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Final Report

Knowledge transfer and uptake of new practices for pest management in irrigated rice

CRC4140

August 2017

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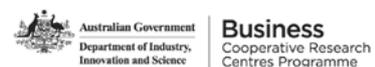
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1. Executive Summary

This project focuses on knowledge transfer and decision-making for management of an irrigated agricultural system, in eastern Indonesia. This study will describe existing farmer's information networks, evaluate engagement with the farming community and external agencies, and investigate the pathways for information acquisition at the household and village levels.

Specifically this project will address the questions of:

- How knowledge of pests and diseases transferred in a system of irrigated, small-holder rice production in eastern Indonesia, and
- Factors that enhance and inhibit sustained acquisition of information and adoption farming practices in this context.

Focus group discussions, key informant interviews and some 50 household interviews were conducted in each of 2014 and 2016, in the case study village. To more deeply explore the issues uncovered, a series of key informant interviews and focus group discussions were conducted in May 2017.

At the household level, we found:

- The top two causes of crop losses were pests and inadequate water provision (volume, and control of timing and levels).
- Knowledge about biosecurity and agricultural practices in general is unevenly distributed (or accessed) within the case study village. Even neighbouring households may have differing knowledge of biosecurity management or other agricultural practices and systems. Some households have little knowledge, poor outcomes, and no ready access to knowledge.
- Some households belong to active farmer groups that effectively share knowledge – some 67% do not, despite it being compulsory for farmers to join a group to access government agricultural subsidies and other resources.
- Processes are unclear for accessing training, demonstration plots and other opportunities to learn, and this information, when acquired, does not spread far from the original recipient in many cases.
- Extension officers are a valued source of information, but overloaded with work and their availability does not match demand.

Information unavailability is a barrier to innovation and adoption. This can be addressed by investing in extensions services, supporting the ongoing development of farmers groups and promoting coordination among key sources of information into the village (e.g. agriculture supply shops, NGOs, research services and extension staff).

In addition, the isolation of individual farmers needs to be addressed. These farmers affect the permeability of the village community to information flow. This will require better understanding of the social networks of these isolated farmers (or lack thereof), such that those networks can be augmented or broken links be repaired. A next step in this research should be to investigate social structures that determine responsibilities for knowledge acquisition and distribution within households, families or neighbourhoods. These investigations may also include focus on “adopters” for example.

Village leadership and the farming community is open to change. For example, the community explained that the questions asked during previous research (since 2009), prompted reflection among village community members on why things were not working. As a result, village leadership is trialling new ways of organising water user groups. Other examples of innovation include: desire to grow irrigated rice in the first place, establishment of aquaculture ponds since 2011, increased areas of vegetable growing in household gardens since 2014 (supported by HKI projects), and trialling and adoption and adaptation of SRI rice cultivation methods. Thus the community as a whole is willing to learn, and there have been successes. Further investigation of the bases of these successes is recommended.

In terms of information pathways and provision, we found the fundamental barriers to household information access and acquisition were:

- Extension services provided by both agency and NGO staff were typically top-down, and driven by external agendas rather than farmer-led demand.
- Farmer Groups did not function adequately, despite their crucial role as a mechanism for farming households to access information and material resources. Many existed on paper only. This lack of functionality appeared to be due to:
 - (a) poor or unregulated governance, resulting in a lack of financial transparency and therefore trust, and
 - (b) a lack of skills within Farmer Groups for good leadership, record keeping, meeting organisation and facilitation, resulting in ineffective group function.
- Agency staff are poorly resourced (e.g. minimal or absent training; isolated by government's hierarchical structures). When available, advice from the District Government extension staff was considered by farmers as useful. However, availability also did not meet demand.

In the face of these issues farmers either:

- Go it alone without the benefit of advice, or
- Turn to commercial agricultural shop for information and materials; as a result, some commercial enterprises are themselves providing formal or informal extension services.

From the wider perspective of the Agricultural Information and Knowledge Systems (AIKS) within which farming practice is situated (Ramirez, 1997), we found broken links and silos at all levels among actors. Broken links occurred between households within a village, between farmers and extension support, between farmers and farmers groups, and among the many layers of government responsible for extension. Universities, governments, agricultural enterprises and NGOs are siloed from each other, despite the potential for collaboration on extension support.

Consequences of the lack of access to information include:

- HH food shortages; in fact by 2017 some 50% of households in the village were officially assessed as eligible for subsidised rice, despite living in an irrigated rice development.
- Poor performance in agricultural and social indicators and wasted resources for Districts.
- Poor return on investment for Central Government.
- Potential biosecurity threats on the northern Australian border.

Alternative approaches to extension services are needed, which are farmer and demand driven. This requires a community of empowered farmers, where extension officers are information brokers and facilitators of technical services, working in collaboration with farmers and supporting leadership. A previously successful model of farmer-driven training and extension is the Farm Field School model. This was originally developed in Indonesian rice farming areas, to promote integrated pest management. Somehow this globally significant movement was lost to the rice growing irrigation developments in eastern Indonesia, most likely due to the political turmoil of Indonesia's transition to democracy. This important strategy for farmer empowerment and demand driven extension support needs to be revisited, in order to stem the lack of success in this case study village, in eastern Indonesia in general and in the 49 new irrigation developments currently proposed by the Central Government.

2. Introduction

This project focuses on knowledge transfer and decision-making for management of an irrigated agricultural system, in eastern Indonesia. This relatively new system requires different practices to those required for traditional agricultural systems, which mainly focus on rain-fed dryland crops (Barlow and Gondowarsito 2009). Thus small-holder farmers generating livelihoods in these irrigation infrastructure developments require new skills and knowledge in order to develop new practices. One of the most significant barriers to adoption is information constraints (Matuschke and Qaim 2009). Previous studies in this and other case study villages in eastern Indonesia indicate that despite Government investment in irrigation infrastructure, household food shortages are common. Reasons cited by village administration and householders include plant pests and poor water access (Harkness 2013; Harkness et al. submitted; Myers et al. 2012; Myers et al. 2015). Underpinning these problems are limited technical capacity, limited capacity for agency extension and poor engagement during infrastructure development. Training provided to farmers in irrigated rice farming during infrastructure development was irrelevant or not widely shared (Golding 2015; Harkness 2013). However, this resilient farming community persists.

Specifically this project will address the questions of:

- how knowledge of pests and diseases is transferred in a system of irrigated, small-holder rice production in eastern Indonesia, and
- what factors currently enhance and inhibit sustained uptake of new knowledge and farming practices in this context?
- what new approaches to “extension” should be taken in this context?

This project is one of a suite of other but related projects undertaken by the project team which are aimed at addressing the “neglected potentials” (Noltze et al. 2012) to raise yields in irrigated rice developments in eastern Indonesia (Myers et al. 2010, Myers et al. 2015). Specifically, in this study we attempt to describe agricultural knowledge and information systems present in the case study village and barriers to information flow into the village and within the village. We attempt to assess the level of community empowerment and multi-directional information flow (Ramirez 1997, Bartlett 2004).

The findings are of relevance to the interests of the Central Government of Indonesia, which has an ongoing program of investment in irrigation infrastructure to increase rice production, and which is currently potentially achieving a poor return on its investment in eastern Indonesia. The findings are relevant to the District Governments of eastern Indonesia who are responsible for the maintenance of irrigation infrastructure within a context of complex governance arrangements (Myers et al. 2015). Most importantly, the findings are of relevance to the small-holder farmers who, despite their high hopes, continue to experience household food shortages and even famines within these infrastructure developments. Finally the findings are of relevant to regional security and biosecurity interests of Australia. As the area of irrigated small-holder paddy fields increase, the catchment area for potential pest and biosecurity problems is also expanded, in a context of poor capacity to manage them – and all in our nearest neighbours, and just a one hour flight from the Northern Territory.

This report presents the findings of field studies undertaken in 2014, 2016 and 2017 in the village of Linamnutu, Timor Tengah Selatan District (*Kabupaten TTS*), Province of East Nusa Tenggara (*Propinsi NTT*) (**Figure 1**). These findings build on related research focusing on water management and agriculture infrastructure development undertaken by the same research team elsewhere in Nusa Tenggara Timur (NTT), Indonesia (Golding 2015; Harkness 2015; Myers et al. 2012; Myers et al. 2015 a, b). This report also uses the findings of Wurm et al. (in prep.) and Tamanna (2017), studies which were undertaken with the support of PB CRC funding (PBCRC4140).

