individual and collective actions are linked, and information and expertise

(know-how) develop with the changing social and material context (Jaarsma et al., 2011). For the case at hand, groups are formed around harvesting, drying, and milling. Tracing how groups organize around these activities with the shared goal of producing marketable quality rice allows us to track how socio-technical change happens.

We use the small groups concept to direct analysis to dynamics happening as groups of actors use new tools and techniques, and adapt these to their needs. The concept highlights ideas of *shared awareness* stemming from knowledge sharing through interaction in groups (Lanigan, 2013). It also highlights *performance* of tasks and interaction within groups that shape socio-technical practices (Richards, 1989; Fine and Hallet, 2014). Lastly, it highlights conditions posed by the *environment* which groups respond to or reshape (McFeat, 1974). Groups negotiate emerging patterns in material interactions and cultural symbols (Langellier and Peterson, 2006).

Considering these, we will examine the learning alliance in Cambodia in terms of 1) how learning alliance members interacted with groups at community-level, 2) how these groups enact specific practices and reshape meanings around rice post-harvest technologies while adjusting with other task groups, and 3) how they respond to conditions in their environment.

4.3 Method for tracing the connections between learning alliance and community-level changes

Data presented here are collected by the first author in 2012-2013 over two rice seasons among members of a Learning Alliance and in four villages in Cambodia where they implemented activities.

The Post-harvest LA worked in six provinces in Cambodia. Battambang is one of two provinces where, since 2006, a project on mechanized harvesting and drying had been implemented. Pursat is one of the four provinces where activities started only since 2009. Respondents were selected from stakeholder groups in two villages each in Battambang (Balat and Snapimok) and Pursat (Prei Kdei and Preah Chambok). The initial stakeholders interviewed were those with direct interaction with the LA. Thus,

some stakeholder groups (manufacturer, miller, service provider for drying and combine harvesting) were purposively chosen because of their connections with the LA. Farmers were randomly sampled from a list at the village level. The initial stakeholders engaged with others while they implemented some tasks related to post-harvest. These groups also became a focus in observations and interviews. There were some groups formed around the introduced technologies that overlapped between villages. For this reason, in the rest of the paper we will consider them as two cases, Battambang (Case 1) and Pursat (Case 2).

The main methods were semi-structured interviews and participant observation of post-harvest activities. Details were registered about who were involved in what tasks, activities involved in tasks, what tools and machines were used, and how people coordinate towards the goal of making quality rice. A total number of 87 interviews were held with farmers and 20 interviews with millers. Other persons interviewed were service providers, manufacturers and NGO staff.

4.4 Background on rice post-production in Cambodia and the push for mechanization

In the 1990s, Cambodia re-built its agriculture after political turmoil (Van Acker, 1999). Land ownership, collectivized during the socialist restructuring in the 1970s, was put back to individuals. Farming thus became a family or small-group enterprise. Harvesting of rice was done by manual cutting of the panicles using hand-held sickle. In the 1990s, there were no mechanized-cutting or gathering machines in the country (Nesbitt, 1997). For some varieties that lodged easily, farmers used bamboo poles to push the crop down in in one direction to make manual cutting easier (Javier, 1997).

Farmers make bundles of the cut crop. These bundles are dried in the field till they have a moisture content of about 25%; farmers then transport them to a central threshing site in the field or in the village (Javier, 1997). After 2-3 days or once sufficiently dried, grains are threshed. Households with livestock preferred to transport bundles near the village so that straw can be stored for animal feed. Threshing was done over the entire harvest period (about 2 months) (Nesbitt and Chan, 1997). Farmers had

manual and mechanical options for threshing. These included laying cut crop on the roadways so that grains are removed when vehicles pass over them, letting cattle walk over the cut crop in threshing floors, using pedal threshers, or using engine-powered threshers (Rickman et al. 1997). Drying is done by spreading grains on mats under the sun for 3-4 days (Javier 1997). Grains are sold to traders and millers immediately after threshing, although farmers kept most of the produce for consumption (Rickman et al. 1997).

Consolidated at a national level, that situation supplied roughly 60% of subsistence needs, as 65-75% of the caloric intake in Cambodia is from rice (Yu and Fan 2009). Studies have also found that such practices, common across Southeast Asia, incur 15-50% losses, which includes physical losses and losses to quality (Mejia 2004, Gummert et al. 2010). From 2010, the Cambodian government initiated a policy to reduce the post-harvest losses and improve rice quality to export standards (RGC 2010).

With the aim to produce good quality with minimal losses, national programs promoted and supported dissemination of technologies to affect rice processing and trade. Combine harvesters (which cut and thresh in one operation) and mechanical dryers were produced and sold in the country. Sales for combines grew rapidly. One company sold 1000 units in 2010, 1900 by 2011, and 2000 by 2012 (Interview with Kubota, 2012). The Department of Agricultural Machinery (DAM) provided a conservative estimate of 3000 combine harvesters in the country by 2012. Manufacturers of mechanical dryers also attest to an increase in commission of dryers, especially from millers. Dryer components are however made separately at local level and can be easily copied by artisans. Flatbed dryers have an enclosure (bin) which fits 1 ton of paddy (or more depending on the design); it dries rice through hot air blown into the bin.

While combines and flatbed dryers were starting to be used, these are not widespread or used by most farmers (Table 4.1). The majority of farmers still implement harvesting and drying in partly mechanized ways that involve tools and small machines in subsequent tasks of cutting, bundling, threshing, bagging, hauling and drying.

Table 4.1: Percentage of farmers using combines and dryers, wet season of 2007, 2008 and 2009, Battambang

	2007 (n=60)	2008 (n=94)	2012 (n=86)
Combine harvester	3.2	10.6	18.1*
Flat-bed dryer	0	10.6	19.8

**Of these, 7% also use manual harvesting (in different parcels)*
Source: IRRI-Postharvest surveys in 2007, 2009 and 2012 (unpublished)

The use of combine harvesters also varies depending on the season. More farmers (80%) would use combines in the dry season harvest, but only 18% (Battambang) and 41% (Pursat) in the wet season or late wet season. Use of combines also varies by village. The number of farmers using combines and dryers is low. Notably, there is a slow increase over the years (Table 4.1). More millers than farmer-groups and NGOs own dryers in Battambang and Pursat.

Although the Post-harvest Learning Alliance and national programs support change in practices for harvesting and drying, specifically towards reducing losses, change is only starting and not many farmers use machines. Considering these, we now examine how actors in an alliance aligned with the objective of producing good quality rice with minimal losses, interacted with groups at community-level.

4.5 Activities of Learning Alliance members at community-level: comparison of two cases

We examined activities implemented by the LA from 2009-2012 in the cases of Battambang (Case 1) and Pursat (Case 2). Some activities were the same for both cases, most of these involved limited interactions such as training activities (Table 4.2). Notably, some activities were done in Case 1 but not in Case 2, and vice versa. These also included spin-off activities, which were sustained by alliance members in the communities. Related activities that happened after interaction with alliance members were implemented by community-level actors without support from the alliance.

Table 4.2: LA activities at a community-level by case, with target actors and type of interaction relating to use of combine harvester and dryers in Cambodia

Activity	Case*	Target actors	N	Type of interaction	
				Limited	Sustained
Implemented by Learning Alliance					
Training activities, meetings, demonstrations (information)	1,2	Farmers, key farmers, millers, NGO	237		x
Capacity building on machine operation (cross visit to Vietnam or Philippines, sharing from technicians)	1,2	Operators (combines and dryers)	6	x	
Technical support by researchers/engineers	1,2	Manufacturer, service providers	11	x	
Technical support by dryer manufacturer	1	Dryer operators	5**	x	
Support on business plan for cooperative with dryer	1	Operators and farmers in a cooperative	1 cooperative	x	
Certification and training of operators	2	Combine-harvester operators and drivers	8	x	
Training and capacity building	1,2	Millers	45	x	
Capacity building for key farmers	1,2	Two key farmers per village (12 per case)	24		x
Link with finance institutions (business forum)	1,2	Farmers, millers and service providers	31 (11 from finance institutions)	x	
Support to NGO to provide training and services	1	Farmers, students	2 NGOS		x
Spin-off LA activities in small groups					
Informal training activities provided by dryer operator	1	Millers and other operators (dryer)		x	
Technical support by trained combine operator	1	Combine-harvester operators			x
Key farmers coordinate harvesting, paid by combine operators	1,2	Farmers			x
Key farmers provide informal training, coordinate use of simple tools (scale, moisture meter, grain cleaner)	1,2	Farmers			x
Key farmers coordinate bulk selling	2	Farmers, Traders			x
Miller manufactures dryers (sell to millers)	2	Millers			x
NGO provide trainings, drying services	1	Farmers, students			x
Activities by community-level actors (non-LA)					
Banks and micro-finance institutions start to offer loan products for equipment	1,2	Millers, service providers			x
Informed millers prefer machine-harvested paddy	1	Traders, Farmers			x
Millers set-up their own dryers, dry rice	1,2	Farmers			x
Two farmers set-up own dryers, start to provide service	1	Farmers			x
Miller provides drying services	1	Farmers			x

*Case 1 = Battambang, Case 2 = Pursat; ** Includes only those mentioned in interviews
Source: IRRI-ADB Project reports 2010-2012, Interviews with LA members

As shown in Table 4.2, although the LA was established at national level, it had activities at community-level. One activity, for example, targeted farmers through trainings and meetings to demonstrate tools and practices. There were two key farmers in each village (8 in total for both cases). They were trained providers of extension services to other farmers. All meetings and training activities were coordinated by key farmers. Some of the meetings were informal visits, village discussions with movies, or lectures on specific topics that included technology demonstration. The formal training activities were provided by researchers, NGOs, and government extension staff. These activities reached 95% of farmers interviewed in Battambang and 93% in Pursat.

Photo 4.1: Extension materials used by researchers and key farmers to spread knowledge on dryers and improved grain quality; poster at a village barbershop; Photo by R.Flor

Aside from formal training activities, 89% participated in informal training provided by key farmers who sustained activities even when researchers and extension staff were not around. The project also provided equipment for demonstration in villages. These were communally owned by village residents. Communally owned tools such as weighing scale, grain cleaner, or moisture meter were also managed by key farmers, for lending to other farmers. A flatbed dryer unit, also managed by key farmer, was set-up in Battambang (details will be discussed in the section specific to this case). Furthermore, key farmers also provided informal trainings to millers or other service

providers. Thus through the network of key farmers, capacity-building support, coordinated use of communal equipment, and knowledge sharing happened.

Researchers in the LA also targeted actors who were manufacturers and service providers for tasks related to combine harvesters and dryers. These actors were leaders from cooperatives, manufacturers, or service providers for machines, providers of repair services or farmers interested in investing on machines. For these actors, researchers provided training and technical support as well as supported cross-learning visits to other areas. The actors were also involved in discussions regarding their experiences and concerns regarding post-production practices. The manufacturers and service providers linked to the LA were trained, but were also commissioned to build dryers, discuss about their equipment, or provide technical support to operators.

The LA also involved banks and micro-finance institutes accessible from the villages. Farmers shared that it was difficult to apply for loans to invest in combines and dryers because financing agencies do not normally have loan products for it, their terms were not suited for a service-provider business, or procedures were difficult to follow. Micro-finance groups started to discuss with farmers and millers about policies and procedures to obtain loans during business fora organized by researchers from the LA. Follow-up meetings were made by farmers and millers with microfinance groups in Pursat and Battambang.

4.5.1 Activities specific for Case 1: Battambang

In Battambang, one of the key farmers was also a dryer service-provider. The key farmer managed drying services for farmers in a cooperative, as well as for millers and other farmers outside the village. Through informal connections, the key farmer coordinated interactions of LA members who were manufacturers, researchers, or extension staff with farmers. The key farmer also engaged with millers and service providers. These are spin-off activities from interactions with LA and his own knowledge about operating dryers.

A combine-harvester operator was also involved in cross-learning visits organized through the LA. The operator's own network of coordinators for combine harvesting, operators, and farmers provided feedback to researchers, manufacturers, and policy-makers in the LA. The interactions were on how the machines should be operated, modifications for combine harvesting equipment, or issues observed from an operator's perspective.

Lastly, there were NGO-led activities related to harvesting and drying in Case 1. These activities were merged into the operations of an NGO that has a mandate for vocational training, but also produces rice for its campuses all over the country. The NGO expanded its scope to include drying services for farmers.

4.5.2 Activities specific for Case 2: Pursat

Four interviewed millers in Case 2 said they installed flatbed dryers after having seen and discussed it with one of the millers connected to the LA. Other millers learned from their relatives, extension staff, and millers outside the association. In this network of millers, all were of the opinion that 'all medium to large-scale millers needed mechanical dryers.' This perspective emerged from their experience with using flatbed dryers.

The key farmers in Case 2 had different spin-off activities. They included activities different from extension activities for which they were trained. Instead, in addition to their extension and coordination tasks, they started to coordinate harvesting for farmers, link combine harvester operators where needed, and coordinate bulk selling.

In 2011, some farmers and alliance members assessed that operators, paid per hectare harvested rather than per day, incur more losses because of the rush to complete the job. They then explored certification of service providers to ensure that these service providers are aware of losses and will do the job well. This activity therefore linked staff from a government agency on agricultural machinery with combine-harvester operators from Pursat.

The differences between Case 1 and 2 show the emergence of specific clustering around the introduced post-harvest techniques. These clusters work as groups sharing information, adjusting to conditions in their environment, and coordinating with others. In the next section, we examine how these groups perform the task of making good quality rice. In this process, we also pay attention to how the group responds to conditions encountered in its environment, and how it reshapes meanings and re-create institutional conditions around rice post-harvest.

4.6 Socio-technical change process in small groups

A network mapping of LA members in the communities shows where the groups emerged that are involved in producing good quality rice with reduced losses. These groups employ tools, skills, and practices in performing this task by coordinating with actors who implement specific activities (Figure 4.1). For each case, a group can be distinguished as organised around specific tasks. To explore this further, we compare two small groups, involved in: 1) harvesting and threshing, 2) drying, and 3) assessment during selling. For each activity, we indicate what tools are used, what emerging needs they respond to, and further linkages they explore or establish.

4.6.1 Harvesting and threshing

To harvest and then thresh, the crop has to be ripened to a certain extent. Farmers consider advice from technicians and leading farmers. They also rely on their knowledge on the number of days for maturity of the rice variety, or their visual assessment of yellow grains per panicle. However, other considerations are equally important, a major one being availability of labour. According to many farmers, additional labour is difficult to find during harvest season because people work outside the villages and those left behind have their own farms to harvest (Interview of farmers from Snapimok and Preah Chambok, 2012).

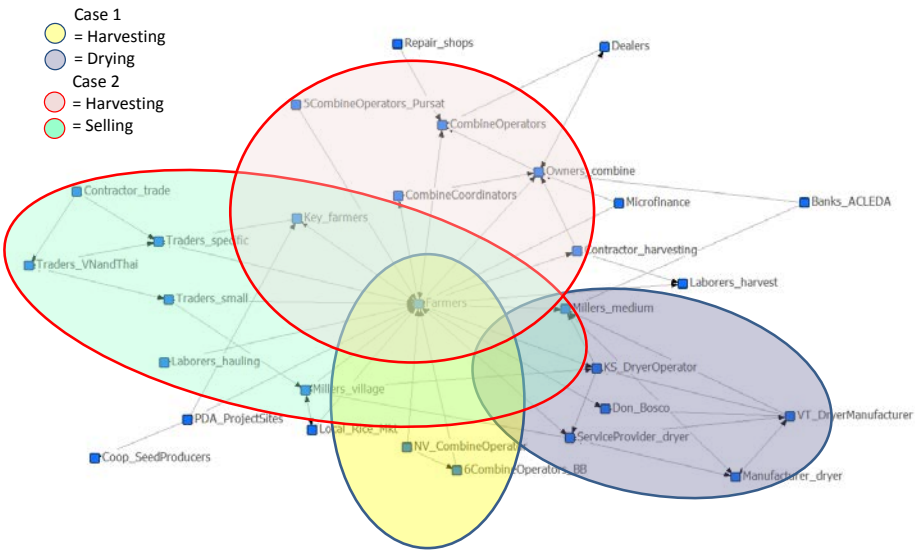

Figure 4.1: Small groups working on specific tasks (in coloured circles) from two cases affected by the Learning Alliance in Cambodia

Closely associated with the decision to harvest is whether a thresher service provider is available. If the crop looks dry enough to be threshed, the service is required as soon as the crop is harvested. Presence of the trader and his truck may enforce a decision, especially when a good price is offered. According to a farmer, 'even if the crop is not completely ripe (roughly 80% golden grains), they need to harvest because the trader is here.' This particular trader has been coming to their area; the trader is reputed to give equitable price for wet paddy (interview with farmer from Prei Kdei, 2012). Moreover, the weather, flooding in the paddies, as well as distance of the field of a farmer to a pathway accessible for harvesters are also considered. Some farmers whose fields are locked in by other farms cannot harvest unless neighbouring farmers have finished. Lastly, the availability of combines can also push farmers to harvest immediately; 'if combines come, we have to harvest; otherwise it is difficult to get them to come back' (interview with farmer from Balat 2013).

Photo 4.2: Manual harvesting by family labor, with bundled cut crop left in the field for field drying (left); transporting the bundles for threshing (right); Photo by R.Flor

Harvesting involved men and women farmers as well as paid labourers, contractors who mediate between labourers and the farm-owner, combine-operators and thresher service-providers. Other actors and connections in the network are equally important but do not have immediate impact on the decision to harvest. For example, 'the advice from leading farmers is exchangeable with advice from and local extension staff or technicians and additional to farmers' own knowledge of the crop. Likewise, dealers of equipment, finance institutions, and repair shop owners affect the availability of combine harvesters and thresher service providers.

Furthermore, certain factors make farmers mutually dependent. For example, because plots are relatively small, a harvesting service-provider prefers to stay in an area and finish all the fields at once. This lessens operating cost which in turn, lessens the cost farmers have to pay for the service. Flooding also affects the options and pace for labourers and combine operators. Table 4.3 lists the main factors that affect harvesting and threshing, or the use of combine harvesting.

Table 4.3: Factors that affect harvesting and threshing (use of combine harvesters); wet season (WS) 2012 in case villages, Battambang and Pursat

	Village	N	% Using harves-ters (WS)	Mean area (ha)	Flooding at harvest	No. of contrac-tors*	Cost for machine harvest (USD/ha)	Cost of manual harvest + threshing (USD/ha) **	Traders in village
1	Snapimok	17	0	1.6	No	0	94	67	0
	Balat	16	20	1	Yes	0	87	68	2
2	Preah Chambok	32	75	2.5	No	10	80	65	0
	Prei Kdei	22	0	1.3	No	0	--	53	0

* Contractors for harvesting using machines, ** Cost does not include hauling

Small-group interactions in harvesting and threshing for Case 1

Considering the small group linked with the learning alliance in Case 1, preference for manual harvesting is affected by flooding during harvest in both wet and dry seasons. More farmers prefer manual harvesting because 'it is clean,' alluding to less grains and panicles scattered on the ground during harvesting (interview with farmer from Balat 2013). This becomes more important when fields are flooded because operating machines in flooded fields is difficult. Moreover, farm size is relatively small which affects mechanized harvesting in two ways: costs can be higher or it can be difficult to manoeuvre the machine in small plots.

Given these conditions, manual harvesting where labourers cut using sickle, was a better option. While manual-harvesting contractors said they were losing business because of combines, the scarcity of labour also added tasks for farmers. To ensure that labourers are available, farmers need to provide additional incentives in form of higher pay, food or social incentives (e.g., they always hire that particular labourer, drinking parties). A woman farmer for example, said she pushed the crop down with a bamboo pole because otherwise 'the labourers will not come to harvest' (interview with farmer from Balat, 2013).

Photo 4.3: Combine harvesting in an area which is difficult for machines to access (had to cross a canal, neighbouring fields still flooded, full of trees, not a contiguous plot) entails hiring additional labourers (top); manual harvesting by hired harvesting groups where some labourers cut using a sickle, others collect and bundle the cut crop (bottom); Photo by R.Flor

In this situation, the group emerging around mechanized harvesting consisted of farmers with fields where machines could operate, additional labourers depending on the size of field, and a combine-harvester operator. Within each group, specific adjustments can be made. Each combine operator had contractors within or going to the village to arrange service for neighbouring farmers. These contractors are not always from the village. Operators also make changes to their machines. One operator explained how they modified the machine so that straw can be collected more easily for animal feed. Farmers were willing to pay 10USD per hectare more; and that they hire him every season for this added service (interview with operator from Battambang, 2012).

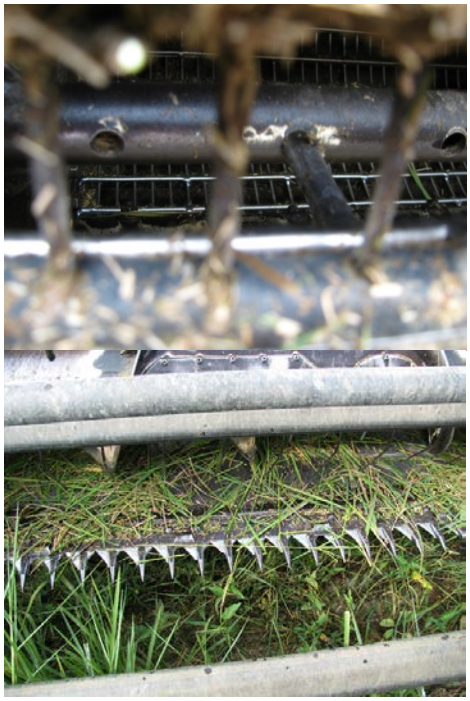

Photo 4.4: Technical modifications on combine harvester machines to accommodate need of farmers for easier collection of rice straw after harvesting; Photo by R.Flor

Small-group interactions in harvesting and threshing for Case 2

In the second case, group dynamics were slightly different. Many farms in Preah Chambok village are a result of land reforms after the socialist regime; farmers cultivate fields of 5 hectares or more. That made the use of combine harvesters attractive; so ten contractors operate in the village (Table 4.3). When asked why farmers opted for combine harvesting, they mentioned 'lack of labour,' 'expensive manual harvesting,' or 'ease in finding a [combine] service provider' (interview with farmers, 2012). Farmers also described their situation as having 'no choice because there are no labourers in the village' due to labour migration. Manual-cutting services 'used to be more accessible' when there were organized labour groups in villages. Lack of labour however, does not automatically result in a choice for combine harvesters. Most farmers interviewed from Prei Kdei said that lack of available paid labour, and high labour plus thresher costs, made them harvest with only family labour, taking weeks to finish one hectare.

In Preah Chambok, two key farmers became contractors to coordinate harvesting. With their knowledge and connections in the village, farmers trust them to assess the field and contact the combine operator. Farmers said this helps to ensure fields are harvested on time at reduced cost because it is coordinated with other farmers. Contractors collect the payment from the farmers; they are paid by the combine operators 5 USD per hectare of contracted field. Their services also expanded to contracting for bulk selling because some combine operators became middlemen or traders. The value for the farmer is convenience and a secure buyer, in that the operator pays for hauling costs directly from the farm. The middlemen (combine operators) can offer gifts to the contractor but no money or percentage cuts are provided for this service. Farmers who avail of the harvesting service however, have the option not to sell to the coordinator or sell immediately. This bulking of harvested crop by coordinators is done on short terms of 1-2 days so coordinators do not dry the grains.

Photo 4.5: Actors involved in harvesting task: coordinator, farmer, laborer for hauling, combine operator; combine-harvesting machine; Photo by R.Flor

The small group also maintained connections with LA members outside the group. An option to certify combine operators was tried, in the idea that a certified service-provider could be more trustworthy to provide service with less grain losses during harvesting. This activity was done with the support of actors working on policy at national-level. They aimed to address issues on high costs but high losses in harvesting service. Farmers observed that if only 1-2 combine operators were around, the costs of harvesting would be 120USD/ha or higher, whereas if there were many combines operating in the village it can be lower (informal interviews with farmers,

Preah Chambok 2013). Over time, farmers also noticed a rise in the cost of combine harvesting services from 70USD/ha in 2009 as trial price from very few combine operators, to 90USD/ha in 2010. The competition and increasing demand thus also affects operators and their prices. After the certification activity, none in the group could check if a service provider had a certificate or not. There were no policing mechanisms in place, so the tried activity was just an information drive for operators.

