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Report

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Mobilizing indigenous knowledge, innovations and practices of the Kalanguyas farming systems in Tinoc, Ifuago, the Philippines.

A contribution to the Piloting of the Multiple Evidence Base Approach

CO-PRODUCED BY:

The Kalanguya people of Tinoc
Naundep ni Napahnuhan ni Kaanguya, NNK

Indigenous Peoples' International Centre for Policy Research and Education TEBTEBBA

SwedBio
A programme at Stockholm Resilience Centre

Foreword about the background to the collaborative partnership: Piloting the Multiple Evidence Base approach: Connecting across knowledge systems for enhanced ecosystem governance

This report is part of the outcomes of a collaborative partnership for piloting a Multiple Evidence Base approach[1] to co-generate knowledge and methods for mutual learning across knowledge systems. The project partners are: African Biodiversity Network[2] with Institute for Cultural Ecology (ICE)[3], Kenya and MELCA, Ethiopia[4]; Forest Peoples Programme (FPP)[5] with Fundación para la Promoción de Conocimiento Indígena (FPCI); Pgakenyaw Association for Sustainable Development (PASD)[6], Thailand; Tebtebba Foundation, Philippines[7]; and SwedBio[8] at Stockholm Resilience Centre, Sweden[9].

The collaborative partnership emerged from an ongoing dialogue across knowledge systems, involving SwedBio and partners among indigenous peoples and local community organisations (e.g. International Indigenous Forum on Biodiversity[10], IIFB) and networks of experts from different knowledge systems. All participants are committed to valuing diversity and are engaged in biodiversity management and its links to policy processes from local to global, such as in the Conventions on Biological Diversity (CBD) and the Inter-governmental Panel for Biodiversity and Ecosystem Services (IPBES). The starting point was the window of opportunity emerging from the possible inclusion of indigenous and local knowledge in IPBES, during the years before IPBES was established. See for example the Guna Yala Dialogue from 2012 at www.dialogueseminars.net/Panama, held back to back with the founding plenary of the IPBES. One of the outcomes of the ongoing dialogue has been the envisioning of The Multiple Evidence Base (MEB) approach that sees indigenous, local and scientific knowledge systems as different manifestations of valid and useful knowledge that generate complementary evidence for sustainable use of biodiversity. MEB emphasizes the importance of equitable and transparent processes for mobilizing knowledge and connecting across knowledge systems, and of maintaining the integrity of each knowledge system throughout the process. This means that evaluations of knowledge occur within, rather than across, the contributing knowledge systems when mobilizing and synthesizing knowledge, for example, in an ecosystem assessment process.

One of the objectives of the piloting of MEB has been to develop methods, procedures and good examples for how evidence can be mobilized for multiple needs, at local to global levels, and across knowledge systems. For example, knowledge that is relevant for feeding into local and national policymaking, as well as in processes such as assessments for the CBD and the IPBES, and other fora where working with synergies across knowledge systems are essential. Additional objectives have included: contributing to changing the views that governments hold about indigenous governance and management systems, towards respect and benefit for indigenous peoples and local communities; strengthening livelihoods and well-being within the communities, based on their indigenous governance systems, and finally, promoting joint learning around this across the participating communities and other partners. The community research that is part of the piloting has been initiated and conducted by the communities themselves, based on their own needs and priorities. Biodiversity, food and culture were the unifying topics. Most of them have earlier experiences of mobilizing knowledge e.g. to recover lost seeds or to protect and revitalize sacred natural sites and rituals connected to them. Past experiences encourage communities to continue such

1 http://swed.bio/focal-areas/themes/biocultural-diversity/a-multiple-evidence-base-approach-for-equity-across-knowledge-systems/
2 http://africanbiodiversity.org/
3 http://www.icekenya.org/
4 http://www.melcaethiopia.org/
5 http://www.forestpeoples.org/
6 http://www.pasdthailand.org/
7 ttp://www.tebtebba.org/
8 http://swed.bio/
9 http://www.stockholmresilience.org
10 The International Indigenous Forum on Biodiversity is the Caucus for Indigenous peoples and local communities and their oragnizations actively engaging in the CBD. See: http://iifb.indigenousportal.com/

Documentation by:
Florence Daguitan, Milanie June Cadalig Batang-ay, Reyaline B. Aquino, Gemma Das-ilen
Cover photo: Kalanguya farmer with grandson on their way to their inum-and and the experimentation of innovations to strengthen the traditional land management. Binabalyan, Tinoc. Photo credit: Pernilla Malmer

work. Some communities are mobilizing knowledge as part of efforts to demonstrate the sustainability of their traditional management and governance systems, as a way of creating an evidence base for policies and decisions at scales beyond the local, that protects rather that counteracts their rights and capacities to manage their ecosystems and resources.

A number of insights have emerged across the five piloting projects. One is the importance and role of mobilizing knowledge before engaging with other knowledge systems. The communities engaged in methods and approaches to mobilizing knowledge that were well suited to the local context and engaged with multiple facets of knowledge, including cultural and spiritual dimensions. How knowledge was mobilized was an important part of building confidence for interactions with other knowledge systems, including authorities. Another insight is the relevance for co-production of knowledge across knowledge systems to connect with interests and needs of all actors involved, including at the local level. For all the communities, mobilisation of knowledge was part of securing territory, authority and rights to govern their ecosystems in a sustainable way. In several communities, the outcomes were well received by local and regional authorities and collaboration has improved.

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Content

1. Background

Payew and *inum-an* in Ahín, one of the 12 barangays in Tinoc where traditional farming still dominates. Photo credit: Pernilla Malmer.

The aim of this project was to determine the effect of some innovations undertaken on the indigenous *Kalanguyas* farming systems in the *payew* or rice terraces and the rotational farming in Binablayan, Tinoc, Ifugao, Philippines. The research was undertaken by the communities in collaboration with Tebtebba as a response to changing realities, such as the erosion of some of the indigenous knowledge systems and practices, coinciding with decreasing rice production.The research was implemented in 2015 with the aim of testing some promising innovations and practices that might support and maintain the sustainability of the *payew*.

The study also contributes to the piloting of a Multiple Evidence Base approach for bridging and creating synergies across knowledge systems, in a way that keeps the integrity of each knowledge system, and that is built on mutual respect and meaningful outcomes for all involved actors.[11]

For understanding the background to the study, we have to go back to 2008 when 4 of the 12 barangays[12] of Tinoc decided to join in a process based on the ecosystem approach to find solutions towards a more sustainable governance and management of their biodiversity and other natural resources. In 2010 the project attained a municipial scope with the First Tinoc Land Summit, up to the formulation of the Land Use Plan. The Ecosystems Based approach[13] is a strategy to manage land, water and living resources that promote conservation and sustainable use of the different parts of the environment, thereby ensuring continued ecosystems services and functioning for people's wellbeing. An important principle is that ecosystem management should be decentralized to the lowest appropriate level.

The collaboration with Tebtebba and the process itself, has been productive in many senses. First of all, it has led to a Land Use Plan for Tinoc, where watersheds are better protected, and there are unified efforts to break the vicious

11 http://swed.bio/stories/a-multiple-evidence-base-approach-for-equity-across-knowledge-systems/

12 A barangay is the basic unit of local government in the Philippines, followed by municipality, province, region and whole country. Binablayan is one of the 12 barangays of the municipality of Tinoc.

13 https://www.cbd.int/ecosystem/principles.shtml

circle of land and forest degradation. Secondly, it has contributed experiences in bottom up monitoring of traditional knowledge indicators, for the Convention on Biological Diversity, as well as to methods development for Community Based Monitoring and Information Systems (CBMIS).[14]

Changing trends in farming

In 2000, *inum-an* areas, the rotational farming areas of the Kalanguyas, were the first to be converted to commercial vegetable farms in Binablayan. Around the same time, there was an increase in population due to in-migration and the Kalanguyas began extending the cultivation periods, rotating different main crops for more years (maximum of eight years) and at the same time shortening the fallow period. Thus, the soil could not fully recover its fertility any more.

Those areas that remain as *inum-an* are no longer as diverse as the traditional *inum-an*. Since much labour has been diverted to commercial vegetable farming, people are not very keen to put in place the soil erosion measures to mitigate and prevent soil run off.

Since 2009, meetings have been convened to assess the impact of commercial vegetable farming and to put together the concept of upgrading the *inum-an* and *payew* cultivation. Village level meetings were co-convened by elected officials or leaders of farmers organisations and attended by various sectors in the community, i.e. women, elders and farmers, and in some meetings also teachers and village midwives. Municipal level meetings in Tinoc were co-convened with the municipal government unit represented by the Municipal Planning and Development Office in Tinoc. Aside from representatives of the barangays villages, municipal meetings are also attended by other Civil Society Organisations and government line agencies.

During the unification process conducted with the farmers in Tinoc, to build a shared understanding and consensus around the problems and plans to go forward, some have shared their predicament regarding the tungro (*Fusarium wilt*), a plant disease affecting not only their camote plants but the banana and the ginger as well. Some of the farmers clearly remember that in 2004, they started to observe the impact of the tungro to their agricultural crops. This trend continues and as a result, agricultural crops harvested, especially the camote, notably decreased in yield and camote no longer thrives. The widespread occurance of tungro is said to be caused by low levels of soil fertility because it cannot give the plant the nutrition needed to combat the fusarium wilt any more. Dismayed, with no clear support from any government agency, the farmers stopped planting and cleaning the *inum-an*.

In order to reverse the trend, community members identified possible innovations in *inum-an* farming including installation of permanent or semi permanent erosion control measures (contour plants, hedgerows); multi-story cropping that integrates short and long term food crops, cash crops, and animals; integrating biomass-producing plants to serve as a continuing source of organic fertilizers (green manure or compost materials); and the revival and re-integration of traditionally grown food crops in the *inum-an*.

These innovations were adopted by three piloting farmer cooperators. One of them was able to integrate hedgerows, poultry and has attracted bees in her farm through the traditional practices and was able to collect honey from this. The other two focused on crop diversification. Accordingly, some additional farmers also revived the diverse intercropping practices but monitoring was not conducted.

The first step taken in the unification process within the communities was the assessment of the status and trends of the ecosystem of the territory of the Kalanguyas (the main indigenous tribe in Tinoc) using some of the indicators that were identified as relevant to indigenous peoples, i.e. land use and land use change, traditional knowledge, traditional occupation, and people's well being. The assessment revealed increased challenges from rapid land use change brought about by the adoption of commercial, chemical-based vegetable production and people veering away from traditional land use management. It started a more proactive process of people coming together to discuss and find solutions towards a more sustainable governance and management of their biodiversity and other natural resources. Individuals started to revive some of their traditional farming practices such as rotational agriculture and retrieving traditional rice varieties. Other actions included trying farming systems from other areas like System of Rice Intensification (SRI) and improving their farming systems, like using foliar fertilizers from fermented plant juices and cultured Indigenous Micro Organisms (IMO).

One major gathering was the First Tinoc Land Summit in 2010, where farmers and other actors living in Tinoc agreed to break the vicious circle of land and forest degradation and to revive indigenous knowledge systems and practices of sustainable resource use and land management. To concretize these agreements, the comprehensive land use plan (CLUP) was formulated through barangay workshops from 2011–2012. In 2014, they planned to develop their community-based monitoring and information systems (CBMIS)[15], to monitor their intervention and changes in their territory brought about by climate change and others.

One of the goals of the CLUP is enhanced ecosystems for community resilience and food sovereignty. One of the methods, which became part of piloting the MEB approach in 2015, is to conduct in-situ experiments for the development and adoption of sustainable technologies. Thus, the piloting research in 2015 is a continuing process of innovations initiated before 2010 but was the first opportunity to

14 http://tebtebba.org/index.php/content/361-mapping-our-lands-a-waters-protecting-our-future

15 A description of CBMIS can be found here: http://tebtebba.org/index.php/content/361-mapping-our-lands-a-waters-protecting-our-future


Commercial vegetable farming has been rapidly expanding into the traditional farmlands. Tucuklan, Tinoc. Photo credit: Pernilla Malmer.

systematize the process of innovation, i.e. of mobilising the existing traditional, indigenous knowledge, at the same time as identifying scientific knowledge, to support the efforts of revitalizing indigenous knowledge and practices and assessing the effects of the innovations.

The introduction of the Multiple Evidence Base community research project in 2015 which sought to strengthen and monitor innovative practices adopted by the farmers have made the farmer cooperators decide to work on their *inum-an* again with the hope that their crops will not be affected by the tungro. This is also to try the different *inum-an* innovations and to revive the different agricultural crops planted in the *inum-an*.

2. Introduction to Tinoc and the biocultural system of the Kalanguyas

Geographical location

Tinoc is one of the eleven municipalities of the Province of Ifugao. The area is generally characterized by rugged mountains, an elevation range of 800 to 2,900 meters above sea level, and slopes of 50% gradient and above. The total land area is about 37,000 hectares and is situated on the eastern part of Mount Pulag, the second highest mountain in the Philippines, and is bounded by Benguet province in the west, the province of Nueva Vizcaya in the south, the municipality of Asipulo in the east, and by the protruding strips of Mountain Province in the north. Tinoc is occupied by three ethno-linguistic groups that are part of the indigenous peoples of the Cordillera region. They are collectively called Igorots. In the 2015 census, Tinoc's total population was 16,559 people (PSA, 2016).

