Japan International Cooperation Agency

Ministry of Agriculture and Cooperatives

THE PROJECT FOR FLOOD COUNTERMEASURES FOR THAILAND AGRICULTURAL SECTOR IN THE KINGDOM OF THAILAND

FINAL REPORT

Appendix II: Technical Papers

July 2013

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Preface and Acknowledgement

"The Project for Flood Countermeasures for Thailand Agricultural Sector" is a part of a comprehensive assistance program from the Japan International Cooperation Agency (JICA) to the Royal Thai Government concerning the damage sustained in Thailand, during the 2011 flood. Serious damage was caused to the business and agricultural sectors in the Chao Phraya River Basin. The JICA assisted in emergency response by dispatching portable pump units, experts on disaster management and goods and supplies, for both medium and long-term support. It was identified that the preparation of an Integrated Flood Mitigation Plan needed to be undertaken. To support the Thai agriculture and rural sector, the JICA dispatched a preliminary study mission in early 2012, following this it was decided to conduct the main Project from March 2012 up until July 2013. This Project consisted of the three components, i.e. 1) support for the reproduction of pastures, 2) rehabilitation and reinforcement of damaged irrigation/drainage facilities, and 3) a guideline for disaster-resilient agriculture and agricultural community.

This paper is one of a series of technical papers, relating to component number three (3), "Guideline for Disaster-Resilient Agriculture and Agricultural Community", which consists of a general guideline and five thematic guidelines for five sectors. In the process to formulate the guideline, seven Tambons and a District were selected from five provinces, namely Phitsanulok, Chainat, Ayutthaya, Pathumthani and Nakhon Pathom, as the model areas for research and activities to be conducted. A total of 21 programs, in five sectors were conducted as pilot projects/activities in those model areas. The details of the procedures and results of the pilot projects/activities were summarized as technical papers by JICA experts, counterpart agencies and/or Thai academics, in order to back up the sector guidelines.

The projects and activities introduced in the technical papers are not necessarily countermeasures that are designed only for situations of serious flooding, such as the 2011 flood. This information is also of great benefit to the people of Thailand during the annual normal flooding time and even non-flood situations. Based on an assumption that people are reluctant to change their habits or behavior, particularly farmers, just for an event such as a huge flood, that may only occur every once in a while, the JICA and the residents of the model areas selected pilot activities which can benefit farmers even in a normal flood or non-flood period. The selected projects were then considered by the JICA, concerned agencies and experts, to see whether or not these projects would be also useful as countermeasures to a big flood. This paper has explored many avenues of thought; unfortunately, a full examination could not be done, due to the very limited time allowed to complete the Project.

Some of the technical papers themselves are a guideline for some activities to be conducted by farmers, Tambon Administration Offices (TAOs), and other supporting agencies. Other papers are an introduction of knowledge gained throughout the Project. All of these technical papers were translated into Thai and then prepared in different forms of media such as leaflets, booklets, posters and videos, so that the information would be readily available and easy to use by the farmers and agencies concerned.

The JICA Project team sincerely believes that the technical papers in Thai are practical and useful for people in the flood risk areas as the information will enable them to be more prepared for disasters, in particular any future large scale floods. It is hoped that the concerned government agencies in

Thailand will promote and continue to support the activities and the media that has been prepared by this project. For the people who are the readers of the English version, we would be delighted if you could grasp the points of diversity and the benefits of the activities for developing and enhancing the rural community's resilience to large floods in the future.

The authors wish to thank the counterpart agencies concerned under the Ministry of Agriculture and Cooperatives, the Ministry of Interior of the Royal Thai Government for their cooperation and contribution, and the JICA Thailand office for its logistical support. It should be noted, that the opinions expressed in the papers are those of the authors and do not necessarily reflect those of the Thai Government or the JICA.

JICA Project Team

Sanyu Consultants Inc. & Nippon Koei Co., Ltd.

The Project for Flood Countermeasures for Thailand Agricultural Sector
'Guideline for Disaster Resilient Agriculture and Agricultural Community'

Technical Paper Series

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The Project for Flood Countermeasures for Thailand Agricultural Sector

<u>'Guideline for Disaster Resilient Agriculture and Agricultural Community'</u>

Technical Paper Series No. 1

Community Flood Disaster Risk Management Plan

Prepared by JICA Project Team

Community Flood Disaster Risk Management Plan

1. Introduction

In Thailand, there has been a paradigm shift in disaster management at the community level. In the past, disaster management at the community level only began after the disaster had occurred without appropriate preparation for disaster risks and impacts. However, with the increase in international recognition, the importance of the community's participation for disaster risk management has become more emphasized to prevent and mitigate disaster impact on the society and economic situation in the community. Capacity development of the community, from preparation to post-disaster stages, has become a key issue. In the early stages of the Participatory Rural Appraisal (PRA) survey conducted it was understood that the impact and damage caused by the massive flood that occurred in 2011 was more severe due to the lack of preparation with respect to appropriate disaster risk management by the community.

Accordingly, the project supported the development and implementation of the community flood disaster risk management plan as a pilot project at three target communities (tambons), namely T. Khlong Ha (Pathumthani Province), T. Singhanat (Ayutthaya Province), and T. Gop Chao (Ayutthaya Province). These three communities identified the development of a flood disaster risk management plan as a prioritized countermeasure for the flood disaster risk in the community. The objective of the pilot project was to improve the community disaster risk management through the development of a participatory disaster risk management plan at each target community.

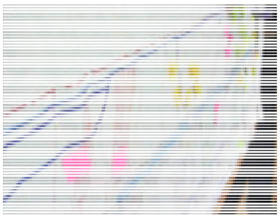
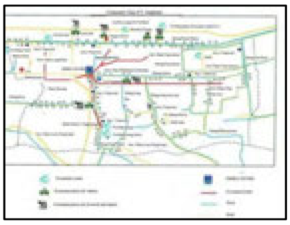
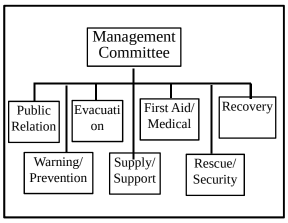
In the pilot project, the following activities were conducted at the three target communities in collaboration with concerned agencies, particularly with JICA/DDPM 'Project on Capacity Development in Disaster Management in Thailand (Phase II)' and Provincial Department of Disaster Prevention and Mitigation (DDPM) of Pathumthani and Ayutthaya provinces. This technical paper was prepared based on the results and findings of these pilot activities as well as the review of related documents[1].

- PRA survey to collect necessary community information and impacts/causes of the 2011 flood
- Study tour to the advanced sites of community-based disaster risk management (pilot project sites of the JICA/DDPM 'Project on Capacity Development in Disaster Management in Thailand (Phase II) in Lamphun Province)
- Development of a community flood disaster risk management plan
- Practice of an evacuation drill

[1]Please refer to the 'Guideline on Community-based Disaster Risk Management (CBDRM)' (published by the DDPM)for more technical information on the overall disaster risk management.

2. Contents of Technical Information

This technical paper demonstrates the process of making a community flood disaster risk management plan with the following four steps. The plan can be developed based on these steps with the effort of the community. However, the community may need assistance from external personnel, such as personnel of the Provincial Department of DDPM, Community Development, and NGO, to organize these steps.

STEP 1	STEP 2	STEP 3	STEP 4
			Issue / Task / Necessary Action / In charge
Collection and analysis of community information	Risk analysis and development of a hazard/evacuation map	Set-up of management committee/ working groups	Development of a flood disaster risk management plan

STEP 1) Collection and analysis of community information

The first step of making a community flood disaster risk management plan, is to gather necessary information in the community with participatory methods, such as PRA survey. Related documents and statistics are also reviewed. Information to be collected includes, but is not limited to;

- Location and geographic information
- Land use of the community, particularly use for agriculture
- History and type of flood, including water flow, cause, period of inundation, damage, and community's countermeasures
- Population, religion, type of residents
- Infrastructure and facilities, including possible evacuation centers
- Socio-economic information such as health status and community groups/volunteers
- Vulnerable groups, such as the elderly and disabled
- Occupation and income
- Seasonal calendar for flood risk and crop pattern
- Number, location, and type of livestock
- Other necessary information

STEP 2) Risk analysis and development of a community hazard/evacuation map

As a second step, a community hazard/evacuation map is developed with the basic community information collected in STEP 1 mentioned above. The community hazard/evacuation map should include information such as;

- Geographic information and land use
- Administrative boundaries in the community
- Water resource and related facilities and water flow during past inundation
- Infrastructure, facilities and households, including facilities to be used as evacuation centers
- Evacuation places and routes for human, livestock, and other assets (such as car and machinery)

A community hazard/evacuation map is suitably developed from a scientifically drawn base map, such as a topographical or GIS-based map, provided by DDPM or other government agencies. In the case where there is no scientific drawn map available for the community, the community can draw a village map by themselves on a large piece of paper. Development of the map with relevant information is effective for providing flood warning and evacuation announcements swiftly and, eventually, for preventing and mitigating the flood disaster impact on the community[2]. It is considered more effective and in some cases necessary for a community in a flood-prone area to utilize a scientifically drawn map with detailed topographical information to manage flood risks.

STEP 3) Set-up of a flood disaster risk management committee and working groups

The third step of the planning is to set up a community flood disaster risk management committee and working groups. Community members participate in the flood disaster risk management through different community-based working groups under the management committee to timely and effectively respond to disasters and their risks. Examples of community working groups and their responsibilities for the flood disaster risk management are introduced in the next page based on the results of the pilot project.

[2] Please also refer the Technical Paper on 'Constructing Flood Hazard Map and Evacuation Map with Community Participation'.

<Examples of Working Groups and Responsibilities>

Working Group	Responsibilities
Management Committee (composed of; head of each village, TAO,head of each working group, and other key persons)	● Plan/review/revise the plan for flood disaster risk management ● Organize meetings and coordination with working groups ● Examine/ approve tasks/actions proposed/requested by working groups ● Give directions to tasks/ actions concerning flood risk management ● Search possible financial and other supports from various organizations ● Function as a command center at the time of the disaster ● Supervise operations of working groups ● Collaborate with internal and external organizations ● Report flood disaster situation/ impacts to DDPM and other organizations
1. Public Relations	● Search knowledge/ information for prevention/ mitigation of flood impacts ● Receive information from internal and external organizations ● Accumulate, cross-check, and analyze the collected information ● Disseminate necessary information to the public, including water level and necessity of evacuation, through various methods
2. Warning and Prevention	● Gather and update geographic, demographic and other community information ● Maintain necessary equipment, such as boats and floating toilets, to be used at the time of the disaster ● Collect information on water level and situation and give ample warning to the committee and community ● Inform preparation process to the community for possible inundation and evacuation in collaboration with Public Relation Working Group ● Coordinate with community people and volunteers to set up flood protection systems, such as water protection by deploying sandbags
3. Evacuation	● Identify evacuation centers and evacuation routes for human, livestock, and assets ● Prepare places and equipment for each evacuation center ● Inform necessity of evacuation and assembly points to the community people in collaboration with Public Relation Working Group ● Arrange staff/vehicles/evacuation route for fast/safe/orderly evacuation ● Provide special assistance to the people with difficulties ● Register evacuated people at the evacuation center
4. Supply and Support	● Make plans for transportation and distribution system of emergency materials during inundation ● Procure/ maintain appropriate types and amounts of necessary materials for emergency cases ● Receive and distribute donation materials systematically and effectively ● Provide moral support to the people as well as materials ● Support and monitor the transportation during inundation
5. First aid and Medical *Health Center and Village Health Volunteers join this group	● Make a plan for providing medical/health care at the time of disaster ● Procure/maintain appropriate types and amount of medicines/ materials ● Provide first aid service at the evacuation center ● Provide mobile medical and health care service to the persons in the evacuation center as well as in-house visits during the inundation ● Provide mental care to evacuees and people who stay in their houses ● Coordinate with hospitals in the area for necessary support ● Inform community about potential diseases and dangers caused by the flood
6. Rescue and Security *Civil Defense Volunteers join this group	● Make a plan for providing rescue/ security at the time of disaster ● Conduct search and rescue work during the emergency period ● Set up security guard team to patrol evacuation centers and community ● Support physical works to prevent and mitigate disaster impact ● Maintain basic facilities/utilities in the community
7. Recovery	● Record the situation and survey flood damage ● Report the situation and impact to concerned organizations through the Management Committee ● Coordinate to restore facilities/ utilities/ houses and equipment to condition prior to being damaged ● Coordinate the support from government and non-government agencies

STEP 4) Development of a community flood disaster risk management plan

The last step of the process is to actually make a plan. In this step, problems and constraints for the flood disaster risk management in the community are comprehensively identified by the community people based on past disaster experience and particular characteristics of that community. Then, necessary tasks and actions are identified to prevent and mitigate flood disaster impacts on the community. The tasks and necessary actions are considered for each of the following four stages/periods: *1) Preparation, 2) Pre-inundation, 3) During inundation, and 4) Post-inundation* periods.

'Preparation' period means the normal period without inundation risks, while *'Pre-inundation'* period means the time when the community faces the risk of damage from possible inundation. Examples of format and contents of the plan are provided from the next page based on the result of the pilot project. Once the plan is developed by the community's effort, it can be used as a check-list for the disaster risk management. The plan can be incorporated into an overall community disaster risk management plan, which covers countermeasures for other disaster risks as well as flood risks, particularly in a community with low flood disaster risks.

The plan should be developed based on the individual characteristics of each community. These characteristics include the risk for flood and its type, facilities and other resources in the community, degree of urbanization and other aspects. The approaches for developing the plan between communities in flood-prone areas and those in non-flood-prone areas will be different. Communities in mountainous areas where people are often hit by flash floods may require a better warning and emergency evacuation system, whereas communities with high inundation risks may put more emphasis on the supply of services and support during the inundation. It is also noted that approaches vary between the communities in rural areas, where traditional unity in the community is still strong, however in there is a lot less local support in a community in urban/ sub-urban areas where the community is more urbanized with many in-bound/ out-bound migrant residents and business entities.

It is emphasized that the plan should be practical, based on the community's situation and constraints, particularly in terms of financial and other resources for related activities. In this regard, it is important for community leaders to strengthen their network with government and other organizations to search for additional resources. It is also necessary for the community to review and revise their plan from time to time, based on the current situation and available resources for the disaster risk management.

Examples of tasks and necessary actions for Community Flood Disaster Risk Management

Issue	Task	Necessary Action				Committee/ Working Group in charge
		Preparation in normal time (necessary consideration/ arrangement)	Pre-Inundation (when community face the inundation risk)	During inundation	Post-Inundation	
1. Information on flood risk and water level	1-1. Obtain/share information on flood risk and water level	□ Have geographic, demographic and other community information □ Establish communication network with RID and others, including list of organizations to contact □ Develop a flood risk/evacuation map and share with the community □ Establish water measurement spots and standards in the tambon	□ Obtain/ analyze information and share with the Management Committee □ Measure water level at the measurement spots □ Assess the necessity of evacuation	□ Obtain/ analyze information and share with the Management Committee □ Measure water level at the measurement spots □ Assess the necessity of evacuation	□ Record and share flood situation with RID	Warning and Prevention Public Relations
	1-2. Publicize warning	□ Set-up warning system, including warning rules, equipment to be used, and person in charge.	□ Inform warning rules and preparation process to community □ Put up signs that indicate risk/safe areas	□ Publicize the warning □ Put up signs that indicate risk/safe areas	-	Public Relations Warning/ Prevention
	1-3. Raise public awareness and skill on flood	□ Raise the awareness on the flood risk of the community through publicity, meeting, campaign, etc □ Conduct activities at schools to enhance children's life-skills	□ Collect information from the community on flood situation and risk	□ Collect information from the community on flood situation and risk	-	Public Relations
2. Transportation during inundation	2.1 Procure and maintain vehicles/boats to be used during inundation	□ Study the suitable transportation methods during inundation □ Identify necessary/available number of vehicles/boats and procure necessary resources □ Procure necessary resources with internal/external financial sources □ Register and maintain all machinery to be ready for use □ Examine and prepare stocks for necessary materials, such as fuel and spare parts	□ Coordinate to procure necessary amounts vehicles/boats, including rental □ Examine the condition of machinery and keep ready to use □ Examine the stocks of fuel and spare parts	□ Provide the transportation service □ Procure necessary amount of machinery □ Maintain the condition of machinery □ Procure fuel and necessary materials	□ Repair/clean the machinery for future use □ Prepare stock for future use	Supply and Support Waning and Prevention

	2.2 Provide transportation effectively during inundation	□ Set-up rules for transportation during inundation, such as rules for driving boats, public boat service, and rental boats	□ Inform the community about the rules	□ Provide and monitor the operation	-	Supply and Support
3. Evacuation	3-1. Evacuate the people, livestock, and assets smoothly	□ Identify evacuation centers for people, livestock and other assets, and evacuation routes in the flood risk/evacuation map □ Identify necessary facility, equipment, and emergency materials, such as medical station, tent, blanket, mosquito net, water and food, etc	□ Identify evacuation centers/ routes and prepare signs to indicate the routes □ Prepare for possible evacuation, including facilities, equipment, and materials	□ Announce evacuation with assembly points and routes □ Support the evacuation □ Set-up evacuation centers □ Register the evacuees □ Support evacuees with difficulties	□ Maintain the equipment for future disasters	Evacuation Supply and supports Warning and Prevention
	3-2. Support the evacuation of vulnerable groups	□ Survey to identify people with difficulty, such as elderly and disabled, and plan for evacuation support	□ Examine the situation of people with difficulties and prepare for possible evacuation	□ Support the evacuation □ Provide care at the evacuation center	-	Evacuation Supply and support First aid and medical
	3-3. Enhance the knowledge and awareness for evacuation	□ Plan/practice evacuation drills regularly □ Inform community on evacuation preparation, including carrying important documents, such as ID.	-	-	-	Evacuation
4. Supply of essential commodities/services during the inundation	4-1. Provide emergency materials for people at evacuation centers	□ Identify kinds and amounts of emergency materials necessary for possible evacuees □ Procure and store adequate amount of materials for emergency care □ Prepare contact list for possible support	□ Prepare for the distribution of emergency materials □ Procure emergency materials to distribute □ Organize volunteers to cook for evacuees	□ Supply emergency materials both for people in evacuation centers and households □ Procure emergency materials to distribute □ Arrange distribution of donated items □ Keep records of distribution materials	□ Summarize the use of emergency materials and numbers for future disasters	Supply and Support Evacuation Public relation
	4-2. Provide emergency materials to the people in households	□ Survey the number of households and distribution points of emergency materials □ Develop the distribution system of emergency materials, including donated items □ Encourage people to prepare emergency items in their house				