Women expressed that they like the combine harvesting because it freed them from unpaid harvesting duties (group discussion with women farmers, Prei Kdei 2013). However, the downside is that they have fewer opportunities to offer wage labour to other farmers. Some women who used to be labourers said they got more income from other jobs, for example factory work or seasonal work in towns. This shows that the new connections around mechanized harvesting also imply the loss of connections that were built around manual harvesting.

Photo 4.6: Transporting combines on trucks also increases operation costs, thereby increasing the fees paid by farmers for harvesting service; Photo by R.Flor

Most owners of combine harvesters are also owners of repair shops or small-scale manufacturers of agricultural equipment. Some farmers were interested to own machines and provide service to other farmers as a business, but they were initially not considered for loan applications in funding agencies. The number of combine service providers in the area expanded when farmers with access to capital started to invest, and previous owners bought more machines. When combine manufacturers and dealers provided better terms of payment (e.g., minimal down payment, with the rest payable in

one year), some farmers were able to buy machines. Others were still waiting for better and more accessible loan products from banks and micro-finance agencies. Millers in Case 2 responded to follow-up with funding agencies after the learning alliance activities.

4.6.2 Drying

The situation for mechanized drying was also different between the two cases. In case 1, a cooperative of farmers used a flatbed dryer unit; whereas in case 2, only millers had dryers, which they made accessible for the two villages.

Small-group interactions in drying for Case 1

In case 1, the traders living in Balat village specialized in trading sticky rice. The sticky rice market is for specific cooked-rice products, where the milled rice is sold locally with good prices. Farmers are thus encouraged by traders to sell milled rice rather than grains. Recognizing and producing quality rice through drying well is incentivized by these traders. The farmers in the group acted on this. Since the dryer has a capacity of 4 tons per batch, they had to improvise and use nylon mesh to separate grains of different customers in the drying bin. Thus, the dryer operator devised mechanisms where farmers with limited amount of grains, mostly sticky rice varieties, can dry together. In this case, coordinating was crucial because grains should be harvested at about the same time. The operator refined the schedules and provided the mesh. Farmers who dry had to provide labour to transport grains to the dryer then spread the grains on the drying bin. The farmers pay 10 USD/ton, according to the weight of fresh grains loaded into the dryer. For a farmer with about 1.5 tons of grains to sell, the cost incurred was 84000 Riel (21USD), including labour for hauling.

The network of the dryer operator also included millers (Figure 4.1). They were customers of the cooperative's dryer, who sustained the operation when not enough farmers were using the dryer. Five millers invested in their own dryers after having used the dryer from the cooperative. They observed higher milled rice recovery (percentage of grains from milled paddy) from machine-dried paddy. According to millers near Battambang town, all medium and large-scale millers who do not have dryers will lose profits because millers have to compete to buy good quality varieties (e.g. Phka

Romdoul or Neang Malis) (interview with millers, 2013). Without the capacity to buy fresh paddy and dry by himself, the miller cannot get as much grains during the harvest of these varieties. Therefore, millers who could not afford to install their own dryers obtained drying services. Other smaller millers provided by-products (rice husk) to dryer operators to diversify their business.

With competition from millers, farmers had to wait for their schedule to dry grains. Two farmers who were customers of the same service provider, thus decided to install their own dryers. They learned from observing the operations at the unit in Balat. The farmers dried for their own produce, but also provided service to other farmers. These farmers and some millers decided to provide drying services since there was market for it during peak harvest season.

Small-group interactions in drying for Case 2

In case 2, the group involved the association of millers. From their interactions, many millers invested in dryers. They observed other millers, 'after I saw in [his] mill…I had a unit installed in 2010.' (interview with miller, 2013). They further assessed that while flatbed dryers could give them good quality rice, a lot of labour and time were also needed to load grains into the bin and bag them again after drying. Millers who use flatbed dryers hire labourers to load and unload four to ten tons of grain per batch. One miller learned, with support from the alliance, to manufacture a second-generation mechanical dryer. This time, the machine was a re-circulating batch dryer, which could dry at a higher capacity, shorter time and with less labour. Re-circulating batch dryers are bigger dryers that require more complex operating technology, and more financial investment. The group in Case 2 thus focused on handling bulk of grains at centralized points at the mills rather than in the villages managed by farmers.

The common mechanical drying arrangement in case 2 is when millers specify buying fresh paddy from farmers to dry in their own milling complex. Officers from the millers' association in Pursat said that about 80% of millers have dryers since 2013. Some millers have 2-4 flatbed dryers with bigger capacity (e.g. 10 tons per batch). The farmers in Case 2 commonly sun-dry their grains, or sell fresh grains.

Photo 4.7: Initial design by a miller from Pursat of a recirculating-batch dryer (left); a unit manufactured for another miller (right); Photo by R.Flor

Photo 4.8: Grain drying operation at a mill with laborers unloading the grains into bags (top); Sun-drying near the homes, usually done by women, takes 2-3 days depending on amount of sunlight (bottom); Photo by R.Flor

4.6.3 Quality assessment during selling

The making of quality rice does not end after drying, because the full assessment is made only when the grains are sold. In selling grains, farmers deal with traders and millers who assess the grains. The buyers prefer grains with golden colour, and no brown or darkened patches from soaking or improper drying. Buyers then use a scraping board to ascertain purity of the grains and percentage of broken grains. If mixtures in colour and size of grains are found in the de-husked rice, the buyer reduces the price. The buyer also bites on the grains to assess if the rice is dry enough based on brittle grains. If not, they also reduce prices or deduct up to 10% (5kg per 50kg-bag) depending on how wet the produce is. Many millers use moisture meters for more accurate assessments during negotiations with farmers. Therefore, due to the standards implemented by millers, the practices were largely similar although the actors around selling for Case 1 and Case 2 differ.

Photo 4.9: Small milling machine: Testing tool used by millers to know purity of grains; also indicates if grain is well dried (not chalky, not easily broken); Photo by R.Flor

The preference of traders to obtain fresh grains is backed by millers who prefer to dry the grains themselves and have the capacity to take in the bulk of the grains. According to millers, their preferences changed after some millers observed that they can get higher milling recovery if the grains were dried well (interview with millers from Battambang 2013). Preference is as follows, in order of priority: 1) fresh grains that will be dried by miller mechanically (will give them up to 65% milling recovery); 2) farmer-dried grains, with good quality at 14% moisture content; 3) farmer-dried

grains that are not of good quality; and 4) fresh grain that farmers stored without drying for more than 2 days—this is said to result in very low milling recovery. According to farmers, the milling recovery they get from farmer-dried grains is 58% on the average (informal discussions with farmers from Snapimok 2012).

Millers have contact traders who live in or travel to the villages. A network of contact traders help them obtain the bulk amount they need. Some traders are also contacts of cross-border buyers from Vietnam and Thailand. These buyers have larger capital and can play on price differences. According to farmers, traders connected with cross-border buyers usually give higher prices. They also encouraged farmers to sell fresh grains immediately. In close contact with millers and these cross-border buyers, local traders are attuned to whether their market will buy fresh or not. Such conditions largely impose upon their buying practices and interactions with farmers.

The interactions with traders resulted in additional tools purchased by the group such as weighing scales and moisture meters. These instruments are provided by the LA through key farmers. Farmers could provide their own moisture content reading during negotiation with the buyer. They said that the tools allowed them to negotiate rather than let the trader decide based on their scales or routine tests of biting the grains. There were incidents when millers stopped buying because they had enough grains; but when farmers started giving moisture content readings to prove that grains were well dried, the millers bought immediately. In both cases, key farmers managed communally owned tools and collected small fees from farmers for repair and maintenance of the tools.

4.7 Discussion

The Learning Alliance and national programs supported change in practices towards mechanized harvesting and drying but not many farmers used combine harvesters and dryers in 2012. We found that groups at the community level emerged around mechanical harvesting practices without discarding the option of manual harvesting. As a result of the introduced changes, farmers, contractors, and combine operators learned when, where and under what conditions mechanized harvesting and

drying was suitable. Groups made various adjustments to the machines and operational procedures. Their own learning was shaped by the conditions posed by their environment, routines established with other groups, and by their preferred tools. In short, the task and the group co-developed.

4.7.1 Influences from the wider environment

The changes resulting in the emergence of small groups are affected by external influences such as export-market oriented production, local adaptations based on users' feedback, or after-sales networks of new postharvest technologies (Gummert et al., 2010). In line with national policies, support was promised to the rice sector not only for manufacturers but also other value chain actors (RGC, 2010). The support paved the way for increased interest in rice postproduction in both cases. Millers could access loans to rural development banks for improvement of their machines. Hence, more millers could access loans for flatbed dryers than farmer groups. Companies producing machines such as combine harvesters also came in with various models of their products and established market retailers in the provinces. For some companies, after-sales service included visits by technicians to buyers of the machines at 1, 3, and 9-months after purchase. They also gave some support for maintenance and repairs. Farmers who are interested in investing on equipment could not access loans from the government. With some down payment however, they can have instalment agreements with dealers that were supported by companies. Some banks and micro-finance agencies provided loans for equipment, but mostly for tractors and other small machines. Only in 2012 did these funding agencies start to explore loan products for rice post-production.

The export orientation also emphasized quality, especially for some varieties. Examples include sticky rice, which gets three times the price of typical wet season rice, and aromatic rice, which can be 30-100% higher price (ACI and CamConsult, 2006). Another high-quality Cambodian rice is organic 'Neang Malis' aromatic rice from Battambang, which is exported to niche markets in Europe and Hong Kong. Generally, this special rice receives a $100 per ton price premium over best export varieties, and more than twice the price of domestically marketed rice (MAFF and MOWRAM 2008). These trends are felt at the community level (case 1) such as in the preferences of traders, or higher price for sticky rice that provides incentive for drying.

4.7.2 Co-dependent adjustments in small groups

The learning alliance interacted with small groups at community-level but there are differences in activities and actors reached between Case1 (Battambang) and Case 2 (Pursat). These differences resulted in different compositions of the small groups around these technologies. The groups however, were changing and doing things differently. For harvesting, the small group, for example, explored effective ways to diversify the value of combine harvesting machines. The rise of service providers and the connections made by actors in the learning alliance to this was important. It affected farmers in terms of availability of services, operators in terms of contracting and scheduling for services in an area, and buyers in terms of bulking. Institutions regarding the process of assessment and pricing, schedule of post-production activities, or process for contracting services were changing. In addition, monitoring by the small group regarding problems around service providers was also evident, to which they responded with certification as a mechanism. These results show interactions between small groups, which are learning, and a wider network aiming to steer certain processes (Klerkx et al., 2010). We find that both explore how to make technologies work with different but sometimes overlapping motivations. Some activities to change practices and arrangements did not achieve the objectives; groups did not sustain the practice.

For drying, the difference in focus of the small group in two cases was related to material conditions around trying a mechanical dryer. When a farmer group tried the dryer, they enabled adjustments that were targeted towards mechanisms to accommodate smallholder concerns. When a group of millers explored and learned about dryers, they opened up issues about labour and drying capacity concerns for large-scale drying. This reflects how drying is mutually constituted in the learning environment; the idea of situated learning (Lave 1986). It also highlights the role of material objects such as recirculating batch dryers or nylon mesh in the learning process (Dant, 2008; Jaarsma et al., 2011).

Another significant connection made in both cases regarding dryers was the link with millers. These millers changed their own practices, patterns of managing their operations, as well as market preferences and buying practice of traders. Since millers were changing with respect to standards in buying, the small group also had to perform

in ways that addressed emergent concerns. These were through tools that affect negotiation, coordinating the use of the tools, or trying out how millers respond to farmers using these. In these interactions, the actors in the group who picked-up on the information to use for their own concerns varied.

There were key actors who influenced the choices of others in the groups. Millers, key farmers, and service providers were example of this. The preference of the millers, which they tried to align with export and local market preferences, shaped buying practices in communities. When they prefer wet paddy, traders encouraged combine harvesting and speedy delivery of the produce to the milling complexes, which have dryers to accommodate the grains. When millers preferred dry paddy, traders were very specific with moisture content, and imposed their standards on farmers. Competition among the network of traders drove spikes in buying price, which gave incentives to farmers to decide on which tool to use for harvesting.

The key farmers had an extension mandate that the local extension office supported. Farmers were well-linked to them. Key farmers gave advice, which some farmers considered as expert opinion. Part of their influence was in linking between combine-harvester operator or trader and farmers. Shifting from merely providing advice to coordinating the way farmers could avail of cheaper service together, or helping farmers with bulking their grains was an important change at community-level.

4.7.3 Tracking change from learning alliances

Impact from learning alliances are often monitored for benefits obtained by actors within an alliance, particularly with direct connections to technology adoption (e.g. Stür et al. 2009, Lundy et al. 2012). Such analyses do not untangle complex relationships in the innovation process, or tease out interactions with material objects as well as influences of the environment. This focus on small groups however puts emphasis on learning as a socially embedded process (Brown and Duguid, 1991; Harrington and Fine, 2006; Lave and Wenger, 1990). Understanding the community-level process happening in small groups can provide a solid step towards tracing long-term impacts from projects with learning alliance approaches. It can emphasize how change is happening. In the case of Cambodia for instance, change was not driven from

only one angle, such as national programs or even learning alliance agenda (Poncet et al. 2010). Rather, small-group driven adjustments are also at play in the dynamics within communities.

4.8 Conclusion

We examined community-level processes from a Learning Alliance, which connected with national-level interests in rice post-harvest in Cambodia. We proposed the small group as the analytical starting point to monitor possible impacts from a LA in communities. Furthermore we discussed connections made by the LA with actors at community level then explored what outcomes this had on the small groups in rice farming communities.

While we found limited use of combine-harvesters and dryers, we observed that small groups in communities make reconfigurations connecting change in technologies with new social arrangements for post-production activities. Connections with the network facilitated by the LA supported these changes made by community-level actors. Therefore, the LA as a multi-stakeholder platform engaged with various stakeholders, but had pockets that affected small groups; these groups facilitated innovation processes at community level.

We compared how the LA connected with small groups in two cases. Differences were present in how actors responded to new technologies based on activities and priorities of the small group involved. For different tasks such as harvesting, drying, and assessing quality, the small groups responded to different concerns resulting in varied adjustments. New routines, practices, and norms for the task groups were emerging. The wider environment also influenced the groups. A condition, which similarly affected groups that we compared, was the response of millers towards meeting quality standards. This was influential in both cases. It affected how other actors in the groups became interested or not in mechanized harvesting or drying technologies. Its influence was not only during the implementation of specific activity such as selling, but in various related activities starting with harvesting rice. Therefore,

reaching millers through the LA provided an impetus for change at community level. The LA thus provided a network of actors that supported the innovation process by responding to changes observed and addressed by task groups at community level.

Tracking the changes in small groups, rather than individual actors for example, is an important step towards assessing community-level processes from multi-stakeholder platforms such as LA. Indeed, changes at community level were complex, interrelated, and emergent. The changes were not because of the LA alone. Using small groups as a point of observation however, allowed us to view intersections among technologies, institutions, environment, and other emergent patterns that groups initiated in the innovation process (Harrington and Fine 2006). Our findings contribute to monitoring of long-term changes, which would be measured as impact in the future.

Chapter 5

Socio-technical analysis of a Learning Alliance at community-level to facilitate adaptation of flat-bed dryers[4]

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5.1 Introduction

Post-harvest losses to rice production in intensive rice-based production systems in Southeast Asia are of major concern. Post-harvest losses to rice production are in the range of 7 to 25% (Gummert et al., 2010). Appropriate technologies and management approaches are available but a major challenge has been the low level of adoption (Douthwaite, 2002). Assessments of flatbed dryers, a technology for mechanized drying of rice, have pointed out for example that participatory introduction of the technology can address problems that result in low adoption (Ragudo, 2011; Hien, 2010). To increase adoption levels and create opportunities to better tailor the technology to the needs of users, multi-stakeholder approaches such as Learning Alliance (LA) are recommended. Like many technologies, compounding factors in the broader environment around the dryer were identified as constraints to its sustained use. These compounding factors included unsuitability of design for smallholder conditions, lack of technical and 'after-sales' support, and lack of incentive to pay service fees (Pamplona, 2000; Ragudo, 2011). Simultaneous change in practices of different actors--not only farmers, is necessary to deal with these constraints.

Interventions to spread flatbed dryer technology through national programs in Southeast Asia before 2005 have met little success. An exceptional case where flatbed dryers are widely used is in Vietnam. A key difference in Vietnam was the process to adapt the technology to local conditions, through engagement of users and learning by local manufacturers. Instead of a national dissemination program, an informal and self-organized learning process for local adaptation of flatbed dryer technology happened (Douthwaite, 2002).

The Vietnam example spurred interest to know whether a similar process can be orchestrated in another country. In Myanmar, a LA was facilitated to see whether it can generate a self-organizing process of innovation around flatbed dryers. We present the results from a study into this process, addressing the question if and how a learning alliance supports self-organization in relation to the adaptation of flatbed dryers in Myanmar.

An ethnographic approach is adopted to examine the social and technical changes required for effective adaptation of the technology, and to what extent a simultaneous social and technical re-design was achieved. The study contributes to understanding the role of multi-stakeholder approaches in facilitating innovation around agricultural machinery.

5.1.1 History of flatbed dryers

Initial design and factors which limited adoption

The initial concept of the flatbed dryer emerged in the 1960s in response to increased volumes of rice paddy from IR8 harvested during rainy periods (Douthwaite, 2002). The yield increases created a bottleneck in the amount of paddy farmers could handle with sun drying (Ragudo, 2011). In the Philippines, the government introduced a centralized drying system. It had sophisticated controls requiring high-level expertise to operate. For these reasons, the dryer was not used by farmers (mostly smallholders) who had fragmented farms far from drying centers (Ragudo, 2011).

In 1966, a new type of dryer emerged to address user constraints. A team from the University of the Philippines Los Baños (UPLB) designed the 2-ton flatbed dryer. Their purpose was to encourage proper farm-level drying, through an accessible, less centralized system. The International Rice Research Institute (IRRI) also made a 1-ton flatbed dryer and released drawings to manufacturers in 1972 (Douthwaite, 2002). Both designs had three components: a furnace, a bin with a perforated sheet above an enclosure (plenum chamber), and a fan that blows heated air through the enclosure and perforated sheet (Ragudo, 2011).

As Douthwaite (2002) documented, the Philippine government included the flatbed dryer in its national program. Other Asian countries followed suit by designing and disseminating their own version of the dryer. All were similarly unsuccessful in generating widespread and sustained use. Vietnam however, had a different result. In 1983, a lecturer from Nong Lam University (NLU) obtained a drawing of an IRRI dryer and started construction in Vietnam. There was an informal process of learning among researchers, local manufacturers, and farmers to co-develop the dryers. In this self-organized process, the manufacturing industry adapted components of the dryer

according to the needs of its users (Hien, 2010). Knowledge of the dryer spread by word of mouth; with various improvements added over two decades. The changes made by local manufacturers and users supported the spread of the flatbed dryers in Vietnam. By 2004, more than 6000 units of the 'modified' flatbed dryer were sold and used in the Mekong Delta despite a levy of about 200USD per year charged by the government in the 1990s to dryer manufacturers (Douthwaite, 2011; Hien, 2010).

Lessons learned on the social and technical adaptation of flatbed dryers

The complexities in adapting the flat bed dryer have been documented. For one, it involves a process of technical adaptation. Adjustments to the technical design can be perceived as a process of learning by different actors to increase suitability of the equipment to its environment (Douthwaite and Gummert, 2007). This process involved engineers, scientists, manufacturers or artisans and farmers who interacted with the equipment, making modifications as needed.

There were also social changes required so that the innovation could progress. Simultaneous with the technical adjustments, the relations between various actors also mattered because a collective effort was required to make the equipment work. Hien (2009) emphasized strong ties between technology and local people such that manufacturers, after-sales-service providers, and operators interact with users in the locality. Interaction based on experience with the technology is thus vital. Second, reputation of the equipment requires management that should be informed by experience of users. Negative experiences can spread by word-of-mouth and have a large negative impact (Hien, 2000). Understanding the experience of users can tease out operation concerns from concerns on the technology itself. Communicating these effectively is then needed. Third, adapting the hardware also meant timely assessments on indications of economic benefits. The cost of drying with respect to the value of the grain is a precondition for farmers (Hien, 2009). This stimulates willingness of farmers to pay a service fee (Pamplona, 2000). Where the benefits from mechanical drying do not outweigh the costs of sun drying, and farmers faced a clear risk of price fluctuations, then developments to sustain the use and spread of dryers can be hampered (Ragudo, 2011).

In addition to technical modifications and field-level social changes, changes in market conditions also are required. The spread of dryers has been reported to be linked with the situation regarding standards set by rice traders (Pamplona, 2000). Only when traders learn to appreciate the difference in grain quality obtained from the use of flatbed dryer, farmers can sell with good price. Farmers can fuel the interest of traders by collectively selling good quality grains in bulk. Farmers however need access to dryers and a price advantage for machine-dried grain. In short, farmers, traders and millers are dependent on each other and when advantages and trade-offs are balanced, new quality standards and ways to value grain quality emerge, where each obtain benefits (Ragudo, 2011). Lastly, credit and access to financial support also affects initial investment decisions. The experience in Vietnam had two clear examples according to Hien (2010). A credit scheme in the late 1990s with a revolving fund was available with reduced collateral and low interest rate for farmers. This resulted in the establishment of about 600 dryers. Even with a different credit scheme a decade later, the spread of flatbed dryers was similarly boosted in An Giang Province.

5.1.2 Can innovation around flatbed dryers be facilitated in Myanmar?

In 2005, one representative from the Myanma Agriculture Service (MAS) and two from the private sector joined an IRRI-supported training course on manufacturing dryers at NLU. For demonstration purposes, private sector partners built a large commercial dryer and a 1-ton IRRI dryer. In the same year, they started to locally produce Vietnamese-designed, 4-ton dryers. Pioneer Postharvest Development Group (PPHDG) promoted these in Myanmar. This resulted in the installation of 47 dryers in the country by 2008, and 135 by 2011 (Kyaw and Gummert, 2010; interview with MAK, 2014). In 2013, IRRI, PPHDG and NGO partners planned to introduce flatbed dryers of similar design through a project in the Lower Delta, Myanmar.

Considering what has been learned over the years about this technology, an identified need for drying by farmers was not enough to make it work. The LA approach was taken on board to engage private, public and civil sector actors in an innovation network to jointly identify, share and adapt suitable practices (Lundy, 2004; Lundy et al., 2005; Stelling et al., 2009). This approach is relatively new in research projects involving rice farming communities. An LA involves a wider set of actors who possibly

have a stake on a shared concern. The goal is to support coordinated change of practices among these actors at various levels thereby also targeting institutional change (Douthwaite et al., 2009; Smits, 2002). The approach also has been used to solve complex interdependent problems and scale out impacts from research (Verhagen et al., 2008).

A project, jointly implemented by research and NGO partners implemented the LA approach to support the spread of suitable technologies. Through this, a village-level LA in Myanmar was established with a focus on the flatbed dryer technology. The current study is a socio-technical analysis on how this LA orchestrated innovation around dryers in a rice-farming community. Considering the lessons learned from the introduction of dryers in other countries, we ask 1) what kind of network does this approach support, and how does it function; 2) What learning agenda and activities were facilitated and how do these affect the process of social and technical re-design by different stakeholders; and 3) what insights can be derived from usingthe LA approach as a platform to facilitate a self-organized learning process similar to the case of flatbed dryers in Vietnam. Our hypothesis is that an LA can facilitate a self-organized learning process to adapt flatbed dryer technology in Myanmar.

5.2 Theoretical and methodological framework

5.2.1 Performance in re-design for successful innovation

An innovation systems (IS) perspective underpins the concept of LA. IS direct attention to the networks or chains of organizations and individual actors, such as in a community where mechanized drying is introduced. This implies for example that community factors are considered next to individual farmers' interests. This is needed because successful innovation requires an effective combination of new material technology, related knowledge, and relevant organisations and institutions (Smits, 2002; Leeuwis, 2004; Oria et al., 2014). By institutions we mean the formal and informal rules which affect practice, e.g. shared labour agreements between farmers or established payment arrangements. A heterogeneous and interdependent network of actors in an innovation system operates at different levels, and manoeuvres the organisational and institutional structures to enable innovation (Hall et al., 2003; World Bank, 2006; Kilelu

et al., 2011). Innovation is not only new technology and knowledge but the re-design of technical practices and ways to organize them (Leeuwis, 2004; Dormon et al., 2007).