Up until 2003, Tinoc had one of the last remaining intact mossy forests and formed part of the headwaters of the Magat Dam that generates 360 megawatts of electricity. Up until 1996, Tinoc held the distinction of being the only town in the country without any roads. In 2003 the road network that connected it to the province Benguet, and Banawe and Kiangan, Ifugao was completed.

Knowledge, practices and rituals

The Kalanguyas of Tinoc hold their own traditional knowledge on climate, season and weather and they have incorporated these into their agricultural system. Plant indicators, migratory birds and cloud reading have been used to ensure the correct timing of planting the different crops. The different agricultural tasks in the *payew*, or rice terraces, are based on the local agricultural calendar developed through observing the environment. Each stage of rice cultivation is marked by the performance of rituals that are officiated by a tribal/native priest called *mabaki*.

Coping with disaster

Major disasters occurred in 1970 when continuous heavy rains lasted 45 days and in 1996 when the el Niño phenomenon resulted in prolonged drought – the summer extended substantially into the rainy season. People were able to cope with the first, due to integrated farming systems and sound management practices; good yield, the value of sharing and their traditional labour exchange network helped them cope and to rise above the disaster. They fared worse the second time, suffering lower yields – a result of disappearing traditional knowledge and the practices that support and enhance livestock fertility, field sanitation and farm maintenance. In the past five years, erratic changes in weather have resulted in decreased yields of major crops, both for subsistence and commercial crops grown for the market, leading to increased food shortages and decreased income and food security.

Additionally, past experience has shown the Kalanguyas that strengthening their traditional risk management systems which integrate the different farming systems (agro-forestry *inum-an*, wet rice cultivation *payew*, home gardens of trees, herbs and various food crops, livestock and poultry raising), is an important way of conserving wildlife.

Changing agricultural practices

Subsistence agricultural crops, cultivated in the *inum-an*, the rotational farming areas of the Kalanguyas, supplemented by the rice harvest in the *payew*, the traditional terraced rice-fields, and wild food was adequate for people's sustenance up to the 80's in Tinoc Ifugao. However, by the late 90's, there was a significant decrease of production in the *payew* and *inum-an*. This was noted especially in areas where the commercial, chemical-based vegetable farming dominated the agricultural landscape. A series of difficulties such as increased health problems, the exploitation of farmers, the high cost of farm inputs, unregulated prices for farmers' products and food insecurity became realities in these villages.

Various interplaying factors caused such a situation. Among them was the rising need for cash, leading to increased numbers of people engaging in seasonal outmigration. The shortage in available labour resulted in decreased productivity because women, children and the elders had to take on the maintenance of farms. Another factor was the adoption of chemical-based commercial vegetable production. Vegetable farms encroached into the forests and farm lands. Problems such as decrease in irrigation, increased pest damage to crops and the resulting decrease in harvests was made worse by the erratic rainfall and typhoon patterns. Expansion of vegetable areas, which was initially perceived as the way forward, worsened the situation as the vegetable industry was beset by problems, such as effects from unregulated markets and exploitation of farmers, amongst others.

Meeting in a community group for the planning and discussion of the pilot research. Photo credit: Tebetbba.

3. Description of the project

As early as 2009, the need for innovation for the *inum-an* and *payew* to restore productivity and to minimize the use of chemicals in the vegetable areas was recognized and planned. Unfortunately, there was not enough support for implementation of these plans at that time. Tebtebba started supporting a few individuals but there was no systematized monitoring. In 2015, the multiple evidence-base (MEB) approach[16] was introduced to systematize synergies between indigenous, local and modern scientific knowledge to formulate innovative concepts and to monitor effects of such innovations. This specific project involves an ongoing research process to generate knowledge from different knowledge systems to develop and systematize plans for agricultural innovations. It engages in monitoring the efficacy of such innovations, making use of both traditional and scientific monitoring systems, to document the process and the results of the innovations. Thus, it opens up a space for the discussion and exchange of ideas of the various knowledge systems for joint learning, analysis and evaluation towards the production or enrichment of knowledge for sustainable management of ecosystems. One aim in particular, is to improve development planning of upgrading knowledge and technologies in the *inum-an* and *payew* towards increasing food security and resilience.

The objectives of the project are to mobilize knowledge, with indigenous as well as scientific methods and data, in order to:

1. Systematize the information and deepen understanding of the indigenous knowledge systems and practices in *payew* and *inum-an* management;
2. Generate quantitative and qualitative information on the effects of people's innovations in the farmlands and determine efficacy of pre-identified innovations in the *inum-an* and *payew*.
3. Enable communities to improve their planning (e.g. to formulate indicators of success in their intervention/ innovations in technology development) for increased food security and improved governance and input on community development plans.

16 Tengö et.al 2014. http://swed.bio/wp-content/uploads/2015/11/Connecting-Diverse-Knowledge-Systems_MEB.pdf

4. Research methodology

Prior to conducting the research, a unification process to build a shared understanding and consensus around the problems and plans to go forward was conducted with Naundep ni Napaknuhan ni Kalanguya (NNK), an organisation which partnered with Tebtebba in the area, to inform the organisation about the project and to gain their support. A reconnaissance visit was also conducted to become familiar with the study area.

The research employed two sets of methodologies:

1. The deepening investigation of the indigenous knowledge systems and practices, customary laws and cultural practices in the management of the *payew* and *inum-an*, through data generation to substantiate previous research findings and looking at other literatures or research findings that support these local knowledge and practices.

   a. Documentation of indigenous knowledge systems and practices
   To gather information on indigenous knowledge systems and practices, key informant interviews with selected knowledge holders identified by the community were conducted. The interviews followed an interview guide to ensure that the interviews were based on the issue but would stay conversational enough to allow the informant to articulate and discuss aspects relevant to the practice and management on *payew* and *inum-an* cultivation. Focus group discussions were also convened to validate the information derived from the interview. Finally, a community validation was organized after the project was finalised to confirm the findings and to gain insights and suggestions from the community members.

   b. GIS mapping of the source of irrigation.
   Data from various sources including a GPS survey were gathered and were transformed into GIS format for full digital processing and spatial analyses. These were used to produce the watershed map in order to locate the source of irrigation to the rice fields used in the study.

   c. Insect inventory.
   An inventory was compiled of insects associated with rice in the *payew* and the agricultural crops in the *inum-an*. Insects were collected and classified according to order, family, and their role in the agroecosystem – whether predator, parasitoid, neutrals or visitors. The most common insect pests of rice/agricultural crops and their damage and the entomophagous insects associated with insect pests were determined.

2. Generate data from actual experimentation. For this, innovations were indentified and results were monitored through periodic recording. The experiments were conducted in the fields of voluntary farmers, "cooperators". Like in the case of the traditional knowledge systems and practices, focus group discussions were held to reflect together over the outcomes. The following were employed in the farmers fields:

   d. Soil collection, sampling, and analysis.
   Composite soil samples were drawn in each of the experimental rice fields[17] to assess the basic information and evaluate the soil properties before the land

17 Experimental rice fiels in this project is defines as the field on which the conventional farming and SRI are being compared

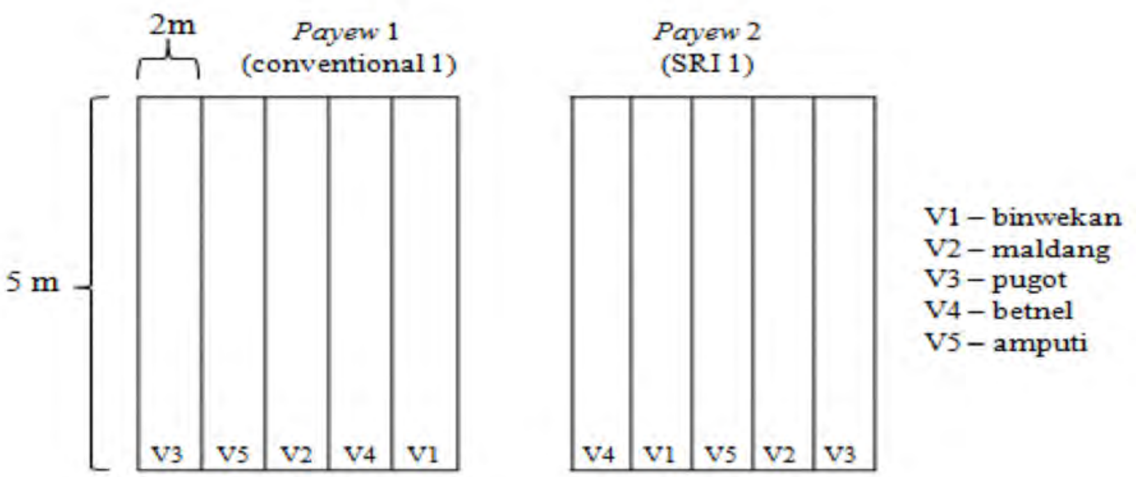

Figure 4. Randomized complete block design used in the experimental fields. V1-V5 are different rice varieties planted in the plots

preparation and after harvest. The samples were brought to the Benguet State University Soils Laboratory and to the Regional Soils Laboratory at the Department of Agriculture, San Fernando, La Union for analyses of physoscal (soil texture) physical, chemical (pH, organic matter, nitrogen, available phosphorous, exchangeable potassium, water holding capacity) and micronutrient (zinc) properties that are essential for rice nutrition. A T-test was used to analyse the data.

e. Monitoring and documentation of data and observation of the effects of innovation on the growth performance and yield of rice in the *payew*.

Data on the experimental rice fields planted with five rice varieties (represented by each plot) that have the same growth duration were monitored using a randomized complete block design (Figure 4). One rice field was divided into 2 blocks, one block represented the present day practices, refered to here as "conventional" and the other set of plots was designated for the innovations to be applied, referred to here as "where innovations were applied". The plots were treated the same except for the elements that were tested so that the difference could be credited to the innovation inspired by the "System for Rice Intensification" [SRI][18].

The different practices that characterize SRI include: single transplanting of 8 – 12 day old seedlings in square pattern; controlling weeds in a regular interval; applying organic inputs which increase the soil's organic matter and; alternate wetting and drying water management (Bourman et. al., 2007). The yields that can be achieved by the farmers depend on the careful and timely transplanting of seedlings, on the preparation and management of the soil, on the control that is maintained over water, on the soil quality, and on the variety of rice planted.

f. Monitoring and documentation on the effects of innovations on the agricultural crop diversity in the *inum-an*.

Data on the impact of the revival of traditional knowledge and practices and the different agricultural management conducted by the farmers during the commencement of the research in the *inum-an* were likewise documented.

The research project was implemented from February to December 2015. However, it followed on from earlier studies and discussions with regards to issues and concerns in the farmlands (see Chapter 2) and data gathering extended up to May 2016. The study site was the barangay Binablayan.[19]

18 http://sri.cals.cornell.edu/aboutsri/methods/index.html

19 A barangay is the basic unit of local government in the Philippines, followed by municipality, province, region and whole country. Binablayan is one of the 12 barangays of the municipality of Tinoc.