	4-3. Provide medical/health care	□ Survey the types and number of people who need medical support and share the information with health stations □ Develop medical/health care plan for evacuation centers and households, including setting-up mobile service units □ Prepare/stock necessary material/medicines for medical and health care services	□ Prepare for service, including medicine and equipment for the service □ Organize health volunteers and instructions for mobile medical/health services	□ Set-up medical stations at evacuation centers □ Dispatch mobile units to provide service at households □ Share information with health stations for appropriate action □ Provide information on disease and hygiene □ Provide mental care	□ Report to the health authorities on the medical/health situation during the inundation	First aid and medical Supply and Support
	4.4 Provide other supports	□ Study the types and volume of support needed during an inundation not only for humans but also for livestock and others	□ Coordinate and prepare support, such as feed for livestock	□ Coordinate and provide necessary support based on the needs	-	Supply and Support
5. Rescue and Security	5.1 Rescue the disaster victims promptly	□ Organize rescue and security team to work systematically □ Identify and procure necessary equipment and materials for the rescue work	□ Examine the situation and prepare for possible actions □ Patrol the risk area	□ Conduct the rescue work based on the information from the community	□ Report the cases to the authority	Rescue and Security Public relations
	5.2 Maintain the facility and utility in the community	□ Identify facilities and utilities to be maintained during inundation, such as roads and electricity □ Procure necessary equipment and materials to maintain the facilities, such as sand bags	□ Monitor the situation and prepare for possible actions □ Conduct preventive works, such as making walls with sandbags	□ Monitor and maintain the use of facilities and utilities □ Elevate electric transformers above water level	-	Rescue and Security Warning and Prevention
	5.3Maintain the security during inundation	□ Identify the high risk areas during inundation □ Develop security plans including patrol route and units	□ Patrol the risky areas □ Review the plan and prepare for action	□ Patrol the community as well as evacuation centers □ Be on 24 Hour Stand-by for action	-	Rescue and Security
6. Recovery	6-1. Support the recovery from impact/damage caused by the disaster	-	-	□ Record situations and damage caused by the disaster, including photos, and actions taken	□ Report the situation/impacts □ Coordinate for support	Recovery

During the project, each target community of the pilot project conducted a flood evacuation drill based on the developed flood disaster risk management plan. Practice of an evacuation drill is considered effective to; 1) raise the awareness of community people of disaster risk management, 2) strengthen the network among concerned organizations in the community, such as schools and health centers, and 3) identify and practice the tasks of the management committee and each working group during the simulation. Community organizations, such as schools, health centers, and police stations should also be involved in the drill. Practice of an evacuation drill at a school is also considered an effective education method to enhance the awareness of students, teachers, and parents of disaster risk management.

In order to encourage the participation of people and concerned organizations in the community to attend and be involved in the evacuation drill, simulative situations, advance warning and publicity about the drill should be given to the community. Examples of simulative situations actually used for an evacuation drill during the pilot project are provided in the next page.

<Simulation for a flood evacuation drill used at T. Gop Chao, Ayutthaya>

The news about the danger of the flood water breaks to warn community members to evacuate to an evacuation center.

Act 1: After the flood disaster risk management committee is informed about the water situation by the ***Warning and Prevention Working Group***, a committee meeting is held to share the situation information and set roles for each working group. The ***Public Relation Working Group*** will announce the situation to the community about the water situation and preparation for evacuation.

Script for the announcement*" The water level in Klong Bang Ban has risen to a danger level. The committee received an announcement from RID Chainat that they are draining out the water at 1500 cubic meters per second, therefore it is estimated that flood water will cover Gob Chao area in two days. The staff at Gob Chao's staff gage reported that water level reach 4 meters already. Villagers should now lift belongings to higher places and prepare themselves for evacuation."*

Act 2: After a while, the ***Public Relation Working Group*** will announce to start the emergency evacuation to the community, including the opening of the evacuation centers. At this point people will move to the evacuation center set for the drill with the support of the ***Evacuation Working Group***.

Act 3: After people move to the evacuation center, they will register to create the real situation of the evacuation center for proper management.***Evacuation Working Group*** is in charge of the registration.

Act 4: Young school children will be escorted by their ***school teachers*** to meet with their parents at the assembly point around the TAO area. This act will teach small children to line up readily and follow the instructions of their supervisor for evacuation. The children will get registered before being taken back by their guardians.

Act 5: The two (2) following rescue practices concerning health and security will be performed while participants are lined up for the registration.

1. One aging man has a heart attack and is rescued by ***village health volunteers*** for receiving emergency treatment. ***First Aid and Medical Working Group*** will take part in the role to show the correct way to treat the patient.
2. An elderly woman is lost from the family. ***Civil defense volunteers*** help by retrieving her and bringing her back to the evacuation center's registration area before meeting with the family. This will demonstrate the process of retrieving a lost person by the ***Rescue and Security Working Group***.

Act 6: From the assembly point, the evacuees will be guided to the rooms and other facilities, including a place for a medical check-up, which has already been prepared for them.

Act 7: The***Public Relation Working Group*** will make an announcement to inform the evacuees to pick up emergency bags which contain necessary supplies, such as emergency food and water, at the distribution point, arranged by the ***Supply and Support Working Group***.

3. Impact and Adaptability as a Flood Countermeasure

3-1. Impact

It is difficult to assess the actual degree and types of impact of the community flood disaster risk management plan introduced in this technical paper without the experience of a flood disaster. However, judging from the response of the target community, the development of the plan is considered as an effective measure for the flood disaster risk management. Through the planning process, the community has pictures on how to prepare for the possibility of future flood disasters.

As floods are seasonal and a community can foresee the possibility and timing of flooding, a community's preparation based on the planning and practice of the disaster risk management contributes to prevent and mitigate disaster impacts. Institutional set-ups for the flood disaster risk management can be also utilized for the management of other forms of disaster and their associated risks. It is also expected that the planning process of the disaster risk management contributes to the overall capacity development for the participatory planning of the community.

3-2. Adaptability

Development of a flood disaster risk management plan can be introduced at any community, particularly those in flood-prone areas. It does not cost much, but needs strong commitment by the stakeholders, particularly of community leaders who take on the initiative of planning and practice. The plan can be developed with the effort of the community, however, the planning process can also be facilitated by external personnel, such as personnel of the Provincial Department of DDPM, Community Development, and NGO, to organize the process. Some activities, such as evacuation drills, can be implemented as an education tool in schools.

Priority of the planning and practice of the flood disaster risk management should be given to communities in flood-prone areas where the people in the community are more likely to voluntarily participate in the planning and implementation. On the other hand, it may not be easy to get strong participation and commitment on the flood disaster risk management in a community located in non-flood-prone areas. In these areas, the development and practice of the plan may be integrated as a part of an overall disaster risk management. As already mentioned in this paper, the plan should be developed based on the characteristics of each community, such as flood risk and its type, facilities and other resources in the community, degree of urbanization and other aspects.

4. Prerequisite Conditions

There are several necessary internal and external conditions for the development and implementation of the community flood disaster risk management plan. These are summarized below. Although necessary conditions are varied according to the characteristics of each community, these are regarded as common conditions to be considered when the community makes the plan.

1) Participation and commitment of the community, particularly community leaders, to develop a practical plan as well as to implement the actions according to the plan
2) Participation of concerned community organizations, such as school, civil defense volunteers, and health station and volunteers, who take on important roles at the time of the disaster
3) Overall support from TAO, particularly on coordination with external organizations and budget allocation
4) Technical support by the Provincial Department of DDPM and other organizations, which can provide guidance and facilitation for developing a disaster risk management plan

5. Role of Government Agencies and Other Stakeholders

Development and implementation of the community flood disaster management plan is basically the responsibility of community leaders and its members with the overall support from TAO. However, external support from government agencies as well as non-government agencies is also important to meet the institutional and financial constraints, faced by the community.

As DDPM is working to develop a community-based disaster risk management plan at the tambon level, technical support from the Provincial Department of DDPM is effective for the planning of a flood disaster risk management plan. Cooperation with the regional RID office is essential for the community to appropriately understand flood risks through the information and data provided by the RID. Regarding the awareness raising of the community, particularly of students, the roles of the educational administrations are highlighted for a school education program on the disaster risk management.

6. Lessons Learned from Pilot Activities

Although impacts of the community flood disaster risk management plan supported by the project cannot be assessed in the project period without the experience of severe floods, the plan is expected to contribute to the prevention and mitigation of flood disaster impacts with practice of the developed plan by the community.

It is indicated from the experience of the pilot project that there are several conditions to develop and implement the community disaster risk management plan effectively as presented above. Among the conditions, strong and continuous commitment from community leaders is a particularly important factor. As stronger and more continuous commitments from community leaders are expected, the priority of the development of the plan should be given to the communities in flood-prone areas.

When we consider the community flood disaster risk management plan, locality and individual characteristics of that community should be considered. For instance, approaches between the community in flood-prone areas and those in non-flood-prone areas will be different. Similarly, actions between communities with high flash flood risks and communities with high inundation risks will be different. It is also noted that the participation of the community can be largely different between rural areas and urban/sub-urban areas where there are more inbound/outbound migrants and business entities.

7. Key References

- Technical Papers on this study
- Guideline for Community-Based Disaster Risk Management (CBDRM), DDPM

The Project for Flood Countermeasures for Thailand Agricultural Sector

‘Guideline for Disaster Resilient Agriculture and Agricultural Community’

Technical Paper Series No. 2

Securing Drinking Water during Emergency Situations

Prepared by JICA Project Team

Securing Drinking Water during Emergency Situations

1. Background

The catastrophic flood which took place during the period from the end of July 2011 and continued into 2012 in the Chao Phraya River Basin during which a vast area of land was submerged had a serious effect on and people living and working in this basin and many businesses and people suffered from the huge scale of damage caused by this long-term submersion. In these situations, not only rice and household goods, but also the availability of drinking water becomes a problem. Rural people suffered from the water shortage and needed to buy drinking water from a nearby Tambon or receive support from government agencies or donors. People in the Tambon gave this problem a high priority and decided to improve the existing water purifying system. This included using a vending machine at the primary school behind the TAO office in cooperation with JICA Study Team when the Participatory Disaster Resilient Planning Workshop was held in September 2012.

2. Objectives

Objectives are summarized as follows;

- *To secure safe drinking water during flood periods.*
- *To keep stocks of safe drinking water available for use in heavy demand or flood periods.*
- *To create income for the Operation & Maintenance (O&M) cost of installing a vending machine*
- *Through the O&M of the vending system, we hope to enhance the solidarity in the community*

3. Project Component

The Drinking Water Purifying System comprises of a water purifying system house 5 x 5 meters and its equipment as follows,

1. Raw Water Tank
2. Raw Water Pump
3. Color and Odor Filter Column
4. Hardness Filter Column
5. Rust Filter Column
6. Reverses Osmosis System Equipment
7. Purified Water Tank
8. Ultra Violet Light Set
9. Purified Water Outlet for bottles and tank
10. Drinking Water Vending Machine

4. Methodology

Procedure of implementation and activities are shown in figure below.

Participatory Disaster Resilient Planning Workshop

- Selection of the water purified system as a priority project September 2012

TAO, community representatives and Study Team

1st Workshop

- Study of the existing purifying systems
- Select the best one which is simple, low cost and easy to operate and maintain
- Mid-December 2012

TAO and Study Team

Contract

- Request the quotation of the cost from contractors (at least 3 contractors)
- Select the successful contractor and negotiation
- Award contract
- End of December 2012

JICA Study Team
Refer to the contract documents

Implementation

- Construction of the system house
- Installation of the water purifying system
- Mid-January 2013

Supervision by TAO and Study Team

2nd Workshop

- Meeting with supplier for explanation of the water purifying system.
- Component, annual O& M fee, etc.
- Establish the water management committee Mid-January 2012

TAO, Villages representatives and Study Team
Refer to Annex1

Final Inspection

- Check & operate the purifying system
- Submit the O&M manual
- Training on the operation of the system by Supplier
- Mid-February 2013

TAO, community representatives and Study Team



5. Cost and Implementation

Total cost is estimated at 460,000Bt including the water purifying system house which costs about 150,000Bt. The implementation schedule is shown in table below. The construction of the purified water system house should be completed during the dry season.

Implementation Schedule

Component	Dec	Jan	Feb	Mar
Contract between JICA ST & Supplier	▲			
Explanation to the TAO ,etc. (components, establish a water supply management committee, WSMC)		▬		
Implementation		▬	▬	▬
Final Inspection				▲
Support to strengthen the WSMC by JICA ST			- - - -	-
Training of the WSMT				▲

6. Prerequisite Conditions

Prior to implementing the project, a water purifying system management committee, having the responsibility of O&M of the system, should be established by TAO.

7. Role of Governmental Agencies and Other Stakeholders

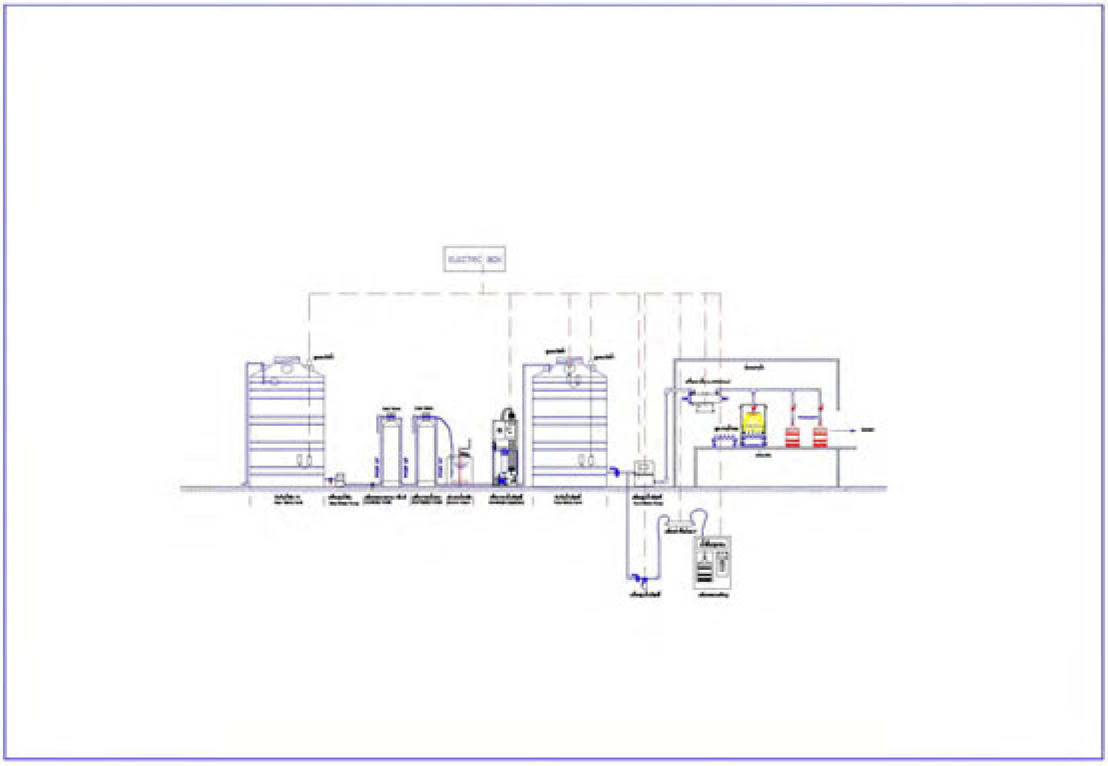
- A water purifying system is very compact and simple. The implementation cost should not exceed 250,000Bt. This cost excludes the cost of the facility to house the system.
- It should be possible to construct the system in other Tambons with their own development budget.

8. Lessons Learned from Pilot Activities

- Quantity of purified drinking water production is around 6,000 litres per day.
- So that the operation and maintenance cost can be covered for the vending machine an appropriate water fee such as, 0.25 to 0.4 Baht/litre should be set.
- To get more income/benefit at the location, a business that sells plastic pet bottles with FDA (Food and Drug Association) certification should be considered.
- Operation of the system is very easy for TAO staff but, the supplier of the machine should be asked to do maintenance at least once a year.
- Ordinary maintenance fee per year is between 7,000 and 8,000Baht. Therefore the water management committee should make sure they raise the finance needed for its maintenance.
- Ceremonial functions such as marriages, funerals, etc., occur often in the local community and demand on these occasions for purified water is very high. Therefore, TAO and the Water Management Committee should make a good marketing plan to promote the purified water system.