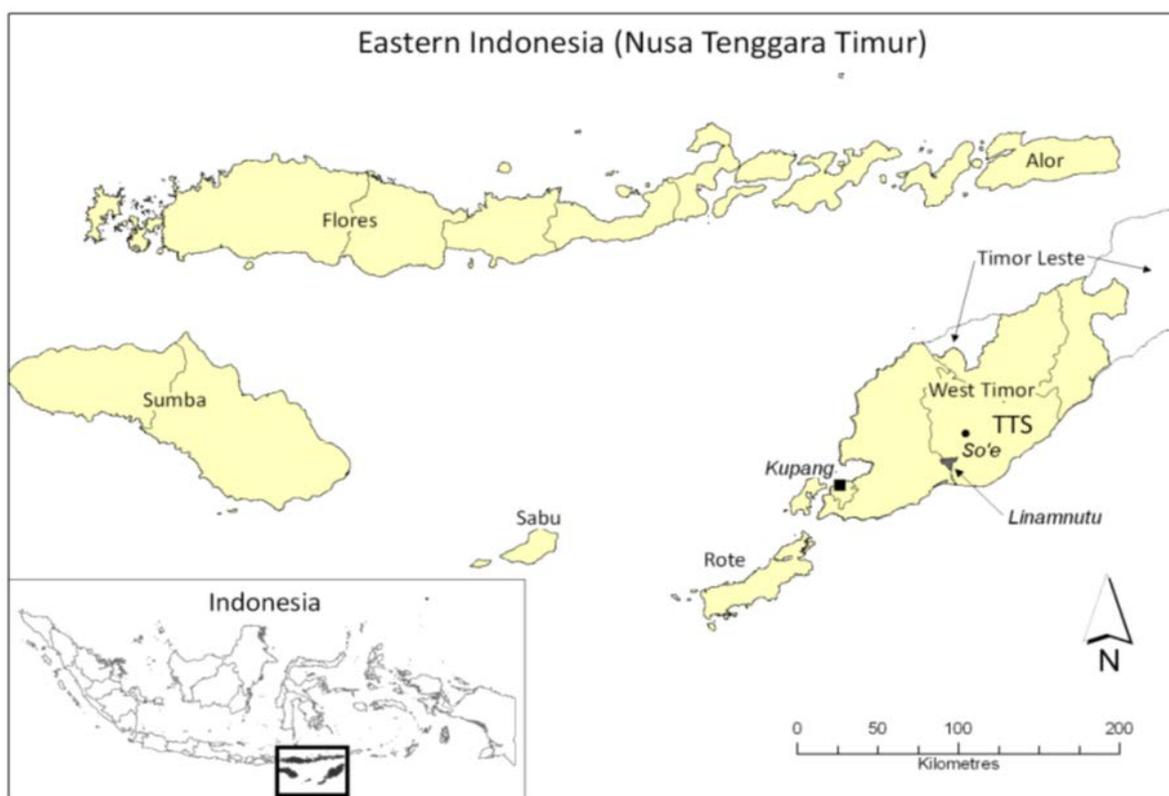


Figure 1. Location of Linamnutu Village, South Central Timor District (*Kabupaten TTS*), in East Nusa Tenggara Province (*Nusa Tenggara Timur NTT*), Indonesia. (Source: Harkness, 2012)

3. Aims

- a. How is knowledge of pests and diseases accessed and acquired in a system of irrigated rice production in eastern Indonesia?
- b. What factors enhance and inhibit sustained acquisition of knowledge and new farming practices in this context?

4. Materials and Methods

4.1 Context

The eastern Indonesian province of Nusa Tenggara Timur (NTT) has a high proportion of food insecure households (e.g. Barlow and Gondowarsito, 2009; Timmer, 2004; WFP, 2009). Some 80 per cent of the people of NTT live in rural areas and rely on agriculture for their livelihoods. The Province has a monsoonal wet-dry tropical climate, low annual rainfall with high inter-annual variability, and as a result water resources are scarce (Foenay, 2000).

Previous studies have uncovered ineffective use of irrigation infrastructure (Ancev 2009) due to management issues (Myers et al., 2015). The function and benefits of irrigated rice cultivation in the village of Linamnutu have been the subject of field activities since 2009, undertaken jointly by CDU and UNDANA (2009, 2011, 2014, 2016), UKSW (2009, 2011, 2014) and UGM (2011). In the first two field programs the research focused on water access, food shortages and landholding characteristics (size, ownership, utilisation). In 2011, widespread food shortages were reported due to the pest *hama kuning* (a stem boring moth).

Access to information appears to be a barrier to improved agricultural practices, including water management and pest management (Myers et al., 2009; Myers et al., 2012; Harkness, 2012; Golding, 2015; Myers et al., 2015). Information management has emerged as a core issue, and formed the basis of the PB CRC project application and the field work it supported in 2014, 2016 and 2017.

This work was generously supported by the village administration and residents of Linamnutu, who provided accommodation and logistic support for the field team, as well as actively engaged with the research consortium since 2009. The work was also kindly supported by *Badan Perencana Pembangunan Daerah TTS* (BAPPEDA TTS) District Officers, So'E. The Plant Biosecurity CRC provided funds for travel by the CDU team and operational costs associated with field work.

4.2 Development model

The project was developed within a framework of community engagement and community development, with a focus on the use and management of natural resources (food, water, pests). Specifically, it investigated community information sharing and capacity for pest management, among people for whom poverty, poor health indicators and food and water shortages are annual realities.

Community development is addressed by including Village administration and leadership and District agencies as partners in the project. This ensured research outcomes were communicated directly to those in a position to implement recommendations.

Community capacity building was integrated into the project by including Village administration and leadership and District (*Kabupaten*) agencies in the framing of the research questions, during the course of the research engagement. Village elders and leaders were employed as guides during the conduct of the research, and so became very familiar with the research project methods. After each field program, preliminary findings were presented back to the village community on-site, and to the District government, via an open seminar in the Government offices in the District capital, So'E. Village leaders were funded by the project to attend these seminars also. Prior to each of the field work programs, results of the previous field work (e.g. Myers et al. 2010) were reviewed by the village community and District Government staff, and the project methods and objectives modified as appropriate.

The project also incorporated an *agricultural knowledge and information systems* (AKIS) and communication networks approach to understanding farmer perspectives, and aimed to engage farmers as collaborators in problem-solving issues with current information sharing (Ramirez 1997). This was addressed by our emphasis on relationship-building prior to and during the project implementation, the focus on data gathering at the household level, and the engagement of the village leadership in discussion about the achievements and objectives of the project during each field visit. One of our roles as researchers is to provide a forum in which access and availability issues for information, water and food resources in Linamnutu can be discussed and documented in a way that is useful for planning and prioritising for agency staff and the village community.

4.3 Approaches to analysis

A realist-informed approach was taken in the analysis in this study (Pawson and Tilley, 2004; Westhorp, 2014). To realists, interventions (e.g. information resources, extension services, new infrastructure) enable opportunities for change to occur, rather than cause change. Change itself occurs through the interactions of interventions with their target population. Thus a realist approach asks the question: 'To what extent is this working for whom, in what contexts, why and how?'

Finally, our research led us to an empowerment evaluation approach (Bartlett, 2004, after Kabeer 2001). This approach builds from Ramirez's (1997) proposition that effective extension services are demand-driven. In order for farmers themselves to identify their requirements and demand relevant services, they need to be empowered. This requires *means* of empowerment (resources, rights, capabilities, and opportunities), *processes* of empowerment (individual or group analysis, decision-making and action), which lead to *ends* such as better outcomes and greater control (Bartlett, 2004).

The AKS model assisted in identifying broken links and silos among actors in information and knowledge access and acquisition (Ramirez 1997).

4.4 Data collection

Data was gathered by household interviews (HHI), focus group discussion (FGD), key informant interviews (KII) and in June/July 2014 and 2016.

Villages have a complex system of governance. Linamnutu Village comprises three sub-villages or hamlets (*dusun*): Oetaman, Hausanuf and Linamnutu. Within the *dusun* there are a total of nine neighbourhood units or RW (*rumah warga* or community solidarity units) which are in turn divided into a total of 20 RT (*rukun tetangga* or neighbour solidarity units). As is often the case, the *dusun* are naturally-occurring units separated geographically (Bebbington *et al.* 2006), and Linamnutu includes floodplain lowlands here the paddy field themselves occur and an adjacent upland area where dryland agriculture is undertaken.

The area where paddy fields are located is divided into five blocks for the sake of irrigation water and paddy management. These blocks do not correlate with the village sub-divisions described above.

FGD's were conducted with the Federation of Water Users Groups (GP3A), the coordinators of delivery of irrigation water, including Head and Secretary of GP3A and six members of Water User Groups (P3A) from various irrigation or paddy blocks, in 2014, 2016 and 2017. A FGD was also conducted in 2017 with staff from an NGO which is active in the village. Water User Groups are different to the Farmer Groups referred to in the findings.

KII were conducted with the Head of the village (*Kepala Desa*) and a senior engineering consultant in charge of the reconstruction work at the weir (2014), the proprietors of three agriculture supply shops (2016, 2017), the former project leader of a rural development NGO that was active the village during the entire study period (2016), and with a former *Kepala desa* (2016), extension officers from the District Department of Agriculture and Provincial Department of Public Works (2017), and a senior officer from the District Planning Board (2017).