Innovation around the flatbed dryer technology requires re-design or a series of adjustments of social and technical aspect. This means that actors in the network change and work around different challenges and tasks (Klerkx et al., 2009). Individual practices are an outcome of mutual shaping of the social and technical (Law, 1986); hence, the ways farmers and other stakeholders engage with these interplays cannot be considered from a social standpoint alone. We use a concept of performance to delve deeper into the adaptive capacities of actors. This notion is particularly useful to better understand what happens when individual farmers or a community makes decisions at the moment of use (Richards, 2001; Jansen and Vellema, 2011). 'Agriculture as performance' directs examination of farming practices through the lens of improvisational capacity (Richards, 1989). This connotes both intended and unintended actions which emerge from varying circumstances or the 'needs of the moment' (Suchman, 1987; Richards, 1989). Performance also considers the interactions of material and ecological conditions along with the social-organizational conditions. Actors in communities do not only engage with other actors and institutions but at the same time also deal with rice varieties, markets, or weather variability for example, when they dry their rice.

These ideas taken together allow us to examine the socio-technical re-design process. They direct analysis of how the LA influences actions of individual and collectives through social interaction, and how 'performance' under specific material and ecological conditions is happening in adapting the dryer in a village in Myanmar.

5.2.2 Methodology to understand process of re-design

The site of focus was the village of Kyee Chaung, in Mawlamyinegyun Township, Ayeyarwaddy Division, Myanmar. The village is located in the Lower Delta. Although the dryer is in Kyee Chaung, the farmer-users are from eight surrounding villages, which belong to two adjacent townships, Mawlamyinegyun and Bogale. For the current study, the data gathering at village-level is specific to Kyee Chaung.

The main method to capture the process was participant observation during the activities, and the monitoring of discussions of the LA. Observational data, exchanges with manufacturers and project documents provided the basis for analysis of technical as well as organizational re-designing of the drying process. Focus group discussions and interviews of actors who were part of rice post-harvest activities in the community, were undertaken. The subjects included labourers, traders, thresher and reaper service providers, boatmen, NGO, researchers, and millers. Some of them were part of the LA, and others were not. Lastly, 30 farmers in Kyee Chaung village were interviewed on their involvement, practices, and management decisions as well as farming conditions within which they operate. The farmers were purposively sampled based on the distance of their farm to the dryer (near/far), and the condition of their farm with respect to flooding. They were queried on their use of the flatbed dryer in the village, their connections to its use, arrangements affecting use (or not) of the dryer and the outcomes they observed.

Analyses of data from the village-level actors were triangulated with data from observations of LA activities and documents to track how the activities were connected with the re-design by the community of the approach of using the dryer.

5.3 Results: Process of adapting the flatbed dryer

We expound chronologically on what happened with the introduction of the dryer. The first is on the formation of the LA. This is to examine how the LA was set up and how different actors began to make adjustments related to the dryer. The next section expounds on issues addressed while setting up the dryer in the village. This is followed by an assessment of subsequent activities by LA on social and technical re-design to facilitate the innovation process. Lastly, findings on responses by actors, the adjustments and adaptations set in motion by interactions with and about the dryer, as well as conditions at the village level relevant to drying are discussed.

5.3.1 Starting the process, 2012-2013

Forming a network with shared interests

In the foreground of the LA was a partnership of a few organizations involved in promoting agricultural technologies to benefit farmers in the lower delta. They implemented activities with limited coordination. From the private sector, two companies had started constructing dryers for farmer groups and millers in other parts of Myanmar, although not at the site of the project. The companies were Pioneer Postharvest Development Group (PPHDG) and Tin Oo Engineering. They started in 2006 as a business partnership. Tin Oo Engineering made the components of the dryer based on a Vietnamese model. PPHDG meanwhile promoted mechanical drying to policy-makers from the government, rice millers, government staff, and farmers. It also produced manuals and leaflets for owners and users of dryers. By 2011 they had installed 135 dryers in the country. PPHDG, which represented the two companies in the LA, is operated as a business with interest on corporate social responsibility (interview with PPHDG, 2015).

Several relief agencies and other non-government organizations (NGOs) in the lower delta of Myanmar implemented community and livelihood support strategies for farmers after the Nargis cyclone in 2008. The organisations, GRET (Professionals for Fair Development) and Welthungerhilfe collaborated with the IRRI researchers to introduce technical options to improve livelihoods. One of the technical options agreed upon at the start of the project was the dryer. joined the LA. Both organisations had existing programs in the villages, including credit systems based on communally-stored paddy.

The IRRI team implemented two initial activities. One was a training course for NGO staff and farmers on improved post-harvest practices and tools for drying and storage. Another was a rapid appraisal with PPHDG and farmers to assess current conditions and the feasibility of setting up a dryer that could be used sustainably. The assessment from experts was to think beyond the component technologies. Since there was no market incentive, the dryer had to be set-up in a value chain context where better market linkages for a group rather than individual farmers was possible.

In 2013, the main partners of the collaborative project set up a participatory impact pathways analysis (PIPA). The PIPA formally opened the LA where representative farmers, laborers, NGO staff, researchers, dryer-manufacturers, traders and millers came together. Notably, the representatives were from the existing networks of the three organisations. For example PPHDG had contacts from the private sector so they could invite manufacturers, millers and traders; while GRET could invite farmer leaders and laborers from their own programs in the village.

In this first meeting, the representatives from the village assessed who was currently part of their network for rice postharvest (Table 5.1). The starting point of the network of the LA had a different scope and did not involve all actors who were part of the rice post-harvest activities in the village.

Also, the LA network excluded funding sources (lenders, micro-finance, village-based traders) that were identified by farmers to be important. Nonetheless, the first issue which the multi-stakeholder group analysed was why farmers do not receive good profits from their rice production or higher selling price. This was an issue where the group could start to discuss different points of interest.

Technical starting point: designing the dryer

Among the members of the alliance, PPHDG with limited support from IRRI provided technical background on manufacturing the dryer in the village. The company had experience in coordinating the construction, with components made through sub-contracted labour. The commissioning and training for these sub-contracted artisans were done by PPHDG. It also provided the technical knowledge and labour for assembly on-site.

Descriptions from technical implementers showed there was a target model in mind at the start of discussions regarding construction (interview with PPHDG 2015). It had 4-tons capacity, a rice husk furnace with a cylindrical top for fly ash separation, and a bin made from concrete or bricks. This was an exact copy of the Vietnamese design, which had previously been refined in the Mekong Delta.

Table 5.1: Stakeholders involved at the start, and through 2 years of activities compared with actors perceived by farmers to be part of the Learning Alliance network in Kyee Chaung, Mawlamyinegyun, Myanmar

Category	Village-level network*	Network at the start 2013	Actors engaged by LA 2014-2015
Private sector	thresher operator	PPHDG (and Tin Oo Eng'g)	PPHDG
	miller	local millers	local millers
	trader	village-based trader	village-based trader
	mechanic	thresher operator	thresher operator
	boat owner	town-based millers	town-based millers
	micro-finance		thresher manufacturer
	fertilizer seller		fertilizer distributor and retailers
	private lenders		MRPTA/ Yangon-based traders
	pesticide seller		seed producers
	seed grower		
Farmer group	Farmers	farmers	farmers
	farmer leaders	farmer leaders (representing 7 villages)	farmer leaders (representing 8 villages)
	labourers	labourers	labourers
NGO	GRET	GRET	GRET
		Welthungerhilfe	Welthungerhilfe
Research		IRRI	IRRI
Government	local leaders		local leaders DOA - township level

*network of rice postharvest actors in the villages from stakeholder analysis by farmers in 2013

There were however, small modifications decided upon before installation. One is that the bin would have a capacity of 3 tons rather than four. This was a technical decision made by the manufacturer based on the rapid appraisal and discussions with farmers. The diesel engine used was one that was locally available. Lastly, the bin was made from metal instead of concrete. This was for ease of fabrication and construction on-site. These were minor modifications translating into a more powerful air delivery which slightly increased the performance of the dryer at marginally higher investment

cost per ton capacity. The cost difference was not considered important at this stage since the dryer was built as a demo unit and funded by the project.

Photo 5.1: Pilot testing of the flatbed dryer, with manufacturer explaining about the dryer to farmers; Photo by M.Gummert

Initial socio-organizational context affecting the agenda on dryers

A small part of the network did the technical analysis of existing drying systems and the assessment of feasibility of the dryer in the village. There were issues pertaining to the social aspect that had to be resolved before the dryer could be set up. These concerns were tackled by various groups in the LA.

The LA members proposed that the dryer would be tried in complement with existing credit systems that are coordinated by the NGOs. Credit was provided to farmers when they store part of their produce in a communal storage. The collected grains are stored and managed by a committee of farmers, for sale when prices are higher. For the Alliance an underlying objective was to support farmers to sell good quality at higher prices through timely drying and then communal storage to wait for better prices. The set-up of the dryer therefore aligned with the interests of the NGOs and farmer groups involved in communal storage. Thus, the GRET communal storage system was selected as the unit where the dryer would be tried.

Farmers in the group brought up various concerns, summarized in Table 5.2. These concerns show that the farmers were aware of the organisational complexity of a shared dryer, not only with respect to the functioning of the device as such but also changes in their relationship with millers for example. These concerns influenced the

agenda of the LA. Millers were part of the initial concerns of farmers because at that point farmers only had options to sell to traders or millers in Bogale and Mawlamyinegyun townships (Table 5.2). If these millers control the price, the farmers would lose profit by paying additional for drying services. The traders either live in the village or come with their own labourers and transportation.

Table 5.2: Concerns discussed by farmer representatives* on the establishment of flatbed dryer at a Learning Alliance meeting in December 2013

Need to clarify ownership (community or individually owned)
There was experience of communally-owned equipment that was not successful; concern by farmers that they could not access the equipment if ownership was unclear
Suggestion for making a policy outline on the use; need to discuss this some more, GRET can help
Can be privately owned but supporting the community
Suggestion: one person has to own but partially pay for temporary investment
Possible to explore loan to be paid back within 2 years
Check if certification (FBD-dried rice) will lead to millers paying a higher price
Where to set-up: start where there is communal storage, it might help to get it going
Potential users make suggestions (in future meeting)
Someone from the project can participate in user-group meetings

*Farmer representatives were from five villages in Mawlamyinegyun and Bogale

This service is convenient for farmers, but according to them traders may pay low prices or have inequitable buying practices. The risk can be through high reductions in price or weight for wet grains, mixtures, dark grain color, or less-preferred variety (interview with farmers, 2014). Millers can give better prices but are 30-45 minutes away by boat, so farmers have to transport when they want to sell. For farmers in Kyee Chaung and neighboring villages, the millers in Bogale were more accessible by boat than the millers in Mawlamyinegyun. Road access is difficult between villages and town centers; some are possible only by motorbike.

Many of the millers do not have dryers. Those who do, have recirculating batch dryers that are not suitable for drying small amounts. Some have started to invest in parboiling machines (interview with millers 2014). The Myanmar Rice Federation,

which regulates rice trade in the country, has supported the increase of parboiled rice exports (interview notes, 2014). With parboiled rice, millers are not strict about the colour of the grains they buy. Farmers also said the millers around Bogale will buy any type of rice and will not provide premium for good quality rice grains (LA meeting notes, 2013).

Photo 5.2: Transporting rice paddy by boat (top); selling paddy at a mill in town, in the lower Ayeyarwaddy Delta (bottom); Photo by R.Flor

There were actors, influential in activities for drying rice, whom facilitators of the LA had not considered from the beginning, most prominently, fertilizer sellers, micro-finance, and private lenders (Table 5.1). Farmers interact with them at the start of the season to get a loan. These actors can impose repayment immediately after harvest, thereby limiting selling options of farmers (FGD notes, 2014). The exchange is on a

basis of trust, therefore farmers are strongly pressured to meet payment deadlines if they want to get loans for succeeding seasons. These influential actors were not discussed directly in the plans about the dryer, but farmers flagged them as important in village-level interactions. From 2013-2015, they were not involved in the LA meetings.

Other service providers such as boat owners, thresher operators and labourers, also listed in Table 5.1, were important in the links between farmers and millers. River channels separated villages from the town, so farmers need to transport produce by boat. Therefore, farmers need to consider availability of service providers, the costs, and scheduling. Farmers said that during the harvest period labour services are scarce or expensive (interview notes, 2014). They have a system of paying the labourer at the start of the season to ensure the farmer will be prioritized at harvest time. Moreover, thresher owners are also important because they provide bulking services to millers. As middlemen they can also link farmers with millers. Thresher owners are paid usually in-kind; 4 baskets for every 100 baskets threshed (approximately 84 baskets for every 2090 kg) for the threshing service.

It is notable that at the start of the discussions, there were concerns which were discussed by the LA, but there were also underlying social concerns affecting the dryer which were not thoroughly discussed.

5.3.2 Setting-up the dryer, 2013

Following up on the first meeting, diverse interactions at the community were organized separately by GRET, PPHDG and IRRI to set up the dryer. The agenda were not so much on the technical design, but rather on the social issues affecting the construction.

While there was enthusiasm from farmers, there were also conflicts. The initial plan was to set-up the dryer in a village where the GRET communal storage was already working. In this village however, there were farmer leaders who were controlling the communal storage thereby excluding other farmers from benefitting (interview with NGO staff, 2014). Putting a dryer there risked a continuation of the same set-up. Also, the accessibility of this village from surrounding villages was more difficult. There were

competing interests in that other farmers wanted a separate dryer in their own village. To manage these requests, project managers and GRET requested farmers to wait until it could be verified that having a flatbed dryer would benefit a farmer group with communal storage system (LA meeting report, 2014). Also, GRET in consultation with farmers, suggested to set-up the dryer in Kyee Chaung village which is more-centrally located for access by eight surrounding villages. This decision was deemed workable for many.

IRRI staff started to explore the business model for a dryer in Kyee Chaung village. This analysis was on the costs of the dryer, how much was needed for operation, and what returns it would provide over time assuming a number of users. The unit was paid for by IRRI, but scenarios for repayment by the group of farmers were also studied. PPHDG and IRRI provided technical training to GRET staff and farmers who were to manage and operate the dryer. GRET provided capacity-building on accounting and management concerns.

Agreements were drawn with the farmers regarding the specific land where the dryer would be placed, the labour contribution by the farmers during construction, as well as initial ownership and rights to use the dryer. These discussions were facilitated by GRET (interview with NGO staff, 2014). Then together with PPHDG, farmers joined the decision making as parts of the dryer were assembled in Kyee Chaung. Decisions also had to be made as to who would operate the dryers. According to a dryer operator interviewed, the choice of operators was partly from farmers, farmer leaders and GRET (interview notes, 2014). In 2013 there were five operators who were selected. They were trained by PPHDG.

Furthermore, as construction of the dryer was on-going, representative farmers from eight villages around Kyee Chaung met with GRET staff. They decided to have a committee of 18 members who would manage the dryer. The committee, selected every year, was composed of representatives from the eight villages around Kyee Chaung that are target users of the dryer. Committee members were not paid but they had the chance to represent the interest of farmers in their village. The set-up of this committee was aimed at providing a balanced and transparent process in management, wherein the

ownership and operation of the dryer can be reviewed. The operators and the committee made plans on how users can be scheduled during peak harvest season when there would be more users.

5.3.3 Learning to make the dryer work, 2013-2014

Technical and operation concerns

During the initial operation in December 2013, there were different technical and social concerns which were tackled. On the outset, PPHDG provided materials and technical backstopping to farmer-operators. This was however not enough to get the operators going. The LA met to discuss activities which were implemented separately, and update the others on these. From the technical side, PPHDG and operator farmers reported the construction of the dryer. A demonstration of how the dryer operates was also done.

Farmer-operators had to discuss their experiences and their questions with the manufacturer and researchers. The technical concerns they were interested in are listed in Table 5.3. The issues that were discussed covered topics on maintenance of the dryer. This was to ensure safety of the operators and users, and to keep the dryer functioning well. Considering that the dryer would be run by different operators over time, the need for a manual and checklists for operators emerged as important.

Another point was the general operation and fees. Table 5.3 provides an overview of the major issues discussed. Many of these points were negotiated or finalized months after the meeting. Some of them could not be resolved without first trying if the suggestion would work. Some were also hypothetical in that they planned for possible scenarios that could be encountered during operation. For example, the need to speed up operation during flooded harvesting period, if there were many farmers who needed immediate drying services. The group discussed 2-stage drying with immediate pre-drying to 18% and final drying to 14% later when dryer is available, as a possible way to deal with the bulk of wet grains. They also discussed who would be the users, and how to ensure that farmers from target villages could be given priority in case there will be competition later on.

Table 5.3: Concerns discussed by various stakeholders in a learning alliance meeting during the start of operation, 2013

Technical	Maintenance	Operation	Fees
How to control temperature	Operation manual needed (available)	8 villages share the dryer	Fee is 7USD/ton (all-in vs. bring own fuel)
How to determine quality	Fan belt covers / extension of exhaust pipe (for safety of operators)	Special drying fee rates in target villages	Cash balance shown once a month
How to manage rice husk input to maintain 43°C	Person-in-charge assigned and trained	Limit on amount to dry to be set (to allow others to use the dryer)	
Ok to store immediately after drying?	Have a maintenance checklist	Introductory fee still being discussed	
How does the dryer improve seed germination vs. sun drying?		Schedule for drying operation	
Is drying needed when moisture content is 14-15%?		Two-stage drying as one strategy if high demand	
		Consider different varieties	
		Options to dry together in one batch	

Regarding the use of the dryer, committee drafted agreements on who owns, who can use and who has priority. The committee implemented several trials and discussions of what service fee was acceptable for farmers. the management committee and GRET shared their proposed service fee, which they based on calculations from operation and maintenance costs (Table 5.4). This was further discussed during alliance meetings and the initial costs tried were still slightly different. They examined where adjustments could be made to make the fee more attractive to users.

Table 5.4: Initial dryer service fee discussed in 2013 and 2014, per 3-ton batch of paddy, Kyee Chaung, Mawlamyinegyun, Myanmar

Item	**Proposed in 2013***		**Tried in 2014**	
	MMR Kyats	**US Dollar**	**MMR Kyats**	**US Dollar**
Fuel			4000	4.4
Labor charges for loading (jetty-dryer)	6000	6.7	6000	6.7
Contribution for dryer maintenance	1500	1.7	1500	1.7
Labor charges for operating dryer	3000	3.3	3000	3.3
Rice husk (for the furnace)	1500	1.7	500	0.6
Revolving fund	5000	5.6	5000	5.6
Total	**17000**	**18.89**	**20000**	**22.23**

*Agreement on fuel provided or paid separately by the farmer or client

Response from the network on technical problems

There were problems which emerged during operation. On the first and second batch of drying, there were no problems; but during the third batch, the operators encountered problems in achieving the target moisture content for dried grains. These problems were discussed with the manufacturers and researchers. In the discussion, PPHDG found that the corners of the bin were not filled well. This let the drying air escape there, lengthened drying time considerably and caused the problem. The operators were reminded to follow the manual provided by PPHDG. Operators also flagged the need for a more detailed manual.

There was also realization that even if the grains were well dried, storing the grains could risk re-wetting. A storage area safe from extensive moisture and other pests would be needed. To complement on-going construction of the dryer, the farmers and GRET also started the construction of a warehouse beside the dryer. It had concrete floor with corrugated metal roof and walls. This was constructed by the farmers, with funding from GRET. Having this storage area also required further discussions among farmers on ‘who could store their grains inside the warehouse’ (interview with operator, 2014). GRET facilitated discussions on the rules and regulations for the use of the warehouse.

There were technical questions from farmers which went into the LA discussions, for example “how do we know paddy is dry enough for milling?” (LA meeting report, 2014). Simple experiments which could be tried to learn about this was discussed, with farmer leaders expressing interest to try them; however, no activity was formally organized for it. Lastly, informal interactions between PPHDG and the operators continued to enhance capacity for operation and troubleshooting.

Response from the network on emerging needs in the social aspect

Other emerging needs pertained to the social side of establishing the dryer. The need for spread of information came about from reflections that quality standards were different, and millers do not know about the benefits they can get from well-dried paddy. The interactions between farmers and millers during facilitated meetings were sometimes heated debates regarding low quality paddy from farmers and low price from millers (observation notes, 2013, 2014). Discussing these led to activities to inform various actors like farmers, NGO staff, and millers regarding quality of paddy and drying by machine.

The management committee and farmers also continued to try and discuss price arrangements. At the start, farmers said if they get ‘200 Kyats more per basket (about 10USD/ton) the cost is not a problem’. At that time, the current price was about 3800 Kyats/basket (180 USD/ton). The discussion on price became more targeted as farmers started to try the dryer. Farmers observed ‘the quality was good’ but still did not see significant changes in selling price. One farmer sold at higher price of 300 Kyats/basket (about 14USD/ton) with machine-dried paddy but this was not the case for others (interview notes, 2014). This shows the risk in price difference, where quality assessments are different. Outcomes from the trials by farmers were shared during alliance meetings, but the service fee amount continued to be reviewed and re-negotiated. Still, farmers were interested to assess benefits or incentives in using the dryer. In the 2014 dry season harvest there was continuous rain for 1 week during harvest period. Farmers used the dryer when there was no option to sun-dry their crop. Some individual volunteers who tried the dryer shared their experiences during LA meetings. There were also farmers from other villages who were interested. This was not enough however to encourage many more farmers to use.

Activities targeting millers aside from orientation were tried. These included open discussions, market visits and market auctions. LA members believed millers needed to assess quality grains differently and provide premium for this. Millers near the village however were not fully interested in quality grains. They could get more profits with low quality grains which they process into parboiled rice or sell as low quality milled rice to a different market segment. Thus a link with wholesale traders and millers was explored. The Wardan and Bayint Naung wholesale markets in Yangon cater to national and export markets. The problem was that farmers from Kyee Chaung needed to first learn how to sell into this market, including the quality standards and bulk amount required. In the first meeting, line traders from the Yangon markets were interested and offered to take charge of transportation and hauling as long as a certain bulk with one variety was met (observation notes, 2014). Individual farmers volunteered to dry, store together and then try selling in bulk to this market in the subsequent season (LA meeting report, 2014).

The market activities encouraged farmers to store and sell together rather than individually. Meanwhile, another strand of activity targeted a group of millers at the town level, in Bogale and Mawlamyinegyun. With a few farmers who had stored grains together, GRET facilitated a market auction where millers were invited to bid on the price of grains. The farmers who sold in this auction said the price was 15USD/ton higher, and they did not even have to spend on transportation. At the next LA meeting, there were more farmers interested to store and sell together (observation notes, 2015).

At the side of millers, there was also a millers' trial coordinated by PPHDG. In this trial, one miller bought grains from farmers, dried using the dryer, then sold milled rice in Yangon. The miller incurred losses rather than profits because the grains were mixed (low quality) and had to be re-milled. Insights from this trial were shared during the LA meeting. Since the grain quality concern was not a direct effect of drying, the discussion also prompted more discussions on grain purity, which researchers related to seed purity (field notes 2014). Both millers and researchers encouraged farmers to start with pure seeds.

After two seasons of use and with interest on bulk-selling gaining ground, more farmers wanted to encourage other farmers to join them. They wanted materials that could easily explain the benefits of using a dryer. The material with pictures should pique the interest of other farmers who do not know there is a dryer in Kyee Chaung. One activity in 2015 was a workshop where farmers discussed what messages they want to share and what media would be most useful for them. With a local artist, they designed flyers and posters. They also planned where and how to distribute these (LA meeting report, 2015). The motivation of the group of farmers was to encourage other farmers to store grains and sell together with them to achieve the bulk requirement from the market.