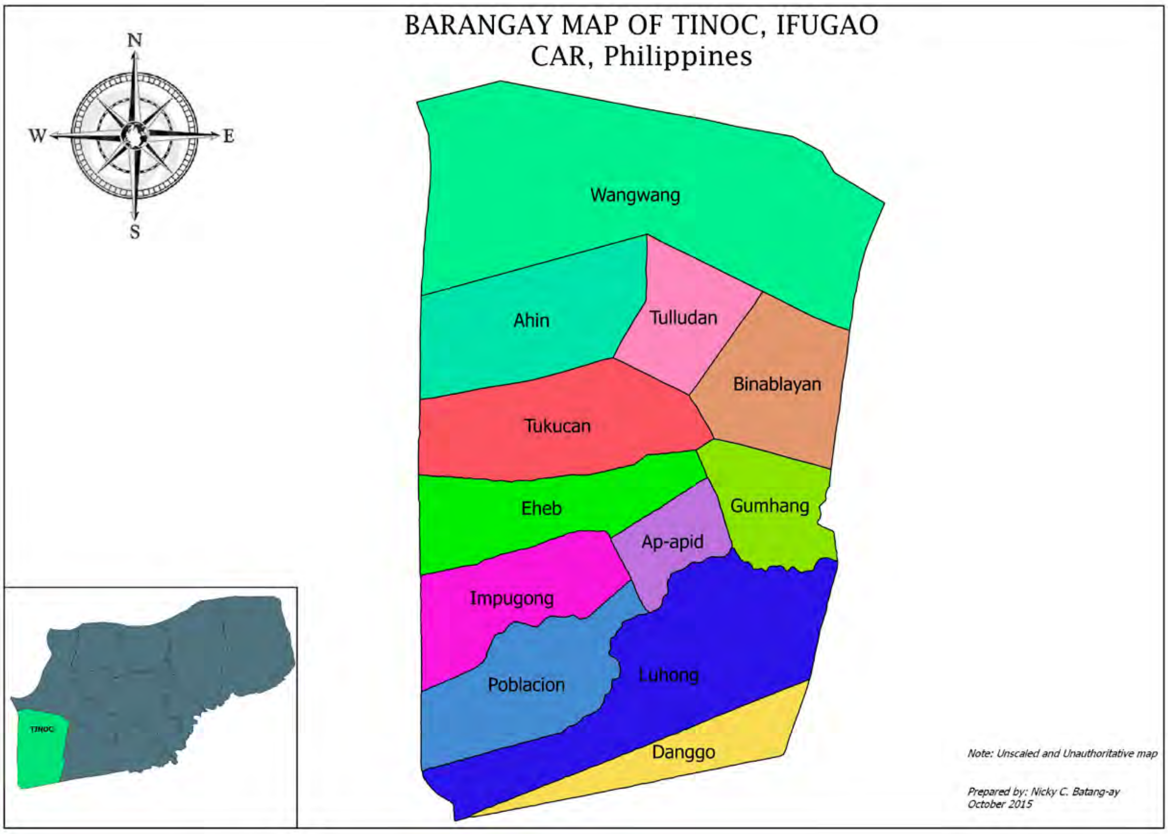

Figure 5. Location map of barangay Binablayan, Tinoc, Ifugao

4.1. Description of the Study Sites in Binablayan, Tinoc

The sites are composed of forests that serve as the watershed and the communities' source of wood, grasslands, agroforestry areas, *inum-an*, *payew*, *wangwang* (river system) and the *pan-abungan* (settlement areas). Tinoc has two seasons, the dry (*ti-egew*) from mid February to May and wet (*baka ni udan*) from June to January. It is situated within the regular path of typhoons that pass within the Philippine area of responsibility and is affected by an average of five tropical cyclones annually. The average precipitation in the municipality is 149.4 mm and the average temperature is 26.91 degrees centigrade that ranges between 190C – 350C. The project was implemented in the barangay Binablayan (Figure 5). It can be reached after a 6–7 hour drive across the Halsema highway and the Tinoc – Buguias national road.

The area is further characterized by steep slopes, various moisture and temperature regimes that vary greatly from place to place, distances, and altitude. The area has fertile land that is favourable for agriculture. Typically, the soil types of Tinoc are clay loam, silt loam, and sandy loam.

Cultivated areas (*inum-an*, gardens, *payew*), grasslands, agroforestry areas and built-up areas are also present (Table 1). These are intertwined in a mosaic landscape of the Kalanguyas traditional ecosystem.

Table 1. Land utilization in barangay Binablayan, Tinoc Ifugao

Land-use	Area (hectares)	% distribution
Forest	**2,445.0**	**89.20%**
a. primary forest	1877.4	
b. secondary forest	567.6	
Extensive land use	**252.5**	**9.21%**
a. inum-an	86.0	
b. garden	32.7	
c. rice fields	46.3	
d. grasslands	29.5	
e. agro forest	58	
Intensive land use	**43.5**	**1.59%**
a. built-up/settlement areas	43.5	
total land area	**2,741.0**	**100%**

Source: Community mapping in Tinoc, Ifugao as of April 2013 google map

The different land-uses are being managed through the application of the Kalanguyas' unique resource management that is believed to have been practiced by the tribe since time immemorial. Different activities that are favourable for the practice of certain agricultural mechanisms are carried out depending on the season and climate. The practices were developed and employed to maintain solidarity and harmony among the people, including working together to maintain rice terraces and other farming activities such as *dang-ah*[20] and *ubbo*[21]. The local management of these areas has evolved and has been influenced by culture embodied in customary laws based on social taboos and customs handed down from one generation to another (DENR, 2008).

According to key informants interviews[22] (2009), Binablayan is one of the newest settlements in Tinoc, about less than a hundred years ago.

4.2. Limitations of the Research

The research was implemented by volunteering farmers, who saw potential in the innovations. They were observing continuously during the research period, however, some of the planned periodic monitoring of crop performance turned out to not be possible to fulfil. These reasons are attributed to natural disasters that limited access to the rice fields, the presence of armed groups that limited mapping some of the watershed areas and also limited time and capacity to monitor due to other work commitments. A substantial limitation was that the research was implemented during only ten months which is not enough to observe the whole cropping season of the *inum-an* and to have another cropping season for the rice to validate the results of the first cropping. It would be important to follow up on this first round of experiences. It is also worth noting that the documentation of the indigenous knowledge systems and practices (IKSP) of the *payew* and *inum-an* agricultural activities as described in this report, has been generated from different areas of Tinoc[23], but the focus for the study of effectivity of the innovations in farmers' fields was limited to the experimental plots of the farmers in Binablayan.

20 *Dang-ah* is a group activity planned in advance such as stone riprapping of rice terraces where heavy stones are used needing the help of other men in the community, and clearing and fixing irrigation canals

21 *Ubbo* is a strong bayanihan spirit of unity and cooperation among the people where collective labour exchange is being practiced by individuals or group of farmers to perform a task (planting, weeding, harvesting, etc.) of each of the member of the group. The group takes turns working on each other's farm and the member of the group who is helped reciprocates by offering food and drinks for each day's work.

22 One key informant was an elder women, who estimated her age at around 75, claimed that her family was among the early settlers when they went to the area when she was in her early teens

23 Information mainly from Ahin, the mother settlement of Tinoc.

5. *Indigenous Knowledge Systems and Practices in the Farmlands*

5.1. The traditional *payew* – irrigated paddy fields – cultivation

Rice is the staple food that provides sustenance for most Filipinos and can be cultivated under a variety of climatic and soil conditions. Rice production became one of the main agricultural activities in Tinoc since the introduction of wet rice cultivation – itself the product of the ingenuity, industriousness and engineering principles of the people in response to the mountainous habitat that has been shaped by the forces of nature. The system of rice production has evolved with local customs and traditions of the Kalanguyas.

The water supply comes from surface runoff from the watershed and flows to the irrigation canals to the paddy fields. In the process of mapping, the farmers were able to review and enhance their understanding of the importance of protecting and conserving the watershed that supplies the water to the *payew* (Figure 6).

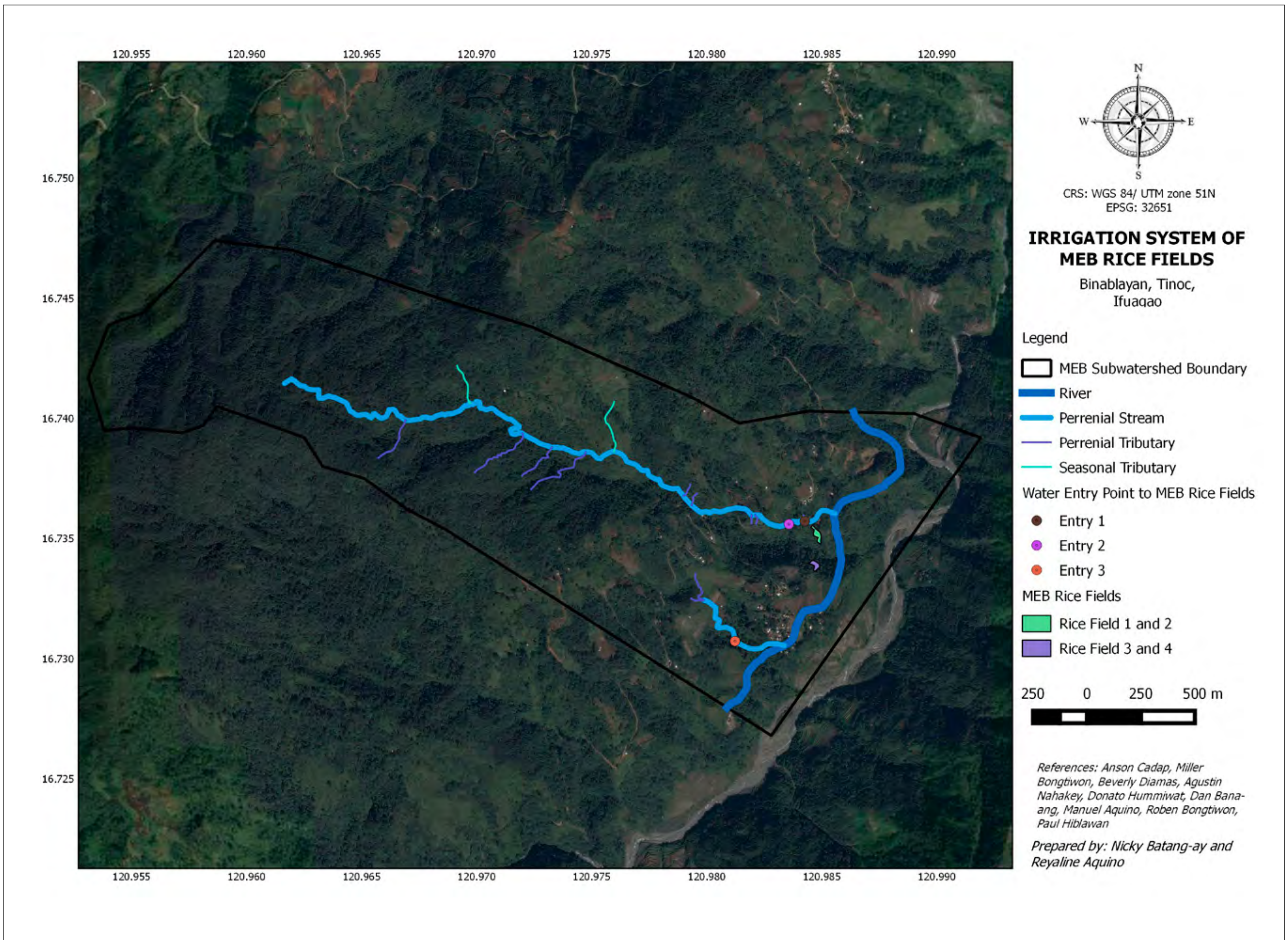

Figure 6. Irrigation system of the *payew* in Binablayan, Tinoc Ifugao. Source: Tebtebba

5.1.1. The physical structure of the *payew*

The *payew*, the rice terraces cut into the steep mountain slopes, were constructed by following the natural mountain contours and water source. The *payew* is reinforced with stonewalls that are made of compact soils and stones to conserve the soil from erosion and to maintain the high water intake of the rice plant. *Payew* are considered as privately owned and are valued because of the amount of effort put into constructing them through the *ubbo* – the collective labour exchange – provided by the community. It is primarily planted with traditional varieties of irrigated rice suited to the water and temperature conditions of the terraces. The varieties include, among others, *indawag, binwekan, tuballi, inbanneg*, and *talukituk* that are traditional farmers' varieties grown for home consumption.

The *payew* is composed of the *guhingan* (spillway that serves as the entrance and exit points of the irrigation water), *teneng* (dike or the pond-field rim that serves as the embankment constructed surrounding the field that controls the water and holds the soil in the field), *tuping* (stone retaining wall), *taban* (dry area within the rice field), *lidah* (un-irrigated space at the base or above the rice field that can be planted with agricultural crops), *waklitan* (surroundings of the rice field), and the buyagan (property marker) (Figure 7).

In case an owner abandons the *payew* for a period of time, and another person takes it up and clears it, tills and plants it, the latter has the right to use the *payew* for the same number of years that it was abandoned. At the end of the time, the field reverts back to the owner unless the latter wilfully gives the permission to the person to work his *payew*.