HHI were conducted with some 51 households in 2014 and 53 in 2016. As much as possible, sampling was stratified with respect to village sub-divisions (15 RT across 11 RW in the paddy area of the village). These HHI also captured approximately 10 households in each of the five irrigation blocks in the paddy area. The interviews were semi-structured and conducted in a conversational style. A list of interview questions for 2016 field study is presented in Appendix 1. Responses to these questions were gathered either by a direct question, or during the course of the conversational interview. Each interview was conducted by a team comprising a translator (English/Indonesian/*Dawan*), students from several universities and at least one senior staff researcher. While the necessity for translation was an added complication to the interview process, it also slowed the conversation and facilitated more considered responses and valuable re-tracking of topics during interviews. It also served to break down barriers of formality and status. Each interview team carried a large printout of a satellite image of the village to stimulate discussion and assist with identifying locations being discussed. Roles were allocated within groups as principal questioner, principal note-taker and principal question checker, although all interview team members took part in all these responsibilities, for a given interview. HHI interview transcripts were then written collaboratively and cross checked by the team who conducted the particular interview. Once the interview team agreed on the content of the transcript, an interview transcript was prepared in both English and Indonesian for analysis.

In 2014, the topic focus was information sources into the village, especially for SRI (System of Rice Intensification) (SRI-Rice, 2015), as well as coping strategies during the reconstruction of the weir (undertaken between 2013-2014) (Myers *et al.* 2015). In 2016, studies focussed on pest problems, information access and knowledge about pest management, and on management of irrigation infrastructure (Wurm *et al.*, in prep.). We report here on data relating to information access and pest management.

Questions included information about SRI, as representing a technological innovation in agricultural practices and one that is knowledge intensive. We thought that questions about SRI would be likely to reveal information about agricultural knowledge and information systems (AKIS). Other questions related to providing a context for the household.

5. Results

5.1 Household interviews

Household interviews revealed that pests and problems with access to irrigation water were the key issues causing low yields or crop losses. Further information about problems with water management, in this and similar irrigation developments in Sumba and Flores, is available elsewhere (Myers et al. 2012; Myers et al 2015; Wurm et al., in prep for 2017).

Types of pests and pesticides

We found that householders had difficulty describing and naming pests, potentially reflecting a lack of detailed knowledge about pests. Some eighteen (18) pest types were reported by householders, along with unspecified weeds and a group of pest descriptions that were too general to be identified further by the research team (**Table 1**). Regarding knowledge of pests, HHIs revealed a lack of knowledge of terms to describe pest types. It often took a long time and much discussion for a householder to find a suitable word to describe a pest. We found a lack of standardised naming of pests. For example, sometimes pests were named by the colour of their impact on the rice plant and other times by the colour of the pest itself. There also appeared to be a lack of knowledge of the life-cycle of pests, such as crop-threatening stem boring moths. For example, a pest was described as a kind of worm (after much searching for a suitable word to describe it) in one household and as a moth in another, in a manner that indicated a lack of awareness of the biology of the pest. There also seemed to be confusion about the mode of impact of pests, with different householders attributing the one pest to root damage and stem damage (HHI 2016).

A total of fifteen (15) types of pesticides (five of unknown origin or composition), three (3) herbicides, three (3) fungicides and five (5) non-chemical means of pest control were reported in the HHI (**Table 2**). Among the pesticides is the highly toxic Furadan (active carbofuran). Even though only one incidence of fungal disease was reported, three fungicides were reported as being used in a number of households – and in at least one household to treat insect pests.

Although all farmers interviewed were small-holders, the number of products used by any one household ranged from zero (0) to eight (8) products with a majority of households naming between 2-4 products. Few reported organic approaches, and if they were used, it was alongside chemical control measures.

Information sources and access

We found accessed information was very patchy among households within the village, even differing between neighbours. This is despite a number of targetted activities within the village, instigated by a number of NGOs, commercial and government actors. A total of seventeen (17) information sources were identified by household interviews during the 2014 and 2016 field trips (**Table 3**). These sources included structured groups (farmers groups, water users groups (P3A), NGO project participant groups), which served as a mechanisms for technology transfer from external agencies into the village. In addition there were ad hoc sources of information flow into the village, which included: a landholder who lives in SoE but farms in Linamnutu and brings new information; workshops by Syngenta; individuals who have relevant agricultural employment or formal education gained outside the village; newspaper articles; and, agriculture supply shops in the village and nearby Batu Putih township. In two cases individuals reported contacting the Department of Agriculture extension officer directly by phone for information (both were committee members of their farmer group).

Householders report that the main source of information about pest management and pesticides is the **Department of Agriculture extension staff** (either directly, or indirectly through Farmer's Groups), with agricultural shops, and Syngenta representatives, product labels or workshops held in the village as other village sources. Farmers were generally very satisfied by the quality of information provided by the extension officers (PPL), but reported inadequate presence (e.g. frequency of visits, numbers of households engaged with during visits). Some households reported not seeing an extension officer for several years, some reported monthly visits to the village and some reported annual visits. A key informant reported that a single extension officer is required to cover some 50 villages. We cross checked this with the extension officer directly, who explained they have just one village to service. This confusion about when and if extension services are available would prohibit famers from requesting services.

Clearly the variety of pesticides being accessed by so many farmers meant the **agricultural supply shops** are likely to be a major source of information (Table 2). However, few farmers identified them specifically as important sources of information (Table 3).

The **farmers groups** are a key mechanism for information entering the village, with some 67% of households reporting it as a source of information. Most of those householders who identified extension officers or the Department of Agriculture as sources of information also indicated that this information was accessed via the farmer group they belonged to. Despite membership of farmers groups being compulsory, some 33% of interviewed households were not members. Farmers groups typically include 20-25 members. In one case a farmers group consisted largely of an extended family network. In another case, a farming couple referred to separate men's and women's farmer groups that they each belonged to, explaining that because men and women have different interests, they discussed different topics. In many other cases the husband was the person who accessed information from the farmer groups, and in some cases the woman of the household did not know anything about the farmers group or how information was accessed, but knew that her husband did. In some households both spouses were familiar with the function of farmers groups, and in one household, the woman was the key decision maker in farming matters, as she had completed high school and her husband had not completed primary school.

The main mechanisms for accessing information flowing into the village is via training workshops in the field, meetings at the village office, or participation in NGO project group meetings. However, farmers frequently reported being unsure about how to access these mechanisms. The most commonly reported reason for not being a member of a farmer group or NGO project was not being invited. Other key reasons included the farmer group not being active or being a waste of time, that too much time and effort was involved in helping other with their land preparation, or finally householders reported being too busy with their own work to join these activities.

Information and innovation uptake

Household and key informant interviews uncovered issues with the sustainable uptake of information and longer term impacts of extension activities. There have been many **NGO projects** in the village focussed on vegetable growing, chicken rearing and aquaculture (Helen Keller International), emergency and disaster management and coordination (CARE), fruit tree growing (Christian International Service (CIS)-Timor) and others. Participating households are organised into householder groups, provided with materials and training and support for some period to support adoption. However, most households reported little ongoing adoption of the technology introduced during these programs. When asked why there was not ongoing adoption, non-explanatory answers were provided, such as "that project ended", "chickens all died", "the seeds ran out", "the fish died", but "the water tank they gave us is useful".

In order to address low rice yields prevalent in small-holder farms in NTT, the rice cultivation method known as **System of Rice Intensification (SRI)** (Doberman 2004; SRI-Rice 2015) has been introduced to Linamnutu, principally through the District Public Works Department. Some 88% of interviewed householders did know about SRI, and 12% of farmers interviewed did not know about SRI. Of the 45 (88%) of farmers who knew about SRI, 28 (55%) did not opt to apply it to their own farming. Of those 28 who did not adopt SRI, 12 (43%) felt they did not have enough knowledge to implement the method. An additional 6 (12%) households did not know about SRI at all. Thus insufficient knowledge was a barrier to 18 (35%) households adopting this method of cultivation. There were also biophysical barriers to the uptake which included, extra labour required, extra inputs (organic fertiliser which had to be made), but most importantly unreliable supply, and poor control over, irrigation water delivery, which worked against the careful water management required for SRI.

5.2. Key informant interviews and focus group discussions

Extension officers perspectives

We interviewed two extension officers with substantial experience in the case study village. These KIIs indicated Government extension services are scattered within a hierarchy, principally between Provincial, District and sub-districts levels and across Divisions within Departments. Because of this hierarchical and scattered positioning of staff, there was a lack of critical mass for support and mutual capacity building among extension staff. A KII indicated the position of extension staff as being structurally isolated, and poorly supported with technical advice, or training in facilitation or leadership. One extension officer reported their most recent training opportunity was in 2012. The internet was an important source of information for an isolated extension officer.

A KII indicated that extension officers may feel they are not listened to. One particularly concerning issue is regarding advice about pesticide use. According to this interviewee pesticides are being applied at much higher levels in the case study village, than are recommended by the Department. The respondent felt that the crop pests were now resistant due to this overuse. The extension officer will collect pest samples for identification during field extension services. However, before the identification is confirmed, farmers want quick action so “use two lids of pesticide instead of one lid in their mixes” thinking it will result in quicker results and control. The Pest Observers (specialised plant pest experts located in the District Offices), also explain health risks and proper-use instructions but the farmers ignore the dangers. The respondent believes from observing the soil structure that it is already saturated with pesticides. The Department is considering introducing and promoting integrated pest management programs (IPM) to manage the pesticide misuse. This program will require governments from Province to the lowest levels to work together. Since the new weir has been opened they have suggested this but farmers think it means more work, is too slow and that it’s just easier to use chemicals, according to a respondent.