5.3.4 Outcomes from interactions around the dryer, 2015

Interactions around the dryer led to changes, including unplanned ones. Interactions with market actors in Yangon continued in 2015, with farmers deciding to form a small group that can try to bulk grains and sell there. Farmers also explored the difference if they sold in Mawlamyinegyun rather than Bogale. The committee for the dryer also explored boat rental, hauling labour, and warehouse services as additional services they could offer to increase the incentive for farmers to dry, or to address constraints for farmers. Farmers also developed greater interest in some varieties which had seen from an IRRI trial on variety but which they also saw as a preferred variety at the wholesale market in Yangon. The LA continued to facilitate visits to seed farms to encourage farmers to find sources of seed. PPHDG also linked the farmers to seed sources in other provinces in Myanmar.

Although the LA had an explicit agenda, members included discussion about other project activities in the area. IRRI and PPHDG introduced various other postharvest technologies, for example different designs of small threshers, solar bubble dryers, and hermetic storage options. Moreover, IRRI, NGOs, and some farmers were doing trials on varieties and crop production technologies (crop establishment, fertilizer, pest management). The active NGOs focused on credit and other livelihood-improvement, for example supporting landless women to get involved harvest activities. From the interviews, it became clear that some members in the LA had additional

interests, PPHDG and key farmers for example became involved in fertilizer retail, training from the NGO for landless women allowed them to not only get contracts for harvesting but also for transplanting. In some cases, these additional linkages have a synergistic effect and allowed actors to invest more into collaborative activities. For example, interactions on fertilizer retail also led to links with sources of pure seeds. At the same time, it also resulted in competing fertilizer recommendations.

Outcomes on adoption by farmers in the context of their current situation

There was interest from farmers to try the dryer (Table 5.5). Not all farmers however see mechanical drying as an option they would take unless the weather condition would necessitate it. Notably, of the tools and techniques farmers observed, they planned to implement some which they learned from interactions in the LA (italicized in Table 5.5).

Table 5.5: List of technical changes and percentage of farmers from Kyee Chaung who planned to implement these

Change planned for 2015	**N (30)**	**%**
use dryer	*7*	*23*
use new variety	*5*	*17*
use Bullock Head (brand) fertilizer	*3*	*10*
plant Yadanar Toe, got from LA partner (seeds from Yezin)	*1*	*3*
thresh immediately after harvest	*1*	*3*
change fertilizer application: at 15DAS use IRRI-rate but for 45 DAS add more	2	7
compare Sin Thwe Latt with Sin Thukha	1	3
use Integrated Crop Management (ICM)	1	3
none	2	7
use drum seeder	1	3
use alternate wetting and drying (AWD)	2	7
use raised bed method	2	7
use salt water for seed selection	1	3
use seeds from 1 season before (not old seeds)	1	3
stop using raised bed (takes more labor, too expensive)	1	3

Changes in italics are specifically related to LA topics

The context experienced by farmers provides insight to these decisions. In terms of cost comparisons, there was significant added costs when farmers dried using the flatbed dryer. With yield average of 2593 kg/ha sold at 0.21USD/kg, farmers obtained gross proceeds of 557USD/ha (data from 47 parcels, assuming field-dry conditions, n=30). They paid on the average 70USD/ha in total for postproduction activities. Broken down this was 27 USD/ha for harvesting, 22 for threshing, 17 for hauling, and 4 for sun drying labor. With the use of the flat bed dryer, farmers said they had to pay additional 20 USD/ha. Broken down, the additional amount was 11 USD/ha for drying service fee, 3 for hauling labor, and 5 for boat rent. These were costs that had to be paid in cash when the service was provided.

Most farmers who used the dryer could not observe significant difference in selling price if they had done sun drying. One farmer noted 15 USD/ton increase in price after drying, storage and selling later. This translates to about 40USD/ha higher gross proceeds. Storing and waiting for higher price however becomes difficult or even impossible if the farmer had to repay debt. The NGO initiative to buy grains, store communally with inventory credit and then divide profit from higher selling price was not implemented by the farmers interviewed. They said the warehouse was still at its trial stage and organizing for storage was just started.

A maximum of 10 farmers per season had used the dryer since it was operational in December 2013. Farmers said the dryer is ‘useful for rainy harvest’, but they would not use it if they can harvest and field-dry in sunny weather. While conditions around selling have not changed in their experience and debt repayment concerns still exist, two farmers expressed enthusiasm in learning that millers can be positive about buying dried grains. In their experience, bulk grains sold to a miller from Mawlamyinegyun was easily bought at good price than with their usual direct buyers in the village or in Bogalay.

5.5 Analysis and Discussion

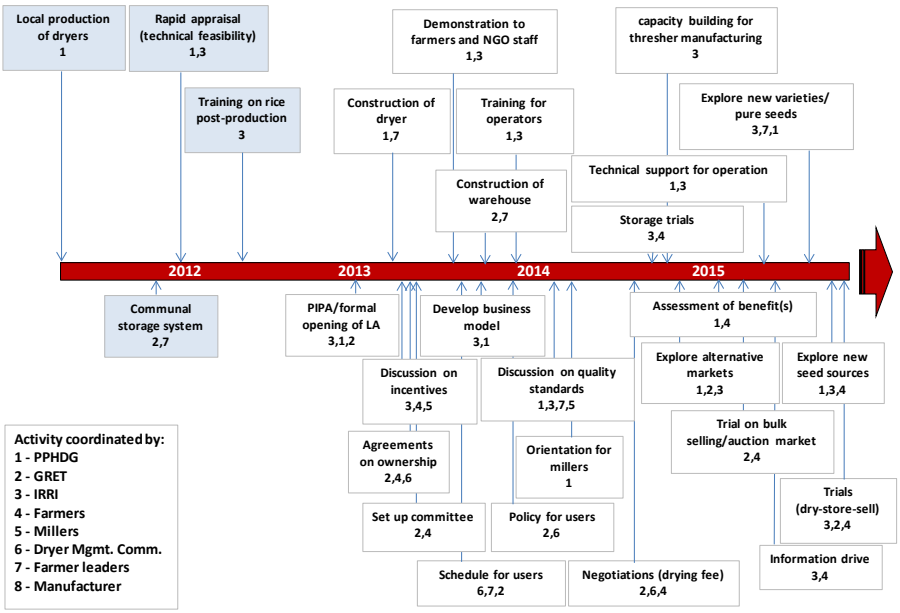
This socio-technical analysis aimed to examine the network, learning agenda and activities towards a re-design by different stakeholders. It also aimed to capture whether a self-organized learning process around flatbed dryers could be facilitated.

5.5.1 Learning Alliance network and its activities

Regarding the network, the LA was formed with a particular interest of key organizations around introducing the flatbed dryer. It included some actors at village level, but not all the influential actors. A network with a specific scope, it expanded the rice postharvest network at the village; for example through links with PPHDG, IRRI, DOA extension, millers and traders from Yangon, and other seed sources (Table 5.1). It also made use of already existing linkages such as between farmers and GRET, boatmen, or labourers (landless farmers and women).

An examination of key activities around establishing the dryer shows various activities which targeted technical and social adaptation (Figure 5.1). Notably, these activities happened simultaneously, with some technical activities requiring a follow-up activity in the social aspect and vice versa. Moreover, while many in the network were involved in these activities, various actors coordinated them (Figure 5.1). They also put in their resources and engaged their own contacts external to the initial network.

In many cases, interactions around the dryer led to other activities which were synergistic and unplanned. These can be considered a type of spin-off effect in that they were not controlled or facilitated by LA facilitators, they also broadened the scope of the LA into other topics beyond the initial agenda. Bulk selling, additional services as a package with the drying service, sourcing of pure seeds, fertilizer retail, and new varieties are examples. These highlight the adaptive capacity of the various actors in the network.



*Activities in grey boxes were implemented before the Learning Alliance

Figure 5.1: Timeline with agenda around adapting a dryer: Activities targeted for technical (top) and social (bottom) adjustments, and actors coordinating them (numbers), 2012-2015

Notably, even with the explicit agenda there were possible conflicts of interest which were not discussed. For one, the linkages with wholesale markets target higher prices or premiums for quality but it also required producing one variety in bulk. This contrasts with interests of farmers to manage varieties suited to the ecology of their different parcels. Secondly, links to government agencies such as for extension were facilitated in that they were involved in the discussions of the LA. This was tried even if farmers said they do not get visits from government extension staff. Although both provide extension services, the government and NGOs had diverging interests.

Furthermore, farmers experience situations which encouraged diversified strategies. Of farmers interviewed (n=30), 83% have additional source of income other than rice (fish, livestock, vegetable gardens, remittances, betel nut, farm labor). Diversification of livelihood opportunities is also supported by GRET and the other

NGOs in the area. Moreover, farm parcels have diverse ecological situations so farmers also vary their management strategies. In one season a farmer can plant rice in up to six parcels with varying conditions. Differences can be in elevation, location, duration of water flooding the fields (waterlogging), ownership, water level and capacity to control water coming into the field from tidal effect, or saline intrusion.

These situations may vary over different seasons or periods. Hence, farmers also diversify their strategies for example by leaving the field fallow for one season. Another example is planting different varieties. Farmers have up to five different varieties in one season. This may include a plot which is for seeds of a variety the farmer will plant in the next season. Researchers and NGO staff encouraged farmers try different varieties to find out new varieties that could be suitable for them. All of these have implications for rice postproduction.

For activities like drying, some farmers say 'they are too busy' and prefer to sell fresh grains. Having different varieties may also mean farmers manage different grains at once and require effort to keep them separate. Possibilities for mixtures of grains can happen in different stages of postproduction particularly in drying. Moreover, farmers may not easily attain a bulk amount for a particular variety. This requires coordination with other farmers when using a 3-ton dryer. It also poses difficulties for marketing in bulk conditions. All these affect the socio-technical re-design process towards drying using flatbed dryers.

5.5.2 The learning alliance in the socio-technical re-design for flatbed dryer technology

The study found evidence that LA can support adaptation for agricultural technologies such as flatbed dryer. Technical and social re-design was facilitated at the same time (Figure 5.1) although this is not well elaborated in literature. First, literature on the establishment of dryers focused on the technical adjustments, particularly adaptations at industry level or the changes implemented by manufacturers during interactions with users (Douthwaite, 2002; Hien, 2009; Kyaw and Gummert, 2010). This was important in the Myanmar case in that manufacturers had to be in tune with what the users required, not only in the design and establishment but also during operation. This could figure into modifications although the unit used in Myanmar had already

been modified through the experience in Vietnam. Secondly, although impact assessments mention social factors which influence adoption (Ragudo, 2011; Pamplona, 2000), they do not elaborate on the process to make it happen. This study therefore highlights the social, organizational and institutional re-design. The re-design included formation of committees, drafting regulations, defining ownership, or scheduling of users, for example. Organizing for drying was also related to organizing for credit and storage and even bulk-selling. We emphasize therefore that 'adapting the flatbed dryer' requires coordinated social and technical re-design such that a supportive environment is formed for farmers to use dryers.

The case in Myanmar also shows the learning and adaptation which is happening in relatively short time. Without any coordination and facilitation, it would take time for various actors to shift back and forth between organizational learning and the technical modifications. As such, the interactions between various actors show how the learning agenda progressed when the different concerns were addressed. This resulted in many activities targeting re-design in a short span of time.

Elements of a self-organized process are evident. There were various synergistic activities which happened outside the initiatives of the project. This includes initiatives driven by community members and farmers themselves. For one, technical modifications to the design of the dryer was made by the local manufacturer. It is notable however, that the manufacturer is not one entity, rather a coordinator of various artisans. Furthermore, changing the selling arrangements, exploring alternative markets, bulking, or collective storage were also targeted in different learning activities. These show the progression of concerns coming from iterative learning cycles. Initiatives from the network emerged to create supportive conditions wherein the use of dryer would be beneficial and attractive to farmers.

5.5.3 Outcomes from a self-organized learning process

If the goal of a multi-stakeholder approach was only on the outcome of high numbers of users of the flatbed dryer, then it was not successful based on the findings after about two years. Instead, the approach can effectively support simultaneous learning about various necessary aspects of innovating with communities. Technology is

only one aspect, and the technology in question, in this case flatbed dryer, is one option which farmers could include in their repertoire as they address needs of the moment. What the process facilitated was instead learning about various ways in which farmers could obtain profit from learning about the tools and techniques to handle grains, collective ways to store and sell, and finding various options to get around constraints in marketing.

Some practices in the network did not change after about two years. Specific institutions that affect these practices would not change easily. The millers and traders, who provide credit to farmers for example, remained influential. NGO members of the alliance tried to change institutions around credit, but it was still at the organizing stage. Lack of financial incentives (from local markets) to produce quality rice was a major constraint. The price differences were too small and the experiences with positive outcomes were still limited to a few cases. Given limitations in control over price, risks of damage, labor scarcity, and need for cash on upfront payments, the 'needs of the moment' push farmers to sell immediately rather than dry and store. Many farmers based their practice on the specific conditions they encountered individually while they dealt with established institutions.

The limited number of users is a possible consequence. The reason is not only the institutions that have not changed but also the techniques of farmers to manage the produce. This shows that even if opportunities exist in the innovation system to support mechanical drying, it may still be that farmers will choose to sun-dry their grains. Farmers also expressed a need 'for more': more dryers, more farmers interested in bulking, more millers who know about benefits from sun-dried paddy. Not all of these were addressed by the alliance. In fact, there was more interest placed on marketing and obtaining good quality (from good seeds to grains), especially in the new agenda. The LA cannot guarantee adoption of flatbed dryers by farmers, however it can support learning to innovate around rice postproduction to try different options to change different stakeholder groups. What this does is support farmers who are willing to try different options such as new technologies, services, or markets such that they are able to deviate from the norm (Pant and Odame, 2009).

Inherent to the process is that outcomes would emerge which were not anticipated at the start. Facilitating a network approach resulted in supporting various learning agenda, but also entailed a balance of many often-diverging interests. This is the social learning and negotiation aspect (Leeuwis 2004). The LA provided a drive on the interest regarding the dryer, but with the objective to research its usefulness and sustainability. Farmers and the manufacturer in comparison, were interested to have more dryers in the area similar to findings by Ragudo (2011). Also, farmers who interact with private sector actors may engage on other interests like buying seeds and fertilizers which were seen with scepticism by other actors in the network. In such an open platform as the LA, who monitors these, who makes sure there is a balance of interests, and who pushes to reflect on initial outcomes from these new agenda is important. On monitoring, the discussions and reflection brought out topics which were built on what was learned from previous topics. Some topics continue to be unresolved, others proved how the options tried worked or not; the important part was these were reflected on and tracked.

Finally, a common call from those who have examined the adaptation and use of flatbed dryers is the need to engage various actors to address concerns in adapting dryers. This was what happened in the case examined in this paper. In comparison, another possibility is to leave the process completely to the private sector hoping it will work out as in Vietnam. The private sector in Myanmar has indicated interest to develop dryers in the country. An important difference however is that in Vietnam, the adaptation process happened within about 20 years, whereas it was less than 10 years in Myanmar. It is also important to note the difference in financial context. There were programs which supported loans accessible to farmers in Vietnam which were not available in Myanmar.

Literature on the Vietnam case shows how the industry picked up on the necessary adaptations during interactions with users. The Myanmar case shows facilitation towards self-organized adjustments at community level. It may be that a facilitated process leads to a different organizational model with ambition to be more equitable. The social part of the process was more complex in that communities had a say in decisions. Having NGOs in the network supports this process as shown by their

coordination where these type of activities were implemented (Figure 1). Examination on this type of research and development intervention shows the need for sufficient space and time for mutual learning to happen (Waters-Bayer et al., 2015).

5.6 Conclusion

The case of LA around flatbed dryers in Myanmar show the complexities of coordinating for adaptation and sustained use of a promising technology in a farming community. Rather than a top-down process of distributing equipment, a network was formed to engage with various actors. Their intended and synergistic activities generated a process of social and technical re-design.

This study found elements of a self-organized process initiated through the LA, wherein actors tried various social and technical adjustments. This shows the adaptive capacity of different actors within the innovation system. They learned to modifying the design of the equipment in order to make it suitable, which was important. This technical modification entailed making connections with various technologies around drying, storage, and seeds. Moreover, there was tremendous effort required to coordinate learning on the social, organizational and institutional aspect. Having a learning alliance supported the coordination of these activities so learning happens in a relatively short time. From all these, various initiatives emerged outside what was planned by the project. Some initiatives were driven by community members and farmers themselves.

The starting point of this paper was whether the process to adapt the dryer could be orchestrated in Myanmar following what was learned in Vietnam. Key elements such as a manufacturing industry with interest and capacity to produce and make suitable modifications, availability of technical options, and space to experiment on these were documented. Moreover, the process to organize users, sustained interactions between manufacturers and users, initiatives targeting change to institutions and markets were captured. These elements and the initial outcomes from them indicate a re-design is achievable and possible to coordinate. With data from the initial years of introduction, however, the study cannot make definitive conclusions regarding the success of this

process towards widespread and sustained use of the technology. It may be too early to determine outcomes on adoption by farmers and millers. Still, this approach should not be seen as a panacea to a speedy and widespread use of an existing fixed technology.

The process of re-design initiated at the village-level shows how different actors become involved in the learning and change process. The actors were not confined to village level only. Change was also targeted at various levels such as at the townships, and even at national level in wholesale markets. Having a multi-stakeholder approach through the LA enabled coordinated learning and adaptation from various levels.

Chapter 6

Adaptive Research with and without a Learning Alliance in Myanmar: Assessing differences in learning process and agenda[5]

[5] This paper is to be submitted as:
Flor, R.J., Leeuwis, C., Singleton, G., Maat, H., Gummert, M. Adaptive Research with and without a Learning Alliance in Myanmar: Assessing differences in learning process and agenda

6.1 Introduction

Agricultural research and development projects have been criticized for a lack of participation by local stakeholders; this limits adaptation of technologies to local conditions (Probst and Hagmann, 2003; Paris and Abedin, 2005). In response to this, research projects explore more inclusive approaches that aim to boost learning and adaptation of technology. In addition, it has been argued that agricultural innovations require learning beyond the farm level such that various stakeholders arrive at coherent practices (Leeuwis, 2004). Triggered thus by the need for effective facilitation of learning, empirical examination is required of projects that aim to facilitate learning through these approaches. This study examines the learning process started through two different approaches, Adaptive Research and Learning Alliances. We investigate the implementation of these approaches to understand whether and how they enhance learning towards innovation in rice farming communities.

Adaptive Research (AR) is a participatory approach which aims to make connections between on-farm practices, new technologies and the institutional context affecting practice such as policy (Hauser, 2008; Horne et al., 2000; Horne and Stür, 2003). In this approach, researchers design learning activities which explore technological solutions to on-farm problems. The technology is adapted together with farmers through these activities (Horne and Stür, 2003). The outcomes often feed into decisions for policy. This approach is more common in research projects and has been used as an extension strategy of projects.

In comparison, the Learning Alliance (LA) approach is not always linked with learning about technologies, but rather targets innovation networks to jointly identify, share and adapt socio-technical practices (Lundy, 2004; Lundy et al., 2005, Stelling et al., 2009). The approach is posited to improve collective learning for various groups, not only researchers and farmers (Lundy and Gottret, 2007). Projects use this approach to support coordinated change of practices among different actors at various levels leading to institutional change (Douthwaite et al., 2009). The approach is relatively new and not as widely used.

While AR and LA are different, the addition of a new approach or the replacement of a tested one raises questions regarding its added value. Such is the case for the International Rice Research Institute (IRRI) where historically AR has been used in projects. The question for project managers is whether the facilitation of innovation networks according to an LA approach, enhances learning that leads to changes in agricultural practices. It therefore merits a look beyond conceptual differences to untangle how these approaches differ once implemented in farming communities. Insights gained from this could enable better targeting of resources to support learning processes within research and development projects.

In Myanmar, a project was implemented to introduce improved cropping options to increase productivity in rice-based systems. The project linked farm-based research activities with the national extension system using the AR approach as its basic collaboration mode. Then, a Learning Alliance was added in one township to involve a broader network of stakeholders. It was expected that the LA approach would facilitate an effective learning process suited to improve coordination of socio-technical change. In comparing the AR and LA cases, we aim to answer these questions: first, how does the AR approach influence learning in the farming community; second, how does the involvement of a wider network of stakeholders (adding the LA approach) differ in terms of learning process for socio-technical change?

6.2. Conceptual foundations

While both the Adaptive Research and Learning Alliance approach are rooted in theories about learning, the emphasis and scope is partly different.

6.2.1 Experiential learning at farm level

Learning processes within AR projects are couched usually in the framework of Kolb's (1984) experiential learning cycle (e.g. Krupnik et al., 2012; Palis et al., 2011; Dorward et al., 2007). The framework directs attention to the learning process. The process has a cycle of four stages wherein participants create new knowledge (Kolb, 1984). In the case of AR, the first cycle involves managing a researcher-designed

experiment on a technology to address the identified problem. In the second stage, researchers and farmers reflect on the technology, discussing its effects on yield or total input costs. In third stage, farmers evaluate and decide on an adapted practice. Fourth, farmers experiment with this practice on their own. Once farmers prove through experience that such a technology works, they integrate the new tool or practice into their existing technological repertoire. This learning is then supported by activities that target policy stakeholders to support spread such a practice.

6.2.2 Expanding the frame with social learning

The idea of a Learning Alliance is that farmers operate in a broader social environment. When farmers learn about new technologies, they also require simultaneous learning with others about connected changes in the wider setting such as institutions or 'social rules of the game' (World Bank, 2006). This is congruent with Yardley et al. (2012), who posit that a social setting or situation exists where the construction of knowledge from experience happens; this connects experiential and social learning. Social learning is seen as essential because simultaneous learning of interdependent actors is needed to coordinate technological, social, economic, and institutional change (Leeuwis, 2004; Ashby, 2009).

From interaction, individuals may develop shared or complementary goals, insights and interests moving towards more collective cognition (Röling, 2002; Leeuwis, 2004). In this view of social learning, interaction allows individuals with separate understanding of an issue to form overlapping or shared understanding. Lave and Wenger (1991) defined social learning differently by putting emphasis on the social mobility that is connected to social learning. Within a Community of Practice (CoP) learners acquire not only knowledge and skills but also status and privileges that they can employ to the benefit of the CoP. Many of these practices are inherently technological, involving materials, tools, techniques and, in the case of agriculture, plants, animals and other live forms. The biophysical conditions and what tools and techniques are available enable and constrain what can be learned, puts limits to who can participate in a CoP and affects social mobility positively or negatively.

Social learning goes beyond the individual and focuses on interactions which lead individuals and groups to reflect on, and change perspectives and actions collectively (Keen et al., 2005). More importantly, it diverts focus from transfer of information processed through individual experience, to the interactive construction of meaning (Leeuwis, 2004). These are collective processes; thus differences with respect to access to knowledge and resources create particular social dynamics generated by the innovation process that require further examination.

6.2.3 Comparison of two models of learning

In this study, we analyse learning processes that emerge in the context of application of different approaches in a research project. Essentially, we compare two learning processes (models) as shown in Figure 6.1. One is on experiential learning process where interactions of specific actors are focused on technologies and on-farm experimentation (A in figure 6.1). Such cycles of learning may not necessarily follow the specified pattern, but the general idea is that observation, reflection and evaluation happen. These are geared towards creating an adapted practice (technology). This adapted technology is what the 'learner', in this case farmers, then integrate into existing farm management repertoire. For example, learning about a fertilizer management technique is aimed at exploring if farmers are willing to invest in inputs and how yields could be increased. The adapted technique is one which considers the varied realities of the farmers, and the goal of increasing rice production. During experimentation, farmers may integrate this technique with other techniques such as choice of variety, or irrigation management.

The other model of learning is one wherein the experiential learning about technologies takes place along with interactions from broader network actors (B in figure 6.1). Through these interactions social learning is expected to occur. In social learning, the aim is not only to adapt the technology and practices on-farm, but also to embed these practices in a wider social setting. The different actors form shared or complementary knowledge and goals, not only about technologies but also make changes in the social, organizational, and institutional aspects therewith extending the interactions to actors outside the immediate sphere of farming. Thus in the example of

fertilizer technique, the learning agenda that can be expected are not only related to tools and techniques on farm, but also on broader agenda such as credit, training, or improved seeds related to further enhancing the adapted practice.