9. Appendix

Plan of Water Purifying System



Breakdown of the estimated cost

Example of Drinking Water Purifying System 6,000 Litre/day

Detail of Cost Breakdown with Building

No.	Set	Item	Unit Cost	Cost (Baht)
1	2	Raw Water Tank PE 2,000 Litre	8,000	16,000
2	2	Mitsubishi Pump 255 Watts	6,500	13,000
3	1	Water Filtration Machine for Odour and Color (CA-FRP-1665-A-7000)	36,000	36,000
4	1	Water Filtration Machine for Hardness (CR-FRP-1665-A-7000)	42,000	42,000
5	1	Water Filtration Machine for Reverse Osmosis System 6,000 Litre/day	95,000	95,000
6	1	Pump + Control Box + Vending Machine	25,000	25,000
7	1	Ultraviolet bacteria Killing System 39 Watts	25,000	25,000
8	1	Drinking Water Nozzle 20 heads with case	20,000	20,000
9	1	Installation Cost and System Provision Cost	20,000	20,000
10	1	Drinking Water System House dimension 5x5 m.	150,000	150,000
		Subtotal		442,000
		Vat 7 %		30,940
		Total		**472,940**

ตัวอย่างข้อมูลราคาของระบบกรองน้ำดื่มขนาด 6,000 ลิตร/วัน
รายละเอียดราคาระบบกรองน้ำดื่ม พร้อมอาคาร

ที่	จำนวน	รายการ	ราคา/หน่วย	ราคา(บาท)
1	2	ถังเก็บน้ำดิบ PE 2,000 ลิตร	8,000	16,000
2	2	เครื่องสูบน้ำมิตซูบิชิ 255 วัตต์	6,500	13,000
3	1	เครื่องกรองตะกอน กลิ่น สี (CA-FRP-1665-A-7000)	36,000	36,000
4	1	เครื่องกรองความกระด้าง (CR-FRP-1665-A-7000)	42,000	42,000
5	1	เครื่องกรองน้ำระบบ RO ขนาด 6,000 ลิตร/วัน	95,000	95,000
6	1	เครื่องสูบน้ำจ่าย + ตู้ควบคุม + ตู้หยอดเหรียญ	25,000	25,000
7	1	ชุดฆ่าเชื้อโรคด้วยแสงอุลตร้าไวโอเลต 39 วัตต์	25,000	25,000
8	1	หัวจ่ายน้ำ 20 หัว พร้อมลังบรรจุขวด	20,000	20,000
9	1	ค่าติดตั้งและเดินระบบ	20,000	20,000
10	1	อาคารสำหรับวางเครื่องกรองน้ำขนาด 5x5 เมตร	150,000	150,000
		รวม		442,000
		Vat 7 %		30,940
		รวมทั้งหมด		**472,940**

The Project for Flood Countermeasures for Thailand Agricultural Sector

<u>‘Guideline for Disaster Resilient Agriculture and Agricultural Community’</u>

Technical Paper Series No. 3

Constructing Flood Hazard and Evacuation Map Making with Community Participation

Prepared by JICA Project Team and Kasetsart University

Constructing Flood Hazard and Evacuation Map Making with Community Participation

1. Introduction

The community flood hazard and evacuation map are very important tools during a flood disaster. The maps illustrate essential information such as the location of evacuation center/s evacuation route, and the areas at high risk of flooding. The information is very useful for both the local community and government agencies for disaster management and prevention.

The construction of a community flood hazard map and evacuation map requires community participation. The members of the local community can contribute very useful information and common practices for flood prevention, measures and mitigation. Local participation also promotes a harmonious approach for the benefit of their community. Social activities during the map construction could promote public understanding of the importance of flood management and prevention. It also supports the cooperation with the government agencies for provincial flood management.

Guidelines for constructing a flood hazard and evacuation map with community participation aims to describe the map making procedures using a combination of engineering and social science approaches. The contents include mapping process for flood risk areas and evacuation map, data collection in GIS format, and examples of activities during map construction.

2. Objective

- The guideline could assist government agencies for participatory flood hazard and evacuation map construction with local communities.
- It promotes public participation for flood hazard and evacuation map construction, warning, measurement, prevention, and recovery from a flood.

3. Methodology

The process of flood hazard and evacuation map construction involves different aspects in engineering and social science discipline, such as setting up a community meeting and social activity to obtain information, an engineering survey for gathering GIS data base information, risk analysis for the flood hazard map, and formatting arrangement of the map. The collected data is then utilized for map construction via ArcGIS program. Finally, the constructed map has to be checked for accuracy with the local community and engineering tools. Figure 1 represents the process of flood hazard and evacuation map construction.

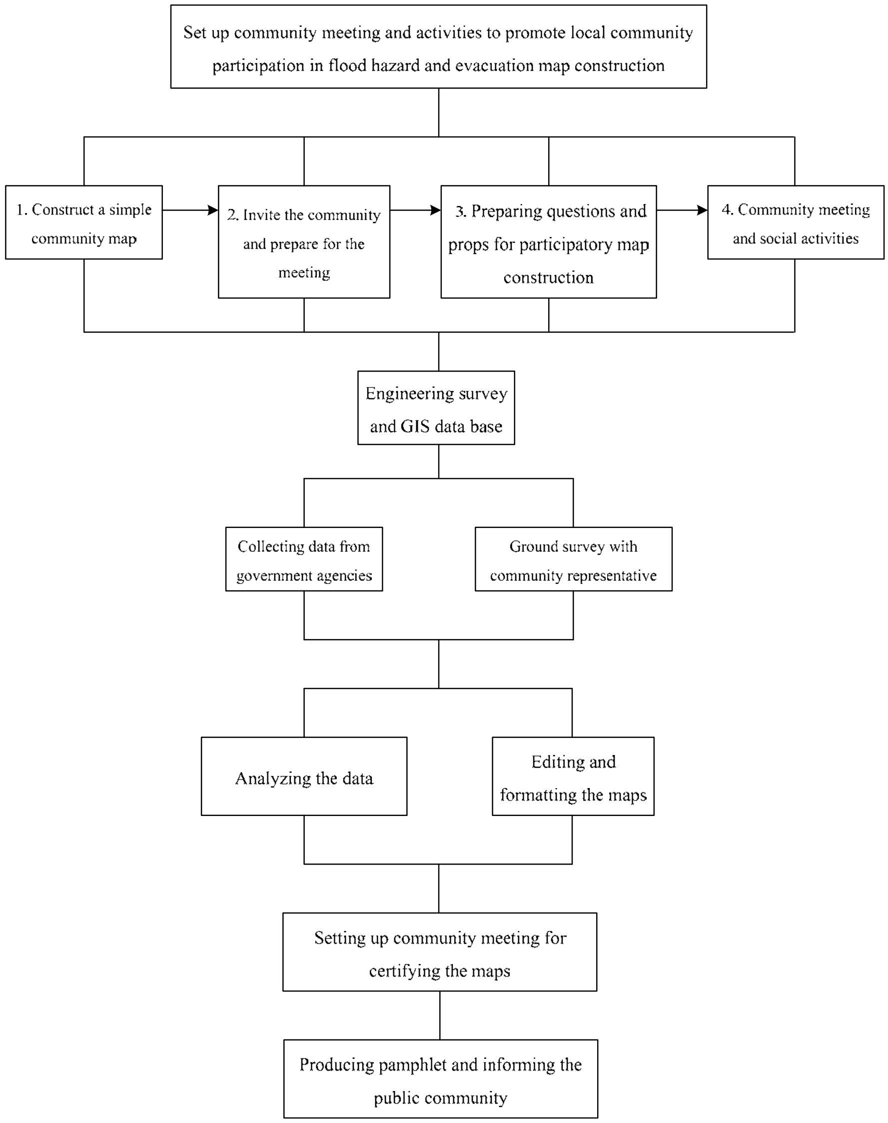


FIG.1 Procedure for flood hazard and evacuation map construction using local community participation

3.1 Set up social activities with local community for information collection

In order to construct a flood hazard and evacuation map, data collection is an important first step through social works and activities as well as an engineering survey. Frequently flooding areas, community evacuation route/s and the location of evacuation shelter/s can be acquired from local community participation by the following.

3.1.1 Sketching a simple community map

In order to communicate with a local community, a simple community map is necessary. The map could be hand sketched showing the community boundary (district and village boundary), local road and highway, river and canal, natural pound, and important places, as shown in FIG. 2.

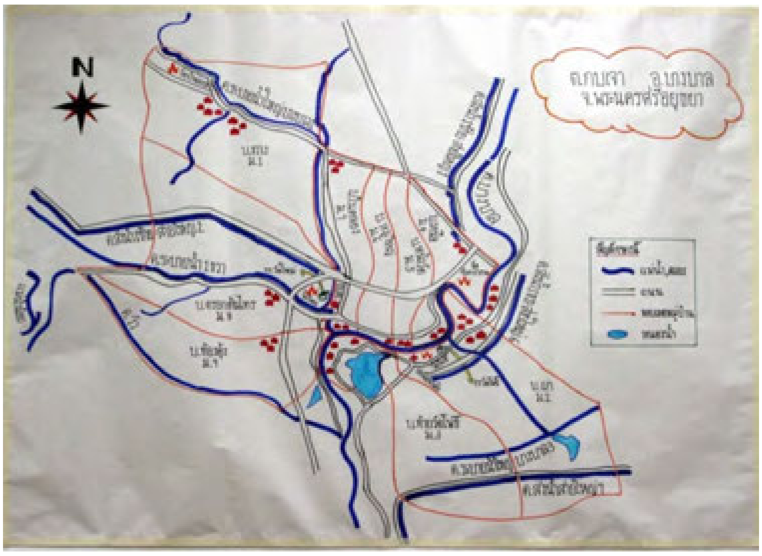


FIG. 2. An example of hand sketched community map

3.1.2 Inviting community members and preparing a meeting

The community participants are selected from various groups with different ages, sex, education background, and representatives of the village and district offices (i.e. head of district office, secretary, Tambon leader, and head of village). Approximately 50 local participants per Tambon would be a good number to gather and effectively gain accurate information about their area. The meeting place should be large enough for the community meeting and social activities, such as a small group discussion. It should have the necessary equipment such as a microphone, projector and screen, and white board, to conduct an effective meeting and discussion.

3.1.3 Preparing questions and props to obtain information for the construction of the flood hazard and evacuation map

Symbols made from color paper are used together with a question-answer exercise and group discussion to obtain important information. Participants are encouraged to discuss and share information and show their results on the map such as:

1) Location of flood prone area is represented by △ . Different colors stand for different level of flood risk area, such as high risk level ▲ , medium risk level ▲ , and low risk level ▲ .

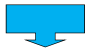
2) Household and village areas that are affected by flood are represented by ⇧ . For example, high flood level ⇧ , medium flood level ⇧ , low flood level ⇧ .

3) Evacuation center for people is represented by ★ .

4) Evacuation shelter for animals (cattle, chicken, etc.) is represented by ▰ .

5) Evacuation center for vehicle and irrigation machinery is represented by ▰ .

6) Evacuation route is represented by .

7) Location for placing a sign of evacuation route is represented by  .

8) Community flood relief operation center is represented by 

9) Warning levels

3.1.4 Community meeting and social activities

The community meeting is set up for making the flood hazard and evacuation map. During the meeting, the participants are divided into small groups for discussions on selected topics and each group has to present its results. An example of the community meeting procedure is as follows: (see FIG. 3.

- Master of ceremonies (MC) explains the objectives and activity schedule.
- Dividing of participants into small groups for brain storming, group discussion, and determine where to place the symbols on the map. It is recommended that the group members should live in the same or nearby village for the ease of discussing and forming an accurate conclusion.
- The MC hands out a set of symbols to each group and group members would discuss where to place the symbols on the community map according to the assigned questions.
- Each group sends a representative to place the symbols on the community map to show the results of group discussion.
- Every group then participates on the results shown on the community map, and discuss any points that need corrections or comments.
- The MC concludes the community discussion and presents the results that will be used for construction of the flood hazard and evacuation map.

FIG. 3. Examples of activities during a social meeting and group discussions for constructing a flood hazard and evacuation map

3.2 Engineering survey and GIS data base

GIS (Geographic Information System) is a system designed to capture, store, manipulate, analyze, manage, and present geographical data. The main data were obtained from 2 sources including:

1) Government agencies such as the Royal Irrigation Department (RID), Department of Public Works and Town & Country Planning, Geo-Informatics and Space Technology Development Agency (Public Organization). The acquired data included infrastructure (i.e. highway, irrigational canal), Tambon and village boundary, community area, elevation map, and satellite images showing the areas that flood.

2) A ground survey and local interviews as shown in FIG. 4. A simple hand held GPS device is a useful tool for local mapping and adding any missing data such as district office, temple, community health center, hospital, and important community infrastructure such as water gate, community water storage tank, community staff gauge station, evacuation center and evacuation route (which were verbally informed during the community meeting).

FIG.4. Examples of the ground survey using hand held GPS together with local community representatives

3.3 Analyzing the data

The collected data (from the social meeting and engineering survey) are verified for accuracy and analyzed for flood hazard map construction. There are 4 main factors used for community flood hazard map construction which are:

- elevation map (FIG. 5.)
- flooding history record from satellite image and local knowledge (FIG. 6.)
- direction of flood water flow (FIG. 7.)

- infrastructures which influence the overland flow (FIG. 8.)

The flood hazard analysis results are presented in terms of risk area and the level of that risk such as high risk, medium risk and low risk. The results are presented in zones designated by different colors.

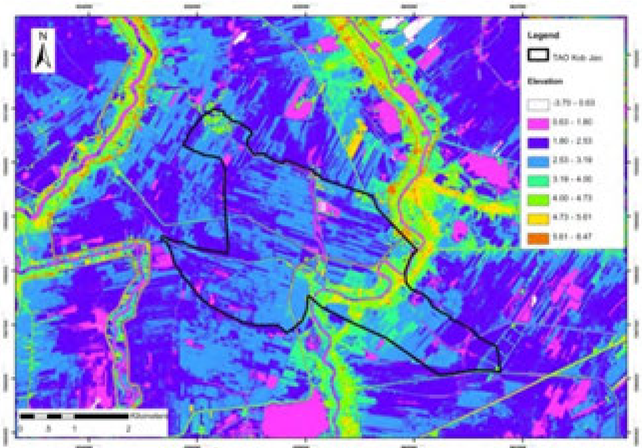


FIG. 5. The community elevation map

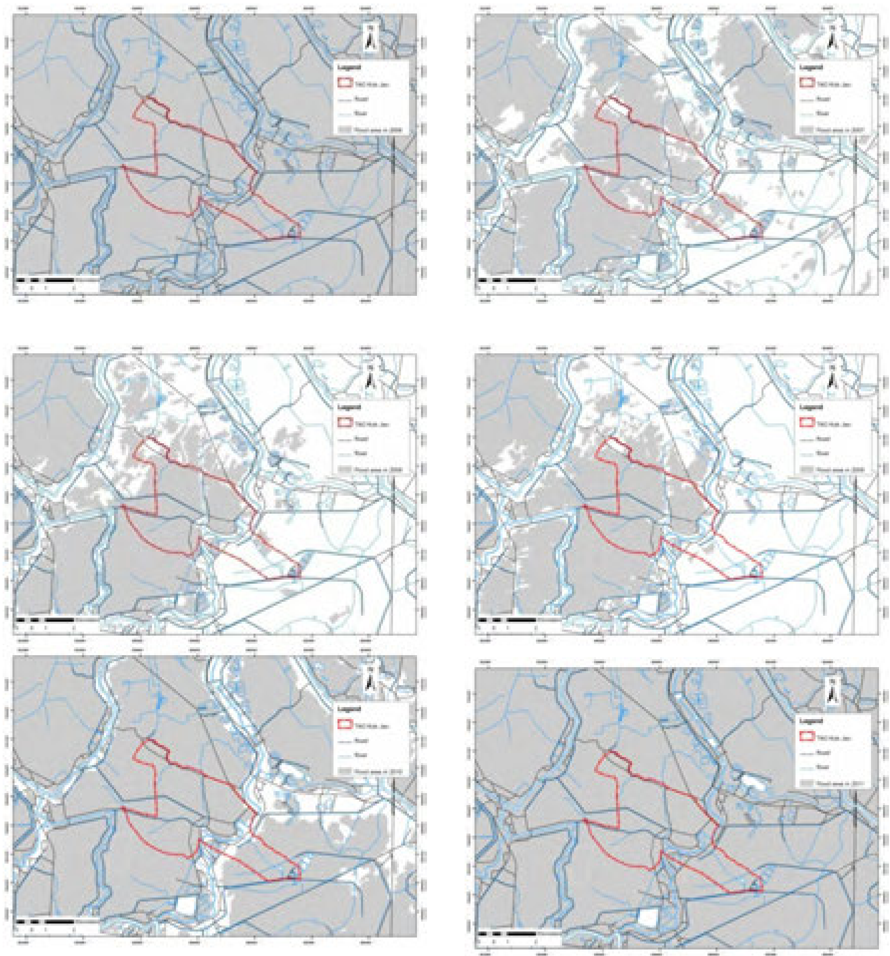


FIG. 6. Satellite images show flooding history record for the past 6 years

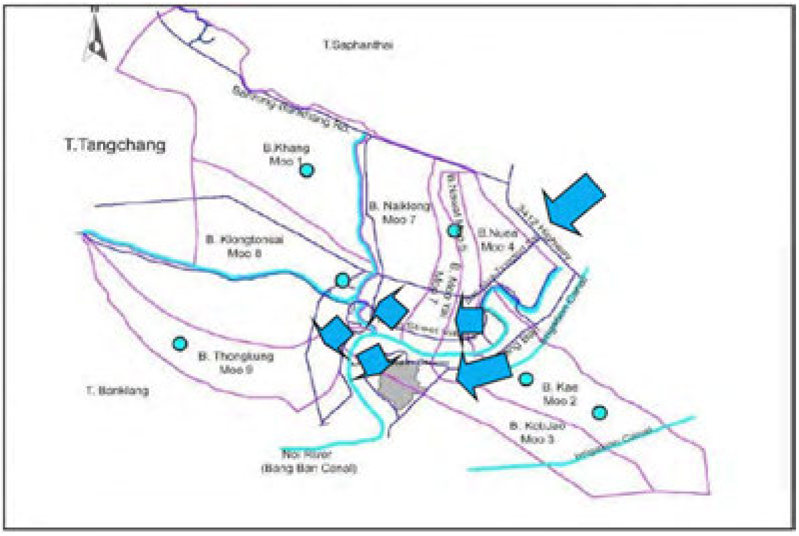


FIG. 7. Arrows indicate direction of the flow of water in the area.

FIG. 8. A map showing important community infrastructures

3.4 Editing and formatting the maps

The flood evacuation map should be in a simple format and easy for the local residents to understand i.e. by using photos representing evacuation centers, and clear and obvious symbols. The data obtained in sections 3.1 to 3.3 are processed through ArcGIS software program as shown in FIG. 9 and 10, for flood hazard map and evacuation map, in their respective order.