The poor membership of farmers groups was identified as a major factor “holding the village back”. Just 302 out of the total 701 households (43%) were members of a farmer group. This makes it very difficult to deliver extension services, or for farmers to coordinate for pest management. A major driver of poor membership levels is an ongoing lack of financial transparency – an ongoing factor for the last decade in the experience of one respondent.

Role of agriculture supply shops

We interviewed the owners of three agriculture shops - located in the village, District capital and Provincial capital. The village agricultural shop owners reported getting their information about pesticides from the distributors in Kupang, or if there are problems with a specific pest. To get this information he phones the distributor and the staff from the So'E office may come to the village to advise directly. This shop owner knows about the extension officer but they do not interact and they do not have knowledge of when the extension officer is visiting the village. They believe that if there is a problem, the extension officer can consult with the number of department staff (i.e. the quality of their information will be high). However this takes time and the information is required quickly. Therefore, to get information quickly he rings his distributor. The shop owners distinguished their role from that of the extension officer by adding that the concept of how to control pests comes from the extension officer but the pesticide comes from the shop.

One agricultural supply shop in the Provincial capital reported employing nine extension officers and had established demonstration plots on land purchased for that purpose in the surrounding area. Extension services are provided to customers who come to them with questions. They were also considering purchasing land for a similar purpose in the case study village. This shop owner explained that by assisting farmers to become more successful, it was a win for the farmers and a win for the agricultural suppliers. This particularly articulate and well-informed proprietor indicated that improved yields were not about a lack of money but about a lack of information.

An agriculture supply shop owner in the District capital also provided extension support to farmers. As with the other shop owners, farmers would bring samples or questions to the shop for advice. However, this proprietor also owned and farmed padi in the case study village, and farmers would often come to them to see how they farmed and asked advice (i.e. it served as a de-factor demonstration plot).

One shop proprietor reported providing advice directly to extension officers, who came to them for advice on pest management. Specifically, farmers require a letter of recommendation for pesticides to use on specific pests, and it was this recommendation an extension officer may seek advice on. (We were not able to verify the purpose of the letter of recommendation or this collaboration with an extension officer. It could indicate a potential conflict of interest, or a valuable source of information to a resource poor extension officer.)

Non-Government Organisation (NGO) perspectives

In 2016, a key informant interviewee identified some factors that may contribute to unsustained impact of many NGO projects. Firstly, governance structures for some NGO projects are very complicated and this may impact on how the project presents to the community and how responsive the project can be to the community itself. Secondly, NGO projects focus at the household level and do not integrate well with community level processes or organisation. NGOs could more systematically evaluate completed projects for what works and for whom, using “appreciative inquiry” or “positive deviance”. This is where individuals who demonstrate high levels of innovation or resilience may be identified and studied to find out how they arrived at the practices they use. Project participants could be chosen who are doing different things, and who are “adopters”. However, the interviewee explained that community processes may also hold back progress. For example, one NGO found that many farmer groups existed on paper only. For this reason, they then established project specific groups. However these groups were abandoned by the community once the project funding ceased.

Regarding leadership and uptake of innovation, language was identified as a barrier by this interviewee. This included lack of specificity – for example when expressing emotions people might just say they feel “emotion” rather than specifying the type and strength such as, for example, irritation, anger or rage. In some situations it is not polite to say “no”, so people will just provide an answer or comment rather than say “no”. Also there may be class barriers, or clan structures that influence communication. For example, in families or clans it is customary for a certain level of unquestioning acceptance of the author and opinion of a clan or family leader. This may lead to a lack of sharing of information, because leadership or power is concentrated. Further, in some situations this person in whom power or responsibility is concentrated may not be knowledgeable about the topic.

The function of farmers groups is a major problem for engagement and information flow into the village. There is a lack of regular meetings, a lack of discussion, no schedule or calendar for farmer group activities, no agenda, no reflection between crops of what the problems were. Reliance on people to people, ad hoc communication is not effective. NGO respondents believed that farmers needed to be encouraged to be active in asking for help. For example, they have provided contact details, such as mobile phone numbers, but they are never contacted. The NGO staff reflect on whether they are taking the right approach, and also asks the village contact directly for feed-back on their work.

In the opinion of these respondents, Village Law (2014) presents a great opportunity, because it means related funding to the village (Dana Desa), to resource themselves to plan, make decisions and acquire information.

Regarding information flow beyond the initial recipient, respondents noted that the head of the farmers group may accumulate knowledge and resources and not share them. This can cause the formation of breakaway break-away group. This may cause problems as the breakaway group members will still be registered with the original group, so may not have direct access to resources acquired in their name by the former group. It is common for people to be a member of two farmers groups for example if they own land in more than one village.

This group of respondents believed farmer group functions should be formalised in policy so that they were required to provide regular meetings, registration books for visitors so that different groups could coordinate more effectively, account books for finances, meeting records etc. The respondents knew of a case where this was done voluntarily in Kupang District, but they understood that there was no legal requirement for book-keeping by Farmers Groups at all.

General perspectives on the role of researchers

KIIs revealed that NGOs have engaged with researchers, in order to draw upon external research capacity. For example, they used reports or presentations resulting from the ongoing CDU/UNDANA research at Linamnutu. They also used visualisation tools that CDU researchers (not directly involved in the EIFI or PB CRC program) provided training in. In addition, they also contracted local professors from UNDANA as consultants on specific topics. For example, Dr Welhelmus Mella was contracted to advise on agronomy and came to the village to provide workshops and support for farmers. These were greatly appreciated and well received in the village as a source of encouragement for the farmers; the fact that a professor would come and work with them and indicated they were on track. Farmers are really keen to learn from Dr Mella. According to the key informant, farmers felt proud to talk to Pak Mella and very motivated. KII indicated that the Government is not able to create this motivation.

The research team has been working in the village intermittently since 2009. During that time the village leadership and community have repeatedly indicated that the research undertaken by CDU, UNDANA, UKSW and UGM has benefitted the community by creating a line for communication between the village community and the District Government (specifically the District Planning Board). At the conclusion of each major field trip, the research team accompanied by a delegation from the village report back on findings open seminars in the village, and to the District Planning Board Offices in So'E.

In 2014, the Secretary of the District Planning Board commented at that report back seminar that the ongoing reporting of findings had assisted them in identifying priorities in a development that experienced so many set-backs despite considerable investment of funds. There is scope to improve the substance of this advice with the research team formally reporting the District government in more detail.

In 2016, a member of the village leadership described to the research team the value of researchers asking questions within the community. He gave the example of 2009 when the focus of research was irrigation water management. He indicated that just the act of researchers asking questions about what was or was not working and why, made the community and P3A leadership reflect on this issue themselves. Subsequent to 2009, the community focussed on improving the governance of irrigation infrastructure at the village level. This system involved organising water user groups around blocks of irrigated paddy fields. In 2016, this system had been revised and irrigation management is now organised on the basis of the five gates from the primary channel that ultimately supply water to the tertiary and quaternary channels that irrigate the farmers' fields. Thus village leaderships had identified two mechanisms by which research report back and problem framing have directly assisted farmers themselves in planning and setting priorities.

In a village focus group, participants noted that the EIFI research program had moved very slowly, and that some farmers were keen for concrete results, having seen the problems now clearly and accurately described. The local university in particular was mildly criticised for not engaging on the ground. These criticisms reflect a trusted relationship (i.e. being able to speak freely) and a desire for further assistance from universities to solve identified problems.

Table 1. Rice pests reported in household interviews and percentage (%) of households reporting each. These are listed in order of frequency of reporting by households, based on 2016 data. (Source: Wurm et al. in prep 2017)

Pests			Households (number and %) reporting
Pest names reported by householders (and literal translation by interview team)	Pest's likely English name (determined by research team)	Pest's likely species name (as identified from resources on IRRI, n.d.)	
Other pests and diseases not consistently named by household – e.g. <i>hama akar</i> (root pest), <i>hama daun</i> (leaf pest), unknown pest, <i>Duan tanaman menjadi kering</i> (plant leaf drying); <i>Hama kuning</i> (that attacks the roots and turns plant reddish yellow); <i>ulat coklat</i> (brown worm, larvae); <i>ulat kecil</i> (small worm);	-	Not able to determine further	22 (47%)
<i>Penggerek batang</i> (stem borer) OR <i>Ulat batang</i> (stem worm, larvae) OR <i>hama batang</i> (stem pest)	Stem borers	Not able to determine further	19 (40%)
<i>Hama putih</i> (white pest)	White stem boring moth	<i>Nymphula depuntalis</i> OR <i>Scirpophaga innotata</i>	18 (38%)
<i>Walang sangit</i> (no literal translation)	Rice bug	<i>Leptocorisa oratorius</i> OR <i>L. acuta</i>	12 (26%)
<i>Hama merah</i> (red pest)	To be confirmed –leaves turn red		11 (23%)
<i>Hama kuning</i> (yellow pest) OR <i>Berwarna kuning</i> (coloured yellow)	Yellow stem boring moth	<i>Scirpophaga incertulas</i>	11 (23%)
<i>Wereng coklat</i> (brown bug) OR <i>Hama coklat</i> (brown pest) OR <i>Wereng</i>	Brown planthopper	<i>Nilaparvata lugen</i>	10 (21%)
<i>Keong mas</i> (golden snail)	Golden snail	<i>Pomacea canaliculata</i>	8 (17%)
<i>Kutu putih</i> (white louse) OR <i>Hama kutu putih</i> (white louse pest) OR <i>Wereng puti</i> (white bug)	Mealy bug	<i>Brevinnia rehi</i>	6 (13%)
<i>Ulat</i> (worm, larvae) OR <i>Ulat putih</i> (white worm) OR <i>Ulat daun</i> (leaf worm)	Rice caseworm moth	<i>Nymphula depunctalis</i>	3 (6%)