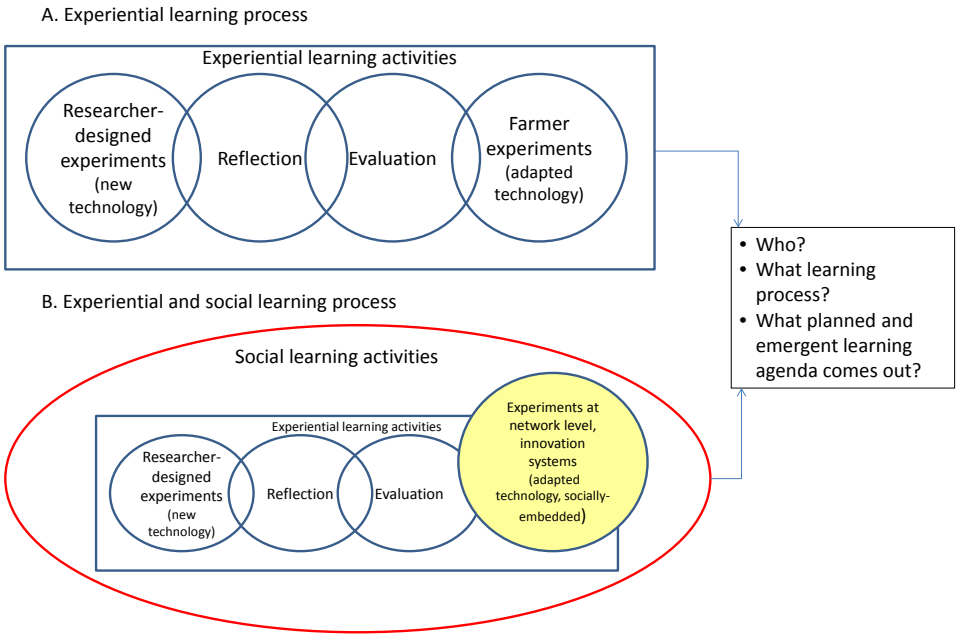


Figure 6.1: Comparison of learning processes underlying Adaptive Research (A) and Learning Alliance (B) approaches

To compare these learning processes, we focus on three questions. The first is who is involved in the process, including who is considered to be the 'learner' or who is making decisions on what is to be learned. The second is what is the learning process. This directs examination on learning activities, the actors involved and roles they play in supporting or steering learning, and how these interactions played out over time. The third question is on the learning agenda over time. The latter includes attention for the outcomes and lessons learned at a particular point in the agricultural innovation trajectory, and newly emerging issues for learning arising from these (Van Mierlo et al., 2010; Kilelu et al., 2014). Therefore it is not only on the expected learning topics but also emergent agenda.

We are interested to assess whether and how processes, networks and agenda differ with and without the LA approach, and what the prospects are in terms of the coordination of socio-technical change. The timeframe for data collection with respect to the implementation of the project entailed that outcomes captured were on the process and intermediate results. It is too early to assess development impact.

6.3 Methodology

We compare two cases where the approaches were implemented through a research project in Myanmar. Case 1 is in Daik Oo Township (17°37'49.5"N and 96°34'29.1"E), where solely adaptive research was used. Case 2 is in Maubin Township (17°37'49.5"N and 96°34'29.1"E), where the project had adaptive research and learning alliance approach. In both cases adaptive research activities ran parallel, while LA had additional activities in Case 2.

The sites are important in the context of rice production in Myanmar because they are both in the lower delta which supplies 47% of the country's rice production (MOAI, 2013). Some farmers from these areas experience seasonal flooding and pest infestation, which limit production, but in general use low chemical inputs (Naing et al., 2008). The two cases represent similar conditions wherein main cropping systems in the area is either rice-rice or rice-pulses.

Field work was done over two rice cropping seasons, in February-March (end of dry season rice or pulse crop) and November-December 2014 (end of the monsoon rice crop), aligned with the cycles of reflection from learning activities. Data were obtained from review of project documents, participant observation in project events, and semi-structured interviews with farmers and others involved in learning activities.

6.3.1 Data collection and analysis

A total of 119 farmers (landowners and non-landowners) were interviewed (Table 6.1). Interviews were done in two project villages each for Case 1 (Kyait Za Kaw and Pha Aung Kwe) and Case 2 (Nga Gyi Gayat and Nyaung Wine) (Table 6.1).

Landowner respondents were purposively sampled striving for equal representation of farm locations that are flooded or non-flooded, and those near or far from trial sites. The co-operators, who were farmers implementing field experiments on voluntary basis were also added. There were 14 co-operators in Case 1, and 8 co-operators in Case 2.

Table 6.1: Number of male and female respondents by category from Case 1 (AR) and Case 2 (AR + LA)

	Case 1 (Daik Oo): AR		**Case 2 (Maubin): AR with LA**	
Respondent	**Male**	**Female**	**Male**	**Female**
Farmers (landowners)	51	3	43	6
Farmers (non-landowners)	6	3	6	1
Manufacturers, artisans	2		2	
Service providers (equipment, labour coordinators, Agricultural bank)	1	3	2	
Input sellers (seeds, pesticides, fertilizers)	1	3	7	1
Research and extension staff	2	2	1	2

The first round of interviews captured experiences of farmers with the learning activities. The questions addressed farming conditions, cropping practices, involvement in the learning trials, observations from these trials, and what they planned to do differently. Farmers were also probed about knowledge of the technical topic, how the trial was experienced by farmers during implementation, how reflection came about, and whether practices were adjusted. Similar questions were asked of the same farmers at the end of the monsoon season (late 2014). All farmers were interviewed twice except those from Nyaung Wine where project activities have discontinued after the 2014 wet season. In this village, all respondents sold their land and were either no longer farming or farming only for household consumption.

The interview of other community-level stakeholders (Table 6.1) were geared towards understanding the interactions they had with farmers, arrangements governing these, and conditions posed by the wider environment around farming. They were also interviewed to explore how the project facilitated engagement with other stakeholder groups in the communities. Aside from community-level stakeholders, partners of the adaptive research project and members of the learning alliance outside Daik Oo and Maubin were also asked about their involvement, the implemented activities, the process of implementation as well as initial outcomes they observed.

Data from farmers on farm conditions and practices were collated into a data base and analyzed through IBM-SPSS 22. Qualitative and observational data were coded through Atlas.ti and analyzed along themes of involvement, observations from learning activities, interactions, changes implemented or planned, and initial outcomes.

6.3.2 The context of using AR and LA to support learning processes: Agricultural extension in Myanmar

Before we examine the implementation of both approaches in Myanmar, it is important to provide a basic idea of the national extension system of Myanmar, because both projects were implemented in a partnership with this governmental body. Moreover, many actors involved in the current project are linked in various ways with this system which therefore had an influence on the way the approaches were used.

In 1927, the Department of Agriculture (DOA) established the agricultural extension service which provided trainings, collected statistical data, enforced standards, and controlled distribution of seeds, equipment, fertilizers and insecticides (Cho, 2013). In the 1970s, as a spin-off of the traditional training and visit extension approach, the post-colonial government used a ‘selective concentrative strategy’ (SCS), an extension approach to improve rice yields (Win and Batten, 2006).The SCS relied on village extension staff who meet farmers to discuss technical problems and then arrange field visits and field demonstrations. It had five components: 1. Proven technology in simplified packages produced by researchers (e.g. Department of Agricultural Research or DAR) and extension agents; 2. Selection of and concentration in sites with promising

yield returns; 3. Centralized management operating through various government levels; 4. Involvement of local people for advice and implementation through organized committees; and 5. Learning by emulation and competition among farmers on who gets higher yields (Cho, 2013). The focus was on yield targets more than addressing needs of farmers (Aung, 2005). Extension activities were managed largely by centralized government organizations, particularly the Agricultural Extension Division (AED) under the DOA, which is part of the Ministry of Agriculture and Irrigation (MOAI).

In recent decades, national programs may have changed, but extension remains a prerogative of the government, which still operates largely on centralized control and planning (Cho, 2013). Also, even after the transition into an open economy, state control on the system of buying rice, decision-making on cropping system for agricultural areas, and land ownership remained the same (Fujita and Okamoto, 2006). State intervention is stronger where rice is concerned since rice accounts for 50% (while pulses only 20%) of all cropped area in Myanmar (MSU and MDRI, 2013). The national policies affect extension services as well as how projects are defined and implemented.

The emphasis on improved technology to enhance production still exists and remains to be a major drive for the extension system (Cho, 2013). Research and development projects engage with technological interests as entry point for collaboration. Adaptive research in the sense of exploring existing technologies with farmers is new in the social dimension of involving farmers as active agents that may steer the research. It is not new however, in the sense of testing available solutions from research, working with a government network, as well as its emphasis on increased production through technologies. Notably, government agencies have established ways to work together and have developed networks to reach farmers, but their linkages with the private sector are still limited (MSU & MDRI, 2013). In this context both AR and LA were implemented by the project under study.

6.3.3 Context of the farmers in the respective study sites

All farmers interviewed were from communities where farming is the main livelihood activity. The mean age of respondents was 52 years old. Most farmers have households with four members. The mean area cultivated by farmers differed slightly between the two cases. Farmers from Case 1 cultivated a mean area of 5.2 ha and 0.63 ha in monsoon and dry season respectively; while those in Case 2 had 4.3 and 1.25 ha, in the respective seasons. For both cases, 95% of farmers can cultivate for two seasons with either a rice-rice or rice-pulse cropping pattern. Of these, 3% vary their second season. They plant rice or pulse, or leave fields fallow, depending on availability of water. All of the sites are covered by the government extension services, as well as visited by private-sector extension staff, who focus mainly on the use (and selling) of pesticides and fertilizers.

Many of the farmers in both cases have diversified sources of income, particularly related to agriculture such as growing banana, betel, flowers, or vegetables. Others are involved as labourers in farms, carpentry, brick-making, or wrapping tobacco. A few farmers also mentioned remittances, having small shops, and renting their thresher or small tractors. Very few own livestock, and only one raises ducks for sale.

6.4. Results: Dynamics of learning in interactions for AR and LA

6.4.1 (2012-2013) Start of the learning activities: the problem definition phase

In 2012-2013, project activities started similarly for both cases in that the partners and activities were parallel. Only the AR approach was planned or implemented at this time. We examine the actors involved and how they made decisions on what learning activities were to be done in the sites. Then we discuss the process of starting-up the LA approach in Case 2 that began mid-2013. The agenda was the same for both cases at this stage.

Building a network for learning: involved actors and their roles

The actors involved in adaptive research were drawn from DOA, Department of Agricultural Research (DAR), International Rice Research Institute (IRRI), and farmers. It is important to note that, within these groups, there were smaller branch-agencies and individuals who had different interests and levels of connection with farmers. For example, The DOA has a national office with departments such as for plant protection or land use. There were interactions involving representatives from these offices. Moreover, the DOA had district and township level staff also involved in the project. At the DOA township level, extension officers were assigned in specific villages. The extension officers collaborated with an IRRI researcher based in the township (one for each case). The officers also facilitated direct links with farmers.

While DAR had no offices outside its national research station, it worked closely with the DOA and IRRI at the townships. IRRI researchers came from outside Myanmar; but there were also researchers based in Yangon, and researchers based in the community. The group of involved farmers includes key farmers or farmer leaders, and male and female farmers, all of whom were landowners.

The roles of the four actor groups involved in AR were defined beforehand. DAR together with IRRI provided varieties, gave technical advice on suitability of varieties, and assessed which trial should be conducted. The IRRI provided resources, technical expertise, and capacity-building support. The DOA extension staff coordinated outreach activities with farmers, and worked with the IRRI researchers and local staff as well as key farmers to manage the trials in villages. Some farmers volunteered to do the trials on their farms; they are termed co-operators of the project. Other farmers attended activities such as participatory variety selection, field visits or meetings, and provided feedback about the adaptive trials.

Shaping the learning agenda: translating diverging problem views

At the start of the project, there was recognition of challenges for those involved in rice production. The different actors highlighted several problems as important, whereby there was large similarity between the two case-study areas (Table 6.2).

Table 6.2: Actors in AR and their characterization of main challenges in rice production in 2012

Actor	Characterization of the problem	Key interest	Details
DOA	Low yields, lack suitable technologies; adjustments in cropping plan; labor scarcity	New crop management technologies/best management options; extension; capacity-building; research; *possibly: improved recommendations for farmers*	"Our main role is to transfer good agricultural practices to farmers"; "The DG is very interested in opportunities to train staff"; "For capacity building, the Minister wants students from Agriculture State Institute to become involved in research"; "...we follow (recommend to farmers) a cropping plan. "; "farmers lose profits because of transporting cut crop in flooded harvest time"
DAR	Farmers lack suitable varieties	Assessment of new varieties; seed production	"DAR is mandated to test and produce new rice varieties for Myanmar"; "...they indicated without prompting that we should select an intermediate duration variety (135 days) and that they have a few options to test"
IRRI	stacking leads to losses and poor quality; lack technology to shorten growing period or hasten postharvest activities (need efficient and profitable cropping patterns)	Research on rice technologies (e.g. what flexibility can varieties provide for monsoon crop?); Adaptive research trials; Dissemination of technologies from research	"...the main constraint in rice production is poor road access. Because farmers do not have good road access to millers, they stack their rice after harvesting and leave on the levee for 15 days while they prepare their land for the next crop. After sowing the next crop, rice on the levee is transferred to the place in the rice field for sun drying. They do not have dryers in both Townships"
Farmers	Unreliable irrigation (flooding and drought problems), financing (high input costs, credit, fluctuating selling prices), pest and diseases, harvesting during rainy period, poor soil conditions	Improve yield and profits; location-specific constraints like water, pests or labor; link with sources of information/ government	*Constraints discussed by Maubin and Daik Oo farmers in needs assessment:* lack of irrigation (at flowering period in monsoon and in dry season); financing (high costs); harvesting during rainy period; pest and disease (leaf streak, bacterial blight, army worm); flooding/heavy rains delay crop establishment; problems with credit and fluctuating rice prices; soil conditions

Sources: Interviews with DOA and DAR staff (2014), Trip reports (IRRI 2012, 2013), Needs Assessment Report (IRRI, 2012)

While there was some overlap and congruence in problem views (e.g. most actors have interest in farm-level issues affecting productivity, and both farmers and IRRI consider issues related to harvesting as important), there were also clear differences in emphasis. For example, DAR emphasized variety issues, while farmers were the only ones emphasizing market and credit constraints.

Photo 6.1: Stacking of rice bundles on the levee exposes the grains to moisture or flooding, and leads to losses in grain amount and reduction of grain quality. It also allows farmers to have time for land preparation of the subsequent crop; Photo by R.Flor

Researchers from IRRI and national organizations made decisions on key questions which were to be investigated in project activities. These decisions considered their perspectives of the problem, and to a large extent, the key problems identified by farmers. There also were constraints brought out by farmers that researchers deemed beyond the scope of the research project (e.g. credit, better drainage after flooding, fixed prices for rice and pulses, land consolidation). The researchers translated the remaining constraints brought out by farmers into a general problem: the lack of time to process the rice crop immediately after harvest such that farmers got poor quality rice, high losses, and low selling price. Doing this opened ways for various actors to reach agreement on addressing the key sub-problems. After completion of the needs assessment of farmers and meetings between IRRI, DoA and DAR, it was decided that Adaptive Research

would focus on three aspects. These were 1) suitable and shorter-duration varieties that could provide enough time for postharvest activities before the next crop needs to be established, 2) improved postharvest practices, and 3) crop management practices that could address floods (wet season) and drought (dry season), and generally improve yields of rice.

When researchers and DOA selected village sites, these were characterized to have specific cropping patterns, rice-rice and rice-pulse. These are however, general characteristics only and not all farmers in the village follow the same cropping pattern. Only one village, Nga Gyi Gayat had a homogenous cropping pattern for farmers (Table 6.3). This point on characterization is important because it had implications in what options researchers targeted for which sites, what strategies farmers employed, and how interested farmers were to learn about the trialled options.

Table 6.3: Characterization of village sites and mean area in ha (range) cultivated per farmer, by cropping pattern in the two cases from Lower Myanmar

Case and village	Characterization by the project	Rice-Rice	N	Rice-Pulse	N	Rice-Fallow	N	Rice – Rice/ Pulse/ Fallow	N
Case 1 (AR):									
Kyait Za Kaw	Rice-Rice	5.34 *(2.2-22.3)*	12	7.29	1	9.15 *(4.1-13)*	11		
Pha Aung Kwe	Rice-Pulse	3.67 *(1.2-5.2)*	8	3.52 *(1.0-12.2)*	17	2.23 *(1.6-2.8)*	2	5.47 *(2.8-8.1)*	2
Case 2 (AR+LA):									
Nyaung Wine	Rice-Rice	3.16 *(0.4-9.3)*	10	1.85 *(0.8-3.2)*	7			2.83 *(1.2-4.1)*	8
Nga Gyi Gayat	Rice-Pulse			6.14 *(0.8-40.5)*	23				

After site selection, researchers implemented benchmark trials. This is a data collection activity implemented in fields owned by farmers to obtain baseline information. DOA and IRRI staff contacted key farmers who were willing to

collaborate. The initial meetings were to present options of interest and to brief possible co-operators on key constraints brought out by farmers in a needs assessment. Technical options benchmarked were alternate wetting and drying (AWD), fertilizer management, four different herbicides, and direct seeding using a drum seeder. Through training events on postharvest technologies arranged by IRRI staff, government staff, key farmers and millers became aware of best practices for handling rice during harvest and the activities subsequent to harvest. The results of benchmark trials fed into decisions for AR activities in 2013-2014 (see Section 6.4.2).

Starting the learning alliance: expansion of the network in Case 2

With the addition of LA for Case 2, other stakeholders were invited such as landless farmers or labor providers, the Agricultural Bank, and seed producers. In addition, private sector actors in the community such as millers, traders, service providers and manufacturers of threshers and dryers were involved. One private sector partner, Pioneer Postharvest Development Group (PPHDG) based in Yangon, has interests on rice milling, manufacturing of dryers for rice, sales of agricultural machines and inputs, and corporate social responsibility (interview with MAK, 2015). In this wider network, the roles and activities were less clearly demarcated. IRRI researchers, who also facilitated the learning alliance, managed who were invited into the network. Involvement was on voluntary basis, depending on interest in the discussions and possible activities.

The first activity was a workshop in Maubin town where various stakeholders shared their perspectives of the underlying causes influencing why farmers do not get good profits from their rice crop. The facilitators decided the topics, including the general problem to discuss in the workshop. Stakeholders in the workshop broke down the problem to aspects that contribute to or cause it. They then discussed possible actions as well as existing opportunities to address the problem. They also analyzed who were the actors in the rice value chain in their community, and who of these needed to change to address the problem. At the end, they explored topics that the group was willing to learn.

In exploring options to target good quality rice for a higher price, the stakeholders encountered a conflict. Farmers brought out issues of 'millers controlling prices no matter what the quality' while millers emphasized 'farmers sell low quality paddy because they use mixed varieties in the first place' (workshop report 2013). Both groups did not trust that if their practices were different, the other would recognize it. After discussions, the stakeholders decided to look into improving quality by starting with good seeds and varieties, and improving postharvest management. Later on, they planned to examine how traders and millers would assess their quality rice and pay a price premium. Farmers also were concerned with the lack of time to manage the crop after harvest, and were thus interested in better threshers and easy access to them.

With the addition of LA in Case 2, farmers discussed with other groups beyond the immediate technical focus of the research. Research and extension stakeholders however, still had a strong influence on the topics. Initial topics of interest from the discussions were translated into threshers and varieties. Notably, these topics aligned well with AR activities.

6.4.2 (2013-2014) Moving from similar AR trials to a broader LA agenda

Similar learning activities under AR were implemented in both cases in 2013, one season after the benchmark trials. The technology options trialled were seedbed management, new varieties and improved fertilizer management. Assessment of grain losses in storage also was done at both sites. Participatory variety trials (PVS) of 12 varieties included rice varieties with potential for higher yields, drought tolerance and salinity tolerance. Researchers and DOA staff selected trial plots based on willingness of farmer, fit with the rice-rice or rice-pulse category, and accessibility or visibility of the site. The agreement with farmers was for them to volunteer to cooperate with the trial. The researchers provided support for labor, fertilizer, and pest management. The trial protocols were sent from DAR or IRRI. This means they also decided what activities would be implemented in the plots of the farmers and when. The farmer's role was field monitoring as well as some irrigation activities. At the end of the cropping season, researchers gave the produce from the plots to the farmer after research data were collected.

Experimentation through researcher-managed field trials

Field trials under AR for both cases were in the fields of farmers at the start but were managed completely by the local IRRI staff and DOA officer. Together with the farmer, they chose plots according to specifications of the trial protocol (e.g. 5 x 5 m, 8 m2). The size of the plots depended on how many varieties there were in varietal trials). Some plots had several treatments and replicates, which researchers separately measured. Then researchers managed the trial plots with input from farmers, hired labor for some activities, and obtained data. Their objective was to compare between performance of the 'new' technologies and a simulated farmer's practice. The trial plots were used as a demonstration field for seedbed management, new varieties and fertilizer management. Researchers implemented these trials in fields owned by different farmers.

At this stage, farmer groups had identified priority needs but the individual farmers who volunteered their land were not directly involved in the "benchmarking" activities of new approaches. Therefore, many of the co-operators said they 'did not know what was done in their fields', nor the details of the research trial (interview notes, 2014). Instead, the learning activities were focused more on capacity building for the local staff and the DOA officer in implementing field trials and obtaining research data (interview with IRRI and DAR staff, 2014). There were field days towards the end of each cropping season and researchers (IRRI and DOA) met with farmers at the end of each season to review results.

A shift to farmer-managed experiments: Increased involvement of farmers in learning activities

In both cases after the season of researcher-managed trial, the involvement of farmers increased. Again, researchers provided the overall protocol for the adaptive trials. In the farmers' practice plots, co-operator farmers made decisions and implemented activities as they normally would.

Photo 6.2: Sign on a trial plot demonstrating new varieties; 15 different varieties were planted with three replicates per trial; Photo by R.Flor

On the adjacent treatment plots, researchers made decisions on the technologies used, but this time farmers were more involved in implementing some activities. Researchers and DOA staff did many of the initial activities from preparation to transplanting, but maintenance of the field such as irrigation or pest management was done by the farmer when specified in the protocol. Some cooperating farmers said “the staff provided fertilizers in bags weighed according to the application protocol and left a list of when it should be applied” (interview notes 2014). The farmer applied these on the plots upon phone confirmation from the staff. Local staff also said ‘there were cases when the staff or DOA officer did the application’, and the farmer was not present or aware when it happened. Harvesting, threshing and recording data were done by the IRRI staff with hired labor. A few farmers helped manage labourers during the harvest and recording of data.

The still rather limited involvement of farmers in data collection, according to both farmers and researchers, was because ‘farmers were busy’ and ‘data collection entailed meticulous work over small plots’. One agreed activity for example was that farmers would irrigate their rice fields and record the level of water in the observation tubes for alternate wetting and drying (AWD) trial plots. This meant visiting the plot and recording data every 2 days from 20 days after establishment to the flowering stage. Meticulous data recording was also done during harvesting. Researchers had to

separately harvest plots taken from each treatment and each replicate. According to local staff (interview notes 2014), this involved managing harvested crop from 1x1 m sample-plots separately. Then researchers counted number of panicles per m2, filled and unfilled grains for 10 panicles, weight of organic matter from the panicles, and weight of 1000 grains from each replicate. After the data were collected the rice grains were given to the farmers with the rest of their harvested crop.

It was even more meticulous for variety trial plots. Researchers counted panicles and tillers per hill for 10 hills, plant height for 10 plant samples, panicle length as well as filled and unfilled grains for 10 panicles, and then recorded yield data and moisture content. This was done for each of 4 varieties for pulses and 13 varieties of rice. The lack of involvement by farmers in data collection resulted in delayed reflection by farmers and researchers on the results from the trial plots. Meetings with farmer groups to discuss the findings and to plan activities for the next season generally occurred at least 3 weeks after the harvest was complete because farmers were busy organizing their harvest and preparing their land for the next crop.

An activity where more interviewed farmers joined was the participatory variety selection. A group of male and female farmers met twice per season. First they visited the trial plots, assessed the varieties and voted on their preferred variety. In a follow-up event, they did a sensory evaluation of cooked rice then voted again on their preferred variety. Researchers consolidated and presented results to farmers.