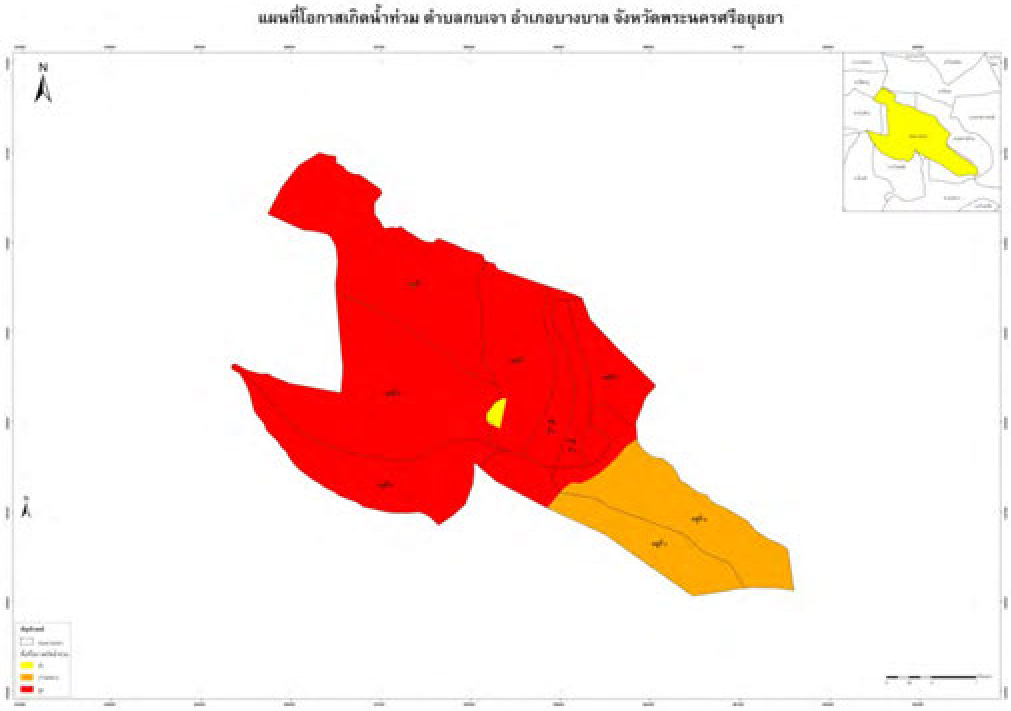


FIG. 9. An example of a community flood hazard map

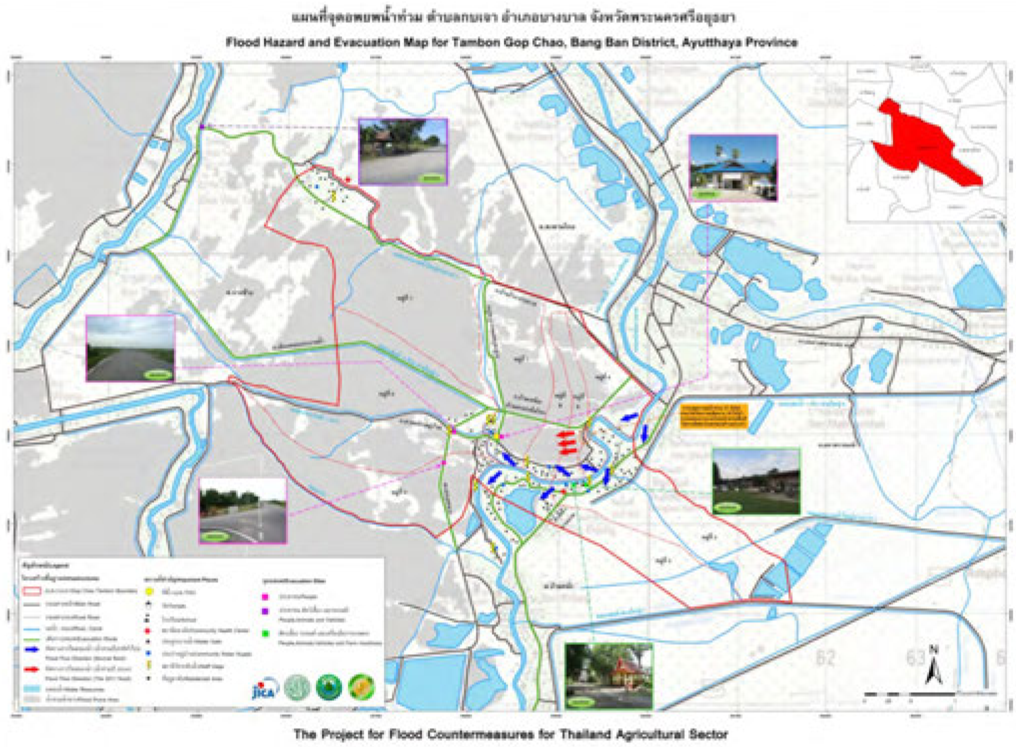


FIG. 10. An example of community flood evacuation map

3.5 Verifying the map

After the map is completed a second community meeting is set up to verify the flood hazard and evacuation map is correct. The draft map is handed to the participants to check the accuracy. Prepared questions are asked of the participants to validate the map such as (i) based on experiences, if the flood risk level and flood area on the map correct?, (ii) is the direction of flood water flow correct?, (iii) are the location of evacuation centers correct? FIG. 11 shows activities during the community meeting.

To inform and educate the public, the flood hazard and evacuation map is produced in a pamphlet format. General information about the Tambon, the procedures for preparation for a flood, living with a flood, recommended recovery activities after a flood are also presented in the pamphlet in a simple format using such things as cartoons, coloured zones and schematic sketches, as shown below in FIG. 12.

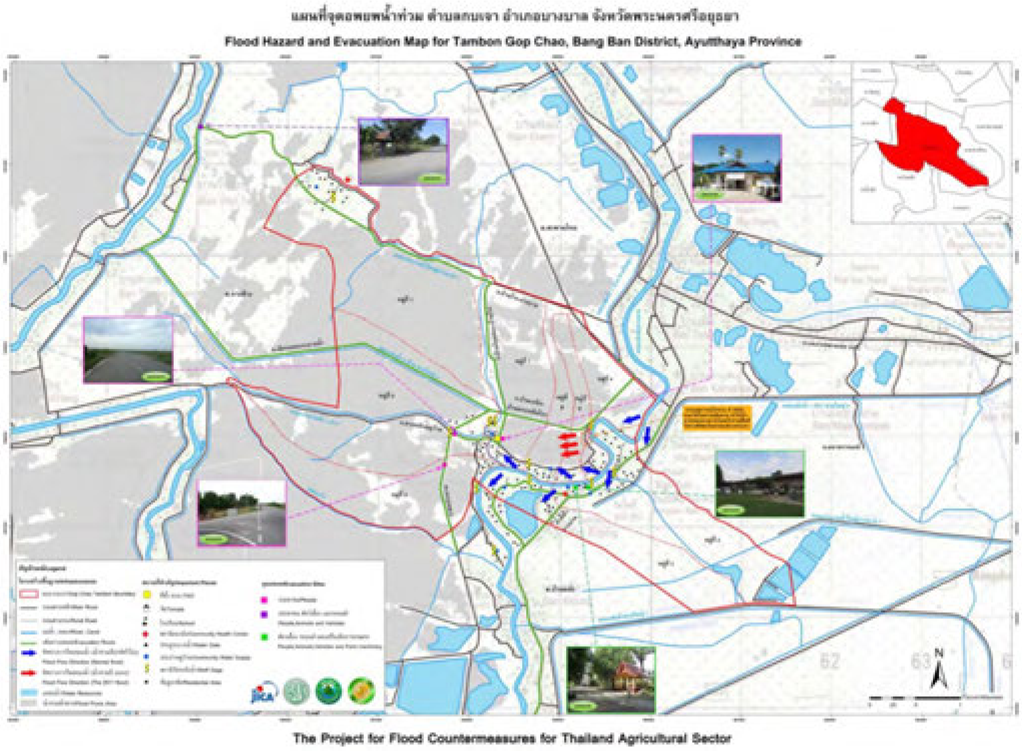


FIG. 12. An example of the pamphlet “understanding and living with flood” and the final version of the “flood hazard and evacuation map”

The Project for Flood Countermeasures for Thailand Agricultural Sector

<u>'Guideline for Disaster Resilient Agriculture and Agricultural Community'</u>

Technical Paper Series No. 4

Community Participatory Water Measurement and Database System

Prepared by JICA Project Team and Kasetsart University

Community Participatory Water Measurement and Database System

1. Introduction

To support community participatory flood management, the local community must understand their topographic setting and the nature of the entire water system in their area, such as the location of rivers and canals, direction of flood water flow into and out of the area, and ground elevation. Many local communities are located in low lying land which is a natural flood retention area (or monkey cheek area), and often face flood every year. Adapting their living styles with flood water could be one of their solutions. Community participatory flood management can also help local community to understand the water situation on both local and regional scales. They could prepare and harmonize their living with the water condition and water management with a proactive approach. Simple tools to help community water management are staff gages for water level measurement and an accurate data base of community water records. The success of community participatory flood management requires both local community support as well as government agency support such as provincial office, district office, and the Royal Irrigation Department (RID).

These guidelines present procedures of community participatory flood management, including procedure of staff gage installation, setting up a water management committee, data base system for keeping water records, and budget.

2. Objective

- To set up a guideline for government agencies for conducting community participatory flood management.
- To support the local community for participatory water management in the Tambon area. For the community to take a proactive approach to flood prevention action, measures and recovery program after a flood.

3. Methodology

Community participatory flood management consists of 2 mains tasks which are (1) staff gauge installation for water level measurement in the community area and (2) set up a data base system for community flood forecast and warning. The details are presented in the following.

4. Community staff gage installation

The community staff gage installation requires some engineering skills such as elevation survey, and constructing the staff gage station. The procedure is presented in Figure 1.

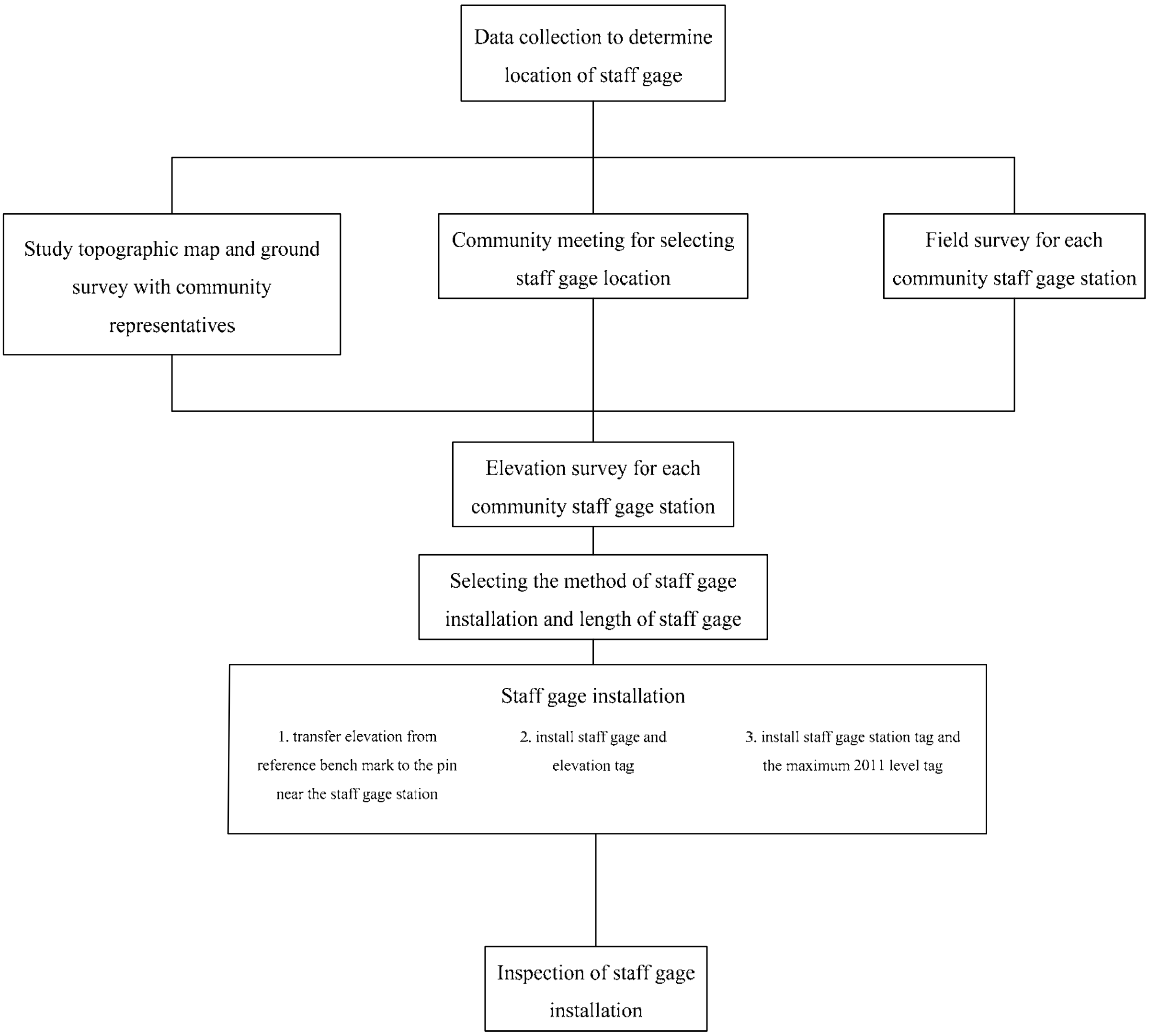


Figure 1. Procedures for community staff gauge installation

4.1 Data collection for suitable staff gage station

Topographic study of the community and surrounding area is conducted to understand the nature of flood in the area, such as canals and rivers which could bring flood water into the area. Field survey and inspection are carried out together with local community representatives. During field inspection, local community should share and discuss flood experiences with the survey team. A community meeting is set up to discuss important location for staff gage installation. Approximately, 50 participants could well represent the district community. Three main criteria for selecting staff gage location are

- river bank and canal dyke where water could overflow into the area
- low land area where flooding begins
- populated area where local residents could observe the water level from staff gage and ease of

maintenance

After selecting the community staff gage location, a field inspection is conducted to decide the method of installation, e.g., on the existing structures such as water control gage, bridge foundation column, electric pole. If the staff gage is to be installed on the existing structures, permission must be obtained from the responsible authority. The staff gage installation must not obstruct the public or cause damage to the existing structure. Otherwise, a reinforced concrete column would be constructed for staff gage installation. The column shall be on a strong foundation for preventing long-term settlement. Figure 2 shows activities during data collection for community staff gage installation

(a) (b) (c) (d)

Figure 2. Activities during data collection (a) study of community topographic map, (b) field survey with community representatives, (c) set up a community meeting for staff gage location, and (d) field inspection of selected staff gage location

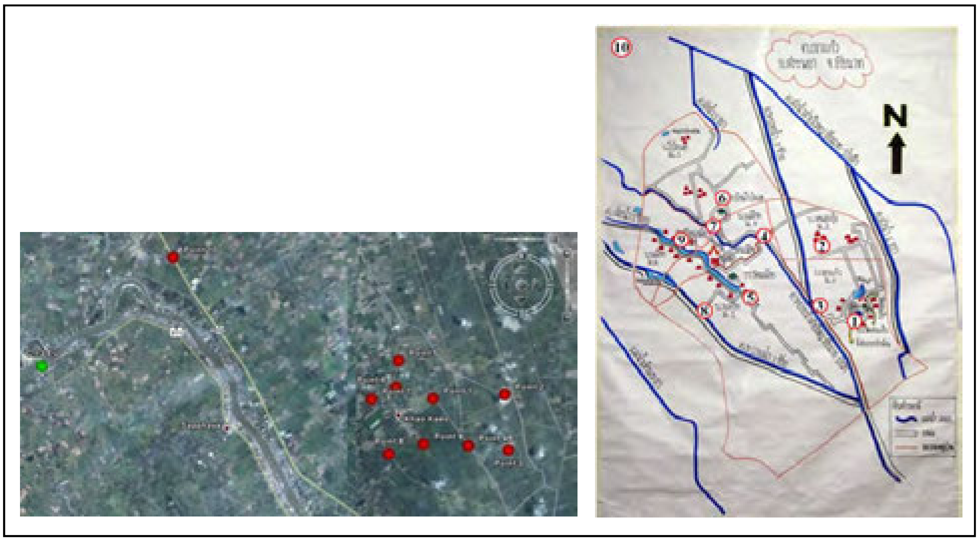
4.2 Ground elevation survey

A ground elevation survey is conducted for every community staff gage station. The ground elevation level is referred to as the mean sea level (MSL) by transferring elevation from the reference bench mark (i.e. bench mark of Ministry of Agriculture). The locations of a staff gage station are given to a survey crew so that the crew could transfer the elevation (MSL) from nearby reference benchmarks to the staff gage station. Figure 3 illustrates activities during a ground elevation survey.

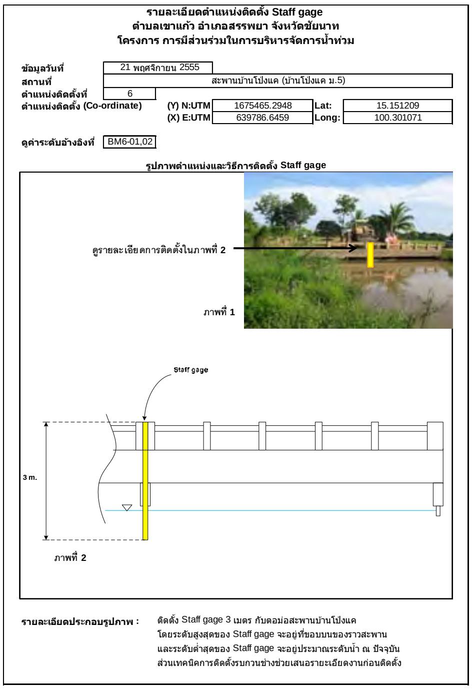
(a) (b) (c)

Figure 3. Activities during the ground elevation survey (a) set up reference pin for staff gage station (b) transfer level from reference benchmarks to the community area and (c) elevation survey of the staff gage station

After sections 3.1.1 and 3.1.2 are completed, details of staff gage installation are recorded, i.e. location of staff gage, station name and coordinate, ground elevation, site photos. A sketch showing method of installation (e.g. staff gage length, installation method) is made and given to a local contractor . Figure 4 shows some forms and data sheets used for staff gage installation.



(a)



(b)

(c)

Figure 4. Examples of data sheets used for staff gage installation (a) a community and topographic map showing a community staff gage station, (b) a sketch of a staff gage installation, and (c) reference pin and coordinate for each staff gage station

4.3 Staff gage installation

Before staff gage installation, the installation team (a local contractor) would study all the survey data and a meeting is set up to explain and verify the installation procedure and details. The process of an installation is outlined as follows.