<i>Kutu putih</i> (white louse) OR <i>Hama kutu putih</i> (white louse pest) OR <i>Wereng putih</i> (white bug)	Mealy bug	<i>Brevinnia rehi</i>	6 (13%)
<i>Wereng kuning</i> (yellow bug)	Not yet determined	Not yet determined	3 (6%)
<i>Wereng hijau</i> (green bug)	Not yet determined	<i>Nephotettix virescens</i>	1 (2%)
<i>Hama kutu loncat</i> (jumping louse pest)	Psyllid	Not yet determined	1 (2%)
<i>Belalang</i> (grasshopper)	Grasshopper	Not yet determined	1 (2%)
<i>Gulma</i> (Weeds, not specified)			2 (4%)
<i>Penyakit karat</i> (rust disease)	Rust	Not yet determined	1 (2%)
<i>Burung</i> (birds including <i>Burung pipit</i> - sparrow)			1 (2%)
<i>Tikus</i> (rats)		<i>Rattus</i> sp.	1 (2%)
<i>Sapi</i> (cattle)		<i>Bos</i> p.	1 (2%)

Table 2. Pesticide applications used for common pests of paddy field in Linamnutu Village, reported in June/July, 2014 and 2016. (Source: Wurm et al. in prep 2017)

Pesticide brand name	Pesticide contents	Pest(s) for which pesticide is designed	Source
<i>Virtako</i>	chlorantraniliprole + thiamethoxam	rice planthoppers and rice leaffolders	http://www4.syngenta.com/what-we-do/crops-and-products/brands ; (Chen et al. 2016)
<i>Alika</i>	Thiamethoxam + Lambdacyhalothrin	insecticide; especially sucking pests	https://www.syngenta.co.in/insecticides
<i>Chix</i>	Betacypermethrin	Leafhoppers (that spread tungro virus in rice)	http://jardinedistribution.com/agchem-products/insecticides/chix/
<i>Furadan</i>	carbofuran	Insecticide, nematicide	http://www.furadanfacts.com/faqs.aspx
<i>Darmabas</i>	BPMC Fenobucarb (2-sec-butylphenyl methylcarbamate)	Insecticide	http://www.sinoharvest.com/products/BPMC.shtml
<i>Matador</i>	Lambda-cyhalothrin	Insecticide	https://www.syngenta.ca/Productsdetail/Matador-120EC
<i>Mipsin</i>	(2-propan-2-ylphenyl) N-methylcarbamate	Insecticide, fungicide	http://www.phenomenex.com/Compound/Mipsin
<i>Curacron</i>	Profenofos	Insecticide, miticide	http://www.syngenta-us.com/labels/curacron-8e
<i>Sidamethrin</i>	Sipermetrin	Insecticide	http://www.petrosida-gresik.com/id/bisnis/insektisida/sidamethrin-50-ec
<i>Santafuron</i>	Metil metsulfron	Molluscicide	http://santanisejahtera.com/index2.php?product=14
<i>“Alkan”</i>	Not found	Insecticide	Not found
<i>“Adokan”</i>	Not found	Insecticide	Not found
<i>“Booster”</i>	Not found	Insecticide	Not found

"Sponsor"	Not found	Insecticide	Not found
"Manufur"	Not found	Insecticide	Not found
"Nofaris"	Not found	Herbicide	Not found
Logran	Butafenacil + triasulfuron	Herbicide	https://www.syngenta.com.au/product/crop-protection/herbicide/logran-b-power
Roundup	Glyphosate	Herbicide	http://www.roundup.com.au/
Filia	Tricyclazole + propiconazole	<i>Fungicide for control of neck blast (Magnaporthe oryzae) on rice</i>	http://news.agropages.com/News/NewsDetail---15970.htm
Topsin	Thiophanate methyl	Fungicide (note: not apparently for rice)	http://www.upi-usa.com/agricultural-products/topsin
Amistar	Azoxystrobin	Fungicide (note: not apparently for rice)	http://apvma.gov.au/node/13096
Organic (alami)	Organic	Miscellaneous	HHI
Koolatron	Electronic insect repeller	Insecticide	http://koolatrononline.stores.yahoo.net/electronic-pest-control.html
Manual removal	Manual removal	Golden snails, weeds	HHI
Lights at night	Light insect repeller	<i>Wereng coklat</i> (brown bug)	HHI
Cans on string	Audio bird repeller	Birds	HHI

Table 3. Household sources of agricultural information identified by households during interviews in 2014 and 2016.
(Source: Wurm et al. in prep 2017)

Sources identified by householders	No. of HH (%)	
	2014	2016
Department of Agriculture or PPL (extension officer) specifically	20 (39%)	36 (71%)
Farmers Group	18 (35%)	34 (67%)
NGO - HKI, CIS-TIMOR, CARE, NIPPON Koei, Farmers for Food	10 (20%)	19 (37%)
Family or inherited	10 (20%)	3 (6%)
Self-taught, learning by doing	9 (18%)	3 (6%)
Neighbours or other farmers	6 (12%)	12 (24%)
Public Works Department staff	4 (8%)	2 (4%)
Village leadership or elders	3 (6%)	1 (2%)
Previous study or employment outside of village	2 (4%)	0
Bottle labels or newspapers	2 (4%)	0
Agriculture supply shops (in Linamnutu Village or Batu Putih township)	2 (4%)	1 (2%)
Catholic Mission or Church in Linamnutu village	1 (2%)	1 (2%)
Catchment management authority (DAS)	1 (2%)	0
Internet	1 (2%)	0
P3A	1 (2%)	10 (20%)
Student field study (KKN)	0	5 (10)%
Syngenta company workshops	0	1 (2%)

6. Discussion & Conclusion

Overall, the community of Linamnutu rice farmers appears not to be empowered (Ramirez, 1997; Bartlett, 2004). Information flow is principally one-way via an inadequately resourced technology transfer model, which is provided not requested. Participants independently join, or are invited to join farmer groups or NGO project groups, through which information can be accessed. However, securing invitations is an opaque process, based upon something other than individual need. Even those chosen to participate in an NGO project did not know why or how they had been chosen in some cases. There is a problem with opportunities to access the information resources available in the village, and farmers are not clear about their rights to participate.

The low level of information sharing among households is surprising - we found even next door neighbours had differing understandings of fundamental agricultural processes or knowledge. Even knowledge and skills gained in farmers groups of NGO projects did not appear to spread far from the original recipient in many cases. Perhaps the “wrong” people are being invited. There may be social structures that normally guide the process of knowledge acquisition, such as there being identified positions of authority for accessing knowledge (e.g. heads of families or clans), rather than an egalitarian process of participation. This needs to be explored further as a priority, in order to promote informed pest management in the community.

As a result of these factors, household interviews indicated that many farmers are isolated and required to draw upon their own or their family’s resources to make decisions, resort to passive strategies such as observing at a distance the practices of others, or not take any action to solve problems. Interview responses indicate that many households may not be well informed about pest management. Thus inappropriate use of pesticides may result in increased pest problems or human health impacts (Sneldera et al. 2009). An isolated farmer is a missed opportunity for the village community. Studies elsewhere found the behaviour of members within individual farmer’s social networks is most important for adoption by that farmer (Matuschke and Qaim 2009). However, in the case study village links among farmers appear to be broken in some cases.

As a consequence of the status quo, strategies that require coordination, such as strategic pest management, are unlikely to occur or be fully effective. Similarly using the management of water levels to adopt new technologies such as SRI is also difficult if not impossible if water delivery is not well controlled, and knowledge requirements are not met (Noltze et al. 2013). This potentially places households and the community at risk of unmanaged, unfolding pest outbreaks that could otherwise be averted with early action. The increasing area of paddy fields under development means this risk is increasing at the District and Provincial levels.

One or two well-regarded but overworked extension officers are not able to meet the needs for knowledge and advice in Linamnutu. Further, the efficacy of extension services under the current model is underpinned by effective farmers groups. While some farmers groups are functional and a valued source of information for members, others are considered a waste of time by members, are inactive or periodically active, or exist only on registration papers (according to interviewees), and many farmers choose not to waste time joining them. Despite membership being compulsory in order to access subsidies and participate in extension activities, just 43% of households were members of a farmer group. Thus, renewal of farmers groups and capacity building towards community empowerment should be a priority (Raya 2016).

Overall, knowledge sources or providers also appear to be siloed from each other. For example (according to a key informant interviews), extension officers and agricultural supply shops do not coordinate or communicate, NGOs have not adequately integrated their activities into other community processes and research services (e.g. universities) work within in a separate, closed process.