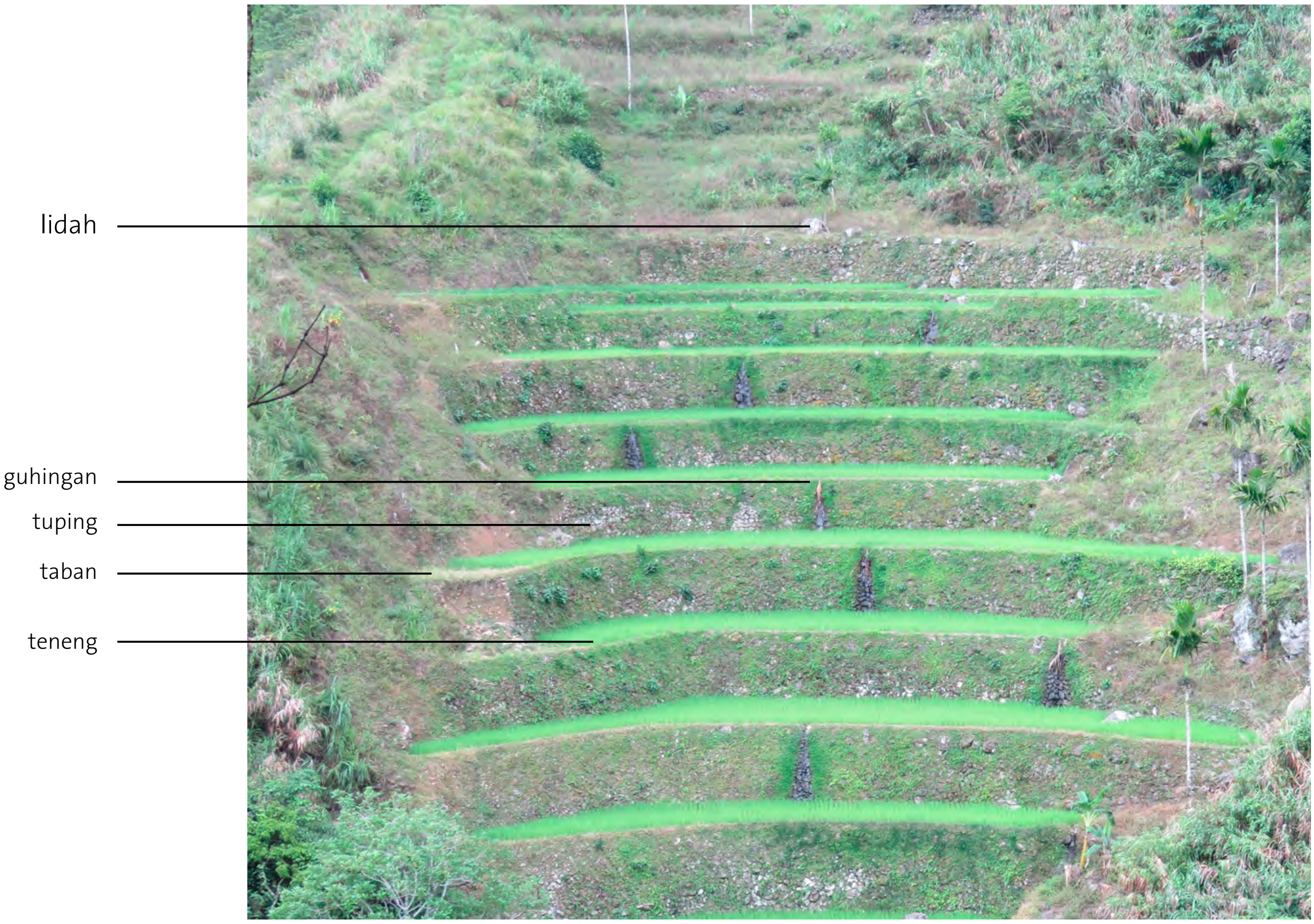

Figure 7. Composition of the *payew*. Photo credit: Tebtebba

5.1.2. Work stages and rituals associated in rice production in the *payew*

The different agricultural tasks in the *payew* are based on the local agricultural calendar developed through observing the environment. Each stage of rice cultivation is marked by the performance of rituals that are officiated by a tribal/native priest called *mabaki*. During the performance of a ritual, a sacrificial animal that is usually a chicken or pig is butchered and is offered to *Kabunyan*[24] while the *mabaki* is reciting prayers (*baki*) that are specific to the ritual. These rites are believed to be a factor of good yield and bountiful harvest ensured by *Kabunyan* and the unseen spirits (*Agmatibew*).

September – clearing the rice fields

The start of the work in the *payew* is signaled by the *manbuyakaw it pal-ut* (flowering of the rono – *Miscanthus sinensis*), *mehteng i pulet* (maturity of the *pullet*, a plant with sticky fruit), and the arrival of the migratory birds *ahib* and *aladug* in the community in the month of September of the Gregorian calendar. Through the *dang-ah*, the men will be clearing the *hippawa tan hihhudun alak* (irrigation canals) and repairing its damaged portions to allow the water to flow directly to the rice fields. The women will start clearing (*higgabut*) the rice fields and its peripheries (*hillamun tan hiwaklit*). The grasses, weeds (*helek*) and rice stubbles are trampled on and incorporated into the soil (*deynek*) to decompose.

Land Preparation

For families who have labour to spare, it is also at this time that they make the intuul. This entails the mixing of the rice straw and other aquatic weeds with mud and heaped up with the use of *gaud* (wooden spades) to form a mound called intuul which is then planted with a variety of short term non-aquatic crops such as pechay, onion bulbs, legumes, and onion leeks. *Intuul*, (Barton, 1992) is done to aerate the soil and to allow decomposition to happen since the field has been under water the whole year. Water is maintained at the bottom of the mound for the survival of aquatic fauna. On the one hand, the mounds are aerated thus improving both physical and chemical properties of the soil. These are harvested just before the next rice planting. This is the traditional way of fertilizing the soil of the *payew*.

"After some years, the rice fields grow old and production is observed to decrease," according to an elderly woman who attended a group discussion. To rejuvenate the paddy fields, the owners of the fields go to the forest and direct forest soil into the irrigation canal which then carries it into the rice fields. The people observed that the field regains its vigour and increased crop production [group discussion in Ahin, 2010]. From the theories of indigenous microorganisms, (IMO's), good microorganisms are maybe behind the recovery of the fields' productivity.[25]

November – germinating rice seedlings

Usually around the month of November, *in-apuy*, a traditional ceremony, is performed to allow the palay seeds to germinate well. A native chicken is butchered and is offered to *Kabunyan*. After the rite, the rice seed (*binantul / bineng-eh*) is taken out of the rice granary and is soaked in the water for three days and is drained in the shaded area for 24 hours to stimulate its germination. During these times, the men will be preparing a separate seed bed (*hapnakan*) where these are sown (*inhapnak*). Sowing is done by women by laying the palay and the panicles (*luley*) close to each other in the middle of the seed bed where they will continue to germinate and grow. The Kalanguyas' sowing techniques are well adapted to the techniques for transplanting the rice seedlings, described below. (Figure 8). Sowing is best done with the observance of the phases of the moon (*bimulan*) and the farmers usually sow during the first quarter (*timmakwal*) or last quarter (*naiggelan*).

24 The Kabunyan is the Supreme Being or the equivalent of Christian God

25 This practice is also being done among the Butbuts' of Kalinga and Bontoks' of Mountain Province

Figure 8. Sowing the palay panicles (left) and a seedbed (right). Photo credit: Tebtebba

Figure 9. Land preparation of the rice fields in Binablayan, Tinoc, Ifugao. Photo credit: Tebtebba

The sprouting of the palay seeds (mapyukan i inhapnak) signifies the building or repairing of the teneng and tuping with the use of gaud. When the short term crops on the *intuul* (raised mounds) are harvested, land preparation (*hila-wang*) will commence to prepare the terraces for the cropping season. This is done by overturning the soil using gaud and trampling it by foot to turn it into mud. Levelling the fields is accomplished manually with a flat wooden board aided by the irrigation water (Figure 9).

December – transplanting the rice seedlings

When the palay seedlings are ready for transplanting (*hibgay*), a hen is butchered and is offered to *Kabuyan* to bless the seedlings to grow well and for the soil to be fertile to produce healthy plants. The arrival of the *kiling* [26] in the month of December indicates the start of the transplanting. Six to eight week old palay seedlings are transplanted (*bagay*) that give the plant a head start over the weeds. Transplanting is done by women[27], (Figure 10) through the practice of *ubbo* while the men will take over the household chores and baby sitting at home during these times. Random method is practiced in transplanting where two to four seedlings, depending on the size of the seedlings, are transplanted with a variable spacing depending on the tillering capacity of the rice variety. *Bimulan* (phase of the moon) is also observed and transplanting is usually done during the *timmakwal* and *naiggelan*, the two latest moon phases, that it is believed to be the best time for planting agricultural crops.

26 *kiling*, a local term for a migratory bird that arrives in Tinoc that signals the start of the transplanting season

27 Referring to Barton (1992) transplanting is allotted to women because their fingers are nimbler than the men's.

Figure 10. Palay seedlings ready for transplanting (left) and farmers transplanting the seedlings (right). Photo credit: Tebtebba

March – growing season

After the transplanting season (usually in March), the community will celebrate *kulpi*, the ritual to signify the end of the planting season. A rooster is butchered and the people will pray for *Kabunyan* to guard the crops from pests and diseases and for it to produce good yields. Food is prepared and *tapuy* (rice wine) is served in each household.

During the growth stage of the rice crop, the agricultural activities will be geared towards crop and field maintenance. *Battikol* [28] management is critical during the first ten days of transplanted crops because it consumes the young plants (IRRI Rice Knowledge Bank, 2015). In order to manage the damage during this stage, the farmers control the water level of the *payew*, hand pick the *battikol*, and replace the eaten and dead seedlings.

Irrigation management and allocation

In order to produce one kilogram of irrigated rice, 1300–1500 liters of water is required. This makes water management a critical factor since the field should be kept continuously flooded at least three centimetres and increased to 5–10 cm with the increasing plant height (IRRI Rice Knowlege Bank, 2015). Continuous flooding also helps control weed growth. In order to achieve these, the *teneng*, the traditional rice dikes, should be well fixed during the land preparation to retain the water in the rice field. Irrigation channels are also frequently checked and are collectively maintained through the *dang-ah – collective work in rice fields* – to sustain the irrigation requirement of the rice crop. The irrigation is dependent on the springs or streams through a series of canals that originates from the watershed that serves as the source of irrigation (*bengbeng ni alak*) that keeps the fields flooded. These are conserved and protected by the community. The water then flows to the irrigation canals (*alak*) where prior right on the use of the water is based on the natural flow of the water.

To ensure the fair distribution of available water for irrigation the *duwaan ni alak*, a term used for the division of irrigation water, is set up before the *bungubong*[29]. This works where a stone or wood called the giti, is installed in diversion canals to regulate the flow of water over the rice fields to be irrigated to ensure the fair distribution of the irrigation water. If the stone/wood is moved, it means that someone has diverted the flow of water to his/her own field, as an indication that the distribution of water has to be adjusted, as the customary law is not followed. As of the time of the study, there is no recollection of the informants that there were people moving the *giti* diverting the flow of irrigation water.

Protecting the crop

During the tillering stage (*pinmengel*) of the rice crop, usually in March, hand weeding (*hikagawkaw*) is done by the women to remove the weeds that have grown in the *payew* and to replace the dead seedlings (Figure 11). The weeds are then treaded in the soil where they decay to enrich the soil fertility of the *payew*. During the pre-booting stage (*nangati i pagey*) in the months of April and May, the surrounding of the rice fields are cleared with weeds (*hillamun tan hiwaklit*). The weeds are bundled and are used to plug the rat holes to prevent the build up of the rat population thus minimizing rat damage. By the time the grains start to boot (*butyog*) or start to emerge (*nambukal*), the men will be installing scarecrows (*tatakut*), bamboo clappers (*iwad*)[30], *bayun/alyun*[31] *tibbug*[32] to drive away the *bading* and *kuti*, bird species that are red and brown, respectively, that feed on rice grains. *Altib* (wooden rat trap tied with string), *hantuk* (rat trap made of tie wire), and *eteb/tal-ong* (stick knotted at the end) are also installed to

28 *Battikul* is the local term for the golden apple snail, an invasive species which was introduced in the Philipppines as early as 1980's

29 *bungubong* is a Kalanguya term to describe the *payew* situated in the topmost part of the hill

30 *Iwad*, bamboo clappers, are materials installed on posts across the rice fields to make a loud noise when the strings are pulled

31 *Bayun/alyun* are light materials tied on the periphery of the rice field that move when the strings are pulled

32 *Tibbug* is the same as bayun but is filled with water to allow it to move

Figure 11. Binablayan women manually removing the weeds in the *payew*. Photo credit: Tebtebba

catch field rats (*utut*) that savage the rice crop. Recently, some farmers admit that they have been using rat poison obtained in agricultural suppliers, a product of the introduction of chemical agriculture in the area, to decrease rat population in the fields.

Harvesting

In June or July, when the grains ripen (*nehteng*) and are ready for harvest (*hi-ani*), a thanksgiving ritual is performed called the *henget*. In this particular rite, a pig is butchered and is offered *Kabunyan* to thank Him for the bountiful harvest. During the harvest, a group of old women will go first to the field and will choose the best rice seed for *binantol/ bineng-eh* that will be stored for the next cropping. The farmers will then form their *ubbo* group where they will go to each member's rice fields to reap the rice grains with the use of the *gamlang*[33]. Harvesting is done by cutting the rice stalk and a handful is being bundled with the use of an *alinew* (thin strip of a bark of a tree used for tying). The harvested *palay* grains will then be brought home with the use of the *batawil* (wooden pole to carry load) carried by men on their shoulders. These are sun dried to reduce the moisture content of the seed and and are stored in rice granaries or in a designated corner of the house after the performance of *hukeb* (meaning to cover), a ritual performed with chicken and *tapuy* to keep the granary safe and sound. After the grains are stored in the granary, *lukyah* is performed where a chicken and *tapuy* is offered to *Kabunyan* for the grain quantity to be enough until the next harvest.

It is important to note that in instances where a woman has just given birth or a family is grieving the death of a member of the family, it is the social responsibility of the whole community (*man-ili*) to assist and collectively work in order to finish the work in the field for the family, such as transplanting or harvesting. This cooperation system is called *baddang*, a form of free labour and mutual assistance, provided by the community to a member that is needed immediately and was not planned in advance.