- If the reference pin (with MSL elevation) is not at the staff gage station, the installation crew must transfer the elevation to the staff gage station.
- Installation process includes the staff gage installation and elevation tag installation. The staff gage could be attached to the existing structure or an RC column. The elevation tag is attached to the staff gage for MSL reference.
- Staff gage name tag and the 2011 flood level tags are installed
- Staff gage inspection is conducted to verify the elevation and workmanship.

Figure 5 shows staff gage installation procedure and Figure 6 represents different methods of staff gage installation.


(a)


(b)


(c)


(d)


(e)


(f)

Figure 5. Examples of the staff gage installation process (a) transfer the reference ground elevation to the staff gage station, (b) staff gage installation, (c) installation of staff gage station tag (d) an example of a staff gage station tag (e) inspection of staff gage elevation and (f)final inspection of workmanship

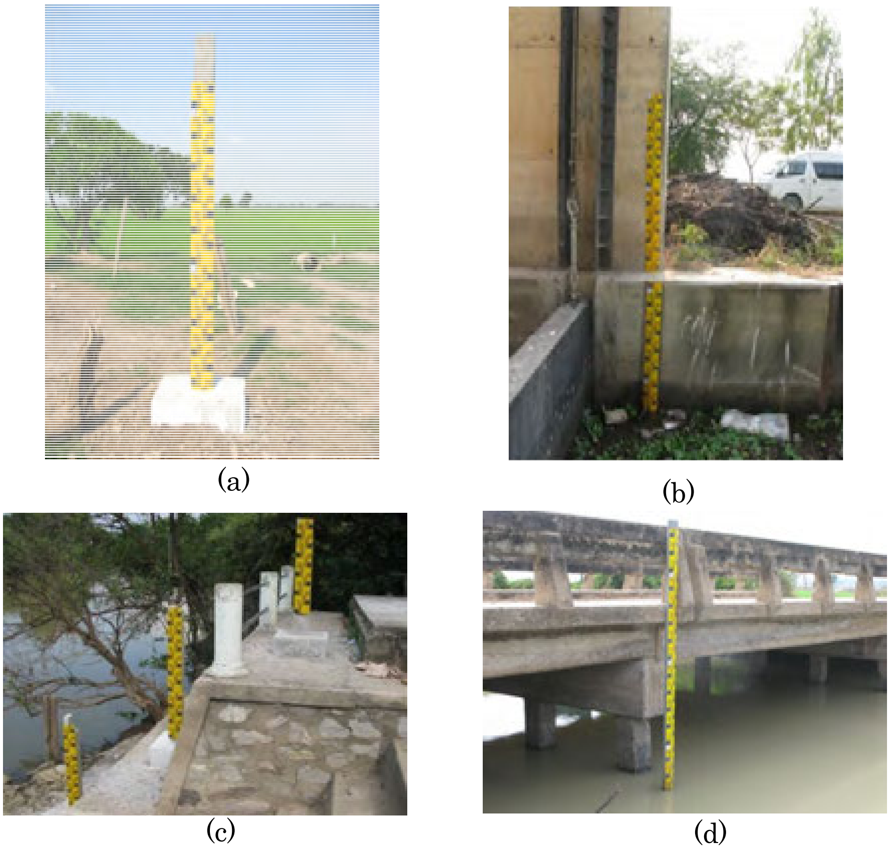


Figure 6. Different methods of staff gage installation

4.4 Set up community database system and committee for flood and drought management

This operation requires engineering and social science approaches. Local community members would be taught about the water situation and importance of community data base and flood and drought forecast. The procedure is shown in Figure7.

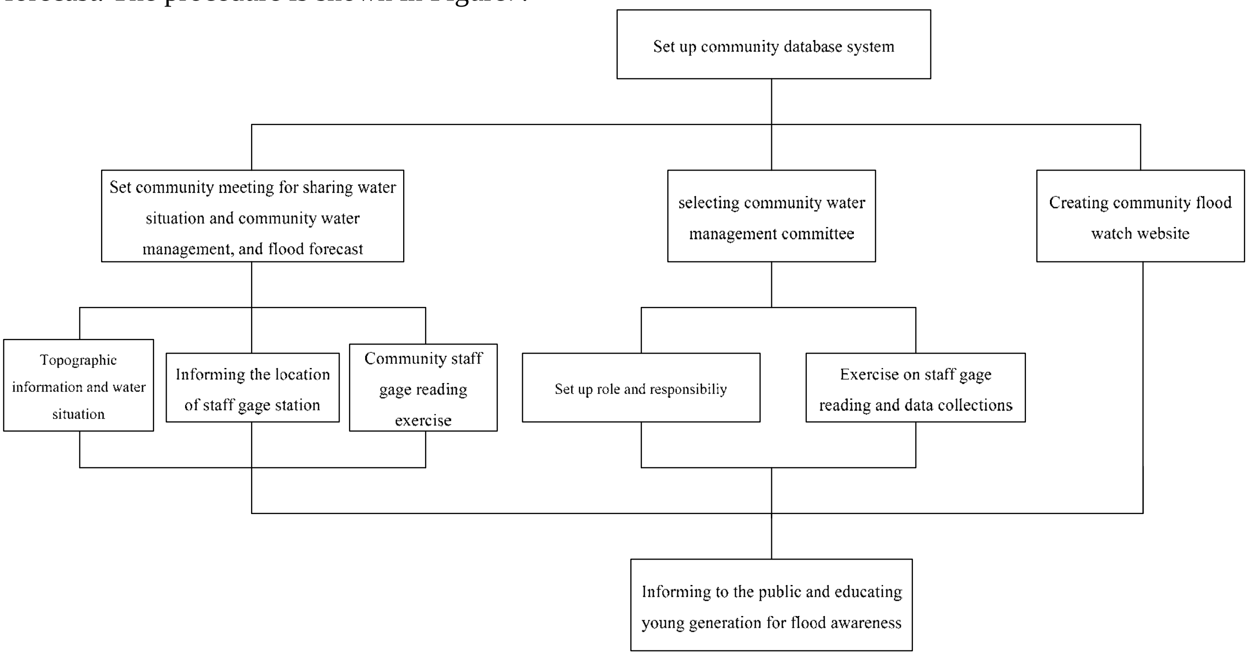


Figure 7. Procedure for setting up the community database system

4.1.1 Community meeting

The community meeting shall include village representatives of about 50 participants per Tambon. The objectives of the meeting are to inform the study results of community water situation, community topographic setting, locations of community staff gage, and educate the community on how to read the staff gage. The meeting consists of group activities and exercises to promote community participation and a positive and active atmosphere, such as a staff gage reading game. The game shall test the participants on staff gage reading and flood awareness. For example, two representatives come to read the water level on the staff gage and inform their group. Then another representative select symbols or prepared props representing activities that would be done according to the flood level and explain the action to all the participants. Prizes of a small gift and token are given to the participants as a reward for being involved. Figure 8 shows some activities during the community meeting.

(a)

(b)

(c)

(d)

Figure 8. Activities during the community meeting (a) give introduction to the project and activities (b) teach how to read a staff gage, (c) test community representative on staff gage reading (d) set up game for participatory flood management

4.2.2 Set up committee for flood and drought management

The committee for flood and drought management is set up. This committee is responsible for the staff gage reading and recording, and coordinating with district offices and government agencies on community water management. After the committees are selected, a meeting would be organized for explaining the role and responsibility for each committee and the practicing of staff gage reading and recording the results correctly on the form, (see Fig. 10). The meeting assignment shall be given to the committee including;

- Responsibility of each committee for staff gage reading. For example, the committee representing each village shall be responsible for reading the staff gages that are installed within that village area.
- About 1 to 2 committees shall be selected for collecting all staff gage reading data and giving it to the district office to update in the community database, i.e. community water management website (which will be presented in the following section).

บันทึกข้อมูลระดับน้ำ
ตำบลเขาแก้ว อำเภอสรรพยา จังหวัดชัยนาท
โครงการ การมีส่วนร่วมในการบริหารจัดการน้ำท่วม

สถานีวัดระดับน้ำ : 01 — สะพาน 1 หรือสะพานหลังเขา (บ้านนมโฑ ม.4)
ตำแหน่งสถานีวัดระดับน้ำ
E:UTM 641129.8400
N:UTM 1675056.9500

วันที่	เวลา	ระดับน้ำ (ม. รทก.)

Figure 9. An example of field data sheet for staff gage reading and water level record

(a)

(b)

Figure 10. Example activities (a) a meeting with the committee for flood and drought management and (b) field exercise of staff gage reading

4.2.3 Set up community database system

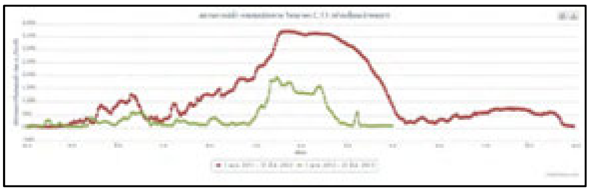
After sections 3.2.1 and 3.2.2 are completed, the community data base system can be set up. The simple system uses a web base so that the local community, public and government agencies are able to access the data in real time. The website shall contain useful information for community water management and flood and drought warning such as;

- Water level and discharge from RID telemetering station that would affect the water situation in the community. The data from RID telemetering system could be found on the hydrology and water management center for each region. These data would be filled into the community data base and shown on the website in the form of a graph and table.
- Community water level from staff gage station. The historical data is shown in graph and table format.
- Regional and national water management data, such as flow charts showing discharge and water level of the river basin, real time CCTV showing dam operation upstream.
- Weather conditions and weather forecast for the community
- Web linkage of important agencies for community water management such as the Royal Irrigation Department (RID), Thai Meteorological Department (TMD), Provincial Office, and Department of Disaster Prevention and Mitigation (DDPM).
- Community news and useful information regarding water situation

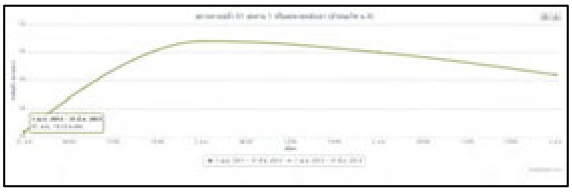
The community water level and RID water record must be input by the committee or district officer who is assigned as the website administrator. The data is recorded daily and updated in the community website as shown in Fig. 11.

(a)

(b)



(c)



(d)

Figure11. An example of a community water management website (a) location of a community staff gage and water level, (b) historical data of the community staff gage, (c) historical record of the water level from RID telemetering station, (d) historical record of the water level from a community staff gage station.

5. Budget

The estimated total budget (per unit) for constructing and installing a staff gage and the setting up of a community database website is summarized in Table 1.

Table 1 Estimated cost for community participatory flood management

No.	Item	Amount	Unit	Cost/Unit (Baht)
1	Elevation survey 10 locations / 1 Tambon	1	Lump sum	30,000
2	Staff gage installation (One sheet has 1 m long)			
	2.1 Metal staff gage	1	sheet	1,200
	2.2 Elevation tag (MSL)	1	Tag	60
	2.3 Installation instrument and labor	1	sheet	1,100
	2.4 RC column 0.15 x 0.15 m and 2 m long with foundation support	1	Lump sum	5,800
3	Community website and data base system	1	Lump sum	40,000
4	Monthly measurement and record	1	month	3,000

The Project for Flood Countermeasures for Thailand Agricultural Sector

‘Guideline for Disaster Resilient Agriculture and Agricultural Community’

Technical Paper Series No. 5

Community Monkey Cheek Development Plan

Prepared by JICA Project Team

Community monkey cheek development plan

1. Introduction

There are many tributaries that flow into main rivers and swamps/ponds upstream of the Chao Phraya River and also a lot of small scale irrigation facilities such as dams, regulators, and weirs which were constructed under the Small Scale Irrigation Program in the 1970's. The appropriate use of these facilities will allow water to be stored during the flood season and to use it later for irrigation, drinking and miscellaneous water purposes during the dry season as a function of monkey cheek.

In general, monkey cheek development is planned mainly in large scale irrigation project areas, operated by RID O&M office and store the water in the flood season for irrigation use in the dry season and this is possible by making effective use of existing irrigation facilities. It is also possible to develop monkey cheek at the community level on a smaller scale, making effective use of canals, ponds, etc., in the hilly/mountainous area where large scale irrigation schemes have not been developed.

It will be necessary to collect the information such as the location and scale of canals and ponds, situation of existing weirs and regulators for monkey cheek development at a community level. To collect the data and information, local people need to participate in meetings, initiated by TAO which will be able to make effective use of existing irrigation facilities and formulate a water resources development plan. TAO is the main core agency to implement this study because the facilities not only SSIP, but also others, have already been transferred to the TAO. In addition, collaboration with PAO, RID and other related governmental agencies is very essential for the project to be accomplished.

This guideline shows the procedure of monkey cheek development plan at a community level by participatory process since the survey for existing water resources, how to make maps of water resources, and how to make effective use of Khlong and Bueng is the monkey cheek function.

2. Objectives

Based on the characteristics of the topography, the flow of tributaries, outbreak situation of the flood, existing irrigation/drainage development level in the Study Area, community monkey cheek development is classified into 3 types of models. This guideline shows the procedure for making a plan for monkey cheek development plan at the community level and introduces the development plan of 3 types of models, respectively as examples. As for the procedure, the field survey and formulation of a plan with a participatory manner are implemented in common for the 3 types of models. Titles of the three types are shown below with basic concepts and the details described in 2.6 Community Monkey Cheek Development.

[Type-A]

Community Monkey Cheek Development in lowland area affected by flood from overflow along the main rivers.(Along the Yom River)

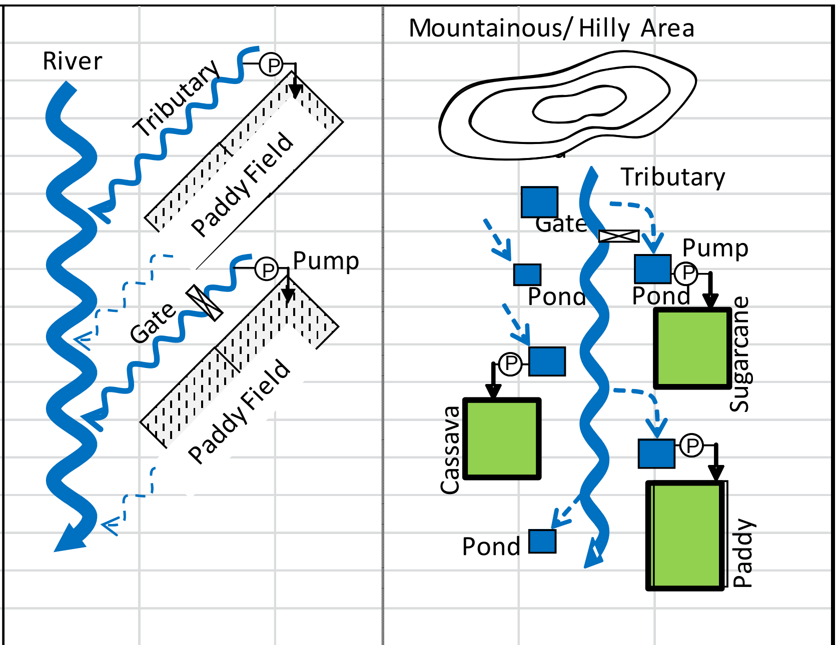
[Type-B]

Community Monkey Cheek Development in lowland area affected by flood from water from the hilly areas (Khwae Wangthong Tributary)

[Type-C]

Community Monkey Cheek Development in lowland in hilly rain-fed agricultural area affected by flood from mountainous areas

Table 1.Type of monkey cheek development plan

<table>
<tr><td>Basic Concept</td><td colspan="2">
</td></tr>
<tr><td>RID project type</td><td colspan="2">Small Scale (SSIP,SSIFP)</td></tr>
<tr><td>Cause of Flood</td><td>Main River</td><td>Rainfall from mountainous /hilly area Flash Flood</td></tr>
<tr><td>Issues</td><td colspan="2">Flood prone area & Drought</td></tr>
<tr><td>Irrigation & drainage network</td><td colspan="2">-</td></tr>
<tr><td>Intake facilities</td><td colspan="2">Small scale Mobile pump, Weir, Gate</td></tr>
<tr><td>Irrigation & Drainage canal</td><td colspan="2">No Large Scale</td></tr>
<tr><td>Drainage canal & gate</td><td colspan="2">No Large Scale</td></tr>
<tr><td>Related Model Area</td><td>CSS</td><td>NKP *& WM</td></tr>
</table>

*)Nakhon Pa Mak project is the only project site that there is a drainage gate.

The three (3) objectives of the guideline are as follows,

- Supporting the collection of data and information and the analysis regarding the water resources situation by TAO and local residents.
- Supporting the formulation of a monkey cheek development plan at a community level
- Make recommendations on utilizing the community monkey cheek facilities

3. Contents of Technical Information

The concept of the monkey cheek development at a community level is shown in the Figure below. Components of the work include, the expansion of the canal section by dredging, dredging of existing ponds, and rehabilitation or construction of regulators and weirs. After this work is completed, it will be possible to store flood water in the canal, reducing flood damage along the canal and also make effective use the water for irrigation purpose in the dry season.