Invariably, interviewed farmers wanted to be rice growers in the case study village, many were satisfied with their farmer group, and not all farmers are isolated and disempowered. The status quo is perhaps even beneficial for some farmers or community leaders. White (2017) recently reminded us not to be deluded by the myth of the harmonious village on which much policy relating to villages is based. Previous research in the case study village found land holdings sizes were mostly well under the original grant of 2 ha, while a small number of individuals had much larger holdings (up to 25 ha) (Harkness 2013). This skewed land holding structure in top-down irrigation developments is reported elsewhere in similar developments (Jayne et al. 2003). This can lead to production issues – at that time, 25% of paddy fields were fallow and not farmed (Harkness 2013). Further, almost 50 % of households in the case study village have been assessed as eligible for subsidised rice. This results in a flow of subsidised rice into the village. In the case study village, a decision has been made not to allocate all of the subsidised rice to those identified as being eligible, in order to be “more fair” and “avoid jealousy”. It is not known if the process for this reallocation is transparent, nor how the decision was made and by whom. An overall lack of transparency in other village level functions was uncovered in this study: financial management of farmer groups; processes and rights to farmer group membership; access NGO trial projects or other information resources. Some village members may be beneficiaries of this disempowerment and may be resistant to changing the status quo. This possibility will need to be accounted for in any further work on farmer empowerment.

7. Recommendations

Information unavailability is a barrier to innovation and adoption. This can be addressed by investing in extensions services, supporting the ongoing development of farmers groups and reducing the isolation and silo-ing among key sources of information into the village (e.g. agriculture supply shops, NGOs and extension staff). The effectiveness of farmers groups is also critical to the improvement of rice farming and the appropriate use of pesticides.

In addition, the isolation of individual farmers needs to be addressed, as these farmers affect the permeability of the village community to information flow. This process will require better understanding of the social networks of these isolated farmers (or lack thereof), such that those networks can be augmented. There needs to be better understanding of the social structures which determine responsibilities for knowledge acquisition within households, families or neighbourhoods (Raya 2014). These investigations may also focus on “adopters” for example.

The village community is open to change, and found that the questions asked during research prompted reflection among village community members on why things were not working. As a result village leadership is trialling new ways of organising water user groups. Other examples of innovation include: desire to grow irrigated rice in the first place, establishment of aquaculture ponds since 2011, increased areas of vegetable growing in household gardens since 2014 (supported by HKI projects), and SRI adoption. Thus the community as a whole is willing to learn, and there have been successes. Further investigation of the bases of these successes is recommended.

From the wider perspective of the Agricultural Information and Knowledge Systems (AIKS; Ramirez, 1997), within which farming practice is situated, we found broken links and silos at all levels among actors – broken links between households within a village, between farmers and extension support, between farmers and farmers groups, and among the many layers of government responsible for extension; universities, governments, agricultural enterprises and NGOs siloed from each other despite the potential for collaboration.

Consequences of the lack of access to information include:

- HH food shortages; in fact by 2017 some 50% of households in the village were officially assessed as eligible for subsidised rice, despite living in an irrigated rice development.
- Poor agricultural and social performance indicators, and wasted resources for Districts.
- Poor return on investment for Central Government.
- Potential biosecurity threats on the northern Australian border.

Alternative approaches to extensions services are needed that are farmer-driven and demand-driven. This requires a community of empowered farmers who are able to respond to change and risk (Fujii, 2016). It requires extension officers with advanced communication and leadership skills, who are facilitators and information brokers working in collaboration with farmers, facilitating links with knowledge developers and providers, and supporting leadership in farmers (Cahyono, 2014; Ramirez, 1997). A previously successful model of farmer driven training and extension is the Farm Field School (FFS) model (Friis-Hansen and Devcog, 2012; Pontius et al. 2002). This was originally developed in Indonesian rice farming areas, to promote integrated pest management in the 1990s, in the face of excessive use of pesticides (Braun and Duvescog 2008). This became a globally significant movement and was transferred to Mozambique (Fredrix 2014), Bangladesh (Banu and Bode 2002), Sri Lanka, Philippines, Cambodia and China (van den Berg 2004). Some authors have cautioned about the need to adapt the FFS model to the local contexts (Banu and Bode, 2002; Feder et al. 2003). Thus a case study in an irrigated rice development may be useful in helping change or enliven the processes currently available to farmers in much of NTT. Knowledge of this tool appears to have been lost in the political turmoil of Indonesia’s transition to democracy, or in the apparently top-down approach to these “blue-print” development in NTT (Golding 2015). This important strategy for farmer empowerment needs to be revisited, in order to stem the lack of success in this case study village, in eastern Indonesia in general and in the 49 new irrigation developments currently underway in the Widodo Government.

8. Links between this project and other PBCRC research and teaching

This \$30,000.00 project has been successful in linking with other PB CRC-supported activities, including teaching and research. In addition, it has provided opportunities to strengthen and broaden current research and cross-institutional partnerships. It has also laid the ground for planning future projects in the case study village and in the region.

Bi-cultural engagement models (project PBCRC4041): This project in Indonesia sits within the larger CRC project *Building resilience in indigenous communities through engagement – a focus on biosecurity threats*. This project ultimately aims to mitigate risk, through effective engagement that builds the community's capacity to respond to biosecurity threats and critical incidents.

The key outputs of that project are engagement protocols based on the knowledge theory of *Mirrwanna* and *Wurrkama* (Ford 2010). These protocols facilitate empowerment of Indigenous and Maori people during the engagement process with researchers, biosecurity professionals and agency staff. They also build capacity of these professional staff to engage effectively. The uptake phase of PBCRC 4041 will now pilot these protocols. This pilot phase is based on "ground up" theory, whereby theory is in the service of solving local problems, and in an "empowerment" framework.

The protocols and principles they are based on are also applicable to partnership development for biosecurity and pest management in eastern Indonesian rice growing developments. The work in Indonesia (PBCRC4140) provides evidence for poor community engagement and its consequences – a lack of community empowerment and broken links in agricultural knowledge systems – and ultimately resulting in underproduction and food shortages. The case studies in NZ, Australia and Indonesia have identified and attempted to address the same problem – ensuring meaningful, effective and culturally appropriate engagement with an empowered community.

Enriching teaching: Grant PBCRC4140 was used to support the collaborative Eastern Indonesian Field Intensive (EIFI) program (for more details refer to the link at <http://www.cdu.edu.au/environment/intensives/eifi>) by providing operational support in the 2014 and 2016 offerings. The findings and outputs of project PBCRC4140 and PBCRC4041 are also being developed as a case study within in the *ENV521 Community engagement for biosecurity and NRM*, a unit in the Master of Environmental Management at CDU and the national Master of Plant Biosecurity at Murdoch. ENV521 was developed under the auspices of a collaborative project funded by CASR and the Cooperative Research Centre for National Plant Biosecurity Limited in 2010. Field work in 2017 underpinned a final minor thesis of a student in the CDU Master of Environmental Management (Tamanna, 2017).

Augmenting research: The EIFI program and other research activities by CDU networks in eastern Indonesian led to the successful AIIRA grant (\$150,000) completed in 2016 (Myers et al. 2015). This work undertook related studies in irrigation developments in Sumba and Flores. This study indicated similar and widespread problems with communication and lack of empowerment in other irrigation developments.

This research also correlates with findings of a PB CRC-supported PhD by a senior UNDANA staff member, CDU PhD graduate and research team colleague, Dr I Wayan Mudita (Mudita, 2013).

Strengthening networks: The funds provided by the PB CRC enabled the continuation of the EIFI at critical time. While the program has managed on ad hoc funds until 2013 (via a MEM student project and minor internal research project grants) the \$30,000.00 received, lent stability and status to the project. As indicated elsewhere, the fact that the CDU/UNDANA team has returned to TTS and the case study village of Linamnutu for such a sustained period has built a valuable social capital resource that will underpin new research into the problems uncovered and explore application elsewhere.

CARE (Indonesia) Kupang have invited CDU to partner with them in further projects.

The Leadership in Desa Linamnutu have invited the EIFI team to return July 2018 to discuss and trial the implement recommendations arising from this research. We aim to use this opportunity to discuss the issue of farmer empowerment, and the potential to trial FFS model of extension with the partnerships forged during this project.

Laying foundations for future research: The insights gained in Linamnutu, TTS, have relevance elsewhere in eastern Indonesia, particularly in light of the 49 new dams planned by President Widodo. However, it is also relevant in Timor Leste, where CDU has established links with senior staff in the Ministry of Agriculture.

The Tri-lateral agreement working party among Indonesia (NTT), Timor Leste, Australia (NT) have is seeking projects. TL Ministry of Agriculture colleagues have proposed a tri-lateral project focussing on farmer organisations, on the basis that farmers need to be organised to negotiate prices, coordinate for transport to markets, access and apply knowledge and information etc. This project would bring together previous projects in:

- Organic cashews in Timor Leste - Amaral 2010; Guterres 2010; Guterres, 2017; Peng et al. 2012, 2013, 2015'
- Irrigated rice in NTT - Harkness, 2011; Golding, 2015; Myers et al. 2012, 2015; Narayan et al. 2017 and this project and
- A new program for coconuts in Timor Leste.