Launch of Learning Alliance activities, Case 2

While adaptive research proceeded in Case 2, there were delays in implementation of the agreed LA activities. Farmers were to explore new types of threshers as planned during the first meeting; but this was postponed for two reasons. First, local production of the IRRI-designed thresher (trial unit) was not done as specified and the machine did not work. Second, importing threshers into Myanmar took time. The trials on varieties and seeds were linked with the AR activities. Learning trials on these were expanded into producing better quality rice through good postharvest management. While the initially planned activities were delayed, alliance members embarked on other activities (Table 6.4).

Table 6.4: List of LA agenda from 2013 to early 2014 with actors involved in the activity in Maubin, Myanmar (Case 1)

Activity	Actors involved
Sharing insights from variety trial (linked with AR)	AR trial co-operators, local staff, farmers
Discussion on quality standards, varieties, price	millers from Maubin, DOA, farmers
Meeting between farmers, millers and traders	farmers, millers and traders
Reflection activity on varieties and markets	
Exploring standards in wholesale market (Yangon)	
Miller trial (buy from farmers, good PH practices)*	PPHDG
Introduce lightweight threshers	IRRI, thresher manufacturer (Bogalay)
Work with local manufacturer in MMR	
Import units into MMR	

Aside from *, all activities were coordinated by LA facilitators from IRRI

As can be noted from Table 6.4, representatives from different groups, e.g. farmers, millers, manufacturers, took initiatives to gather for meetings and discuss relevant issues and technologies. Learning activities were implemented by different groups. Aside from related activities linked with AR trials, which have protocols, the LA members developed additional activities and reflection topics that were implemented as designed by those involved. At the start when the group decided to look into varieties, they depended on the farmers doing adaptive trials of varieties.

During the meeting to share experiences with varieties, farmers gave their observations of the plants or their suitability to specific agro-ecological conditions but had no idea about the yields because the data were being collated and processed by the staff. From AR activities, the local staff presented the top 3 varieties that farmers were interested to plant out of 13 choices. This opened discussions with millers and government members of the alliance who commented that of the chosen 3 varieties, Sin Thwe Latt was more marketable because the ‘millers know about it’, or ‘the government has opened possibility for export of this variety’ (LA meeting notes, 2014).

From these discussions, farmers decided what they planned to do next (e.g. some farmers were keen to try varieties recommended by millers, other farmers wanted to wait and were sceptical because of prior experience with planting hybrid varieties which were not marketable). Where there was involvement by other group of actors, millers for example, it was also up to them what they wanted to try, when they will do this, and how extensive the trial would be. One miller set-up a trial in collaboration with farmers, in which the miller bought fresh grains, then processed it using improved postharvest practices. The miller then milled the grains to assess the quality of the rice and the likely profitability for millers. This emerged from discussions between farmers and millers about the assumptions on quality of grains sold by farmers.

Continuing the learning cycle: observations and reflections from learning activities in early 2014

Prior to harvesting, DOA officers and researchers met with farmers during organized field days where trial plots were shown to the farmers. Once the data from various technology-trials had been processed, usually after the subsequent crop was planted, researchers organized meetings to report on the results from the adaptive trials. This was also a way for researchers to explain the trials. Ideally, farmers shared their comments, and decided what they implement next. This did not happen at the initial stages of the learning activities. In fact, only 17% in Case 1 (N=54), and 41% in Case 2 (N=49) had heard about the trials in early 2014.

The lack of reflection periods in adaptive research trials was addressed during the monsoon crop trials in 2014. Aside from the PVS events, more facilitated discussions were organised to share and discuss the outcomes of the adaptive research trials. Thus, more farmers became aware of what was happening in the experiment plots. Of farmers interviewed in late 2014, 54% (n=54) from Case 1 and 69% (n=49) from Case 2 were aware of the ongoing trials and project activities. For both cases, the number of land-owner farmers who joined activities was similar (27 farmers in Case 1 and 28 in Case 2). There were 3 non-landowner farmers who joined activities in Case 2.

Farmers involved in the trials recalled joining meetings to reflect on the outcomes of trials as well as plan their subsequent actions. Two co-operator-farmers in Case 1 remembered joining such meetings, and recalled that they were presented with results on yield. Farmers had a general idea of the trial such as that it is 'fertilizer trial' but could not reproduce details about treatments and comparisons (interview notes 2014). They felt they had no influence on what to try next. They said the IRRI and DOA extension staff suggested the trials and they just agreed. The extension staff also said they were not familiar with the exact protocols for some trials (interview notes 2014).

After the first wet and dry season of activities in 2014, farmers observed and discussed the trials. Most of their comments were on varieties (Table 6.5). They observed difference in yield, new techniques and how the trial was implemented. Farmers also identified related aspects that they would like to know more about, or indicated why they would not practice the new technique.

Local staff and extension workers arrived at some critical reflections regarding the design of the trials. These included that 'the positioning of the plots did not work for AWD trials', 'the weedy experimental side make my adjacent (own) field also look weedy (even if it is not)', 'farmers are not convinced with observations from small plots' and, 'farmers are concerned they cannot sell if they grow [this variety]' (interviews with local staff and extension officers, 2014).

In case 2, learning alliance members further discussed their observations from the experience of both farmers and millers. A miller shared the result of a trial where, even with good postharvest practice, paddy bought from farmers required additional milling because there were mixed red grains found. Grains had to be sorted and re-polished to obtain uniform white grains. With such impure paddy, the miller then calculated profits and showed how much profit was lost.

Table 6.5: Comparison of observations by farmers from learning activities in 2014 after the first wet and dry season for rice production in two townships in Lower Myanmar; AR = Adaptive research; LA = Learning Alliance

Category	Case 1: AR	Case 2: AR+LA
Varieties	PVS varieties were good but normal, not different from own field Liked HmawBi Liked Site Pyo Yay 1 (pulse variety) Liked Yezin 11, Yezin 9, Site Pyo Yay 1 (pulse) Liked HmawBi 2 Saw varieties for rice and pulse, don't know much about it	Sin Thwe Latt has good eating quality, many plants per hill, tillers; panicles look good Liked IR7754-90-111 Liked Sin Thwe Latt and IR7754-501 Saltol Sinn Htwe Latt was good: tall plants, good panicles; similar to own varieties Liked Saltol Sin Thwe Latt: suitable duration and fit with own area Sin Thwe Latt is suitable for the area; IR7754-90-111 has good tillers and panicles, and high yield Liked the second most-preferred variety (don't remember the name) Saw two promising varieties Liked one variety but Nan Gar is still best for own field Sin Thwe Latt and Sin Thukha performance was good Wants to try Manaw Thukha 2 variety for monsoon
Yield	In comparison with monsoon, summer trials performed better	High yield in trial plots
Techniques	Interested in grain purity and grain cleaner Regarding new variety: how much fertilizer and when? (wants to know; information is missing)	Some varieties would work in flooded area with tidal effects Knows seeds can be reduced by 1.5 baskets but still uses 3 - 5 basket; maybe it only works in small trial plots, too risky First time to use drum seeder (different from broadcast seeding) Good crop establishment: many plants despite low seed rate
Implementation	Do not know trial, not invited because don't grow summer rice PVS from monsoon different from summer PVS Did not see anything different or new Far from trial, only join with DOA activities	Only son and daughter joined, has not seen the trials Crossed trial plots but did not notice what was in it The meetings are informative: now farmers know they need pure seeds, and have machine options they did not know before Wants to join the preference analysis next time Liked the trial because of scientific method

Discussions between farmers and millers on quality requirements, variety preferences and pricing proceeded during learning alliance meetings. Millers not only shared the varieties and rice quality that were preferred, but also encouraged farmers to 'plant a variety which they can sell in bulk'. Notably, this contrasts with the common farmer's practice of using a variety suited to location-specific conditions, naturally entailing several varieties if a farmer had plots with varying conditions. It also contrasts with the practice of planting varieties with varying maturity durations to manage labor needs during the harvest period.

6.4.3 (2014-2015) Implementation of follow-up actions

Integration and expansion of learning topics

By end of 2014 the adaptive trials in Case 2 moved forward into integrating crop management technologies and practices with varieties. This was not the same for Case 1 where researchers and extension staff decided that more trials on separate technologies were needed. At that time, there were trials that were completely farmer-managed in Case 2, but again not in Case 1. The farmer-managed trials were specifically on varieties. Aside from seeds, no inputs or protocols were provided for farmer-managed trials, but researchers collected data on management practices and results.

In Case 1, topics that were considered important at first by researchers (for example, labor-saving through drum seeders) were later discontinued. This was because of lack of interest by farmers on the specific practice and adaptive research results. Subsequently, the adaptive research focus shifted to topics like varieties, weed management, and fertilizer management.

In comparison, Case 2 activities under the LA integrated topics of interest to the co-operator farmer (e.g. Sin Thwe Latt variety + postharvest + selling). Farmers implemented trials and activities on their own, and information on the outcomes were noted by the farmer and shared at the learning alliance meeting. Such integration shows the adaptation of the tool (variety) in terms of farming management. The integration also an attempt to adapt the tool along with socio-technical conditions such as market response. In doing so, a combination of post-harvest techniques were seen to be influential.

The LA had activities for learning about markets and seed sources. Farmers interacted with millers and traders at the wholesale market in Yangon and with a nearby seed farm. They also explored which varieties could be sold with a good price. From the LA activities in 2014, some farmers decided to produce Sin Thwe Latt variety with good quality to see if the price would be different. This activity integrated learning about the variety, some crop management technologies, postharvest practices and market practices. Interaction with farmers from another area, Shwebo, was also facilitated at the initiative of local IRRI staff and PPHDG. Shwebo is known as an area which produces good quality rice and the Shwebo Paw San variety is priced high in the market. The wholesale market in Yangon had no line traders specifically for Maubin or Daik Oo, but they had for Shwebo. The exchange with farmers from Shwebo was to learn from other farmers the integration of variety, crop management practices, market, and bulk selling. Farmers from Maubin also shared their experiences with the new technologies they had tried.

Photo 6.3: Farmers discuss with traders at a wholesale rice market in Yangon, on the varieties, quality, and selling price; Photo by R.Quilloy

Learning networks, interaction patterns and brokers involved in learning activities

In Case 1, there were two categories of actors interacting at village level, the researchers which included DOA extension staff and the farmers. The other adaptive research partners were involved tangentially during end-of-season meetings. There also was involvement from a manufacturer of dryer for rice (PPHDG) through a technology-demonstration event, but in general only researchers and farmers were involved.

There were changes in the staff assigned in Case 1 and many farmers said they were 'not familiar with the staff at all' or rarely saw them. According to the staff the relationship-building activities were different in each village site 'depending on the key farmers' (interview with IRRI staff 2014). They indicated that there were village settings as well as key farmers and groups where it was easier to sit down and talk. In some villages, the house or shed of a key farmer is a central meeting place where farmers often pass by and chat over tea or betel nut. Some of the important discussions between researchers or DOA and farmers about the trials were made in these settings. In Case 2, interviews with farmers revealed more interaction between local staff, DOA and farmers in the AR activities (interviews notes, 2014). Aside from field trials, farmers said they were linked through other activities such as seed production under a different project of DOA, sales of pesticides, or simply sitting together and discussing as friends. Many of the trial plots were in front of areas where farmers normally converge in the afternoon and evening. Farmers said 'the staff visited them even if there were no ongoing activities'. They also had facilitated interactions with groups such as millers, seed producers and manufacturers linked through the learning alliance. However, farmers did not interact with these actors as frequently as they did with the researchers. Thus, there were several communities of practice involved in the interactions but the frequency of interactions between these and the farmers were different.

In both cases, actors who had brokering roles established and orchestrated interactions between the different stakeholder groups. In this regard, these were some context-dependent differences per case, and notably the set of actors playing such roles was broader in Case 2 (see for details Box 1). In some cases, these brokers were beneficial in promoting activities by the project. In others, they also brought in diverging interests, such as trials of different technologies, or support for extension by pesticide companies.

Box 1. Influential actors working between different stakeholder groups

For the two cases, the extension officer was a common broker between local, national and international researchers and other groups. Due to its government mandate, the DOA had strong linkages with the Agriculture Bank (Agribank), with farmers as well as with private sector. It thus had an influential role. The officer can for example recommend and provide seeds of new varieties coming from the government, whether these had been trialled through AR activities or not. Moreover, products such as pesticides and fertilizers were part of the interactions between the officer and farmers. Farmers commonly asked them about these products. In some cases, they were the source of these products.

The officer also coordinated arrangements for credit, irrigation and even transplanting. The release of loans from the Agribank was contingent upon signing of the officer of the list of farmers who were planting rice for that particular season. The bank then released loans to the farmers in that list. Because of its low interest loans (0.75% per month compared with 8% from private lenders), 99% of the farmers interviewed obtain loans from the bank every season. The loans are limited to 100,000 Kyats (about 100USD) per acre for each cropping season. Farmers who rent land or are landless cannot avail of the credit. Aside from the limit on amount, there was also a land area limit; the Agribank only gives credit to farmers with 10 acres or less. Farmers with more land can still obtain loans but only for 10 acres per individual family member. These are all as certified by the extension officer. The officer moreover coordinated with the irrigation department on the release of water such that it synchronized with the cropping schedule. A difference can be observed in Case 1, where the officer also certified transplanting groups. This labor service-provider group, usually non-landowner farmers, obtain training and a certificate to operate in the villages.

The local project staff was another broker that linked farmers and researchers. The staff administered the protocols and trials in plots, summarized research data, as well as convened farmer meetings. These supported the connection between research practice with that of farmers, and promoted the recommended technologies for farmers. The staff facilitated links for farmers to other stakeholders like miller and manufacturers. This miller was trained to construct flat-bed dryers and has been manufacturing dryers in Myanmar since 2002. Through this contact in Case 2, manufacturers and millers are invited to learning alliance meetings. This contact also facilitated meetings with traders and entry into wholesale markets in Yangon. The staff also supported the tracking of adjustments in practice of farmers through farmer diaries.

Co-operator-farmers brokered between the farmers and other groups. These farmers use their farms as well as the plots to convey their own reflections and recommendations. Some of them were seed producers or retailers of pesticides and fertilizers. They also used these objects to convey specific messages which may or may not be related to the learning trials by the project. These farmers obtained training and technical support from DOA as well as input companies. In some cases, they also get support for fertilizers and pesticides.

A few millers and manufacturers involved in Case 2 brokered between the farmers and the private sector. In the interactions, they use market practices and quality standards as a discussion tool to create connections between themselves, researchers and farmers. From these interactions farmers were able to use the existing connections of these private sector actors to link with other market actors, or obtain seeds and inputs.

Emergent adjustments of practices and learning agenda for 2015

An examination of what co-operators (farmers who volunteered to implement AR trials) said they would do differently shows how farmers are still planning to do their own trials after three seasons of seeing these technologies in experimental plots (Table 6.6). Also for both cases, there were co-operators who had no plans to adjust any practice. While farmers (not only co-operators) have signified interest in trying some new varieties, sourcing seeds was still a concern. Most farmers (76%) use their own seeds for about three years. In 2014, eight farmers from Case 2 used seeds that they sourced from seed farms linked through the project. None of the farmers from Case 1 did this although there are seed farms nearby.

Table 6.6: Comparison between Case 1 and 2 of what co-operators will do differently after WS 2014: Data from co-operator farmers in Lower Myanmar

Case 1: AR	**N**	**Case 2: AR with LA**	**N**
Own trial for 2 varieties (2.5 acres)	1	Grow local variety in half the field to test if seed is adaptable	1
Own trial Yezin 11 (1.5 acres), and Yezin 2 (1 acre)	1	No plan for monsoon; for summer crop plans to use drum seeder for 5 -6 acres, because with it he can manage weed problem, with less density more tillers	1
Own trial for Yezin 11 and Yezin 9	1	Test Yezin 2 (< 1 acre) to compare with own variety	1
Nothing because yield is same as local variety	2	Wants to test some varieties; noticed that having fertilizers is better than no fertilizers (not Foliar only) for pulse (rainfall at seedling stage still a problem)	1
Nothing	7	Use good seeds	1
		Own trial for pulse	1
		Nothing	1
		Plans to store to wait for higher price	1

In Case 2, another adjusted practice reported was not technical but relating to trying new forms of interaction with millers or traders. A similar reflection emerged in

the LA discussions (Table 6.7), where a number of topics and concerns were raised and put on the agenda. Clearly, these issues were interlocking in various ways; for example, seed purity and variety are related with market and price concerns.

Adjustments in technical practices of farmers regarding seed rate, use of raised seed bed or separate nursery, fertilizer use, varieties, use of threshers, as well as market practices were examined. There were no significant adjustments measured at farm level due to the introduction of the technologies. One example is regarding varieties. There were new varieties (e.g. Yezin 2, salt-tolerant/Saltol Sin Htwe Latt) but these were not the ones planted in the largest parcel of each farmer. Lastly, not many farmers had tried some of the new tools introduced such as threshers or drum seeders. Only 1 respondent farmer had tried new thresher model introduced. In summary, by 2014-15, farmers were still experimenting in plots but not in larger areas on their farms.

Table 6.7: Activities planned and concerns discussed by the Learning alliance in 2014 (Case 2:AR with LA), from farmers in Maubin, Myanmar

Activity to try for the coming season	**Concern/s**
Produce pure seeds	Available seeds for farmers, market price for new variety
Use the tools (e.g. drum seeder)	What are the tools/machines suitable for the technique? Money to buy equipment Needs skilful labor
Market	Safe credit support (risk with fertilizers bought on credit) No fixed market for the harvested crop
Plant Sin Thwe Latt variety	How to control leaf rot disease (in times of heavy rain?)
Trial of varieties suitable for area	Different soil types (different farming systems)
Establishment methods	How does it work for different land level and soil type
Which fertilizer should be used	How to do this? Need to learn the techniques
Herbicide/pesticide trial	Need to learn (knowledge to care for new variety)
Transportation from field to home	Poor transportation; still a problem
Thresher (fast, can finish threshing crop from 5-10 ac/day)	Not enough time for threshing in short period and for sowing pulses

6.5 Analysis and discussion

We compared the case of AR-only with AR plus LA approach to know how AR influenced learning and how the involvement of a wider network (adding the LA approach) made a difference in learning processes. We found that AR facilitated strong interactions between two stakeholder groups, researchers and farmers. This entailed a process of learning through demonstrating and explaining technical knowledge. There was focus on farmer as the learner in this process. Experiential learning by farmers was however limited. The addition of LA approach brought in more stakeholder groups in the interaction and created visible differences in the learning process. The interaction of varied stakeholders with differing interests broadened the discussions into concerns around socio-technical adaptation as shown in Tables 6.6 and 6.7. The agenda were not only technical concerns but also innovation system issues. The interactions depicted how the learner was not only farmers but also different stakeholder groups such as millers, manufacturers, or seed producers. There was more experiential learning as demonstrated in the reflections of farmers. The broader network in the case of AR with LA supported experiential and social learning wherein varied stakeholder groups brought their insights into the learning activities. These led to differences in the learning agenda between the two cases. Looking further into the results of the interactions, there are indications that learning through LA increased potential for innovations at community level.

6.5.1 Differential learning agenda

Over two years, there were important differences in the learning agenda between the two cases in Lower Myanmar. A summary of how the different topics were linked together for both cases is shown in Figure 6.2. The LA took on the topics and agenda of AR, and expanded these into other agenda and issues outside field trials. The use of the LA broadened the learning topics in Case 2 when compared to Case 1 where AR only was implemented. Case 2, AR+LA, not only tackled a greater variety of technical issues and topics, but also expanded the learning into institutional topics such as standards, markets and collective action.

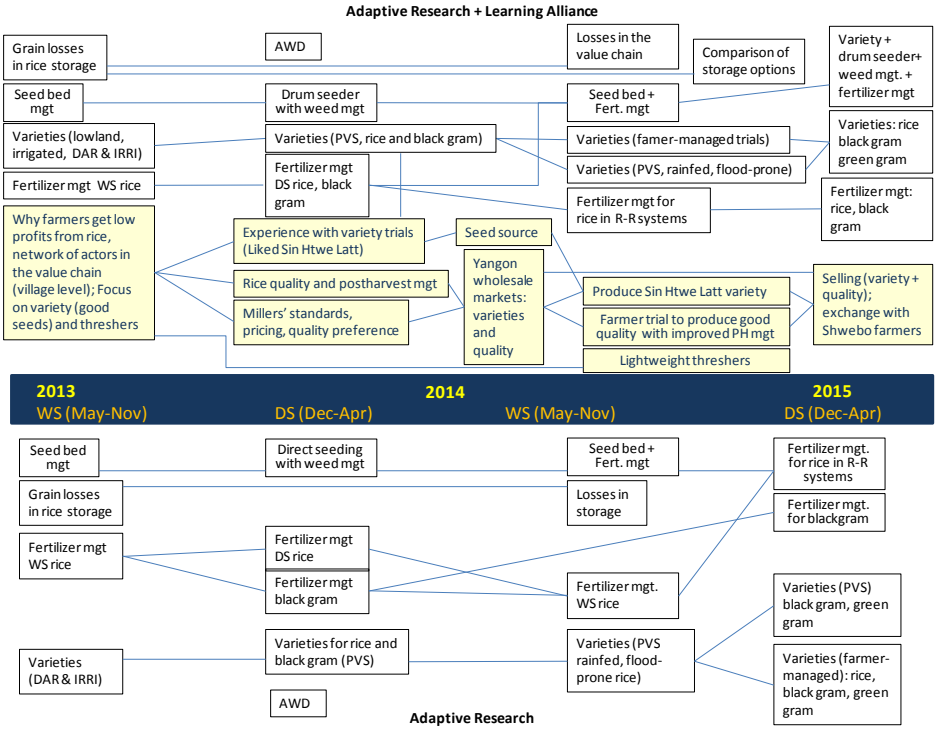


Figure 6.2: Comparison of learning agenda between Case 1 (Adaptive Research) and Case 2 (Adaptive Research with Learning Alliance) from 2013-2015 in Lower Myanmar

6.5.2 Differential networks and interaction patterns

Findings on the learning process point to important differences in the network formation between the two cases. In Case 1 with AR only, there were fewer actors and stakeholder groups involved. The main organizations in the network have defined roles and contributions. The hierarchy for making decisions on activities was defined through the roles assigned. This interaction pattern perpetuated top-down decisions on 'what was to be learned', more than promoting experiential learning. This limited the space for farmers to define their adapted techniques based on the varying realities conditioned by their biophysical and material environment.

In Case 2, with LA, more actors representing different groups were involved extending interactions beyond the immediate CoP of farming. Some of these actors brought in their own networks and thus expanded the groups with which farmers interacted. Notably, facilitators from the project had lesser control and planning on who became involved compared with Case 1. There were more opportunities for other actors to steer learning towards topics of interest to them (Table 6.2).

The interactions brought out tensions in the form of diverging perspectives and views. With AR, these tensions were limited to technical topics and implementation of the trials (e.g. yields were no different, experiment plots were small, or activities were time-consuming and meticulous). Researchers wanted to convey specific messages through the trial plots but farmers also convey that the plots did not satisfy their methods for learning. In Case 2, different viewpoints regarding government-recommended varieties, millers' preferences, market practices or pricing based on quality were discussed alongside technical concerns. When researchers introduced new varieties, farmers observed the plant's performance on-farm. They also had experiences about recommended varieties, which buyers did not prefer. Through interactions with the wider group including millers, they explored whether there is market for such type of grain. Although there was tension in scepticism regarding diverging interests and government recommendations, these interactions supported learning. The learning target was to assess which variety (technology) is suitable for their farm conditions, could give acceptable yield results, and produce grains that farmers can sell at a good price to millers.

6.5.3 Limited ownership and attention for experiential learning in AR

In general, there were two points where decision-making is crucial in the learning activities: deciding on the topics of interest, and deciding who will implement and how these will be done. These moments were recurring throughout the project. Contrary to studies where learning from AR is described to emerge from the accumulation of experience, the AR implemented in both cases studied did not structurally emphasize experiential learning by farmers. Typically, experimentation was researcher-led and the involvement of farmers in the design, monitoring and evaluation

of trials was limited. Thus, experiments influenced learning through the brokering activities of local staff and DOA rather than through self-discovery.