5.1.3. Rice yield and consumption, in the Philippines and in Tinoc

The Philippines is the world's eighth-largest rice producer and has a rice land area of 4.4 million hectares that produces an average of 3.6 tonnes per hectare that is still not sufficient to supply the rice needs of the country. In order to bridge the gap between the production and consumption, the government has to import 10% of its consumption requirements making the country one of the largest rice importers in Asia (Ricepedia, 2015). In Ifugao, it was documented that 62,465 metric tons of palay were harvested from about 17, 193 hectares of irrigated and rain-fed rice lands (PCIP, 2012). This is equivalent to 3.63 metric tons per hectare that is within the average rice production in the Philippines.

In Binablyan, some key informants who were interviewed in 2013, estimated harvest per hectare to be equivalent to 3.5 tonnes per hectare. Binablayan has a 46.3 hectares of *payew* but some areas have been abandoned. If the total area is cultivated, it can produce 162.05 tonnes. This is still not enough to supply the rice consumption for the approximately 1,500 persons living there. Using the rice consumption rate in the Cordillera which is 132 kg per capita per year, there is shortage of 36 tons. From previous group discussion, the average consumption of one person in Tinoc is 200 kgs/year. Using this figure, the rice shortage will be 138 tons in Binablayan.

5.1.4. Present Trends in the management of the *payew*

The agricultural knowledge and practices described above were practiced until the 1990s. However, economic and educational influences threaten the sustainability of agricultural knowledge and practices of the Kalanguyas, as practiced in the *payew*.

As mentioned earlier, the labour available to work in the *payew* and to maintain the irrigation and the soil fertility have been significantly decreased. Also, based on the key

33 simple hand tools used by the Kalanguya in harvesting rice

informants, the conduct of the rituals stopped with the death of the mabaki, the ritual leader, who was not able to transmit his knowledge to the next generation. While there are identified individuals who continue practicing the rituals, they are done at the household level. Kalanguya people believe that conducting the different agricultural rituals is a factor in increasing the crop yield. Conversely, it is believed that not performing the rituals contributes to the decreasing harvest.

Today, farm animals and micro-tillers are used during the land preparation and usually prepare the land prior the transplanting. This is contrary to the traditional practice of incorporating green manure four months before the transplanting period to hasten decomposition and to add soil nutrients, which is not being done any more. The *intuul*, the traditional way of fertilizing the *payew* is no longer practiced and some farmers prepare the rice fields just prior to transplanting the seedlings, leaving no time for the grasses and weeds to decompose. Some farmers even remove the rice stalks so as not to be inconvenienced during the rice planting process.

Additional work in recent years is the hand picking of the *battikul* (golden apple snail), an invasive species that was introduced in the 90's. The *battikul* damage the seedlings by eating the young leaves and shoots of the rice seedlings; this often kills the seedlings which then need to be replaced.

Present challenges in *payew* cultivation include non-maintenance of the irrigation system, increased weeds, rat, bird and golden apple snail infestation, erratic rainfall and typhoon patterns, less acesss to labour for maintaining the traditional practices, the lack of interest of the younger generation in farming and the need for cash incomes that leads to competition for labour.

To address these concerns, initiatives for revitalizating the customary sustainable practices, including the revival of the synchronized activities in the *payew* and the ubbo groups for collective work; retrieval of traditional rice varieties; and the promotion of the use of organic inputs as opposed to commercial fertilizers as a result of the land use planning process under the piloting of the ecosystem approach in Tinoc. An assessment of this undertaking is in process.

5.1.5. Summary of findings on the Kalanguyas traditional wet rice cultivation, in the *payew*

The indigenous knowledge about wet rice cultivation among the Kalanguyas incorporates numerous types of knowledge. First, the many years of existence of the rice fields, in the mother settlement and in Binablayan, attest to the engineering and hydrological skills of the people. Their traditional knowledge has, up to this day, been used to collectively manage and maintain irrigation facilities in their territories. Second, the people were able to attune their farming systems to the weather and climatic condition. For example, irrigation water is still sufficient for the booting stage up to the grain formation and coincides with the start of longer days. The rain would come after most of the grain formations have been completed thus preventing the falling of the pollen grains and empty grains. Third, indicator species (birds and plants] are observed to determine the time for land preparation and transplanting seedlings and certain activities have to be preceded by community rituals [Figure 11]. The net effect is a synchronized agricultural activity from land preparation to harvest, which is important to the practice of ubbo, [labour exchange network], to minimize the damage by birds, rats and pests to the crops and to prevent pest populations from building up [when food is available, the pests will spread to the whole landscape and when harvest time comes, the food supply is cut off]. Fourth, is the soil fertility maintenance which starts in September by the incorporation of green manure into the irrigated rice field. It also worth mentioning that minimal tillage has been the traditional way of land preparation. Lastly, the gender roles in the *payew* management system are complementary.

To date, some of the indigenous knowledge systems and practices are no longer practiced, i.e. starting the different activities with community ritual, turning in cut vegetation into the soil 3 months after transplanting, maintaining soil fertility and cultural practices for pest control. At the same time, a decrease in rice production has been observed.

Through the unification process the the Kalanguya people of Binabalayan, Tinoc, Ifugao reflected on these issues and came to the conclusion that they needed to take action. They decided to partner with Tebtebba to test some promising innovations and practices that might be supportive in advancing and maintaining the sustainability of the *payew*, in a time of changing realities, related to environmental as well as social conditions.

5.2. Indigenous Knowledge Systems Practices in the *Inum-an*; the rotational agricultural areas

Inum-an are non-tillage cultivation areas that are usually established in forest patches located in sloping areas, planted with a diversity of agricultural crops, with camote[34] (*Ipomea batatas*) as the main crop. *Inum-an* are dependent on rain for irrigation. These lands are considered as communal but the usufruct right[35] is given to the cultivator. Depending on the condition and soil fertility of the site, these areas are being utilized for agricultural production for 2 – 8 years.

34 A tropical sweet potato with numerous varieties that comprises half of the Kalanguya diet

35 Usufruct right is the right of an individual to enjoy the use of a property of another individual with the obligation of taking care of it

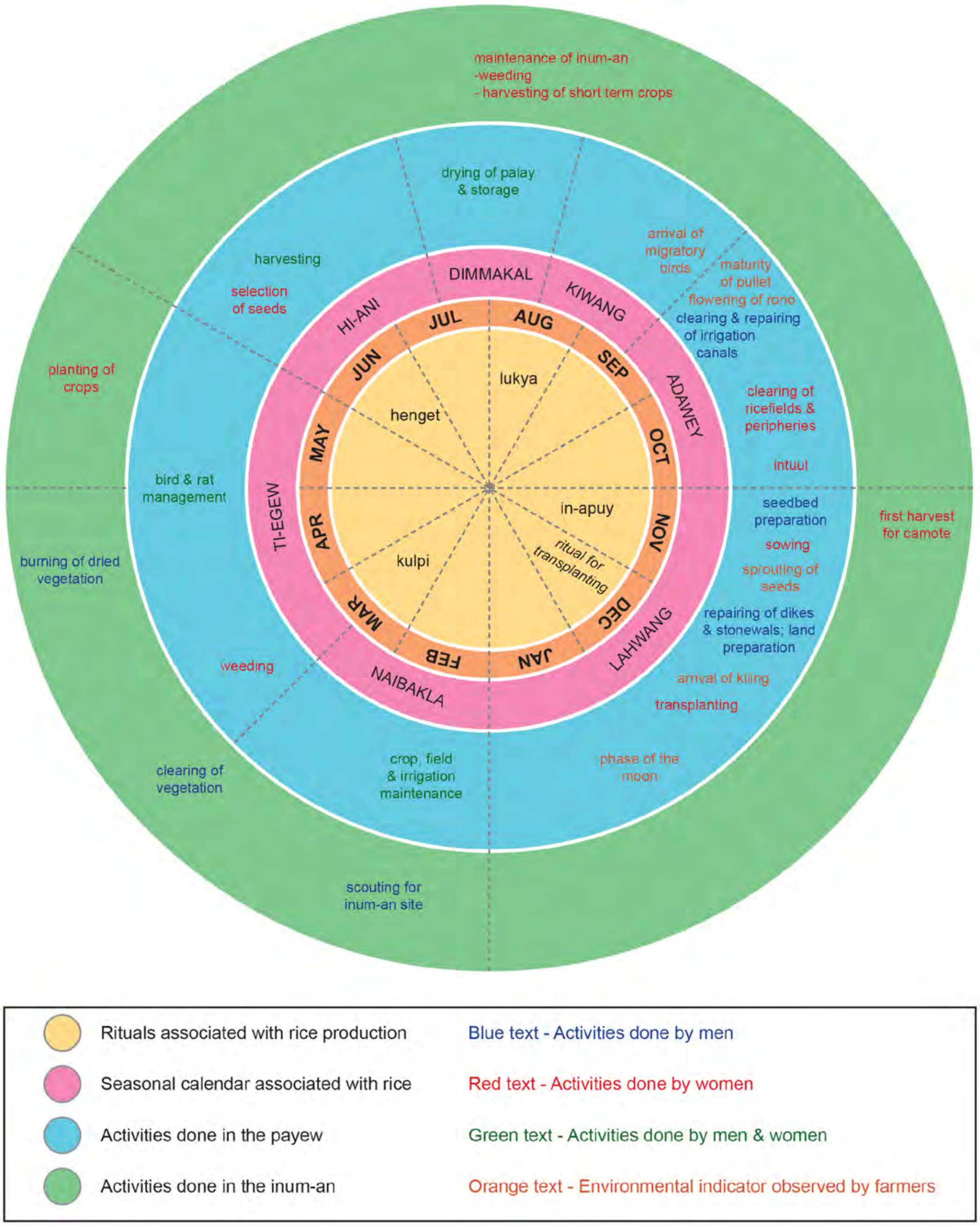

Figure 12. Agricultural calendar of the Kalanguyas in Tinoc, Ifugao drawn from the many discussions in the farmers groups during the validation. Source: Tebtebba.

5.2.1 Activities in the *inum-an*:

The *hij-uma* or the preparation of the *inum-an* starts after the celebration of the *kulpi* that usually takes place in the month of February or March. The male members would start prospecting for a good place to open the *inum-an* depending on the sites' biophysical characteristics and would reserve it by clearing the lower portion of area (*gahat*). The farmers would then form an *ubbo*[36] group that would help them clear the area by cutting the vegetation but leaving the trees that will serve as trellis for climbing agricultural crops. The cut vegetation is spread on the land and left to dry and is then burned to increase the soil fertility. Prior to the arrival of the first rain, usually in April, the remaining debris that was not burned is gathered for another round of burning (*ngap-ul*).

36 *Ubbo* is a strong bayanihan spirit of unity and cooperation among the people where collective labour exchange is being practiced by individuals or groups of farmers to perform a task (planting, weeding, harvesting, etc.) of each of the members of the group. The group takes turns in working on each other's farm and the member of the group who is helped reciprocates by offering food and drinks for each day's work.

Figure 13. Inum-an planted with corn and beans. Photo credit: Tebtebba

At the start of the rainy season, the woman would then start planting. The edges of the *inum-an* are planted with leaf vegetables, onions, ginger, tomatoes and other available seeds (Figure 13). The main farmland is first planted with corn and legumes. After the first three to four leaves of the corn and legumes emerge, camote cuttings are intercropped (inhulol). The cuttings have been prepared by soaking them in water and covering these with grasses three days earlier. This is to strengthen the stem of the camote and to enhance the development of its root, ensuring tuber formation, which will be harvested as food later.

A typical traditional *inum-an* is planted with different food crops, intercropped within the main farm and around the peripheries. Different crops such as rootcrops, legumes, cereals, spices, vegetables and fruits can be found in the same *inum-an*. Examples of crops grown in the traditional *inum-an* are shown in Table 2.