This proposed project will draw on existing networks: Cashews (CDU-TL Ministry of Agriculture), rice (CDU, UNDANA, TTS Planning Board, District Department, Desa Linamnutu, PB CRC), coconuts (TL Ministry of Agriculture; special Zone for Economic Development project), and align with relevant government documents such as the Government of Timor Leste (2011) Strategic Development Plan 2011-2030, and possibly Australia's Developing the North CRC.

The rice growing areas of west Timor are being expanded under Central Government policy. Thus the "catching mitt" for rice pests is expanding just one hour's flight north of Darwin. The vast areas of native rice on northern floodplains and emerging cultivated rice growing areas across northern Australian comprise the "other catching mitt" for pest and disease introduction. We applied unsuccessfully in 2015 for a small PBCRC grant, to develop village level tools for biosecurity risk assessment. We will explore further the potential funding for this, as part of a larger future project.

In 2018, we will be seeking funds for a period of consultation and report-back with partners in the EIFI/PB CRC project, during which Village, District and Provincial government levels will be consulted about the best direction for future work. Specifically, this work will involve developing a new, locally appropriate extension model, based on bottom up approaches. Initially, we will review the literature on the evaluation of Farmer Field School methods, to identify why they may not have been sustained or applied in NTT and what finer scale issues need to be considered when adapting the FFS model to local sites. . These ideas will then be discussed with farmers, village leadership, extension officers and agency staff. These discussions will inform the development of the larger, new project on farmer organisations (described above).

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11. List of Appendices

Appendix 1: List of Data, Figures, Report and Manuscripts

Appendix 2: Questionnaires used in interviews and focus group discussions

12. Abbreviations/glossary

ABBREVIATION/TERM	FULL TITLE/TRANSLATION
AKIS	Agricultural knowledge and information systems (Ramirez 1997)
<i>BAPPEDA</i>	<i>Badan Perencana Pembangunan Daerah</i> (Regional Planning and Development Board)
CDU	Charles Darwin University
<i>Dusun</i>	Sub-village of hamlet (a sub-division of village)
FGD	Focus group discussion(s)
GP3A	<i>Gabungan Petugaa Pengaturan Pengelola Air</i> (Association of water user groups or of officers)
HHI	Household interview(s)
<i>Kabupaten</i>	District
<i>Kepala desa</i>	Head of the village, an elected administrative leadership position
KII	Key informant interview(s)
<i>NTT</i>	<i>Propinsi Nusa Tenggara Timor</i> (Province of Eastern Indonesian)
<i>P3A</i>	<i>Petugas Pengaturan Pengelola Air</i> (water user group, or an officer of a water user group)
<i>PPL</i>	<i>Petugas Pertanian Lapangan</i> (Department of Agriculture Extension Officer)
<i>RT</i>	<i>Rukun tetangga</i> or neighbour solidarity units (a sub-division of RW)
<i>RW</i>	<i>Rumah warga</i> or community solidarity units (a sub-division of <i>dusun dusun</i>)
<i>TTS</i>	<i>Kabupaten Timor Tengah Selatan</i> (District of South Central Timor)

UNDANA	<i>Universitas Nusa Cendana</i> (University of Nusa Cendana)
UKSW	<i>Universitas Kristen Satya Wacana</i> (Satya Wacana Christina University)

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Linamnutu Village leadership and community: We sincerely thank the Desa Linamnutu community for their hospitality, and their support of our ongoing engagement with the village since 2009. The EIFI team has learnt so much from the many discussions and interviews on the benefits and challenges of rice farming. We hope that our efforts in asking questions and presenting our findings has in some small way also been of benefit and use to the village community. This is our primary concern. In 2014, Pak Agus Nome was *Kepala Desa*. In 2016, we visited during a transition between *Kepala Desa* appointments, and thank Pak Mateos Tse in particular for supporting and allowing our visit in June 2016. We also thank Pak Mateos for his generous invitation to attend the ceremony to mark the first 12 months of the new weir in 2016, and for convening the focus group discussion in May 2017.

University staff at UNDANA and CDU: In 2014, Ibu Jenny Markus and Dr Gomer Liufeto (UNDANA), Penny Wurm, Bronwyn Myers and Pia Harkness (CDU), led the field team. Mr Donan Satria Yudha participated in the pre-field briefing sessions. In 2016, HH interviews and village data collection was undertaken by Jenny Markus, Wida Bunga, Norman Riwu Kaho and Wayan Nampa, staff members at Universitas Nusa Cendana (UNDANA), Kupang, and Kenneth Evans, Monishka Narayan and Penny Wurm, staff members from Charles Darwin University (CDU), Darwin.

In 2017, field work was implemented by a much smaller team of two university staff (Penny Wurm and Jenny Markus), two translators and cultural guides (Arny Boimau and Jaqueline Lakilaf) and one MEM research project student (Bijmoon Tamanna).

EIFI student researchers: We would like to acknowledge the contributions of the capable and motivated junior staff and senior course-work students from UNDANA, Universitas Kristen Satya Wacana (UKSW), Universitas Gadjah Mada (UGM) and CDU, who provided research support as interviewers, translators, field data collectors, data managers, data interpreters and final seminar writers and presenters in 2014 and 2016. Their comments, questions, insights and commitment to the field work made this project possible.

- **UNDANA:** In 2014, Hironimus Seran, Nimrod Umbu Romu, Nobrita Fallo, Aro Balol, Frans Terah, Marlyn Lobo, Alexius Berkanis (Agriculture Agri-business and Agro-technology). In 2016, Uria Atolo, Charles Banani, Agrilis Iraina Labuh, Qrezpy Pariamalinya, Fatrisia Sapala (Faculty of Agriculture), and Ignatia Manek and Asti Malelak (Faculty of Public Health).
- **UGM:** In 2014 Gaudensius Duhan (Master of Biology)
- **UKSW (Junior staff):** In 2014, Yesaya Sandang (Tourism), Yulindra Numberi (Biology), Suszallina Allo Posende (Nursing), Mila Paseleng (Education Technology)
- **CDU:** In 2014, Diane Bowman, Diego Alvarez, Katy Wishart, Michelle Mackie (Bachelor of Environmental Science), Hanna Markones and Sandra Reimer (Master of Environmental Management). In 2016, Janine Abecia, Bijmoon Tamanna, Jigme Tshering (Master of Environmental Management), Roojan Bista (Bachelor of Environmental Science) and James Miller (Bachelor of Engineering).

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14. Appendix 1: List of Data, Figures, Report and Manuscripts

Figure 1. Location of Linamnutu Village, Timor Tengah Selatan (TTS), in Nusa Tenggara Timur (NTT), Indonesia.

Table 1. Rice pests reported in household interviews and percentage (%) of households reporting each. These are listed in order of frequency of reporting by households, based on 2016 data.

Table 2. Pesticide applications used for common pests of paddy field in Linamnutu Village, reported in June/July, 2014 or 2016.

Table 3. Household sources of agricultural information identified by households during interviews in 2014 and 2016.

Technical reports

Wurm P., Myers P., Markus J. and Liufeto G. (2015). Coping strategies during weir repairs in Linamnutu Village, west Timor: Technical report on EIFI field studies in 2014. Unpublished Report, Charles Darwin University and Nusa Cendana University.

Wurm P.A.S., Markus J., Evans K., Narayan M., Bunga W., Nampa W and Myers B.A.M. (2017). *Factors affecting agricultural production of small-holder rice farmers, Desa Linamnutu, TTS, NTT: Eastern Indonesia Field Intensive 2016*. Unpublished report, Charles Darwin University, Darwin, Australia and Universitas Nusa Cendana, Kupang, Indonesia.

Thesis completed at Charles Darwin University

Tamanna B. (2017). Assessing barriers to demand-driven information acquisition in an irrigated small-holder farming community, eastern Indonesia. Unpublished thesis submitted in partial fulfilment of Master of Environmental Management, Charles Darwin University, Darwin.

Manuscript in preparation

Wurm P.A.S. et al. (2017) Barriers to information access and acquisition for small-holder rice farmers: a case study from eastern Indonesia. Identified journal is *Journal of agricultural education and extension*, an open access peer review journal published by Taylor and Francis see <http://www.tandfonline.com/action/authorSubmission?journalCode=raee20&page=instructions#Checklist>.

15. Appendix 2: Questionnaires used in interviews and focus group discussions

HHI Data collection sheet – EIFI 2016

Introduction to the activity

Who is involved in the Project?

The research will be conducted by staff and senior students from Nusa Cendana University and Charles Darwin University.

We have the support of District Planning Board (BAPPEDA TTS) and the Village Head. BAPPEDA TTS is assisting with logistic support in the village and will host a final presentation in the District Capital.

The team has approval from the CDU Human Ethics Committee (permit no. HR16054).

What will the researcher(s) do, and when?

We are interested in finding out how agricultural information reaches communities and then is shared among the farmers within those communities. It is interested in supporting studies that will help improve the exchange of agricultural information in farming communities, especially information about biosecurity.

What will the researchers do with the information they collect?