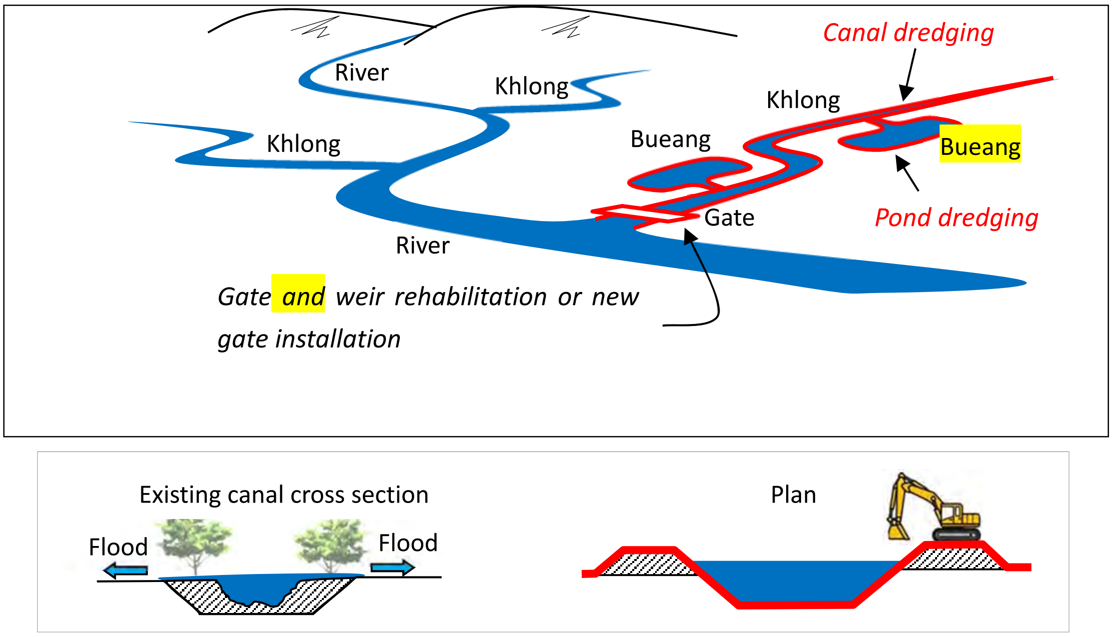


Figure 1 Concept of community monkey cheek development

Expected volume of storage water developed by the monkey cheek at the community level is estimated below.

Case 1, Middle scale size: (15+28) x 4m x 1/2=86m^2, Storage water V=86,000m^3/km

Case 2, Large scale size: (60+75) x 5m x 1/2=336m^2, Storage water V=338,000m^3/km

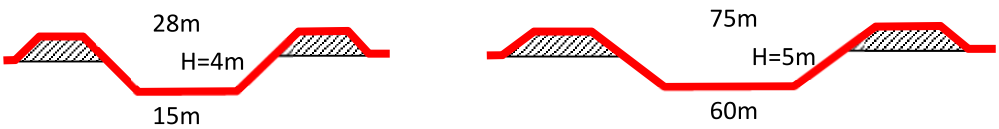


Figure 2 Plan of canal cross section

After dredging a canal in CSS

After dredging a canal in NPM

The procedure of community monkey cheek development plan consists of 7 main tasks namely, (i) Community meeting and Training, (ii) Data collection, (iii) Community Water Resources Map Making, (iv) Data arrangement, (v) Confirmation of outbreak situation of the flood and direction of the flood flow, (vi) Community monkey cheek development plan and (vii) Implementation.

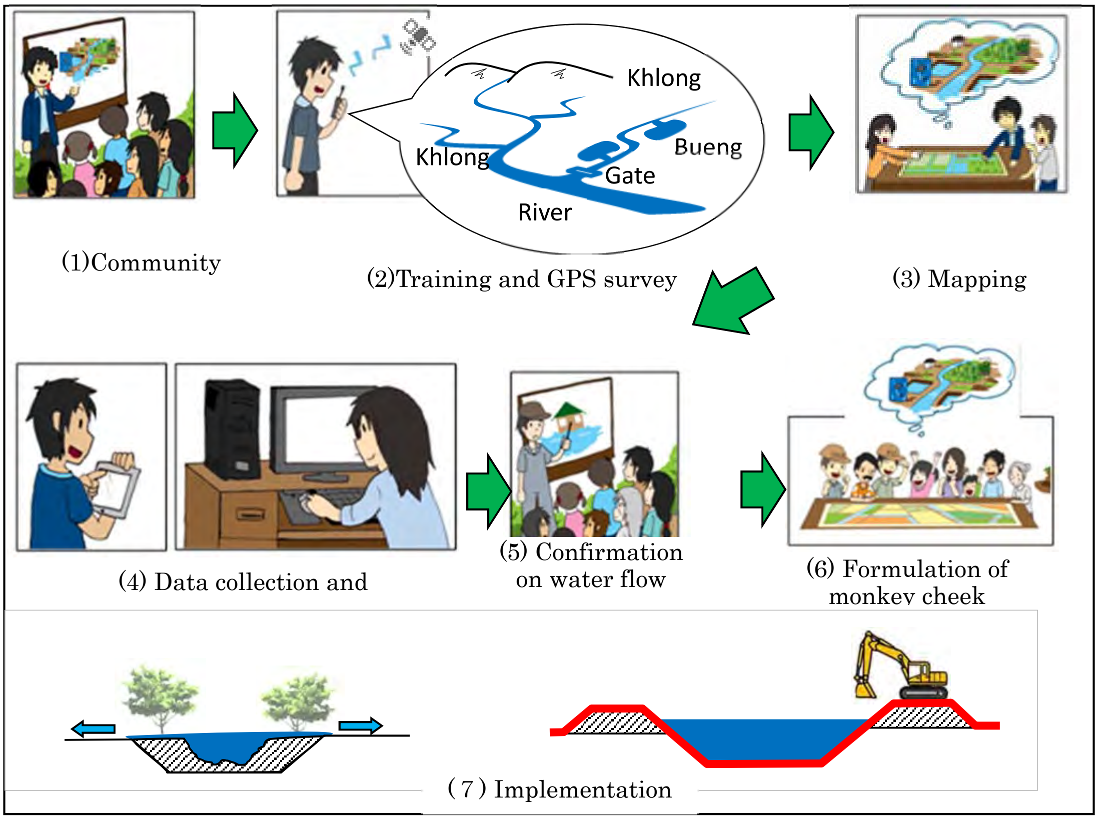


Figure 3 Procedure of community monkey cheek development plan

3.1 Community meeting and training

1) Community meeting

To formulate the community monkey cheek development plan, data collection related to the water resources is an important first step through site survey. In flood prone areas, duration of inundation and water depth, function of existing irrigation and drainage facilities, existing Khlong and Bueng situation can be collected by holding a local community participatory meeting.

The community participants are selected from local residents of various hierarchies with different ages, sex, education background, and include representatives of the village and district office (i.e. head of district office, secretary, Tambon leader and head of the village).

2) Training for reading skill of Map & GPS and Data Collection

These trainings aim to teach map-reading skills, the use of satellite imagery for local survey and practical uses. Together with map training, the ability to use GPS receivers is also essential. In the training, participants learned how to read maps and use a GPS receiver by surveying the local area. Knowledge gained through the training is as follows;

- Participants can gain the skill to use the GPS and to collect data in their own area by themselves.
- Participants can gain the skill of using a map for managing their water resources appropriately.

- Participants will be able to estimate the local water resource potential.

3.2 Data collection activity

The objective is to understand the data collecting process in order to create a community water resources development and management plan. Community members need to collect the data which are used for water resources development plan, irrigation and drainage construction/rehabilitation plan, management plan, etc. These important data are collected by TAO and community people. A study tour to an advanced water resources developed area is very useful for participants to understand how to make a plan.



Study tour (additional activities which depend on the communities understanding level)

Ban Limthong is the best practice site of flood and drought solution areas. It is located in the north east of Thailand which is the worst area for water scarcity. Ban Limthong is a drought and flood community in Nongbode sub-district, Nangrong district, Buri Ram province. Since the main income of community came from rice farming which relied only on rainfall, the community faced the problem of cumulative debt and migration because of unsuccessful agriculture.

The fact is that there is a huge rainfall in the north east area which should be enough for the agricultural purposes throughout the whole year. However, there were not many reservoirs. The solution would be by increasing stored water resources in the area in order to reserve water including the distribution system for agriculture purpose.

Ban Limthong has set up a Community Water Resource Management (CWRM) committee and used IT to plan for water resource management and production planning. The community has a sustainable plan concerning water resources cycles which are to find water, to store water, to use water, and to manage water.

With enough water supply and good management, the community has no more problems after rain recession affecting agricultural products, accumulative debt, and migration. Moreover, the success has been expanding from one community to three sub-districts with strong support from the local government sector.



3.3 Community Water Resources Map Making

Participants from the community attended the meeting concerning community water resources. Map making was conducted to enable local people to understand their area and analyze the need to restore, renovate, and create water resources facilities for drought and flood managing purposes.

3.4 Data Arrangement

GIS is a system designed to capture, store, manipulate, analyze, manage, and present geographical data. The collected data gathered through the community meeting will be arranged and combined with GIS data. The majority of data related to the location are obtained from two sources mentioned below;

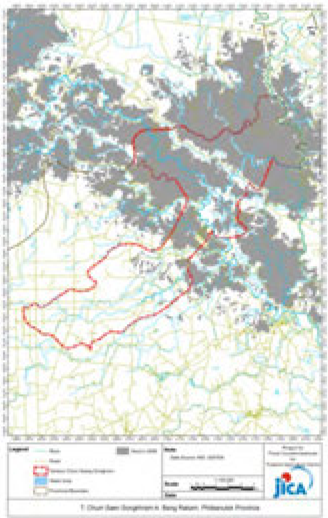
- Government agencies such as the Royal Irrigation Department (RID), related institutes such as Hydro and Agro Informatics Institute (HAII).
- The data including irrigation and drainage facilities, Tambon and village boundaries, etc., were gathered through interviewing local residents and using the Tambon's records and documents.

The collected data are analyzed for the monkey cheek development plan. All the collected data are assembled with a topographical map and schematic drawings of the water flow.

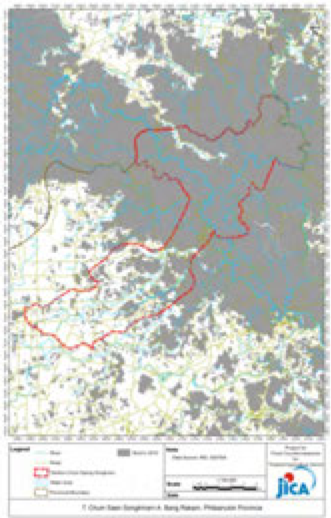
3.5 Confirmation of outbreak situation of the flood and direction of the flood water flow

There are three main factors used for a flood damage reduction plan which are;

- Flooded history record from satellite images and local knowledge
- Direction of flood water flow
- Location map of water resources and its facilities in the area



2009 Flood(Small)



2011 Flood(Big)

Elevation & Flooded water flow

3.6 Community monkey cheek development plan

Three (3) types of models for the community monkey cheek development plan are proposed, based on the topographic and river conditions in and around the target area but, procedure for the formulation of the plans is similar in the 3 types of models. For example, an implementation schedule of the study is the same process as the models as shown in table below. Details of formulation of the development plan of each type are described in the following.

Table2 Implementation schedule for formulation of monkey cheek development plan at community level

Component		Aug	Sep	Oct	Nov	Dec	Jan	Feb	-	Jun
Workshop and training for water resources management, GPS, map, staff gauge installation		▲ ━━	━━							
Study tour for good practice area			▲							
Workshop for water resources development					▲					
Study tour for good practice area						▲				
Training for water resources data collection						▲				
Data collection and analysis					━━	━━				
Establishment of plan							▲			
Additional	Survey by Royal Thai Army						■ ■ ■ ■			
	Project implementation(Canal dredging 12,000km)							■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■

3.6.1 [Type-A]Community Monkey Cheek Development in lowland area affected by flood from overflow along the main rivers (along the Yom River)

A model of Type A is determined where the following conditions exist.

- The canals in the area adjacent to the large-scale river are affected by the water level rising in the wet season.
- The gradient of the tributaries is steeper than the lower basin of the Chao Phraya River.
- The water level of the river rises in the wet season, and water flows into the canal as backwater from the river.
- From a point of view of reducing flood damage and using water resources effectively, dredging and expansion of the canals and ponds are effective.
- The installation of the gate is desirable to prevent the discharge of built up water in the canal when there is a decrease in river water level after the expansion of the canal.

(1) Background

Tambon Chum Saeng Songkhram is located 12 kilometers away on the south west of Amphoe Bang Rakam where is an ancient community along the Yom River with the area of 75,243 rai (120.39 km^2), or 12.13% of Amphoe Bang Rakam. The area normally has flood problems in the rainy season and drought problems in the dry season. In March 2012, the TAO consisted of 11 villages, having the population of 7,775 people: male 3,814, female 3,916: and 2,427 households. The density of population is 64 people per km^2, an average of 4 people per household. Most of the population are farmers, and have some form of secondary occupation such as breeder of dogs, weaving, fish sauce, etc. Important crop products are rice, soybean, and maize. Only 0.84% of the population (20 households) can make less than 20,000 baht yearly income, while 99.16% (2,350 households) of people make more than 20,000 baht annual income.

The Yom River flows through the middle of the Tambon and there are many canals such as Wangrae canal, Klam canal, Ae-A canal, Nong Or canal in the area. Overflow from the Yom River and these canals causes flooding every year. During the flood season, a lot of water flood covers many parts of the Tambon. In upland area, they also faced drought problems. Tambon Chum Saeng Songkhram is affected by flood every year, and was heavily affected in the serious floods in 2006 and 2011 which were years with a much higher water level than others. In the map below, the pink color shows the area that was flooded in 2012, which covered almost the whole sub-district.



(2) Direction of the flood flow and water flow chart of the water resources facilities

1) Direction of the flood flow

The Figure below shows the direction of the flood flow in the Tambon.

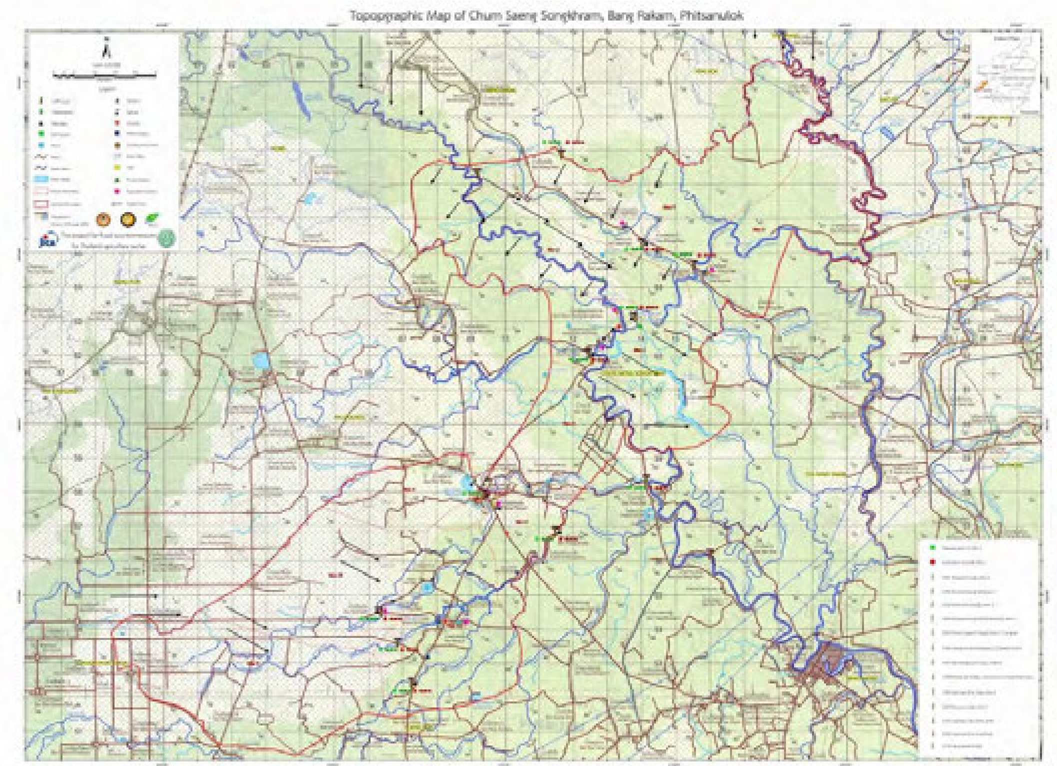


Figure 3 Direction of the flood flow in the Tambon Chum Saeng Songkhram

2) Water Chart

The following figure shows the water flow schematic diagram in the Tambon based on the survey results from in the field and through a series of workshops that the local residents participated in. The chart shows a clear system of the existing water resource facilities such as canals and regulators and also the need for facilities to be renovated.

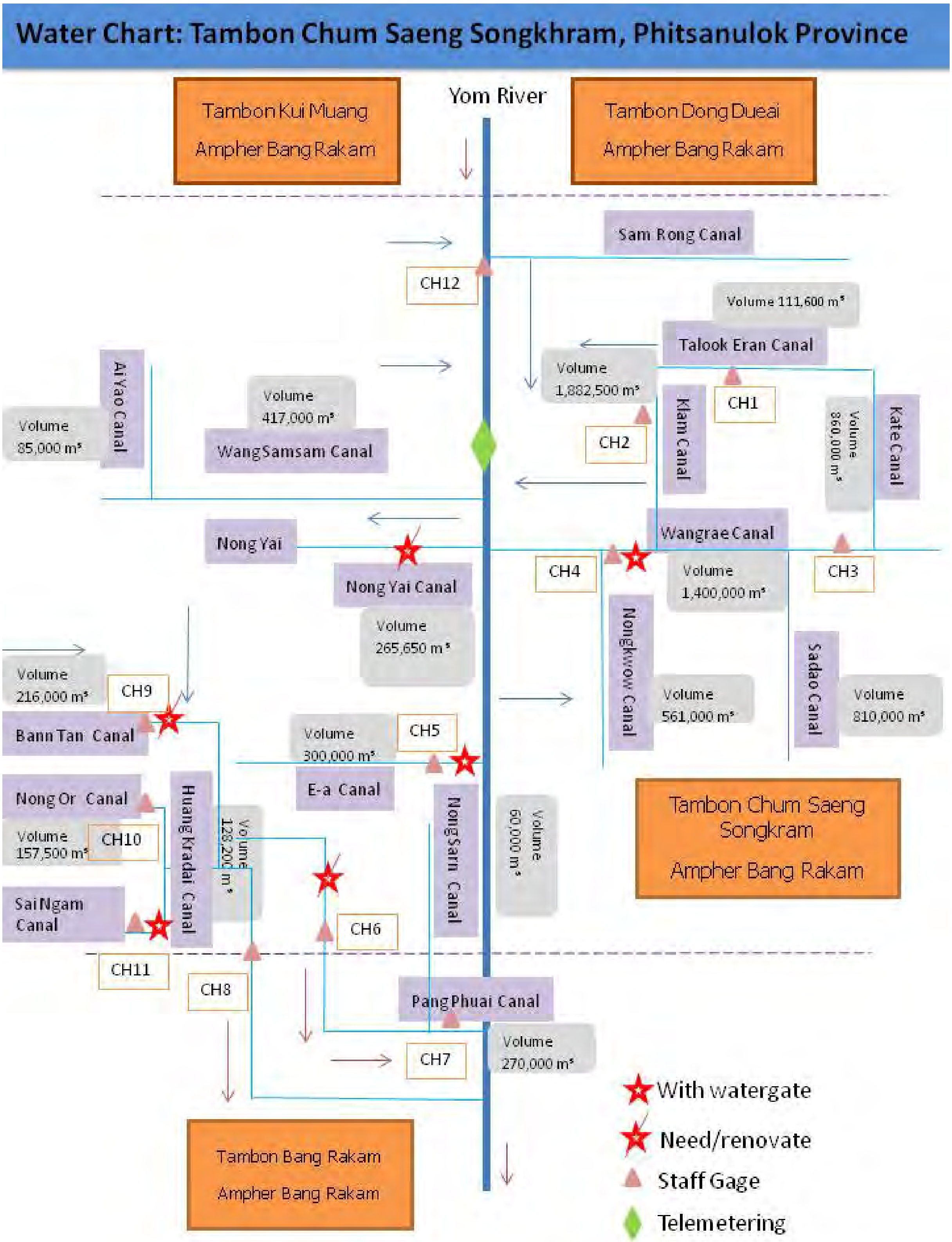


Figure4. Water flow schematic diagram

3) Prioritize projects

To enhance local efficiency of community water resource management, the community had prioritized the need for rehabilitation of all water source facilities in the area in order to reduce flood and drought problems. To determine the priority of project the following process will be used.

a) To study and understand an urgent need for prevention of flood and drought damages.
b) To prepare the direction of the flood flow and water flow chart of the water resources facilities so that the local people can solve problems
c) To put the projects in order of priority by using the water flow chart

Ten water resources facilities in the Tambon were identified as in need of renovation. The following table shows information about the top five prioritized projects out of the ten identified.