One to two months after the planting, leafy vegetables are harvested, followed by legumes, corn and others. The camote tubers (*bunhi*) are also observed to form (*nahbukan*). The crops are effectively covering the topsoil protecting it from run off. After four to six months, depending on variety, the first camote harvest (*tabkay/damun baka*) is done where one or two tubers, if they have reached a harvestable size, will be taken out from the main stem. The camote runner is again covered to allow additional tubers to develop. The regular harvesting of camote, called baka, is done when the camote runner has developed tubers (*pinmakad*). At the same time,

Figure 13. Inum-an planted with corn and beans. Photo credit: Tebtebba

Crops	Local name	English name	Scientific name	No. of varieties
Rootcrops	1. ubi	sweet potato	Ipomea batatas L.	26
	2. luktu	yam	Dioscorea alata	2
	3. pihing	taro	Colocasia esculenta	3
	4. galyang		Alocasia macrorrhiza	1
	5. kahuy	cassava	Manihot esculenta	1
Legumes	1. aggayap	rice beans		1
	2. atab / aknaban	cow pea	Vigna sinensis	2
	3. kaldih	pigeon pea	Cajanus cajan	2
	4. utung	string beans	Vigna unguiculata	2
	5. biligan	winged beans	Psophocarpus tetragonolobus	1
	6. puhnuk / hang-awan	sitting beans		2
	7. mongo		Phaseolus mungo	2
	8. mani	peanut	Arachis hypogaea	2
Cereals	1 . pagay	upland rice	Oryza sativa L.	
	2. habug	wheat	Triticum spp	
	3. gahilang	corn	Zea mays	3
	4. adlay	job tears	Coix lacryma-jobi	1
Spices	1. laya	ginger	Zingiber officinale	
	2. danggo	onion leeks	Allium ampeloprasum	
	3. langih	sesame	Sesamum indicum	2
	4. amput	garlic	Allium sativum	1
	5. hili	pepper	Capsicum frutescens	2
Fruit vegetables	1. appalya	bitter gourd	Momordica charantia	2
	2. talung	eggplant	Solanum melongena	
	3. okra	lady finger	Hibiscus esculentus	1
	4. kalumbaha	squash	Cucurbita maxima	4
	5. tabungao			
	6. kammatih	tomato	Lycopersicon esculentum	5
Leafy vegetables	1.	spinach	Spinacia oleracea	5
	2. kundey			1
	3. amti		Solanum nigrum	1
	4. lagiwey			1
	5. alleyen / kalunay		Amaranthus sp.)	2
	6. petsay	petchay	Brassica chinensis	2
	7.	mustard	Brassica juncea	2
Fruits	1. tappaya	papaya	Carica papaya	3
	2. balat	banana	Musa sp.	8
	3. pinya	pineapple	Ananas comosus	2
Grasses	unah	sugarcane	Saccharum officinarum	2
	talageddew	tiger grass	Thysanolaena latifolia	1

Table 2. Overview of agricultural crops planted in the inum-an. The diversity of crops and varieties are not complete in the table. There are additional crop species such as squash, bananas and others.

the farmers replaced the camote plants in a staggered manner to ensure continuous supply of camote tubers for 2 or 3 years (Figure 14). Harvesting is done with the use of a pointed tool which is ideal for staggered harvesting of the camote tubers. If the farmer notices that the tubers being harvested are decreasing in number and size, this will serve as an indication that the final harvest (*lihad*) should be done. *Lihad* is done by uprooting the camote plant (laklak) and digging up all the remaining camote tubers from the field. The uprooted camote plant is then coiled and lined up vertically in slopes, with half being buried and the other half exposed to the ground (*gengen*) to serve as soil catchment to prevent topsoil from running down the slopes. This is an example of the traditional practice to protect the soil from being eroded.

Inum-an weeding is accomplished by manually pulling the weeds that grow within the fields and its peripheries while doing the camote harvest. Pulled weeds are left in the field to decompose and to add to the fertility of the soil.

After 2 to 6 years rotating plants, the land will be left to fallow up to ten years to enable the recovery of the soil fertility. However, when no better sites are seen, even without completing the required fallow period, some *inum-an* are cultivation again. These are referred to as *kabukab* by the Kalanguya.

5.2.2. Main findings in the development of indigenous knowledge systems and practices of the *inum-an* over the last decades

The diversity of agricultural crops in the *inum-an* have provided the sustenance of the community for generations. But as population increased, the Kalanguyas have adopted and extended the cultivation periods, rotating different main crops for longer years (maximum of eight years) and at the same time shortening the fallow period when the soil has to regain its fertility. Moreover, the entry of commercial vegetable production that introduced the use of chemical inputs and the production of monocrop vegetable varieties is one of the factors that weakened the traditional practices of intercropping and soil conservation management on the *inum-an*. This has resulted in the conversion of *inum-an* and forest lands into commercial vegetable farms.

The concept of innovating the *inum-an* was put together during the consultative meetings with the Kalanguya people starting in 2010 that included a thorough discussion on the importance of the *inum-an* as a sustainable food production system. Contour plants and hedgerows, multi-story cropping, the use of organic inputs, integration of animals, and the revival and re-integration of traditional food crops in the *inum-an* were introduced. These were adopted by some farmers and one farmer co-operator reported that she was able to integrate poultry and bees where honey are being collected.

5.3. Indigenous Knowledge and Systems and Practices regarding Soil Quality

Binablayan farmers classify soil quality primarily on the basis of soil colour and texture using their sense of sight and touch, respectively. This is based on the knowledge that was transferred to them from elder generations and their experiences in the use of the land. The soils are classified as *pedet, panhil, pula* and *lubuy* that are described in Table 3. According to the farmers, black, dark brown and brown soils are considered to have high levels of organic matter, are more fertile, and have high potential to produce good agricultural products. On the other hand, red and light coloured soils, clay and rocky soils are less fertile. This observation is corroborated by the study of Conception and Batjes (1997), and Mahilum (2004) that states that dark coloured soils reflect a higher content of organic matter and possess good drainage and permeability, on which agricultural crops tend to grow highest. Furthermore, in order to differentiate between clay and sandy soil, the farmers feel the soil to determine the texture of it.

The farmers are also aware that the soil characteristics vary from field to field because of the influence of management that they employ. Their experience is that rotating irrigated rice with different agricultural crops and rotating different agricultural crops in the *inum-an* increases soil quality. To improve soil quality and soil fertility, the farmers incorporate available resources such as crop residues (rice stubbles and stalks), green manure (grasses and weeds), sunflower, and animal manure (pig and carabao) to the fields and all these are supplemented by the organic matter brought in by the irrigation water. These crop residues contain significant amounts of nu trients and serve as starting material for the build up of organic matter that affects soil health and other soil properties. This has also been confirmed in scientific studies.[37]

37 Peligrina et.al. 1992.

Soil classification	Soil colour	Texture	Description
pedet			Not capable for growing crops and is very hard to till
panhil	brown, gray	gritty	Mixture of soil, gravel or stones that is productive for root crops
pula	orange-red	smooth when wet	Very hard when dry and sticky when wet; not capable in sustaining crops and is also hard to till
lubuy	black	soft and gritty	Moist and soft soil that is best for growing crops

Table 3. Soil classification of Binablayan farmers.

5.4. Findings and reflections on insect inventory

Rice fields harbour diversified plants, animals and micro-organism that can be both harmful and beneficial to the rice crop (Global Rice Science Partnership, 2013). Except for the rice aphids, farmers in Binablayan are not aware of the many insect species that attack all parts of the rice plant at different rice stages and the natural enemies that are supporting the farmer in controlling the pests' population. Through the project, the farmers were made aware of the pest dynamics and the benefits derived from "insects friends of the farmers" that were present in the field.

The insect inventory conducted in the *payew* and *inum-an* was to identify and clasify the most common insect pests of rice and the sweet potato and ginger (the most dominant crop planted in the *inum-an*). The inventory in the *payew* recorded 14 species of insect pests, 20 species of natural enemies and six species of neutrals or insect visitors. (Table 4) Most of these insects were observed in the different growth stages of the rice from seedling, tillering, flowering, milking and harvest stage. In the *inum-an*, 3 species of insect pests, 8 species of natural enemies and 3 species of visitors were recorded. (Table 5) The continuous presence of the host plants that sustain the population of insect pests could also be the reason why the natural enemies are present at every sampling time. However, despite the higher number of natural enemies, they could not totally eradicate the population of the insect pests and their presence is to regulate the number of insect pests. Other cultural interventions must still be employed to maintain the population of the insect pest and preservation of the natural enemies must also be done to maintain their presence.

During the focus group discussion on insects, it came out that the farmers' knowledge on insect pest damage is limited to *dangew, rice bug damage, and leaf curl*. It was also through this discussion it came out that the farmers in Binablayan consider weeds, birds, rats, *battikul* and *kalakal* as pests in rice production. One of the major concerns of the farmers in rice production is the growth of weeds in the *payew* during the agricultural cycle and which is controlled by manual hand pulling. During the land preparation where water is an important factor, the presence of *kalakal* is becoming a problem for the farmers since they make holes in the teneng that holds the water. The farmers then check the dikes everyday and patch the hole made by the *kalakal* in order to maintain sufficient amounts of water that is used during these period. Before and after the transplanting period, battikul is a major problem since it would damage the palay seedlings, thus manual handpicking before the transplanting period and water management should be observed after being planted, to minimize the damage brought by the existence of the *battikul*. During the booting stage of the rice plant, rat infestation becomes a major problem and is addressed by the clearing of the *payew* peripheries and at the same time, plugging of rat holes with the weeds. Traditional rat traps are also being set up with the *payew* surroundings. When the palay grains starts to ripe, the problem of birds occurs – this is minimized with the setting up of scarecrows and other measures that the community applies. Synchronized rice growth stages among rice plots in the same area also decrease the damage done by the rat and bird in the *payew*.

What would be interesting to follow through further research is the presence of, and balance or imbalance between pests and their natural enemies of insects in the vegetable gardens where chemical pesticides are indiscriminately used.

Insect order	Family	Common name	Local name	Scientific name
A. Insect Pests				
Hemiptera	Delphacidae	Brown plant hopper	paypaytuk	*Nilaparvata lugens*
		Green leafhopper	paypaytuk	*Nephotettix nigropictus*
		Zigzag leafhopper	paypaytuk	*Recilia sp.*
		White backed plant hopper	paypaytuk	*Sogatella sp.*
	Alydidae	Rice bug	dangew	*Leptocoriza oratorius*
	Pentatomidae	Green stink bug	dangew	*Nezara viridula*
		Stink bugs	dangew	*Eurydema sp.*
Lepidoptera	Pyralidae	Rice caseworm	balangaw ni pagey	*Nymphula sp.*
		Leaf folder		*Cnaphalocrosis sp. and Maras-mia sp.*
	Hesperiidae	Rice skippers		*Pelopidas sp.*
Orthoptera	Gryliidae	Mole cricket		*Gryllotalpa sp.*
	Acrididae	Grasshopper	dudun	*Oxya sp.*
Thysanoptera	Thripidae	Trips		*Stenchaetothrips sp.*
Coleoptera	Curculionidae	Grain weevil	bubuk	*Sitophilus sp.*
B. Natural Enemies				
Hymenoptera	Scelionidae	Small wasp		*Telenomus sp.*
	Chalcidae	Small wasp		*Brachymeria sp.*
	Ichneumonidae	Wasp		*Amauromorpha sp.* *Itoplectis sp* *Charops sp.*
	Braconidae	Wasp		*Cotesia sp.*
Odonata	Libellulidae	Dragonflies		*Orthethrum sp.*
	Coenagronidae	Damselflies	dah-utin banig	*Agriocnemis sp.*
Coleoptera	Coccinelidae	Coccinellid beetles	kukudung	*Micraspis sp* *Cheilomenes sp.* *Coccinela sp.* *Harmonia sp.*
	Carabidae	Rove beetle		*Ophionea sp*
	Dytiscidae	Diving beetle	kuttubey	*Dysticus sp.*
Orthoptera	Tettigoniidae	Grasshopper		*Conocephalus sp.*
	Gryliidae	Grasshopper	am-amhik	*Metioche sp.*
Hemiptera	Miridae	Mirid bugs		*Cyrtorhinus lividipennis*
	Gerridae	Water strider		*Limnogonus sp*
Diptera	Pipunculidae	Small black flies		*Tomosvaryella sp.*
C. Neutrals/Visitors				
Hymenoptera	Formicidae	Ants	kakabang	
Coleoptera	Cerambycidae	Twig borer	akikiyeh	
	Chrysomelidae	Flea beetle	paypaytuk	*Phyllotreta sp.*
		Leaf beetle		
Trichoptera	Leptocoridae	Tricopterans		
Hemiptera	Cicadidae	Cicada		

Table 4. Insects in the *payew*. Classification of insect pests and natural enemies associated with rice at Binablayan, Tinoc Ifugao according to the insect inventory.

Insect order	Family	Common name	Local name	Scientific name
A. Insect Pests				
Coleoptera	Scarabidae	Cockchaffer	Giggiya	*Adoretus sp.*
	Curculionidae	Snout beetle	Kubbukub	*Oxyops sp.*
	Chrysomelidae	Flea beetle	Paypaytok	*Phyllotreta sp.*
Hemiptera	Aphidae	Aphids		*Aphis sp.*
B. Natural Enemies				
Coleoptera	Carabidae	Rove beetle	lingngaling ni kih-kihkut	*Calleida sp.*
	Coccinellid	Lady bug beetle	kukudong	*Cheilomenes sp.*
Orthoptera	Gryliidae	Field Cricket		*Gryllus sp.*
Odonata	Coenagronidae	Damselflies	Dah-utin banig	*Agriocnemis sp.*
Mantodea	Mantidae	Praying mantis		*Acontispa sp.*
Dermaptera	Anisolabidae	Earwigs	Ip-ipitan	*Euborelia sp.*
Hemiptera	Lygaeidae	Big eyed bug		*Geocorus sp.*
Hymenoptera	Chalcididae	Small wasp	Gutul	*Brachymeria sp.*
C. Neutrals				
Hymenoptera	Apidae	Stingless bee	Gutul	Trigona sp.
Diptera	Musidae	House fly		Musca domestica

Table 5. **Insects in the *inum-an***. Classification of insects associated with ginger and sweet potato at Binablayan, Tinoc Ifugao according to the insect inventory.