These findings on learning process concur with studies that highlight the effectiveness of learning where there is more experience and ownership of farmers (Kouevi et al., 2013, Krupnik et al., 2012). Translation of the approach by local implementers was an important factor. Implementers of AR had varied assumptions on what the activity was for and prioritized data collection and management more than involvement and learning of farmers. Thus, the level of involvement of farmers in AR for both cases was rather low even if there were plans to increase this. Limited participation was not the only issue since attention to the quality of participation was also important (van de Fliert et al., 2010). If farmers were involved only to accept information, with limited space to experiment and make socio-technical adaptations, then the involvement will not support learning.

In another case of AR from Indonesia, implementers were more aware of participatory engagement with farmers, and engaged farmers better during implementation of the trials (Flor et al., 2015). Thus, where farmers were more involved to make their own observations, they have higher knowledge and more modifications on the technologies. Clearly, the introduction of participatory research approaches in an environment where people are used to top-down approaches requires a learning and adaptation process of its own.

There are indications however that in Case 2, where the LA was added, the degree of involvement and ownership of stakeholders increased more rapidly. Some members of the alliance started more quickly to define their own activities, trials, and agenda based on the reflections from the previous learning cycle. It resulted in agenda where specific technologies were integrated with other learning topics. In Case 2, learning about the performance of a variety on-farm, producing quality grains from it through better postharvest management, and observing how this would sell in the market was one integrated agenda (Figure 6.2). In contrast, where only researchers and farmers interact, the agenda was kept to on-farm technical concerns because these were topics of interest to the CoPs involved. This shows the LA can help to address limitations in

support of learning, concurring with other studies that highlight improved multi-stakeholder interactions (Hounkonnou et al., 2006; Lundy, 2004; Stur et al., 2009).

The manner of implementing the learning activities reflects an apparent difference between the two cases. This relates to the targets in terms of level of explicit and tacit learning. Where AR activities were concerned, the protocols, data collection and other systematized way of capturing differences between the experiments point to a targeting of explicit learning. This learning was collated and shared by researchers to farmers. Within the LA, various groups designed and implemented activities without pre-specified manner of implementation and documentation of learning. The implementation resulted in tacit learning, for example learning about the milling process of grains bought from farmers. It was then a challenge to share these in a way that the other groups, for example other farmers, would understand.

As seen in figure 6.2, the LA developed its own agenda over time, even if it was implemented as a tool in support of adaptive research. This resulted in other initiatives, which were not planned at the start of the project. There is also evidence of farmers defining their own agenda in Case 2, much more than farmers from Case 1 as seen in Tables 6.6 and 6.7.

6.5.4 Indications of outcomes towards successful innovation

Emergent outcomes from the cases point out more outcomes in Case 2, where a broader network was involved. There were more initiatives from various actors; showing how they are exploring possible adjustments to address their needs. Some of these included the creation of an enabling environment around the tools and practices tried on farm. The benefit is in building of skills towards adapting to various biophysical, material, social, and institutional concerns in their environment. This is important in light of findings about innovation that stresses the importance of co-production of knowledge from various actors towards simultaneous technical and social change (Roep et al., 2003, Leeuwis, 2013). In Case 2, we also found a greater emphasis on the combination and integration of different options by farmers. These indicate potential for longer-term outcomes enhanced by the greater degree of ownership from a more open learning process.

6.5.6 Limitations

Our findings are based on a comparison of only two cases, which implies that we need to be very cautious in drawing conclusions about the added value of Learning Alliances. While the projects in the case-study areas were carried out by the same organisation, by the same international researchers and under very similar ecological conditions, there could well be differences in the historical context and/or local people involved that have shaped the differences that we have signalled above. Nevertheless, the kinds of differences we find are largely congruent with the processes and objectives strived for by proponents of Learning Alliances and the shortcomings of participatory research activities that only address locally-specific technical issues (Hounkonnou et al., 2006).

6.6 Conclusion

In this article, we examined the dynamics that emerged in the context of a project using different approaches to enhance learning and adaptation of rice-farming technologies in Myanmar. We compared a case where the research organisation used only Adaptive Research with another case in which the same organisation combined Adaptive Research with a Learning Alliance. We tracked the learning activities that took place, the actors involved and the role they played, as well as the learning agenda that evolved over time. These were done with the view of assessing how processes, networks and agenda- differ with and without the LA approach, and what the prospects are for coordinating socio-technical change.

Our findings suggest that the AR approach was useful in building bridges between farmers, research, extension and the specific context of rice-farming in Myanmar. The interaction led to a largely research-led mode of learning about agronomic processes through engaging farmers in experimentation and demonstration plots, implementation of protocols, discussion of technologies, and/or presentation of research data. This approach supported explicit learning and adaptation evidenced by an evolving technical learning agenda and reflection of farmers on agronomic adjustments. The way in which AR activities were implemented was not optimally conducive to

experiential and discovery learning, and there were indications that trials decided upon by researchers did not always match with farmer's context and interest.

The inclusion of LA in Case 2 expanded the number of stakeholders with whom farmers interact. With this broader network, the learning agenda also expanded out of the initial concerns or interests targeted by the project. Initial outcomes show faster integration of socio-technical concerns, highlighting how LA can support both social and experiential learning towards building capacity for innovation.

Although having a Learning Alliance had added value in linking technical and socio-institutional innovation, and fostering self-organisation with broader agenda, it is not a cure-all solution to making research more inclusive. There certainly remains scope for improvement in several areas. The greater autonomy and informality of the learning process implied that lessons were not always explicated and shared. This may well have led to learning agenda that fit only a specific segment of farmers. Moreover, the follow up on learning experiences could probably be more systematic and strategic. Nonetheless, reducing control from the research side and allowing a wider set of stakeholders to engage and guide the agenda and flow of learning is likely to be conducive for aligning interdependent stakeholders. This will support the creation of an enabling institutional environment for the uptake of technology.

Chapter 7

Main findings and general concluding discussion

7.1 Introduction

This thesis is an examination of the dynamics with which adaptive research (AR) and learning alliance (LA) approaches, implemented through research and development projects, stimulated socio-technical change processes. It is also an exploration of the extent to which the approaches influenced innovation outcomes in farming communities. The research objectives were to 1) understand implementation where projects use the approach, 2) examine learning and change outcomes at various levels where the approach was used, and 3) determine whether the engagement of broader networks would matter to the learning and socio-technical adaptation process. I examined multiple case studies of projects wherein the International Rice Research Institute instigated these approaches in Indonesia, Cambodia, and Myanmar. The selected cases covered different projects, varied implementation contexts, and a range of technologies disseminated. These allowed for investigation of how and to what extent the approaches influenced change processes.

In this final chapter, I will sum up findings from the case studies elaborated in *Chapters 2 to 6*. These will be brought together in a discussion on variations in assumptions and articulation of the approaches that affected activities and composition of networks engaged. Furthermore, I will discuss cross-cutting issues with a focus on the added value of engaging broader networks. This chapter closes with reflections and recommendations for implementers and facilitators on how to implement and monitor multi-stakeholder projects.

7.2 Overview and discussion of main findings

7.2.1 How did Adaptive Research shape outcomes?

Chapter 2 set the scene for this thesis, with an examination of the AR approach, which had been used in different forms by projects at the IRRI since the 1990s. The approach was implemented by a fixed group of institutional partners from research and extension systems, together with cooperating farmers. The implementation of AR provided space for farmers to experiment with various options and fast-tracked technical adaptations of suitable technologies, within a two-year time frame. Farmers

demonstrated improvisational capacities through manufacturing tools associated with recommended new practices, modifying practices to integrate technologies with existing practices and generally dealing with changing or uncertain conditions.

There was evidence of interest, uptake of new knowledge, and adoption by farmers of the various technologies introduced. These findings concur with other studies that also found successful technical adaptations from researcher-farmer collaborations (Krupnik et al., 2012; Rejesus et al., 2011). Significant constraints in the social and institutional aspect however, were found in the case studied. The implementation of AR, missed specific aspects that were important to expanding outcomes toward innovation.

AR implementation did not address issues pertaining to facilitating change in social organization and institutions, such as conflict resolution, involvement of local manufacturers, and coordinating collective action. Lack of inclusion of service providers as well as local leaders and policy agencies maintained institutions (formal and informal rules and arrangements) around access to water and chemical inputs. This resulted in lack of simultaneous technical and institutional re-design.

The findings depicts how re-design could have been supported if a wider network of actors outside research and extension were engaged to support change processes. Literature on AR often take these aspects of the re-design as contextual factors which falls largely outside the scope of AR activities (Palis et al., 2007; Sudarmaji et al. 2010). By examining it in a systems perspective, this thesis shows re-design aspects which implementation of AR could aim to influence. Therefore, AR can enable interactions that support adaptation of 'the tool' (technology), but its monitoring generally renders invisible the adaptations required regarding social arrangements and institutions.

7.2.2 How was the Learning Alliance implemented and to what outcomes?

In 2008, a relatively new approach, the LA, was used at IRRI to support wider spread of technologies (Figure 1.2). *Chapter 3* explored the application of this approach, showing how implementation (mis)aligned with assumptions from project implementers and from conceptual literature of the LA approach. The national-level LA in Cambodia

was implemented by engaging more actors of varied stakeholder types from national to community levels. Its implementation started with building a network around specific technologies from research, with interest in extension. Technology was thus a driver of activities in this network. These findings highlight the divergent threads within LA literature regarding scaling out 'best bet' technologies versus focus on mutual co-innovation (Ferris, 2005; Moriarty et al., 2005; Douthwaite et al., 2009). In the case of the Cambodian LA, the implementers used the approach to scale out specific technologies at first, although there were changes to these focus technologies later in the implementation.

The LA network expanded after three years to include actors from various stakeholder groups including the private sector (millers, manufacturers of rice postharvest equipment), as well as non-government organizations (NGOs). LA also supported emergent network dynamics such as change in roles and informal linkages with small network pockets. These intermediate outcomes were made possible because of interactions with varied types of stakeholders as well as increased capacity of actors such as key farmers, manufacturers, millers and service providers. The intermediary outcomes in turn, supported institutional change such as change in quality standards, that further promoted awareness and stimulated support for technical change. Notably, the institutional changes were aspired for but were not anticipated at the start of the implementation.

Despite the initial focus on technology, there were various emergent outcomes. Some outcomes were produced by project-supported activities but others came from activities of network members without direct intervention from the project. An example of this is the services provided by key farmers to millers, which created support for mechanized drying.

Findings from this chapter regarding outcomes not tracked by the project show that when LA facilitators emphasize scaling out specific technologies using the approach, project implementers miss supporting important emergent agenda. More importantly, I found evidence that a network with broad stakeholder base such as a LA network can support shift in technological focus from the initial research-directed

decisions. Not only did material technologies of interest change (e.g. from hermetic storage and dryers to many other post-harvest technologies), but new agenda also emerged (e.g. certification, interaction with banks). These were explored by the network even if not intended or foreseen. Learning was not only on material or technical issues but also on enabling conditions in the social domain. Engaging a broad network therefore allows correcting mechanisms that redirect focus and interest based on the issues encountered by different actors in the network. From this chapter I conclude that a LA approach can promote actor-network processes which target social, technical, and institutional re-ordering.

In *Chapter 4*, I further examined how a network organized at a national level influenced change at the community level. Actors from the LA network engaged small groups at the community level which led to reconfigurations between technologies and supportive social arrangements. The study found limited use of combine-harvesters and dryers but with visible changes emerging. These indicated potential for innovation in communities.

Two cases were compared where the LA linked with community-level actors around rice harvesting and drying. Actors responded differently to new technologies (mechanized harvesting and drying). The differences were based on activities and priorities of the small groups involved. These groups in turn responded to different concerns and made varied adjustments such as coordination for combine harvesting, modifying machines to fit local needs, and bulk selling arrangements. These speaks to the processes in groups found in other studies which show the way group cultures operate, and respond to, challenge or change institutions thereby creating culture change (Fine and Hallett, 2014).

Influences from a wider environment affected two cases similarly; such as the response of millers towards meeting quality standards and government emphasis on exporting rice. The rise of service providers, changes in standards for quality rice, and buying practices of millers influenced how other actors in groups became interested or not in mechanized harvesting or drying technologies. I conclude from the findings that a LA network, which engages effective small groups in communities, can provide impetus

for change at the community level. The changes which happened at community level were not because of the LA alone but rather the interests pursued and conditions faced by small groups. The small groups were an important locus in which socio-technical adaptations were steered and negotiated change at the community level. Influencing and supporting these dynamics can stimulate change.

In *Chapter 5*, I captured how a learning alliance approach was used to stimulate a self-organized process at the community level to establish flatbed dryers as an innovation. Building on the literature on the development of flatbed dryer technology, the network that was involved and the flow of activities to affect a learning process was documented. The network and process showed that coordinating the innovation process around mechanized drying in Myanmar was possible through LA.

The LA implemented varied learning agenda through different groups in the network. In effect NGOs, research and the private sector actors simultaneously funded and implemented activities and experiments with farmers. The village-level alliance targeted knowledge change of different actors such that technical adjustments, social-organizational changes, as well as changes in institutions that affect rice post-harvest practices were stimulated. Their intended and synergistic activities generated a process of social and technical re-design. This adaptation process happened through learning by different actors which can be coordinated when they interact through the LA.

If the goal of the approach was only to increase the number of flatbed-dryer users, then it was not successful based on adoption findings after about 2 years. Some literature on flatbed dryers have pointed out that use of participatory methods could help address adoption issues (Ragudo 2011). This study shows the process is more complex than merely allowing farmers to experiment with the equipment. It echoes findings from other studies that changes in terms of various innovation system actors and components are required to create the enabling conditions for farmers to change (Leeuwis, 2004; Roep et al. 2003). Furthermore, even when the different actors start experimenting towards that change, it may not happen immediately.

This approach therefore should not be seen as a panacea to a speedy and widespread use of an existing fixed technology. This finding further emphasizes the findings from Chapter 3 regarding focus on a best bet or fixed technology in the use of LA. The approach is better used as a tool to support simultaneous learning about various necessary aspects of innovating with communities. Advancing a new technology is only one aspect, and the technology of interest, in this case the flatbed dryer, is only one option which communities could explore to address their needs.

7.2.3 Was there added value in engaging a broad multi-stakeholder network?

Chapter 6 is an investigation of how the learning process would differ if a LA was added to AR compared with AR only. Observations in both cases revealed different networks involved; with LA having a broader set of varied actors outside research and extension. Findings also showed how the learning agenda differed significantly between the two. The involvement of a LA created differences in the learning process as well as outcomes.

Although slightly varied between the cases, AR was observed to facilitate explicit learning on technologies. This learning revolved around research-oriented topics and was accomplished through demonstrations and experiments in the field of farmers. This case showed that the translation of AR wherein farmers did not have enough space to experiment on the technical options resulted in limited outcomes on knowledge and technical adjustments. Thus the translation of the AR approach which does not support experiential learning hinders capacities of farmers to include the new knowledge in their repertoire to 'perform' in the face of diverse farming conditions as discussed by Richards (1989). This limits the adaptation of new technologies.

The case with a LA had a broader set of activities with a wider network of actors. The learning activities were not only about technologies but also included experimentations on a supportive environment for the access and use of technologies. The agenda included topics such as markets and other topics that could support institutional change. The learning process was not always about explicit knowledge on technical or on-farm concerns. Such learning process was done in a more informal manner compared with the experiments facilitated through AR.

In comparison, there was faster integration of socio-technical concerns where a LA was implemented. This shows technical adaptation, but also is an indication of learning on the social and institutional aspects required to establish the technology. This developed along with increased ownership of technical trials by farmers. Various emergent outcomes were generated because of interactions of farmers with other innovation system actors who shared the demands and standards from outside the farms. Hounkonnou et al. (2006) also emphasized these wider network dynamics alongside technical changes are important to enhance the results from participatory research.

I conclude in this chapter that the added value of engaging broader networks through LA is in its potential to expand interaction with various groups and facilitate learning about enabling environments supportive of the change. It is important to stimulate this process while farmers and researchers are learning about technical modifications to achieve simultaneous redesign required for innovations. For this re-design, the inclusion of a broader set of actors who can experiment on the various aspects in their domain can together contribute to learning towards simultaneous change, concurring with Regeer et al. (2011).

7.3 Discussion of crosscutting themes and conclusions from the thesis

The thesis touches upon issues around processes generated and outcomes relevant to innovation. It thus contributes to debates around the way research projects facilitate innovation processes in farming communities.

An important concern in the application of AR and LA approaches is to influence learning. This thesis shows varied learning processes aimed at, achieved, or triggered by the use of the approaches in projects; these include insights not explicit during implementation but emerged from analysis of the case studies. The two approaches target learning as a cognitive process, but also the development of skills in day-to-day interaction with material technology, the natural environment and other people or groups. The case studies also captured learning within the different networks facilitated by the project. These were in the activities and agenda of the project, the

change in roles and tasks of various individuals and groups (not farmers only), as well as indications of change in institutions and organisational structures at community level. Such learning is directed towards innovations in farming communities.

I conclude that learning in the use of the approaches should be broadened from 1) learning as change in knowledge of farmers and other actors pertaining to introduced material technologies, into development of skills to adapt various interconnected aspects of bio-physical, material and social aspects relating to the technology; 2) learning by farmers is intertwined with learning of individuals and small groups in communities and at higher levels where adjustments are initiated during interaction; and 3) learning is not only in communities and networks, but also happens amongst project actors as seen in the assumptions, activities and agenda of interest to project implementers.

I further reflect on four crosscutting themes: notions about technology and its usefulness as a driver for network formation, influence of context and capacity of actors, concerns regarding public sector networks and the most effective level where the network should be situated, and lastly, tensions and risks on outcomes.

7.3.1 Pervasive notion of technology transfer: technology as driver of interest

Both the AR and LA approaches emphasize engagement with communities, and have implications on suitable technologies and development outcomes. Although there were other important processes observed, the cases show how projects used the approaches to bring out technologies from research. While there is nothing wrong with introducing new technology options, multi-stakeholder approaches used in this way cross two points of contention. The first pertains to the linear manner by which technology is imagined to spread. The second pertains to the partiality towards material technology which disregards the social component of the technique, as well as the social component of innovation around this technology. These points of contention have previously been brought regarding lack of meaningful participation (Connell et al., 2007; van de Fliert et al., 2010; Klerkx et al., 2009; Schut et al., 2011). Whether the motivation is to adapt technologies locally (as in the cases on AR), or learning in

networks (as in LA), the projects using the multi-stakeholder approaches had a focus on technology. All the cases examined started with specific technologies from research.

The root of this issue may not be a lack of intent towards participation, but rather varying translations of the approach. Some may translate AR as an approach where experience is a source of learning for farmers, researchers and other stakeholders; such experience leads to an adapted technique (Kouevi et al., 2013; Walters, 1997). Others may focus on the experiment as a tool for imparting knowledge. In chapter 6, where a wider network was involved through the addition of a LA, the LA still followed the initial AR agenda, which had a strong research- and technology-led focus. In the cases elaborated in chapters 2 and 6, the rhetoric and assumptions from project implementers showed clear motivation to facilitate engagement of local stakeholders. Once the process gets on the ground however, the assumptions and interests on research intertwines with contextual factors including capacity of local implementers (e.g. focus on on-farm research data, expectation of extension staff as providers of technological recommendations). Notably, this issue on involvement, participation, and ownership entailed a clear difference in terms of outcomes on technical knowledge and technology adaptation by farmers.

Technology can create interest and support network formation

Technology attracts attention and brings networks together; making it a convenient starting point for projects to engage various stakeholders. My findings on the networks engaged through both approaches show how the actors came together because of a common interest in technologies. Latour (1994) points out that through the mediation of technology, shared ways of doing and thinking develop. Technology shapes interest as well as creates an ordering process where various actors co-produce and co-reproduce social, technical, and institutional change (Roep et al., 2003). Technology can be an important and useful driver for network formation, even if it is part of a linear process.

If technologies bring networks together and provides a take-off point for interaction, the notion of technology in relation to innovation has to be clear to project

implementers at all levels. Technology is not only the material or the tool, but also the skills and techniques to accomplish an end (Jansen and Vellema, 2011). Such view of technology highlights that the material and knowledge about it (technical knowledge) is not the only aspect to consider when working with multi-stakeholder networks and technologies. Implementers or facilitators have to expect integration and adaptation of these tools and techniques that may require going beyond the original technical agenda. Flexibility on the scope of technologies under consideration supports technological adaptation and integration.

As observed in the case studies, interactions and networks around varieties differ from those around combine harvesters, or rodent management technologies. These tools and techniques implicate varied types of networks. When multiple stakeholders are engaged, different technologies can entail different pockets of actors. Considering innovation systems around particular technologies is important. Questions regarding coordination and re-configuration of social, technical and institutional in relation to the different technologies need to be asked. Therefore, reflection on the different relevant networks is required where baskets of technologies are concerned. Technology creates the group as much as the group re-shapes the technology. One network does not fit all.

Furthermore, monitoring of the small groups that experiment on the adjustments around the technology is useful to engage fully with innovation processes at the community level.

7.3.2 Influence of context and capacity in translation of the approach

The two multi-stakeholder approaches investigated in the thesis were implemented by involving various actors through project-supported activities. Comparing the cases demonstrates how the context of implementation and capacity of actors who implement activities in communities impinge on the translation of the approach and consequently the outcomes. AR implemented in the Indonesia case study (chapter 2) was conceptually similar with the AR in Myanmar (chapter 6). Similar IRRI researchers implemented these with similar technology options. Yet, the translation of the approach was different in that there was more participation and ownership by farmers in the AR activities in the Indonesia case than in the Myanmar one. A plausible explanation lies in the context of implementation. Institutions surrounding extension

practice in Indonesia show increased exposure to participatory methods (e.g. longer history with introduction of Integrated Pest Management (IPM)) (UNDP, 2001). In comparison, extension practice in Myanmar is characterized in the literature to be strong on teaching and technology demonstration (Win, 1991; Young et al., 1998). This has an effect on the translation of the AR approach.

Translation of the LA approach is another example. There was varying translation where government partners (chapter 6) or NGOs (chapter 5) were involved. There was considerable difference in the implementation of the LA in the same country. Where and NGO was involved, there was stronger and more equitable participation of farmers, as well as community-organizing activities. This has to do with contextual influences owing from the mandate and capacity of development agencies compared with national extension agencies. This highlights broader issues towards partnerships with development organizations that are better equipped to work with communities on locally relevant concerns involving technologies (Best et al., 2009).

The capacity of local facilitators was clearly found to shape learning conditions. This highlights capacity-building for national partners and local implementers should not stop at technical and research concerns only but also, where needed, in facilitation of relevant social processes.

7.3.3 Context of multi-stakeholder networks in public sector extension

Concluding that context shapes the implementation and outcomes of the AR and LA, launches a discussion on the way these approaches are implemented with networks in the public sector. As mentioned in chapter 1, CGIAR institutes such as the IRRI traditionally engage networks that are in the national agricultural research and extension systems. Such national institutes work with specific interests and mandates, and have varying capabilities regarding participatory processes. The interests would significantly differ where there are economic interests such as those of a local manufacturer, or from social-organizing and development interests of an NGO.

Moreover, chapters 3, 4, and 6 show how other actors outside research, extension and farmer groups play important roles in creating an enabling environment

for new technologies. This thesis has found evidence of benefits in the involvement of actors from the private sector as well as the civil sector. Research on public-private research consortia specific to new science and technologies by Roelofsen et al. (2011) have similarly highlighted the need to engage demand-side actors such as those in the private sector. The involvement and interest of small private sector actors such as service providers or manufacturers require more reflection amongst project implementers and network actors on how they can be meaningfully engaged or supported. Ensuring that the network pursues a balance of these interests or provides sufficient attention to these network processes entails a negotiation facilitated by implementers of the approach.

Chapter 3 shows there are actors that require effort in facilitation just to keep them on board with the activities of the network. Bringing different actors together can potentially bring out political tensions. In some cases, there is existing scepticism between different stakeholder groups such as between the government and private sector. Facilitators need to make strategic choices on whom to engage, rather than involve many different actors which may impede activities due to conflicting interests. What could guide the selection process is keeping in mind how actor-network processes also involve material technologies. Akrich (2000) emphasized moving between the technical and the social. It means facilitators assess how the actors relate to the material technology alongside assessment of how technology is reshaping interactions among the actors.