Table 3 The top five prioritizing projects against ten projects

No	Area	Project/ Expansion of canals	Coordinate	Natural source	Ex-Structure	New Structure
1	Wangrae Canal	Moo 2, 3 Wangrae Canal 60m. Width 7km. Length 4m. Depth	0613819 1863075	Dredge Yom River Linkage, Moo 2, 3	Fix Regulator Wangrae, connected with Klam canal inlet	Regulator between Sadao canal inlet and Wangrae Canal
2	Wang 33Canal	Moo 2 Wang 33 Canal 20m. Width, 3,000 m. Length, 2.5m. Depth Nong Yai Canal 30m. Width, 800m. Length, 3m. Depth Yao Canal Area: Approx. 45.1 Rai NongSamian Area: Approx. 29 Rai Nong Yai Area: Approx. 157.75 Rai	0612728 1863644	Dredge Wang 33 Canal from Yom River to Nong Yao (monkey cheek), NongSamian(Monkey cheek), Nong Yai (monkey cheek) and loop back to Yom River Dredge Nong Yao, NongSamian and NongYai	Fix Regulator between Nong Yai (monkey cheek) and Nong Yai Canal	Regulator at Wang 33 Canal Inlet Regulator at Nong Yai Inlet Piping along monkey cheek
3	NongSarn Canal	Moo 1, 8 NongSarn Canal 20m. Width 1.5km. Length, 1m. Depth	0611821 1860774	Dredge NongSarn Canal (connected with NongPangpuai, Moo 8 to NongPhayom – TabakNgam asphalt road Dredge Wang Thong Canal (from Yom river to NongSarn Canal)		Regulator at Wang Thong canal inlet
4	Nong Kao Canal Laem Sakae Canal	Moo 1, 2 Nong Kao Canal 60m. Width 7km. Length, 4m. Depth Laem Sakae Canal 20m. Depth 4,100m. Length 3m. Depth	6152324 1860611 0615042 1861194	Dredge Nong Kao Canal (frombox culvert to Nong Kao) Dredge Laem Sakae Canal (waiting for negotiation)		Regulator at Nong Kao Canal inlet Dredging for linkage with Yom river and dredge to make canal wider for storage purpose.
5	Talook I Lan Canal	Moo 9 Talook I Lan Canal 12m. width, 1.2 km. length, 2m. depth	0613997 1867305		Talook I Lan Canal	Moo 9 Talook I Lan Canal 12m. width, 1.2 km.

		Nong Pak Boong 9 Rai, 6m. depth				length, 2m. depth Nong Pak Boong 9 Rai, 6m. depth

(3) Main Works

The main work to be undertaken for prevention from flood and drought damage are mainly the expansion of canals (Khlong) by dredging, dredging of ponds, and repairing the deteriorated regulators.

(4) Progress of the works

The following implemented projects by JICA support, dredging works by RID and expansion of works in the Khlong and Bueng by the Military were commenced in 2012. Examples of the implementation are described below.

1) Dredging and expansion of the canal works by RID (11/May/2012)

Phitsanulok RID provincial office carried out the expansion of the canal for 1.7 km length of the Khlongklam canal in 2012.


2) Support by HAII and the Military

HAII with the cooperation from Utokapat foundation and the Royal Thai Military set up a plan to renovate the community's water resources appurtenant (accompanying) structures to prevent and relieve flood problems in the Tambon Chum Saeng Songkhram. After conducting field work with the local community and HAII, the military service set plan for 2013 and 2014 is to renovate 3 canals in the Tambon area as follows:



Table 4 Implementation schedule by Royal Thai Military

No	Project	Place	Coordinates	Advantages
2013	Dredging parts of 3 canals in Tambon Chum Saeng Songkhram	Tambon Chum Saeng Songkhram, Amphoe Bang Rakam, Phitsanulok Province	16° 51' 41"N 100° 5' 5"E	-Increases water storage area during flooding -Reserve water for dry season utilization
2014	Yom River Basin, Dredging of NongSarn Canal	Ban Bang Ba, Tambon Chum Saeng Songkhram, Amphoe Bang Rakam, Phitsanulok Province		
	Yom River Basin, Dredging of I Hok Canal	Ban Nong Or, Tambon Chum Saeng Songkhram, Amphoe Bang Rakam, Phitsanulok Province		

3.6.2 [Type-B] Community Monkey Cheek Development in lowland area affected by flood from the hilly area (Khwae Wangthong Tributary)

A model of Type B is determined where the following conditions exist.

- There is hilly area in the hinterland of the development area.
- The main cause of the flood is runoff water from the hinterlands.
- The area has a large-scale river flowing through the downstream of the area and the water level of the large-scale river rises during the flood period, and is affected by the back water.
- From a point of view of flood damage reduction and using water resources effectively, dredging and expansion of canals and ponds are effective methods.
- The installation of the gate is desirable to prevent the discharge from the canal by a drop in river water level after the expansion of the canal.

(1) Background

Tambon Nakhon Pa Mak is one of nine Tambons of Amphoe Bang Krathum, Phitsanulok province. Geography of the area consisted of Khwae Wangthong River, Krong Kreng canal and Krong Kreng Yai canal which flow in and along the Tambon; most of the areas of Tambon are flat plains. In March 2012, the TAO consisted of 13 villages, having a population of 6,477 people: male 3,166: female 3,311, and 1,723 households. The density of population is 110.49 people per1 km^2, an average of 4 people per household.

Most of the people in this Tambon are engaged in farming. They get the irrigation water all year round by using electric pump irrigation from the Khwae Wangthong River and from using artesian groundwater wells. The Tambon has been affected by many floods during the last decade, especially the serious floods that occurred in 2006 and 2011. In 2006, over 70 percent of the Tambon community area was flooded. The cumulative flood caused inundation at approximately 1 meter in depth for 1 month's duration.

In 2011, over 80 percent of the community area was flooded. The cumulative flood caused inundation at approximately 2 - 2.5 meter in depth for 2 - 3 month's duration. The Khwae Wangthong River flows through Tambon for a short lengthin distance as well as another main river namely Krong Kreng canal and Krong Kreng Yai canal flow through the Tambon. These 3 rivers are quite big and supply enough water every year for agricultural use, but due to lack of regulation of the water, they cause the land to be flooded in many areas of the Tambon during the flood season. Additionally, some upland areas face drought problems every year.

(2) Direction of the flood flow and water flow chart of the water resources facilities

1) Direction of the flood flow

The Figure below shows the flood flow direction in the Tambon.

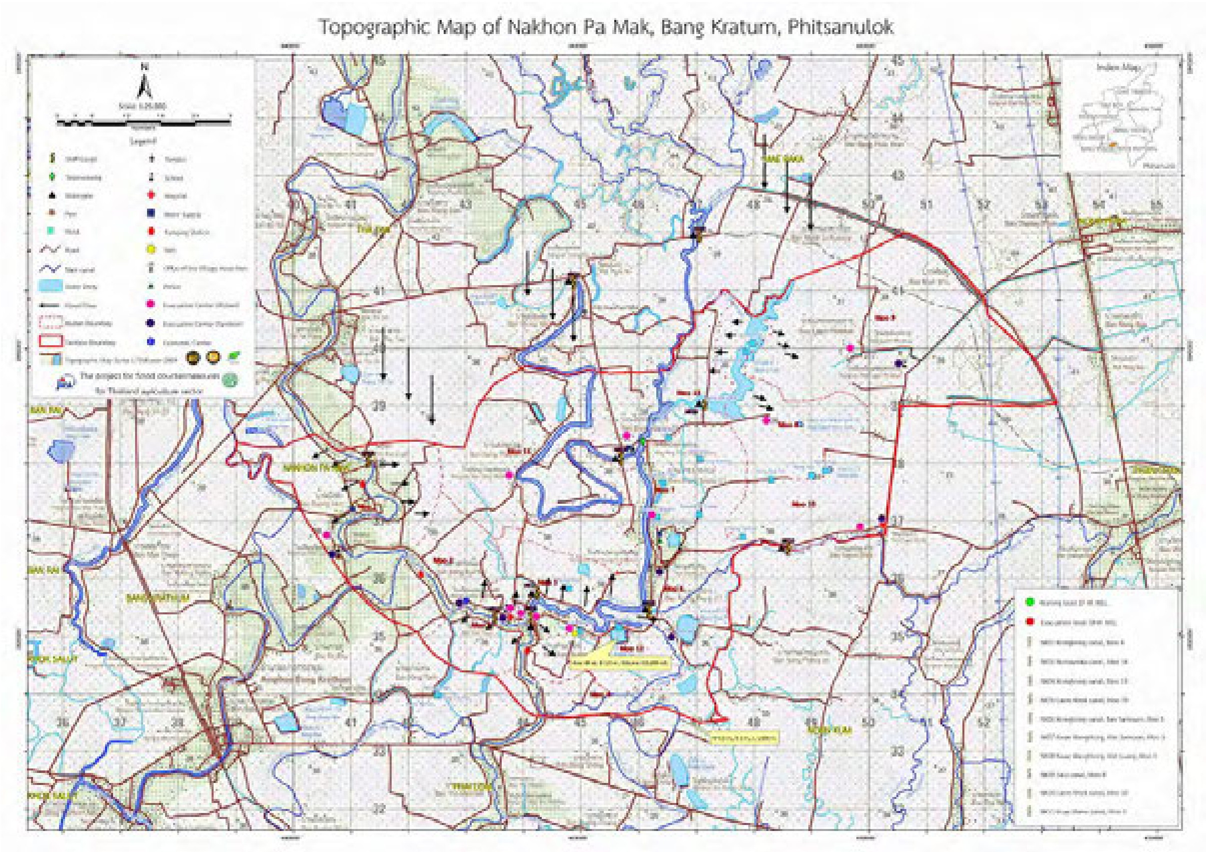


Figure 5 Flooded flow directions in the Tambon Nakhon Pa Mak

2) Water Chart

The following Figure shows the water flow schematic diagram in the Tambon based on the survey results from in the field and through a series of workshops that the local residents participated in.

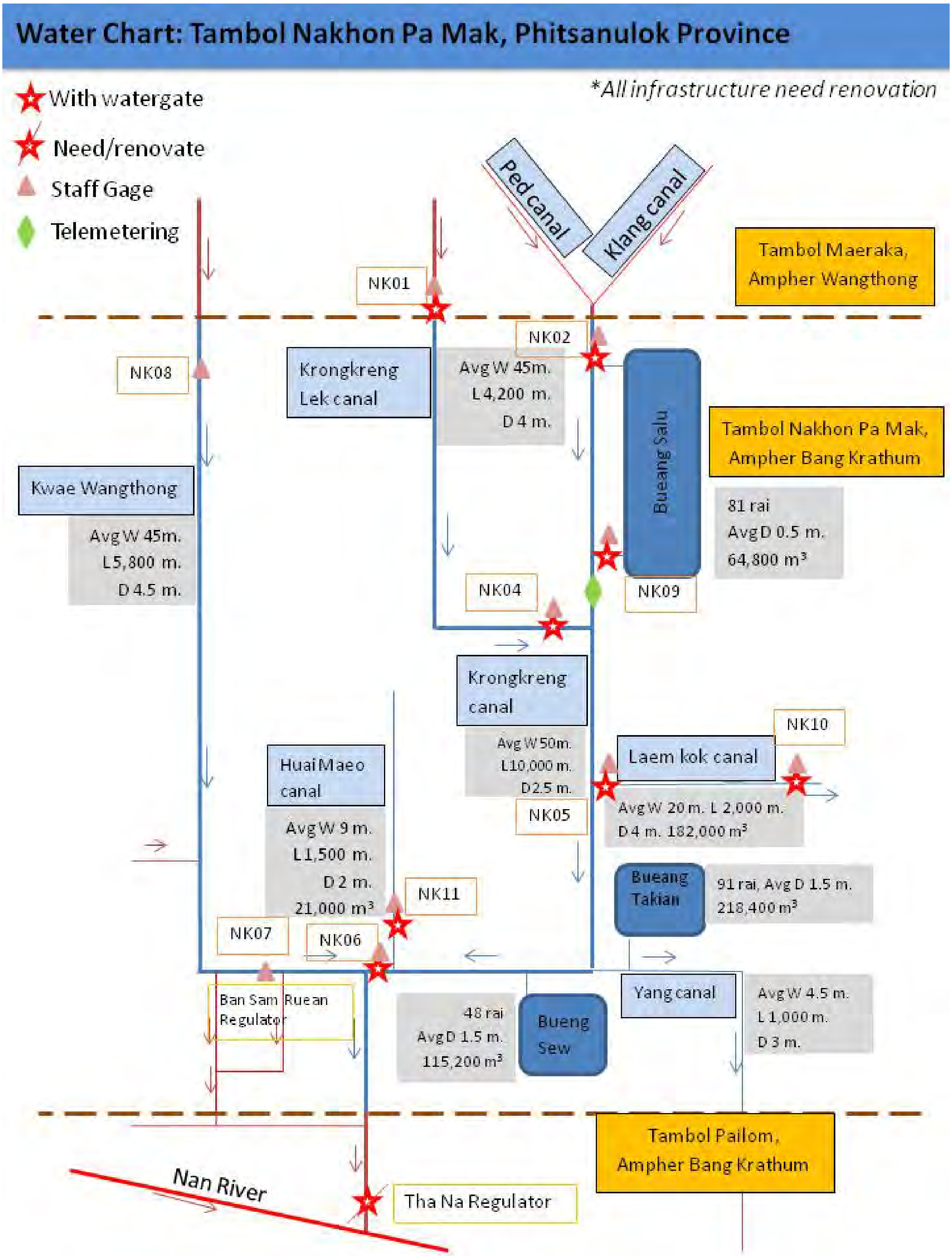


Figure 6 Water flow schematic diagram in Tambon Nakhon Pa Mak

(3) Development Plan

The development plan consists of structural and non-structural countermeasures as shown in the table below. The former will be able to store water during May to September, and the later will be able to use the stored water for irrigation purpose in the dry season through proper water control of the water resources facilities.

Table 5 Countermeasures against drought and flood problems

Hydraulic structure improvement	Non-structure management
1. Organize water resources to effectively store and drain water 2. Develop existing natural reservoirs and remove shallow reservoirs 3. Improve the existing broken hydraulic structures, build new hydraulic structures that make efficient flood management and can transform respective flooding area to be used for fishery during the flooding period	1. Reforestation to protect the top soil from erosion due to water runoff 2. To improve gate and canal for irrigation and drainage purposes 3. TAO annual budget shall be allocated for water management purposes 4. Community people must change their lifestyle during flooding 5. Build Network and partnership capacity among government and community

(4) Main Works

Based on the development plan, main works for structural countermeasures consist of expansion of the canals (Khlong) by dredging, dredging of ponds, and repairing of deteriorated regulators.

(5) Progress of the works

1) Rehabilitation of the Ban Sam Ruean Regulator (SSIP) supported by JICA

Rehabilitation of the Ban Sam Ruean Regulator (SSIP) supported by JICA was carried out during December 2012 to February 2013 by TAO in collaboration with RID Phitsanulok provincial office. Details are referred to in PILOT PROJECT SHEET NPM -WRM-WMFF -01 and TECHNICAL PAPER WRM-WMFE-01

Figure 7 Location map of Ban Sam Ruean Regulator and other projects

Following the implementing the projects by JICA support, rehabilitation/expansion of the canal works by RID and expansion of canal works in the Khlong and Bueng by Military were commenced. Examples of the implementation are described below.

2) RID Phitsanulok Provincial Office

RID carried out the expansion of the KrongKrengLek canal 6km. in length located in the upstream area of rehabilitated Ban Sam Ruean Regulator in 2012.

Photographs show the difference of water volume at the intake structure at the beginning and the end of the dry season (November and March)

3) Royal Thai Military

HAII with cooperation from Utokapat foundation and the Royal Thai Military made a plan to rehabilitate water resources to prevent and relieve flood problems in Tambon Nakhon Pa Mak. After the field work by local residents and HAII, the Military service set plans for year 2013 and 2014 to renovate the ponds as follows.