6. The testing of innovations in the farmlands as applied in Binablayan and its effects

6.1. Description of the *payew* experimental area in Binablayan

Most of the rice fields in the pilot site had already been planted during the planning (Feb 28, 2015) of this project but there were about 10 farmers who adopted some of the innovations. They were spread in all the 4 pilot communities. One option was to unite on the MEB process and mechanisms and to do detailed monitoring of all these on-going efforts for the project but officers of *Naundet ni Napahnuhan ni Kalanguya* (NNK), the partner people's organisation, decided to follow one area, Binablayan. The project implementers also saw this suggestion as a better option as this meant the closely monitored sites would have the same geographical parameter.

The experimental fields have continuously been cultivated since its construction [unknown period] but have been idle since 2008 when the irrigation source of the *payew* was destroyed. For the conduct of the experiment, these were re-opened in March 2015.

6.2. Innovations applied in the *payew* (ricelands)

Each ricefield in the pilot was divided into two blocks with an area of 10 x 5 meters. These two were subdivided into 5 x 5 m plots, one set to follow the present day practices in wet rice cultivation, referred to in this document as " conventional" and the other set was referred to as "innovations applied" or fields where innovations were applied. This was replicated in the four ricefields. All innovations were applied and evaluated together in each field, as an innovation at system level.

Land preparation was done by ploughing, harrowing and levelling the *payew*. The *teneng* (paddy field dikes) are prepared by cleaning and compacting to prevent water seepage.

	Conventional	Innovations	Reasons for innovation
Land preparation (ricefields and seeded)	The dikes and the stone walls are fixed. Spade and grub hoe are used in tilling the rice fields. The fields are also levelled to give better water coverage, better crop establishment and better weed control.	Microtiller is employed in addition to grub hoe and spade	Minimize labour requirement
Sowing	Seeds are pre-soaked in the water for 3 days and and are drained in the shade for 24 hours before being laid in the seedbed.	Same as for the conventional	
Age of seedlings when transplanted	48 days old	18 days old	To increase tillers. Care in uprooting the seedlings is a must, thus minimizes root damage hence easy recovery and can use energy in tiller production
Number of plants/ seedling/s per hill	2–4 seedlings/hill	1 seedling/hill	Save on seeds. More space for tillers
Planting allingment	Random, no specific alignment	Seedlings are planted aligned to each other	Will allow mechanization of weeding
Planting distance	13 cm x 13 cm to 17 cm x 17 cm	20 cm x 20 cm	
No. of hills/m²	32 (average)	25	More space for the rice plant, more sunlight, more space to get plant nutrient
No. of plants/m²	96 (average)	25	

Table 6. Conventional practices and the innovations applied in seedling management

The irrigation canals are also cleared and damages are fixed to ensure continuous water supply in the fields.

6.2.1. Tested innovations in land preparation, seed sowing and transplanting

Land preparation does not require special consideration but the soil should be worked well to get the best result. To address the numerous challenges in wet rice cultivation, some innovations were identified. One was appropriate farm mechanization to address scarcity of labour and, to a certain extent, the growing dis-interest in rice growing due to the intensive labour requirement. This was linked to the revival and development of blacksmithing as an important traditional occupation. Trained individuals fabricated micro tillers and manual rotary weeder which were used in the land preparation and weeding. Hypothetically, what the microtiller can cultivate in an hour, will take 8 hours when done with shovel or grub hoe [1:8]. The rotary weeder still has to be tested. To save labour in the land preparation is to offset additional labour to be incurred in other aspects of the innovations.

A significant positive result is that with the availability of the micro-tiller, other abandoned rice fields were re-opened for cultivation in three of the four pilot sites.

The second innovation is on the single transplanting of rice seedlings at an early age in square pattern and with care. The "System of Rice Intensification" (SRI) is an innovation that has been replicated, locally adapted and tested with positive outcomes in many rice cultivating areas of the world, starting from Madagascar.[38] It was presented for the farmers, and believed that it could be worth testing if it could have positive contributions also in Tinoc.

Traditionally, 1 month after sowing, rice seedlings are transplanted to the main field. But due to labour inadequacy this has now extended to 1.5 to 2 months. The SRI prescribes 8 to 12 days old seedlings (2 leave stage) for transplanting. But based on the observed growth of the seedlings, 18 days was seen as more appropriate in Binablayan. At 18 days old, the seedlings were taken from the seedbed with care and were transplanted, one per hill at a distance of 20 x 20 cm. This saved the amount of rice seed needed for sowing, i.e. 96 seed grain compared to 25 seeds or 74 % less as shown in Table 4. The planting distance is intended to facilitate weeding and at the same time gives the rice plants more access to sunlight and air above ground. To plant in a uniform pattern, the farmers improvised a device that guides them in transplanting the seedlings in the field (Figure 15). Careful transplanting of young seedlings according to Uphoff (2008) reduces plant shock and increases its ability to produce numerous tillers and roots. Moreover proper plant spacing, increases the yield by 25–40 %. (IRRI Rice Knowledge Bank. 2015).

38 http://sri.cals.cornell.edu/aboutsri/methods/index.html

Figure 15. Taking seed bed with care (left) and transplanting using an improvised guide (right). Photo credit: Tebtebba

	Conventional	Innovation
Land preparation	Crop residues, weeds, grasses and other green manure in the *payew* and its peripheries are removed and are treaded in the soil to decompose to add to the soil fertility.	Crop residues, weeds, grasses and other green manure in the *payew* and its peripheries are removed and are treaded in the soil to decompose to add to the soil fertility.
		Vermicompost is integrated during
transplanting	48 days old	18 days old
	IMO is applied on the soil prior the sowing of seedlings.	IMO is applied on the soil prior the sowing of seedlings.
		IMO is applied on the soil prior the transplanting of seedlings
Weed management	Manual hand weeding is done in the *payew* to uproot the weeds that compete with the nutrients of the plants. The weeds are being treaded in the *payew*.	Mechanical weeder was used 4 times to aerate the soil and control the weeds that grow and compete with the nutrients for the rice

Table 7: Innovations in soil fertility management

6.2.2 Innovations on Soil fertility Management

The third innovation was related to soil fertility. Vermicompost was incorporated in the main field in addition to the crop residues, weeds, grasses and other green manure to add to the soil fertility. The seedbeds and the main *payew* were sprayed with indigenous micro organisms (IMO) before seed sowing and seedbed transplanting.This is to facilitate the availability of nutrients to the plants and improve soil quality. In addition, during the vegetative growth stage of the rice plant, compost of sunflower leaves was applied to the soil. The compost of sunflower increases soil nutrients, specifically nitrogen and organic material.

What was not recorded was (1) labour input to prepare the additional fertilizers and (2) the dosage of IMO sprayed and volume of compost applied, and (3) comparison of labour required in the manual way and mechnized land preparation and weeding.

6.2.3 Innovations on Water and weed Management

The fourth innovation is the introduction of alternate wetting and drying or intermittent irrigation. This is done to increase the rice tillers and to have vigorous and deeper root penetration in the rice field. Water management is also important in the management of the battikul population since battikul are not able to damage crops when the water is limited. Aside from manual handpicking of the battikul prior to the transplanting, canals are made in the area surrounding the *payew* to serve as an area where kohols will be staying.

The roots should also be aerated through regular weeding with the use of the weeder. A simple mechanical weeder fabricated by locals is used to eliminate weeds and to aerate the soil that is essential for crop growth because the plant´s roots require oxygen for respiration to maintain life processes (Figure 16). In the experimental fields, the farmers have conducted four weeding activities in the rice fields where innovations were applied. The first one was two weeks after transplanting and three more lots of weeding were done before the rice crops started to flower.

Figure 16. Weeding the SRI rice fields with the aid of the mechanical weeder. Photo credit: Tebtebba

	Conventional	Innovation
Water/irrigation management	Maintenance of the dikes and levelling the fields during the land preparation ensure water distribution across the field. After the transplanting, continuous flood irrigation at 3 -10 cm and is ensured through the giti system.	Dikes are used to retain the water in the field. Alternate wetting and drying is applied in the rice fields during the vegetation stage of the rice. When the rice starts to flower, the field is kept flooded with water.

Table 8. Innovations in water/irrigation management

6.2.4. Observed effects from the testing of the innovations on the performance of the rice plants. Observed effect on plant performance.

The plots where innovations took place show a consistently better performance in terms of tillering capacity, pannicle and grain formation. Of the five traditional rice varieties, Amputi consistently fared better than the other varieties. There is however a major discrepancy in information gathered. These different data is discussed below.

Performance	Varieties	Convention-al	With Innovations
Number of tillers per hill (where rice seedlings were plant-ed)	Binweken	4	5
	Maldang	5	6
	Pugot	4	6
	betnel	5	7
	amputi	5	8
Average number of tillers per hill		**5**	**6**
Average number of panicle/hill	Average	5	6
Rice grains/pannicle	binweken	102	119
	maldang	136	147
	Pugot	150	150
	betnel	176	180
	amputi	212	220
Average grains/ hill			
Average grains per pannicle		**155**	**163**
Average grains/hill		**726**	**1,079**
yield/ sq m (kg)	binweken	0.326	0.372
	maldang	0.544	0.551
	Pugot	0.480	0.562
	betnel	0.704	0.788
	amputi	0.848	1.1
Average Yield per sq. m (kg)		**0.58**	**0.68**
average Yield (tons/hectare)		**5.80**	**6.75**
Average Yield (cavans [50kgs] per hectare)		**116**	**135**

Table 9. Comparison of rice growth and yield performance t

Note: The yield above was computed based on the number of grains per pannicle and number of pannicles which is also observed same as the number of tillers.

The data on yield in Table 9 is based on estimates from the recording of the number of grain count per pannicle. The time element in recording the grain count is missing.[39] The actual recording of yield was done in May 11, 2016 from 1 of the 4 cooperators. It made use of the data available which

39 I t matters if the recording was done at the onset of grain ripening or at the start of grain formation

was the number of pannicles with grain per sq m. For each of the varieties, the specified number of pannicles was randomly picked from the harvest, segregated, pounded and weighed. The lowest yield in the plots where innovations were done was the binwaken variety which is 3.50 tons per hectare and the highest was that of the Amputi which was 6.5 tons per hectare. The average was 5 tons per hectare. The sample from the "conventional" plot was not pounded as almost all are empty grains.

The cooperator of the ricefield clarified that what has been pounded and weighed are from the second harvest. Two of the 4 cooperators specifically stated that in the "first harvest", the harvest in the "conventional plots" were only about 25% of the total harvests of the plots where innovations were made.

Accordingly, rice harvest should be done once in one rice field [left overs are for the birds and others]. But there can be 2 to 3 harvest in one field if there is non uniformity of grain ripening which is attributed to poor land preparation – when the soil is not levelled well and the distribution of water and plant nutrition is not uniform. In such a case, the plants' growth is not uniform and harvest may have to be performed 2 or 3 times. Usually, the first harvests are from crops with better performance. In this particular case, the owner has to do three harvests. [focus group discussion, Binablayan, May 2016]

Other information that came out during the focus group discussion is that one cooperator stated that the maximum count of tillers per plant that she counted was 15 and the other said 17 .

Another cooperator (also from Binablayan) who has been implementing the recommended distance, and also planting younger seedlings and spraying foliar sprays for three consecutive cropping seasons before the pilot testing, was able to realize about 12 tons per hectare of yield, which was about three times more compared to her field production before the innovation. This could be seen as being an promising outcome of the first initiative of testing SRI in Tinoc. More research will be needed to test this further.

The above data sets [Table 9 and above] require additional discussion among cooperators to reconcile or to determine which are the final conclusions regarding the outcomes from the farmers perspective.

After this first season of piloting of innovations in the *payew*, there are mixed perceptions among the farmer-cooperators who volunteered to the experiment. While some perceive that the innovations that were introduced were good and would help them increase their rice production, some said that it was laborious.

The performance of productivity in the *payew*, i.e. crop yield and other bi-products from the fields, should be tested or assessed in relation to inputs in terms of labour, fertilizers, irrigation, etc.

More testing with the farmers will be needed to find clear answers on how to best apply the innovations.

The actual recording of yield and crop perfmance would have needed more detailed monitoring. It would also be important to have data over several years and from more farmers, and follow their experiences of the innovations over time.

6.2.5. Observed effects of innovations of spraying Indigenous Micro Organisms on the soil quality

Prior to the land preparation, soil samples were taken from the conventional and experimental (SRI) rice fields in order to ensure that the soil characteristics are not a major determinant in the result of the study. After the harvest season, soil samples are again collected from the same fields. The results are then compared to the result of the soil analysis prior the land preparation (Table 10 and 11)

Soil texture refers to the particle size distribution of the sand, silt and clay in the soil. In order for the rice to grow well, the soil texture is one of the factors that should be considered. Based on the result of the soil analysis, the texture is relatively homogenous (clay loam) – this is best for rice farming and also has a good water holding capacity.