7.3.4 Situating the network: national- versus local-level learning alliance

Recognition of the different levels of networks and the inherent complexities in each one is an important contribution of this thesis; an aspect that is not recognized or explicated in LA literature. The case studies in Chapters 3, 5 and 6 demonstrate explorations by IRRI project scientists based on a perception of the innovation system linkages, which is relevant to rice postharvest. Having a national-level network or a village-level network created a big difference in implementation and interactions amongst network members. This raises an issue regarding the idea of ‘broad learning alliance networks’. Is there a more effective way to situate such a network such that it

can effectively facilitate innovation processes as well as address institutional constraints coming from the wider environment?

In Chapter 3, I documented the complexities of managing a national level network in terms of coordinating activities, maintaining engagement, and balancing interests. This insight concurs with findings by Adolph (2005) and Verhagen et al. (2008) who also discussed the benefits in terms of stimulating institutional change at higher levels. Chapters 4, 5, and 6 in comparison demonstrate the direct support from a project to a community-level network and how this entails different dynamics. In essence there are two strategies. One starts from the top, engaging organizations towards changing institutional contexts; the other starts from below engaging individuals and groups to adapt the technologies and then implement activities that target institutional change relevant to the local-level.

National innovation systems and system innovation

Exploring the roots of the difference in strategies leads to two similar concepts, innovation system (IS) and system innovation (SI) (Lundvall et al., 2002, Boogard et al., 2013). National level LA networks (as in chapter 3) seem to align more with the IS concept which emphasizes bringing together individuals, organisations, public agencies or institutions at the national level (Sumberg, 2005; Lundvall et al., 2002; van Paassen et al., 2014). The idea is to align an innovation support network from these individuals and organizations. In contrast, concerns of community-level LA networks seem to align well with the SI concept where the process entails re-configuration of hardware (bio-material, technical), orgware (social, institutional) and software (symbolic, cognitive) (Leeuwis, 2013). Network actors deal directly with hardware, orgware and software aspects in the learning process, which in turn generates an enabling environment for technical change.

Considering the capacities of single research projects, the timelines with which it can actively engage networks, and the interest to support farmers through new technologies, situating the network at community-level is more efficient. Moreover, an important finding in this thesis is the importance of local-level, small groups as loci to influence socio-technical change in communities. Small groups, organized informally and located in the communities, interact more compared with the wider or external

network. Influencing national innovation systems requires effort and resources which not all projects with LA have, as demonstrated by the experiences from Cambodia (chapter 3) and Myanmar (chapter 6). These projects can however support system innovations, which then pushes the network to engage with actors that create enabling conditions for new technologies. These actors may not necessarily be located at community levels as in the Myanmar case where engagement with market actors in the capital city was tried (chapter 6).

Outcomes observed from the LA in chapters 3,4, and 5 show that while a project can trigger higher-level institutional changes, it can more effectively use its resources towards reconfigurations at a community level which directly impact farmers. If an LA is implemented to support learning for farmers, the process can be better targeted if it is anchored at a community level or if it is able to trigger change in small groups. Such community-level network, once established with on-going learning agenda, can branch out to engage actors at wider levels to trigger specific institutional change.

7.3.5 Tension between development targets and emergent outcomes: risks for limited control and inclusivity

Behind the projects as mentioned in chapter 3, are impact pathways for the projects to reach development targets. These are often decided upon at the start of the project. As the project progressed however, the network interactions produced emergent outcomes. These outcomes were usually beyond the control of project implementers and facilitators. There is hence, tension between targeting the outcomes as planned or allowing the network to guide the process and just work with emergent outcomes as they develop. Furthermore, limiting the control in the research agenda is useful as in the case in Chapter 6.

It is known of networks however that processes can be steered in ways wherein specific actors like smallholder farmers will not benefit. Studies on inclusive innovations have highlighted this topic (Heeks et al., 2014). Where there is limited control, there is also a higher risk of reducing the balance such that some actors could keep the benefits to themselves while others in the network are losing. This is particularly an issue where there are private sector actors involved, who are well-

equipped to take on market opportunities. Engaging actors from different stakeholder groups can provide the required checks and balances. A need for monitoring and possibility for control are thus necessary.

7.4 Implications for monitoring and research policy

This thesis highlights important aspects which can be used by implementers of project who are interested in multi-stakeholder approaches such as AR or LA. One is to broaden the focus not only on material technologies and on-farm individual learning, but also on the related social, organisational and institutional aspects. Another is to engage various relevant actors even if the initial concern is to 'adapt a technology on farm'. As a guidepost for this decision, facilitators can consider actors in the innovation system around a particular tool or technique. Lastly, an important consideration is the capacity of implementers and facilitators towards engaging networks, particularly towards effective coordination and monitoring of complex and emergent processes that could be triggered.

Monitoring should not only focus on technology and on-farm aspects as shown in Chapter 2, but also on the collective and institutional changes that various actors in the network explore. This is important for research centers since, 'M&E in the CGIAR has largely been based on the use of logical frameworks to identify and report on milestones' and establish a causal chain from project to development outcomes (Douthwaite et al., 2007). This means that research activities can get prioritized at the expense of identifying and supporting project-related activities (may be led by researchers and other actors) that contribute to socio-technical change. Monitoring can provide more insights when it captures not only the planned but also the emergent changes; and not only the project-supported but also the project-related or tangential activities relevant to innovation. This echoes findings by Lilja et al. (2010) to broaden impact evaluation. Suggested innovation indicators for research projects with a multi-stakeholder approach, concurring with assessment focus suggested in Leeuwis (2013) are provided in the Appendix. The different units of observation for each indicator, with examples from the thesis are also provided. It was clear in all the cases that the timeframe in which projects are normally implemented, about 3-4 years, is enough only

to get the process going at a community level. This happened similarly in cases where the entry point is a national-level network or a village-level network. In some cases, there were still adjustments to be made by the project to support a learning process to facilitate stronger community ownership.

Assumptions exist regarding the technologies, extension and spread of research knowledge, and the type of network and process targeted; these need to be clear to implementers at all levels. Clarifying these can support the translation of the approach particularly by those directly interacting with farmers and community-level stakeholders.

Lastly, there are advantages in bringing together a wider network to support innovation, whether at the community or higher levels. Engagement of more and diverse actors is important but space to discuss, negotiate and learn together is equally important. Moreover, for projects dealing with basket of technology options, one network does not fit all. Reflection on the actors relevant to specific technologies is useful.

7.5 Final remarks

International research projects are increasingly required to use multi-stakeholder approaches and influence innovation in farming communities. Adaptive Research (AR) promotes interactions between farmers and researchers. This thesis demonstrated that its implementation can be affected by context and capacity of local implementers, creating different conditions in terms of space for farmers to experiment with technology options. In practice, AR was often research-led and implemented in a technology transfer mode. When experiential learning is facilitated through AR, it can fast-track technical adaptations of suitable technologies. The implementation of AR can benefit from expanding the experiential learning beyond technical and agronomic topics into simultaneous socio-technical adaptations.

The findings suggest that the implementation of the Learning Alliance (LA) approach either at national-level networks, community-level processes, or as

complement to AR approach can indeed promote a learning process that supports innovation in farming communities. In expanding the network with inclusion of various types of stakeholders, topics relevant to the orchestration of social, technical, organisational and institutional change are addressed. In engaging this broader network, facilitators can allow for correcting mechanisms that redirect attention to relevant agenda, enable the integration of various topics, and provide space for synergies to address emerging topics of concern. This thesis shows that the LA approach is better implemented with this focus on learning for innovation rather than on the spread of 'best bet' technologies.

This study uncovered the complexities of implementation, supporting learning in networks and communities, and facilitating impact. From the findings, a way forward is outlined in terms of checking assumptions of implementers as well as monitoring both process and outcomes.

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Summary

This thesis examines the enactment of multi-stakeholder approaches, Adaptive Research (AR) and Learning Alliance (LA), as well as the effects of using these in research projects that involve smallholder-farming communities.

Mounting pressure on research organizations to achieve sustainable development outcomes from research have pushed international research institutes to use multi-stakeholder approaches. These approaches are postulated to support innovation processes and catalyse the use of suitable technologies (practices and tools) in farming communities. Insights are missing however, on how these processes influence social, technical and institutional change, and what outcomes emerge from these. This thesis is concerned with the question: *How and to what extent do Adaptive Research and Learning Alliance approaches influence socio-technical innovation in rice farming communities?*

Four case studies of research and development projects that employed the AR or LA approaches in rice farming communities were elaborated in this thesis. The case studies were on projects coordinated by the International Rice Research Institute in Indonesia, Cambodia, and Myanmar. *Chapter 2*, the scene-setting chapter, is an investigation of the implementation and outcomes of a project with AR approach. Outcomes from individual farmers and those at collective level pertaining to innovation system actors were examined. The study found that AR implementation, where farmers had space to experiment with various options, fast-tracked technical adaptations. Farmers demonstrated improvisational capacities in manufacturing tools, modifying practices to integrate new technologies with existing practices, and generally dealing with changing or uncertain conditions. Varying levels of interest, knowledge, and adoption by farmers were documented. Significant constraints in the social and institutional aspect were also found. The implementation of AR missed to address specific aspects, which resulted in lack of simultaneous technical and institutional re-design. Absence of local manufacturers, limited access to new tools, no support to address cultural constraints and conflicts, and limited inclusion of service providers

and policy agents were found to constrain socio-technical change. The study therefore found that AR can enable interactions supporting technical adaptations, but its monitoring can render invisible the adaptations required regarding social arrangements and institutions.

Chapter 3 is an exploration of the LA approach as implemented at national level in Cambodia. It provides context regarding conceptual assumptions on the LA approach from literature. The study found the network, which started with largely government-actors and interest to spread rice post-harvest technologies, to have changed and expanded to include diverse actors after three years. Tracing what happened in this network brought to light where implementation (mis)aligned with assumptions from project implementers and from conceptual literature of the LA approach. A key finding in this study is on how the LA in Cambodia targeted scaling out of 'best bet' technologies more than mutual co-innovation. Despite the initial focus on technology, the LA also supported emergent network dynamics such as change in roles and informal linkages with small network pockets, thereby catalysing institutional change. This proves that a network with broad stakeholder base such as LA networks can support shift in technological focus and promote actor-network processes which target social, technical, and institutional re-ordering.

Chapter 4 is a further examination of how the national-level network in Cambodia influenced change at community level. Two cases were compared where the LA linked with community-level actors around rice harvesting and drying. The study found limited use of combine-harvesters and dryers but there were visible changes that indicate innovation in communities. Actors from the LA network engaged small groups at community level; the small groups made reconfigurations on technologies and supportive social arrangements. These small groups at community level responded to different concerns and made varied adjustments such as coordination for combine harvesting, modifying machines to fit local needs, and bulk selling arrangements. These indicate new and supportive social, organisational, and institutional arrangements around mechanized harvesting and drying. The small groups were an important a locus in which socio-technical adaptations were steered and negotiated change at community

level. Therefore, an LA network that effectively engages small groups in communities, can provide impetus for socio-technical change.

Chapter 5 captured how the LA approach was used to stimulate a self-organized process at community level to establish flatbed dryers as an innovation in Myanmar. The LA implemented varied learning agenda through different groups within the network. The NGO, research and private sector actors simultaneously funded and implemented activities and experiments with farmers. The technical adjustments, were started along with targeted social-organizational changes, there were also activities that targeted changes in institutions that affect rice post-harvest practices. Although these processes were starting, there was still low number of users of the flatbed dryer. Considering findings from chapters 4,5, and 6, this approach therefore should not be seen as a panacea to a speedy and widespread use of an existing fixed technology. It further emphasizes that focus on a best bet or fixed technology in the use of LA may not necessarily lead to the spread of that technology. The approach is better used as a tool to support simultaneous learning about various necessary aspects of innovating with communities. Technology is only one aspect, and the technology of interest, in this case flatbed dryer, is only one option which communities explored to address their needs.

Chapter 6 is a comparison of the learning process where a project used AR only versus AR with LA. The findings revealed different networks, learning processes, and outcomes in terms of learning agenda between the cases compared. Although slightly varied, the translation of AR was observed to facilitate a type of learning about technologies that emphasized teaching or transfer of explicit knowledge through demonstrations and experiments in plots. Farmers had limited space to experiment with the new technologies, although AR facilitated interactions between farmers and researchers. In comparison, the case with LA had a broader set of activities with a wider network of actors. The learning activities were not only about technologies but also included experimentations on supportive environment for access and use of the technologies. It led to faster integration of socio-technical concerns. This developed along with increased ownership of technical trials by farmers. This shows therefore that there is added value in engaging broader networks through LA.

This thesis therefore demonstrates that project actors implement AR and LA approaches through a range of translations in multiple contexts. These imply varied interactions in different types of networks. Such interactions trigger varied learning processes and thus influence different outcomes, some of which are achieved planned objectives of the research project but others are emergent. In some cases projects do not even note that some outcomes have emerged.

In the implementation of AR and LA, a focus on technology is apparent. Technology cannot be side lined because it attracts attention and brings networks together. This highlights the role of the material, but also makes the point that implementers facilitate engagement in networks with material technology without limiting it only to the initial technologies of interest. It also entails a focus on enhancing adaptive capacity of various actors, especially small groups at community level, to make social, organizational and institutional reconfigurations. Findings in this thesis show projects are better able to influence these when a broader network of stakeholders are involved. Such an involvement not only improves upon strong interactions facilitated around the technical, but also provide the checks and balances needed to ensure smallholder farmers are included in benefiting from network interactions.

This thesis highlights the potential of both approaches to influence innovations in farming communities. It also brings out the caveat that these approaches are not the silver bullets that can address all issues around technology adoption. Instead, implementation that facilitates effective learning processes, and monitoring that flags where projects could support emergent outcomes, can help implementers improve their contributions to development in farming communities.

Appendix

Suggested monitoring indicators for innovation outcomes in research projects with multi-stakeholder approach, with unit of observation and examples from this thesis.

Type of outcome	Outcome indicator	Unit of observation*	Note for assessment	Example from this thesis	
				Outcome example	Chapter
Process	Network expansion	A	Also track disengagement, type of engagement	Network in Cambodia LA comparison between 2008 and 2011	3
	Diversity of stakeholder type (inclusion)	A	Reflection on why they are involved, who else needs to be included	Analysis on involved stakeholders	3, 6
	Interaction in dense pockets	A		Cases of dense pockets in Cambodia LA	3
	Improved or increased interactions	A	Not only meetings, but also around tasks and other agenda	Interactions between local researchers and farmers	6
	Learning process	A, B, C	Training versus experiential learning, learning agenda	AR activities, Assessment of learning agenda in LA in Myanmar	2, 5
	Quality of facilitated reflection	A, C	Not only that there was group reflection, but what was reflected upon	Reflections from farmers on learning trials	6
	Initiatives from network members	A		Spin-off activities at the community level	4
	Resource contribution	A		Activities by service providers in Cambodia LA, activities by PPHDG*	4, 6
	Involvement in decision-making about the agenda	A, B, C		List of LA activities and who led them, comments by farmers about their involvement	6
	Broader agenda:				
	Flexibility in technological agenda	A		New technologies of interest	3
	Exploration of working social arrangements	B, C		Coordination of bulk selling	4
	Activities targeting institutional change	A, B		Training for millers, involvement in setting national grains standards	2, 3, 4

Cont'd

Type of outcome	Outcome indicator	Unit of observation*	Note for assessment	Example from this thesis	
				Outcome example	Chapter
Intermediate outcomes	Adapted tools	C		Modified drum seeders	2
	Adapted techniques, integration	C		Use of nylon mesh to separate grains in flatbed dryer	4
	Change in activities	A, B		Specialized harvesting services provided	4
	Change in knowledge, shared discourse	A, B, C		Change in knowledge on rodent management	2
	Political support	A		Support from ICFORD in project activities	2
	Emergence of champions	A	Champions: enable access and supportive conditions	Miller who shared about dryer and started manufacturing new models	3
	Change in roles	A, B		Harvesting coordinated by key farmer	4
	Spread of technology	B, C		Percentage of users	2
	Economic benefits	B, C		Increase in profit, higher selling price	2, 3
Long-term outcomes	Enabling policies, standards	A, B		Quality standards by millers	
	Equitable value chains	A	Various actors benefit from improvements in the chain	Indicated: possible reduction in postharvest losses	3
	Sustained network relations	A		Indicated: sustained interactions without project support	3, 4

*A = network facilitated by project, B = small groups in communities, C = individual farmers and other end-users

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About the Author

Rica Joy Flor was born on February 18, 1983 in the Philippines. She obtained a degree in Anthropology (cum laude) at the University of the Philippines, Diliman. In 2005, she started working for the International Rice Research Institute (IRRI). While part of a project on water-saving technologies for rice production at IRRI, Rica completed her Master's degree in Anthropology, also in UP Diliman. Her study was on the adoption of aerobic rice technology by farmers in Bulacan, Philippines.

During her academic and professional career, she worked in Southeast Asia on applied social science in agriculture. Rica implemented monitoring and evaluation of farmer-participatory projects, and assessed the adoption of technologies by farmers. Starting in 2008, she was part of an adaptive research project in Indonesia, as well as a project with Learning Alliances in Cambodia, Vietnam and the Philippines. In 2010, she examined campaigns to disseminate crop management technologies in the Philippines and Bangladesh. Rica was also involved to facilitate multi-stakeholder platforms in Thailand and Myanmar.

A combination of her interest to assess what happened through these projects and some gaps identified from project implementation, led her to this PhD topic. In 2012, she was awarded a scholarship from the Global Rice Science Partnership to carry out graduate studies at the Knowledge, Technology and Innovation Group in Wageningen University. In her PhD project, Rica merged the assessment of completed projects in Indonesia and Cambodia with work on current projects of the IRRI in Myanmar.

List of publications

Refereed article in a journal

Flor R.J., Singleton G.R., Maat H., and Leeuwis C. 2015. Farmers, institutions and technology in agricultural change processes: Outcomes from adaptive research on rice production in Sulawesi, Indonesia. International Journal of Agricultural Sustainability (http://dx.doi.org/10.1080/14735903.2015.1066976).

Palis F.G., Diaz C., Todcor G., Flor R.J., Tanzo I. and Datoon R. 2015. Voices from the field: Needs of small-scale Filipino rice farmers. Philippine Journal of Crop Science 40: 64-75.

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Palis F., Flor R.J., Warburton H., and Hossain M. 2006. Our farmers at risk: Behavior and belief system in pesticide safety. Oxford Journal of Public Health 28(1):43-48.

Book chapters

Singleton G.R. and Flor R.J. 2015. Sociology and communication of rodent management in developing countries. In: Buckle AP, Smith RH, (eds). Rodent pests and their control. Wallingford (UK): Centre for Agriculture and Biosciences International. p. 295-314.

Flor, R.J. and Singleton, G.R. 2010. Analysis of communication pathways and impacts of the Boo! Boo! Rat! Campaign. In: Singleton G.R., Belmain S.R., Brown P.R. and Hardy B. (eds) Rodent outbreaks – Ecology and impacts. International Rice Research Institute, Los Baños, Philippines. pp. 191-204.

Sudarmaji, Flor R.J., Herawati N., Brown P., and Singleton G.R. 2010. Community management of rodents in irrigated rice in Indonesia. In: Palis F.G., Singleton G.R., Casimero M.C. and Hardy B. (eds) Research to Impact: Case studies for natural resource management for irrigated rice in Asia. International Rice Research Institute, Los Baños, Philippines, pp. 115-134

Palis F., Flor R.J., and Singleton G. R. 2008. Philippines, Agricultural Extension. In: Saravanan R. (ed.) Agricultural Extension – Worldwide Innovations. New India Publishing Agency, New Delhi, India. pp. 333-370.

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Palis F., Flor R.J., Buresh R., and Singleton G.R. 2007. Adoption of fertilizer best management practices: the need for a sociological approach. In: Fertilizer Best Management Practices. International Fertilizer Association, Belgium. pp. 99-110.

Conference papers

Flor R.J., Maat H.M., Leeuwis C. Singleton G.R., and Gummert M. 2013. How a Learning Alliance Shapes the Use of Postharvest Technologies: Case Study on Mechanical Dryers and Combine Harvesters in Cambodia. Paper presented at the Asia-Pacific Science, Technology and Society Network (APSTSN) Conference 2013. 15-17 July 2013. Singapore.

Flor R.J., Casimero M., Singleton G.R., Abidin Z., and Razak N. 2012. Does adaptive research help rice farmers integrate and adopt from a range of technology options? Paper presented at the International Rice Research Institute Young Scientists' Conference. 8-9 November 2012. Los Baños, Philippines.

Valdivia C.M., Palis F.G., Lampayan R.M., Sumalde Z., Umali C., Flor R.J., Malabayabas A., Quicho E. and Singleton G.R. 2012. Farmers' production and adoption: impacts of alternate wetting and drying on rice farming in Bohol. Paper presented at the Crop Science Society of the Philippines Conference. 16-21 April 2012. Puerto Princesa City, Palawan. (Won best paper, Socioeconomics category)

Flor R.J., Gummert M., Maligalig R.L., Meas P., and Sorn V. 2010. Negotiating change: Farmer adoption of postharvest interventions in Cambodia. Paper presented at the 3rd International Rice Congress. 8-12 November 2010. Hanoi, Vietnam. Available at: http://www.ricecongress.com/extPdfs/OP03-3819-Flor%20TP-edited.pdf

Flor R.J. and Singleton G.R. 2009. Communication pathways and Impact of the Boo!Boo! Rat Campaign in the Philippines. Paper presented at the 4th International Conference on Rodent Biology and Management. 12-16 April 2010. Bloemfontein, South Africa. (Won best presentation from a developing country)

Flor R.J. and Palis F. 2007. Perceptions and Decision-making: A case study on farmer adoption of Aerobic Rice. Paper presented at the Federation of Crop Science Societies of the Philippines (FCSSP) 19th Scientific Conference. 13-15 June 2007. Batangas, Philippines.

Flor R.J. 2005. Transposing power, controlling water: Cultural politics in irrigation technologies. Paper presented at the 19th Annual Conference of the Anthropology Society of the Philippines (UGAT). 19-21 October 2005. Iloilo, Philippines.

Rica Joy Flor
Wageningen School of Social Sciences (WASS)
Completed Training and Supervision Plan

Wageningen School of Social Sciences

Name of the learning activity	Department/Institute	Year	ECTS*
A) Project related competences			
Social justice, technology and development, CPT 30806	TAD, WUR	2012	6
Innovation Management and Cross-disciplinary design, CPT 22806	COM, WUR	2012	6
B) General research related competences			
Research Technography & Development, CPT 31306	TAD, WUR	2012	
Writing the proposal	TAD/COM, WUR	2012	6
Tailored course on systems thinking and practice (IFSA Conference)	COM, WUR	2012	1
Writing Ethnography and other Qualitative-Interpretive Research	WASS	2012	3
Presentation in TAD/KTI Seminar	TAD/KTI, WUR	2012, 2015	1
Techniques for writing and presenting a scientific paper	WGS	2013	1.2
C) Career related competences/personal development			
Introduction course	WASS	2012	1
Writing grant proposals	WGS	2015	2
Communication in interdisciplinary research	WASS	2013	1.1
Working with Endnote X5	WGS	2013	0.1
Project and time management	WGS	2015	1.5
"*Does adaptive research help rice farmers integrate and adopt from a range of technology options?*"	IRRI Young Scientist's Conference	2012	1
"*How a learning alliance shapes the use of postharvest technologies: Case study on mechanical dryers and combine harvesters in Cambodia*"	Asia-Pacific Science Technology and Society Network Conference, Singapore	2013	1
"*How learning alliance or adaptive management approach affects innovation*"	Young Rice Scientist Seminar. Los Banos, Philippines	2015	1
"How Learning Alliance networks foster change in farming communities in Cambodia"	WASS PhD Day	2015	1
MSc student supervision, organizing workshops, training course presenter	IRRI	2013-2015	4
Total			**37.9**

*One credit according to ECTS is on average equivalent to 28 hours of study load

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