The information will be used to create a report on what people experience and think in this village. Individual households will not be reported on. Instead, information from all households will be considered together. This will give an overall view of

what makes information useful and available to most people. It will also help work out why some people are missing out on information.

This report will be provided to the village leadership and administration, farmers groups and water user groups. It will also be given to everyone who provides information to farmers in the village, such as extension officers, Government, and NGOs. We will also plan to publish the findings in a journal so that people elsewhere in Indonesia and the world can learn from this research in this village.

The information we collect will be written in special note books, which will be given to the research leader for safe keeping at the end of the study. The information in the note books will be transferred to computer in a way that does not identify individual households. This anonymous information will be used to work out overall patterns, problems, ideas and recommendations. These will then be used to write the report.

What will happen to the results of the research?

We will report back to the village community on what we have found, at a special presentation at the end of the field work. We will also give the community copies of the report.

We will also give copies to the District Government.

We aim to find a solution too... but we may not be successful. Our success will depend on us asking the right questions and the household, farmers' groups and water user groups and others providing useful information to help solve problems.

Asking for consent for all people being interviewed:

First we will explain what we would like to talk about and the aims of our research.

Then, if you agree to participate we will start. You don't have to participate and there will be no penalties or bad feelings if you don't want to. We won't tell anyone else what you have told us.

When we report our findings we will make sure that no one will be able to tell what information has come from you. All information from Linamnutu will be combined so that individual people cannot be identified.

The information will be used to create a report on what people experience and think in this village.

We will report back to the village community on what we have found, at a special presentation at the end of the field work. We will also give the community copies of the report.

We will also give copies to the District Government.

So, to explain what we would like to find out:

- We are interested in how farmers get the information they need about farming (for example information about: pests problems, improving yields especially of rice, the choice of crops, when to plant, new methods such as SRI or any other information related to agriculture and farming).
- We are interested in your experience, observations of others and opinions on improvements to information access and sharing.
- We are also interested in historical context of how things were done:
 - When the original (now destroyed) weir was first built,
 - When people first arrived and started farming,
 - "Before" and "after" the new weir was built
 - Maybe after certain advisors or others have stayed in the village,
 - When people have gone away for training,
 - How things are done now, and if that different to the past

We hope that our interviews will provide information to help farmers access information they need to produce good yields for their household.

Questions – Kepala Desa:

1. Where do farmers get information about farming in Linamnutu?

(Interviewer Tips: Farmers Groups; P3A; GP3A; Village leadership elected; Village leadership - toko adat; Commercial supplier; NGO; Church; Din Pet Extension officer; Family; Neighbour; Friends network)

2. Where does kepala desa get information from?

(Probes: Government officers, other kepala desa, consultants/advisors, NGOs, church....)

3. Has farming information ever resulted in better farming? – can you give examples – maybe examples of information that wasn't useful and other examples of information that was useful (e.g. programs that have resulted in improved yields or better water management) ?

4. Are there examples of situations where a lack of information led to problems with farming?

5. Farmers groups:

- Where are there farmers groups now (and which farmers are members of these groups – e.g. farmers from one block or RW/RT in each farmer group)? Which ones are active? (refer to map)
- How are farmers' groups formed?
- Who can become a member?
- Are any farmers excluded from farmer groups – e.g. not owning land?
- How do people join?
- Are there fees?
- What are fees used for?
- Why would people decide not to join a farmers' group?
- What do farmers' groups do?
- How do farmers' groups get their information?
- How do farmer groups disseminate information to farmers? Do they pass it on to other farmer groups? Do they make it generally available to farmers who are not members of farmers groups?

6. NGOs:

- Which NGOs have been active in the village? When? Where? Doing what?

(Interviewer Tips: rice growing, dryland, vegetables/fruit, animals, other)

- How did they decide which households to work with?

7. Extension officers:

- How many extension officers are there?
- Where do they live?
- How often do they visit the village?
- Which farmers do they work with? Individual farmers or farmer groups?
- How do they give knowledge? Field visits to farmers? Demplots? How often?
- What kind of information do they provide?

(Interviewer Tips: rice growing, dryland, vegetables/fruit, animals, other)

Questions - Head of farmer groups:

1. How long has this farmer group been going?
2. How did it start?
3. How were members chosen and invited? (Interviewer tip is there a reason that people may not be invited?)
4. What does the group do?
5. How does the farmer group get information? And how do members of the group get information?
6. If the farmer group is no longer active, why did it stop being active?

Questions - Extension officer:

1. What are the most common pests and diseases in rice here?
2. How do you get information about farming practices?
3. What are some examples of new information that has been given to farmers?
4. How do is this information given to farmers? (Interviewer Tips: through farmer groups, field days at dem plots, individual farmer consultations. How do you chose which farmers or do they approach you?)

5. Do you think new information about farming has been used successfully and resulted in improved yields at Linamnutu? (Interviewer Tips: why/why not? –: problems with water management, lack of coordination re pest control, poor application of new practices, information was not suitable for Linamnutu)

Questions - Store owner:

1. What are the most common pests and diseases here in the rice?
2. How do you get information about new agro-chemicals and new farming practices?
3. Do you often advise farmers about agrochemical use and/or farming practices?
4. Have you been a farmer or do you do any farming now?
5. Are you a member of a farmers group?
6. Do you think farming practices at Linamnutu could be improved – how?

Questions – Householder:

Record: GPS location of house

Record: Construction material of roof, walls, floor

1. Information about the household

- Have you lived in Linamnutu for long? If not born here, when did you arrive?
- Do you have family or friends here? How long has your family been in Linamnutu
- Did your household inherit your land or buy it?
- Can we ask if you have been to school and what level? Education level of farmer and wife

2. Does your household have **padi**?

- Approximately how much?
 - owned,
 - leased from others,
 - leased to others,
- How much farmed?

3. Does your household have **dry land** fields?

- Approximately how much – as above?
 - owned,
 - leased from others,
 - leased to others,
- How much farmed?

4. What pests do you have in your

- Dry land fields? How often do they occur?
- Padi? How often do they occur?

5. Where do you get information about farming?

- What type of information from what source?

(Interviewer Tips: Farmers Groups; P3A; GP3A; Village leadership elected; Village leadership toko adat; Commercial supplier; NGO; Church; Din Pet Extension officer; Family; Neighbour; Friends network)

(Interviewer Tips: rice, dryland/corn; animals; fruit/vegetables)

6. Regarding farmers groups:

- How do you find out about farmers ?
- Is there one in your area?
- Are you a member?
- How do people become members?
- Who can become a member?
- Do you know if your neighbour is a member of one?

- Are there fees?
- What are fees used for?
- Why would people decide not to join a farmers' group?
- Are any farmers excluded – if so why?
- What do farmers' groups do?
- If you are not a member of a farmers group, can you get information from the farmers group?

7. Regarding NGOs:

- Which NGOs have been active in the village? When? Where? What activities? (Probes: rice growing, dryland, vegetables/fruit, animals, other)
- How did they decide which households to work with?
- If they worked with you, did you find the information useful? (Probes: Why? How could it have been more useful?)

8. Regarding Extension officers:

- How many extension officers are there?
- Where do they live?
- Do they work with individual farmers or farmer groups?
- How do they give knowledge? (Interviewer Tips: Field visits to farmers? Demplots? Meetings? Via Kepala Desa or farmer Groups?)
- What kind of information do they provide? (Interviewer Tips: rice growing, dryland, vegetables/fruit, animals, other)
- Did you find the information useful? (Interviewer Tips: why? Why not?)

9. What changes have there been to farming while you have been farming?

(Interviewer tips: SRI, growing vegetables, aquaculture)

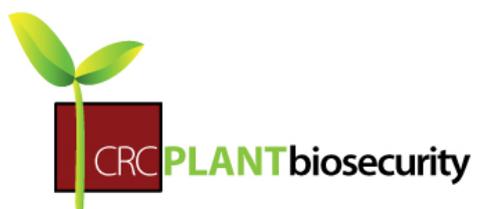
- Have you tried any of these new farming practices? Why? Why not? How did they go?

Questions – NGOs:

We are interested in the access and availability of agricultural information for farmers in Desa Linamnutu.

It is difficult to make sure information flows easily to everyone in a village – even neighbours may not have the same information about a problem or project.

1. How does an NGO decide which village to work in? Who within the NGO decides, and who in the village advises? (Probes: rice growing, dryland, vegetables/fruit, animals, other)
2. How is the focus of a project determined? (Probes: rice growing, dryland, vegetables/fruit, animals, other)
3. Once the village has been selected, how does the NGO officer select participating households?
4. Can households ask to join projects? (Probes: rice growing, dryland, vegetables/fruit, animals, other)
5. Let's talk about an example of a specific project in Linamnutu village.
 - a. What was the goal of that project?
 - b. How was the village chosen?
 - c. How were households recruited within the village?
 - d. What project planning and socialisation activities were done with the community during the project? (probe: who was invited and how were they selected?)
 - e. What training activities were undertaken? (probe: who was invited and how were they selected?)
 - f. Did the NGO expect that information would flow from the project participants to others in the community who had not been direct participants? (probe by what mechanism did the NGO expect that this would happen?)



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