Rice crop grows best when the soil pH is between 6.0 and 8.2 (Hrneck et. al., 2011). Based on the result of the soil analysis, the soil pH has significantly improved. Before the land preparation, all the rice fields have a low, acidic pH – below the optimum pH range for rice. However, it can be noted that after the harvest, pH in all the the 4 rice fields improved – the pH increased and met the optimum pH range for rice that is important for the availability of nutrients.

Soil organic matter (OM) content of the rice field before the land preparation is within the optimum for cultivation and was maintained in one of the rice fields where innovations were applied, however, for the other rice fields, the organic matter declines.

The total nitrogen available in the rice fields is consistently low (<2 ppm) in all the rice fields before the land preparation and after the harvest. The available phosphorous that is needed by the rice plant for flowering, fruiting and rooting prior to the land preparation is moderately high (6.1–10) and very high (>15) as presented on Table 6 and 7, respectively. However, it is interesting to note that after the harvest, the phosphorous available in both the fields increased tremendously. Extractable potasium in the rice fields is low (<35) in all the ricefields prior to the land preparation but two rice fields have increased to moderately low levels (36-55 ppm) after the crops were harvested. Meanwhile, the water holding capacity is consistently low (<100%) in all the rice fields.]

Zinc is one of the micronutrients needed by the plants in relatively small amounts that is generally derived from the soil (Mahilum, 2004). Based on the result of the soil analysis, the zinc content of the rice fields is sufficient for rice crop since the values are higher than 1.5 ppm but is recommended to be maintained.

Parameter	Unit	Threshold value	Conventional 1		T-test	With innovations 1 (spraying with Indigenous Micro Organism, and applying compost)		T-test
			Before land prep	After harvest		Before land prep	After harvest	
texture			clay loam	clay loam		clay loam	clay loam	
pH		6 –8.2	4.65	6.205	0.0086*	4.77	6.25	0.0865
Soil organic matter (OM)	%	3–5	3.53	2.79	0.0695	4.14	2.46	0.0064*
nitrogen	%		0.18	0.135	0.1550	0.21	0.135	0.0942
phosphorous	ppm		10	155	0.0267*	9	4	0.1400
potassium	ppm		13	44	0.0021*	12	41	0.0490*
water holding capacity	%		38.81	72.28	0.0041*	35.57	69.70	0.0219*
Micronutrient								
zinc	ppm	1.5	1.91	6.11		1.97	6.43	

Table 10. Comparison of effects of innovations on the soil physico-chemical parameters in the rice fields
*significant at p = 0.05

Parameter	Unit	Threshold value	Conventional 2		T-test	With innovations 2		T-test
			Before land prep	After harvest		Before land prep	After harvest	
Physical parameters								
texture			clay loam	clay loam		clay loam	clay loam	
Chemical parameters								
pH		6–8.2	5.09	6.145	0.0812	5.18	6.34	0.0399*
soil organic matter (OM)	%	3–5	3.72	0.13	0.0391*	3.51	3.35	0.2604
nitrogen	%		0.19	0.01	0.0353*	0.175	0.17	0.5
phosphorous	ppm		29	85	0.0128*	16	30	0.0385*
potassium	ppm		10	22	0.1173	12	32	0.0310*
water holding capacity	%		43.56	101.35	0.0230*	44.58	78.47	0.0391*
Micronutrient								
zinc	ppm	1.5	2.92			2.89		

Table 11. Comparison of the effects of innovations on the soil physico-chemical parameters in the ricefileds

Just like with the result in the tillers and grains, the impact of the innovation on the soil quality is needed to be tested further, in particular regarding dosages of the inputs and labor requirements.

6.3 Other learnings from the Project regarding pests and irrigation management

The prolific growth of weeds in the *payew* is addressed by hand pulling and it is hard and time-consuming work. This is where the manual rotary weeder would be useful. However, that would mean adopting the uniform and wider rice planting pattern. Another proposed innovation is to control weeds by manipulating the water supplied to them. After transplanting the rice seedlings, irrigation is kept to a minimum, just enough moisture content for the newly planted rice to establish their root system. These conditions are favourable for the germination of the seeds of weeds. After the life-giving leaves have sprouted from these seeds, the whole field should be submerged to suffocate and kill the weed sprouts. This is within the first 7 days after the palay seedlings are transplanted. Weeding, preferably with the use of the rotary weeder should be done at 7-10 day intervals until the crops reach the booting stage. Weeding also aerates the soil and is beneficial to the crops. This frequent weeding was the reason why a rotary weeder was introduced. More discussion on weeding management shall be done to determine what actually happened in the experimental plots and surface out views on such system, and how it can be enhanced.

The presence of kalakal [mole cricket] [40] is still another major problem. They make holes in the teneng (paddy field dikes], hence wasting the precious irrigation water. Also, they do damage to the newly planted palay seedlings. Aside from eating the young leaves and shoots, they roam around the fields overturning the soil including the rice plants. This is a challenge in the proposed innovation on water management for weed control in the first 7 days. But if these are meticulously collected during the preparation, damage can be eradicated or kept to a very minimum level until such time the plant grows to a maturity and can withstand these crickets.

During the booting stage of the rice plant, rat infestation becomes a major problem and is addressed by the clearing of the *payew* peripheries and at the same plugging of rat hole with the weeds. Traditional rat traps are also being set up with the *payew* surroundings. When the palay grains start to ripen, the community applies measures such as setting up a scarecrow to keep birds away. Synchronized rice growth stages among farmers also decrease the damage done by the rat and bird in the *payew*.

It is observed that when rainy seasons start as early as April, [when grains start to harden] irrigation becomes readily available and the farmers keep their fields flooded with water. It is recommended that the farmers should drain their fields 25 days before harvesting to let the soil dry out and encourage the plant to transfer as much of its nutrient supply to the grains as possible (Association Tefy Saina and Cornell International Institute for Food, 2015).

40 In many rice growing areas of the Cordillera, mole crickets are not considered pests. These are edible and are only available for the table during the riceland preparation. While repairing the dikes, mole crickets are coached out of their homes, the part of the dike towards the field. Holes are dug water is splashed into the holes to force the crickets out which are then collected.

7. Conclusion and Recommendation

This study was initiated because the communities in Tinoc, as part of their process of land use planning and unification ongoing since 2008, had come to the conclusion that they urgently needed to find ways of dealing with all the challenges they were faced with, at a time when the traditional farming practices in the *inum-an* and the *payew* are eroding. The study of the traditional indigenous knowledge systems and practices made it possible to draw out the traditional knowledge and to determine what innovations might help them to adapt to the new realities. Issues they have to deal with in this respect are soil fertility maintenance; irrigation management, pest control, managing sloping areas, linking the phases of the moon to their farming activities, use of indicators, plants and birds to mark certain seasons for certain activities; food and nutrition, as exemplified in their *inum-an*. It was clear that people were able to find ways and means to cope with the proliferation of pests, although these remain major problems to date.

7.1 Conclusions and recommendation regarding the piloting of innovations

The process of piloting innovations was able to fill in some knowledge gaps, like the importance of bulubol [use of IMO's to rejuvenate the soil] and and how it can be revived by using modern science to test and show its value. The existence of numerous insects and the importance of the balance of their population for the protection against pests was recognized. Another important observation from the community research was the need to replace the traditional practice of green manuring with compost as the community no longer has the capacity to decompose their rice straw for 4 months before transplanting.

Earlier studies and discussions among the farmers in the area during the unification process identified the current challenges and helped define innovations to be pursued. This project validated some of the proposed innovations, i.e. appropriate farm mechnization, age of seedlings and spacing. The innovations in seedling planting showed a significant savings in seeds.

The effectivity of soil fertility enhancement cannot, however, be determined. To date, there are two different sets of data on yield. One was computed based on grain count. It showed that the yield in the plots where innovations were done showed an average of 6.8 tons per hectare as compared to conventional plots which showed 5.8 tons per hectare. While the former is higher by 1 ton, this difference may not be able to compensate for the additional labour of producing IMO's, compost, applying these not only once and the additional labour in weedng.

The second set of data was gathered from actual pounding and weighing of the harvest based on the recorded number of pannicle with grains. It showed that the harvest from the plots applied with IMO and compost were 4 times more than the harvest from the conventional plot. If this is the case, the innovations on fertility enhancement are worthy of upscaling. This observation calls for further testing of the innovations over several years in collaboration with the farmers.

The prevalence of pests still validates the need to revive synchronized cropping, which was identified as early as 2010, and is worth implementing.

Two major lapses were incurred in the conduct of the study. First, the research design should have spelled out innovations to address labour scarcity and second the inadequate recording of crop performance through the various rice growth stages and yield and no record in labour, including labour investment in IMO and compost production and the dosage of IMO's and foliar sprays. It is recommended that in continuing this undertaking, these should be meticulously recorded so as to be able to analyse return on investment.

Based on this study, it is also suggested that indicators related to food security and community resilience in the context of Tinoc can include the following:

1. increase in productivity of the ricefields [to record labour, other farm inputs and yield];
2. no. of people adopting innovations both in the *inum-an* and *payew*;
3. no. of hectares recovered from abandonment [need baseline data per barangay]
4. no. of people adopting the proposed innovations in the *inum-an*;
5. no. of hectares planted to diverse food crop

Finally, it is recommended to study if there are changes in the pattern of indicator plants and birds and how can these be useful in the context of climate change.

The school building in the community of Binablayan, Tinoc. Photo credit: Pernilla Malmer

7.2. Conclusions and recommendations regarding the piloting of a Multiple Evidence Base approach

The study also aimed at contributing to the piloting of a Multiple Evidence Base approach for bridging and creating synergies across knowledge systems, in a way that keeps the integrity of each knowledge system, and that is built on mutual respect and meaningful outcomes for all involved actors.[41]

The introduction of the Multiple Evidence Base community research project in 2015 which sought to strengthen and monitor innovative practices adopted by the farmers has made the farmer cooperators decide to work on their *inum-an* again, with the hope that their crops will be less affected by crop pests and other damage. They decided to try the different *inum-an* innovations and to revive the different agricultural crops planted in the *inum-an* and have in collaboration with Tebtebba evaluated and reflected on the outcomes. This is an important step towards building the confidence in the kalanguya culture and indigenous and local knowledge systems and practices. A part of this has also been to engage with scientific knowledge on rice cultivation, such as the system of rice intensification (SRI) and scientific methods to study the effect of the innovations. This has helped to strengthen the local knowledge and understanding and to find ways forward.

The mobilisation of the kalanguyas indigenous knowledge, through their unification process from 2008 onward, empowered them to identify needs to recover and enhance their traditional farming system, that might be facilitated through applying various modern scientific methods and techniques. It opened up a space for discussion and exchange of ideas from equally valid knowledge systems for learning, analysis and evaluation. The innovations were tested in the volunteering farmers' fields, and the outcomes were discussed and further analysed in farmers groups, based on the perspective of what is useful in the Kalanguyas livelihood context. This is an important outcome as such, and a recognition of the strength in the mobilisation of knowledge that has been an outcome of the long term unification process.

41 http://swed.bio/stories/a-multiple-evidence-base-approach-for-equity-across-knowledge-systems/

Community life in Binablayan. Photo credit: Pernilla Malmer

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About the report

This report presents the outcomes of a collaborative partnership between Tebtebba Foundation, Philippines and SwedBio for piloting a Multiple Evidence Base approach to co-generate knowledge and methods for mutual learning across knowledge systems.

As a response to exploitation and degradation of their ecosystem, the Kalanguyas have gone through a process of unification over the last decade, contributing to revitalizing their indigenous knowledge and confidence in their culture and local practices. The process empowered them to identify innovations that could strengthen their farming systems, such as the System of Rice Intensification, and Indigenous Micro Organisms. Farmers engaging in the pilot project used indigenous methods as well as methods from western science to test these innovations in the inum-an, or rotational farming areas and the payew, the traditional rice terraces, with important results that contribute to the revival of sustainable agricultural practices and increased yields.

Tebtebba

Tebtebba, an indigenous Kankanaey word of Northern Philippines, refers to a process of collectively discussing issues and presenting diverse views with the aim of reaching agreements. It is the name given to the Indigenous Peoples' International Centre for Policy Research and Education, an indigenous peoples' organisation working to have the rights of indigenous peoples respected, protected and fulfilled worldwide. Tebtebba and its networks advocate and create models for self-determined and sustainable development and advance knowledge generation through community-based monitoring and information systems (CBMIS).

Swedbio

SwedBio is a knowledge interface at Stockholm Resilience Centre contributing to poverty alleviation, equity, sustainable livelihoods and social-ecological systems rich in biodiversity that persist, adapt and transform under global change such as climate change. SwedBio enables knowledge generation, dialogue and exchange between practitioners, policy makers and scientists for development and implementation of policies and methods at multiple scales.

SwedBio at Stockholm Resilience Centre,
Stockholm University, SE – 106 91 Stockholm, Sweden
Visiting address: Kräftriket 2b
Telephone: +46 8 674 70 70
Email: swedbio@su.se
www.swed.bio, www.stockholmresilience.su.se

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Co-produced by:
Tebtebba Foundation
No. 1 Roman Ayson Road
Campo Filipino 2600 Baguio City,
PhilippinesTebtebba@tebtebba.org
http://www.tebtebba.org