Table 6 Dredging works by the Royal Thai Military

No	Project	Place	Coordinate	Advantages
2013	Dredging BuengSalu Expansion of canal in 6km	Tambon Nakhon Pa Mak, Amphoe Bang Krathum, Phitsanulok province	16° 37' 42"N 100° 23' 0"E	- Add more water storage during flood season - Store water for use in the dry season - Connect the water system between BuengSalu and KrongKreng canal for efficient water management
2014	Dredging of ponds	Tambon Nakhon Pa Mak, Amphoe Bang		- Store water for use in the dry season

		Krathum, Phitsanulok province		

3.6.3 [Type-C] Community Monkey Cheek Development in lowland in hilly rain-fed agricultural area affected by flood from a mountainous area

A model of Type C is determined where the following conditions exist.

- There is a mountainous area in the hinterland of the development area
- The main factor of the flood is runoff water from the hinterlands. In general flash floods occur in some places.
- From a point of view of reduction of flood damage and using water resources effectively, dredging and expansion of canals and ponds are effective.
- The installation of the gate is desirable to prevent the discharge from the canal by a drop in river water level after the expansion of the canal

(1) Background

Tambon Wang Man suffers from flood caused by mountainous runoff during the wet season especially in the lower part of the Tambon. In 2012, 359 farmers lost their crops (5,751 rai of rice, 489 rai of cassava and 1,494 rai of sugarcane). Similar flood occurs almost every year. On the contrary, drought occurs in most parts of the Tambon in the dry season. Dry season cropping is regularly damaged by insufficient water. The main issue is how to balance these contradictory situations. During the PRA survey and field visit of the JICA Study Team, it was observed that there are some existing ponds and canals. These ponds were constructed by different government agencies such as Land Development Department, Water Resources Department, etc., but not functioning properly at present.

The team identified the potential of water resources and to improve the ponds and canals with the participation of the people, so excessive water in the wet season could be stored in the ponds and utilized in the dry season. Since the water resources of this Tambon connected to the upstream Tambons, representatives from other Tambons will be invited to the workshop to discuss possible cooperation as micro watershed monkey cheek development

(2) Community Water Resources Survey and GPS Survey

Community water resources survey was carried out by JICA Study Team together with TAO staff to grasp an understanding of the existing facilities of water resources and the current situation of flood and drought damage. It was found that there are 3 rivers/canals namely Wang Man River, Wang Man canal and Sadao canal and a lot of public or private ponds including SSIP facilities which are the available water resources in the TAO.

The Figure below shows the water flow chart in Tambon Wang Man.

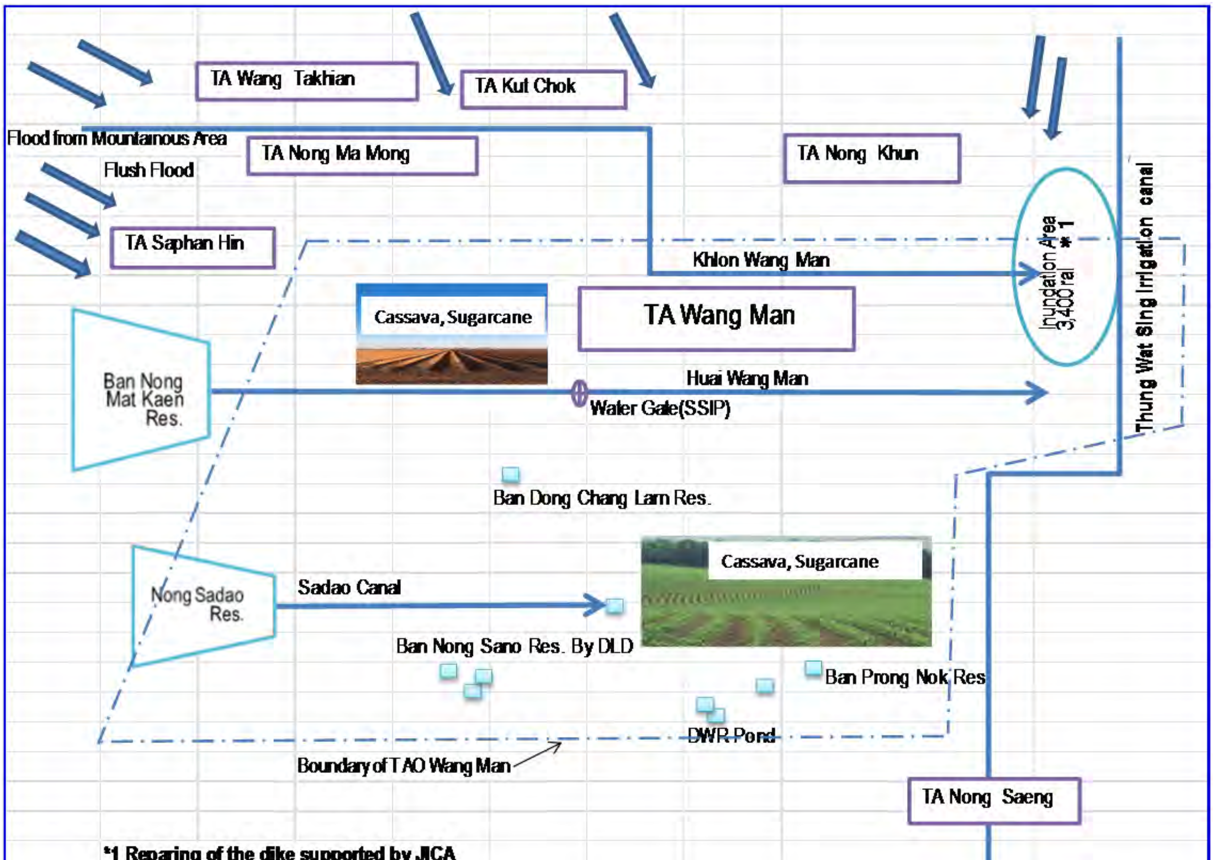


Figure 8 Water Flow Chart in T. Wang

(3) Community Water Resources Workshop and GPS Survey

1) Community Water Resources Workshop

Community Water Resources Workshop was held, initiated by TAO and attended by TAO staff, representatives of 8 villages and the Study Team. Each villager made a map to confirm the water resources facilities, outbreak situation of the flood and drought situations, direction of the flood flow, etc. The participants then discussed how to mitigate the flood and drought damage.

2) GPS Survey

Based on the map prepared by the each villager, the GPS survey was carried out. The objective of the GPS is to clearly identify the location and water storage capacity of existing water resources facilities. An inventory list of the facilities and location map of the main facilities were prepared. Location of the existing facilities is shown in the Figure below

Figure 9 Location map of existing water resources in Tambon Wang Man

3) Implementation Schedule of the Study

To formulate the water resource development plan, JICA Study Team supported the process of site survey to preparation on necessary information and topographic map up until the time limit of the JICA Study period. The Table below shows the schedule of the study and further activities initiated by TAO.

Table 7 Study Schedule and further activities initiated by TAO

Component	Feb.	Mar.	Apr.	May	Jun.
Water Resources Survey by JICA and Wang Man TAO					
Community Water Resources Survey by Village Leaders					
GPS survey supported by JICA Study Team					
Submission of the Data and Information to TAO (Inventory list of facilities, Topographic Map, etc.					
Further activities initiated by TAO					
Workshop on Water Resources Improvement Plan					
Formulation of Water Resources/ Monkey Cheek Development Plan -Selection of the priority project -Prepare Implementation Schedule					

4) Further activities initiated by TAO

Based on the information and topographic map, formulation of the water resources development plan should be prepared and initiated by TAO with the requested assistance of RID, PDLA, etc., including the selection of priority projects and preparation of an implementation schedule for the next 2 years. To formulate the development plan, the source of finances is the main issue. According to the Study, RID, Royal Thai Army and PAO will be the financial sourcing agencies. In addition, the Pilot Project on Water Resources Management for Sustainable Development at Amphoe Trakanphuetphon, Ubon Ratchathani Province was proposed for study tour in order to generate the participants understanding on Inter-Tambon Water resources development, Water Distribution and Enhancement of farmer group's participatory on water resources management.

4. Impact and Adaptability as Flood Countermeasure

- ❖ Inhabitants are interested in not only flood countermeasures due to proper gate operation and rehabilitation and expansion of the canal cross section in the wet season, but also water utilization from the stored water in the canals for irrigation purpose in the dry season through implementing the gate repairing and dike rehabilitation projects supported by JICA .
- ❖ Due to the implemented monkey cheek development projects in the communities by JICA support, river draining by dredging, pond and swamp dredging works, etc., have been commenced through

utilizing the Utokapat Foundation by HAII, Royal Thai Military or RID support.

- ❖ TAO and local residents understood the current situation of deteriorated or insufficient use of the existing water resources facilities through the field survey with JICA Study Team. They have also studied the effective use of these facilities among villages. Accordingly, information-sharing among the community members has been strengthened.
- ❖ Inhabitants have recognized the necessity to formulate the micro watershed water resources development and management plan as monkey cheek development. Because the effective water use and control of a river against flood and drought damages is not to be solved a single Tambon, it should be formulated in collaboration among all Tambons related to the watershed.

5. Prerequisite Conditions

- ❖ To formulate a monkey cheek development plan, participatory manners initiated by the TAO is essential and it is necessary to have the support from outside agencies.
- ❖ It is very important to make clear the effectiveness of the plan, priority of the project, and the source of finance.
- ❖ Required cost,
  Formulation of Monkey Cheek Development at a Community Level is about 1million Baht

6. Role of Government Agencies and Other Stakeholders

- ❖ TAO is the core body to implement the project and getting the participation of residents in that area is essential.
- ❖ To formulate a monkey cheek development plan in a Tambon, support from outsiders is necessary such as PAO, Consultants, and HAII, etc.
- ❖ DWR, DLD, RID and Royal Thai Army, etc., will support the implementation of the plan if requested.

7. Lessons Learned from Pilot Activities

- ❖ It is essential for collaboration between TAO and inhabitants to formulate the monkey cheek development plan at a community level
- ❖ To formulate a plan effectively, facilitation of the workshop will be supported by NGO, Consultant, HAII, etc.
- ❖ To formulate a plan, technical assistance by RID is essential.
- ❖ To implement a plan, financial support from DWR,DLD, RID, etc., is indispensable

8. References

- Drainage gate repair for monkey cheek development in community level（Technical Paper Series No. WRM-WMEF-No.1）
- Improvement of dike for prevention of flood damage, (Technical Paper Series No.WRM-WMFE-No.2)

The Project for Flood Countermeasures for Thailand Agricultural Sector

<u>‘Guideline for Disaster Resilient Agriculture and Agricultural Community’</u>

Technical Paper Series No. 6

Drainage Gate Repair for Monkey Cheek Development at Community Level

Prepared by JICA Project Team and RID Phitsanulok Province

Drainage Gate Repair for Monkey Cheek Development at Community Level

1. Introduction

Ban Sam Ruean regulator is a small scale irrigation project (SSIP) facility which is known as the Khlong Krong Kreng regulator. This regulator is located at Moo5, Ban Sam Ruean, and it was constructed in 1986. Currently, its control has been transferred to T.Nakhon Pa Mak by Royal Irrigation Department (RID) since January 28, 2003.

This regulator has two functions, one is to control the flood water which comes from Nan river direction, and the other one is to store the water in an upstream canal area during the rainy season for utilizing as irrigation water in the dry season. This gate has been partially broken and is unable to perform the above functions. Because there have been no gate operational rules, it has not been operated appropriately.

Through this pilot project, gate repair will be implemented, and a water user’s committee and gate operational rules will be established. Additionally, cooperation with canal dredging work around the upstream area, will allow this regulator to make a big contribution to community level monkey cheek development.

The location of the Ban Sam Ruean regulator and related facilities are shown below.

2. Objectives

The objectives of the project are summarized below.

- About 5,000 rai of paddy fields will receive better conditions especially in appropriate water management.
- Through the gate repair work, TAO will gain gate operation and maintenance skills.

- Able to utilize as a monkey cheek development at community level because 6km of canal was dredged by RID in 2012 and swampy area will be dredged by the Military in 2014, upstream of the rehabilitated gate.
- To establish the water user's committee and gate operational rules.

3. Components of the project and implementation schedule

Components of the project consist of the following 4 items.

- Cost estimation by RID provincial office.
- Supervising of gate repair by RID & TAO and providing labor for installation of gate repair work by TAO.
- JICA Study Team provides gate repair materials.
- Set up a workshop for establishment of a water user's committee and gate operational rules.

Implementation of the repair work should be done in the dry season from February to April and the implementation schedule is shown in table below.

Component	Nov	Dec	Jan	Feb	Mar
Workshop and site investigation					
Design and cost estimation (already made by RID)					
Contract between JICA and Material supplier					
Delivering of gate repair materials					
Repair work implementation					
Final Inspection					
Establishment of water users committee and gate operational rules					
Support and training to strengthening the WUC by JICA and RID provincial office					

Procedure of the Implementation

Participatory Disaster Resilient Planning Workshop - Selection of the gate rehabilitation as a priority project September 2012	TAO, community representatives and Study Team
1st Workshop - To confirm the deteriorated gate facility and inappropriate operational situation - Site investigation November 2012	TAO, community representatives, RID and Study Team
Cost Estimation & Implement Schedule - RID prepared the necessary materials, cost estimation and work schedule plan November 2012	Phitsanulok RID provincial Office
Contract - Request the quotation of the cost from contractors (at least 3 contractors) - Selection of a successful contractor and negotiation - Award Contract December 2012	TAO and Study Team Refer to the Annex1
2nd Workshop - Explanation on the gate rehabilitation work, schedule and cost sharing - January 9th 2013	RID, TAO, community representatives and Study Team
Implementation - Delivering the gate materials by Contractor - Implementation of the repair work	Supervision by RID, TAO, Providing labor by TAO
Final Inspection - Check the repair work and operation of the gate - February 2013	RID, TAO, community representatives and Study Team

4. Impact and Adaptability as a Flood Countermeasure

- ❖ Through the gate repair work, TAO has gained gate operation and maintenance skills.
- ❖ After JICA support of the gate rehabilitation, other agencies such as RID, Military and HAII have also supported these flood mitigation measures.
- ❖ A monkey cheek at community level is developed because 6 km of canal was dredged by RID and swampy area will be dredged by the Military upstream of the rehabilitated gate.
- ❖ Phitsanulok RID provincial office has continuously supported the technical aspects such as prevention of settlement and slope protection around the rehabilitated gate structure.

- ❖ A new community water management committee was established and criteria of gate operation and role of the committee will be soon decided.

5. Prerequisite Conditions

RID provincial support for cost estimation of gate repairing and supervision of the implementation is essential,

Required cost.
450,000Bt for materials associated with repairing the gate and 150,000Bt for labor costs and miscellaneous goods as necessary. Total cost is 600,000Bt

6. Role of Government Agencies and Other Stakeholders

- ❖ It will be possible to rehabilitate similar irrigation facilities in TAO which there a lot of, and they are deteriorated not functioning well without technical support by RID provincial office.
- ❖ Rehabilitation of the irrigation facilities of a small scale and project cost should not exceed 500,000 Bt. Therefore, TAO will be able to implement repairs using its own budget and initiative.
- ❖ The local administration promotion department is one of the sources of funds able to implement the similar projects.

7. Lessons Learned from Pilot Activities

- ❖ People in TAO have encouraged combating flood damage and a lot of activities have been carried out in a positive manner due to JICA support.
- ❖ It will be possible to rehabilitate similar irrigation facilities in TAO which there are lot of, and they are deteriorated and not functioning well without technical support by RID provincial office.
- ❖ Rehabilitation of the irrigation facilities of a small scale and project cost is not exceed 500,000 Bt. Therefore, TAO will be able to implement repairs using its own budget and initiative.
- ❖ The local administration promotion department is one of the sources of funds able to implement the similar projects.
- ❖ A new community water management committee was established and criteria of gate operation and role of the committee will be soon decided.
- ❖ To implement similar projects, support by Phitsanulok RID provincial office will be indispensable.
- ❖ In order to control water properly for both, flood prevention and irrigation use, the gate operation system requires rehabilitation of both this regulator and the Thana regulator which is located about 7km downstream of Wang Tong River.

8. References

Reference 1. Procedure of Gate Repairing by RID
Reference 2. Breakdown of repair material cost

Reference 1: Procedure of Repair of the Krong Kraeng Regulator

At Ban Sam Ruen, Tambon Nakhon Pa Mak, Amphoe Bang Krathum
Phitsanulok Province

1. The gates and its structure were jet cleaned by TAO Water Truck.

2. The hoist set where rubbish accumulated was cleaned for new rust preventive color painting.

3. The ruined steel sling was removed from the hoist.

4. A new steel sling was installed in order to lift up the 3 gates to be repaired.

5. The 4 ton gates were uplifted out of its frame by crane and delivered to TAO Office Yard for repairs.

6. The steel plates and the new J seal rubber were replaced and the leakage points of gates were filled by welding.

7. The gates were painted using a rust preventive color.

8. In the meantime, the damaged regulating structure was strengthened by steel beams with concrete placing.

9. After the gates were completely repaired, they were sent back and reinstalled in their concrete structure frame on site by a crane.

10. The gates and regulating structure after the repair was finished.

Reference 2 Breakdown of repair material cost

Irrigation System Opeartion and Maintenance Reparation Work

Ban Krong Krange and Ban Sam Ruen Pipe Drainage Gate Reparation

Tambon Nakhon Pa Mak, Amphoe Bang Krathum, Phitsanulok Province 1 Site

Quantity	Items	Unit	Rate	Cost	Total
210	Sling Wire dia. 28 mm.	meter			
40	Fitting Couple with Sling Wire dia.28 mm.	Piece			
6	Sling Roll Plate dia. 28 mm. thick type	Piece			
6	Length Adjusting Screw dia. 1 1/4 ″ x 24 ″	Piece			
6	Jungle dia. 1 1/4″	Piece			
24	Gate Wheel with boot and axel dia. 260 mm.	Set			
2	Rubber Water Stop J-Seal size 4 ″ Standard Tensile	Roll			
	Strength 210 kg/cm2 Elasticity 450%				
	20 m. length/roll Type A				
6	Rubber Plate with Rubber Water Stop J-Seal size 4 ″	Pieces			
80	Screw Bolt with Nut	Kg.			
10	Flat Bar size 3/8″ x 2″ x 6 m.	Bar			
5	Angle Bar size 4″ x 4″ x 6.0 m. 7 mm. thickness	Bar			
10	Welding Rod for Mild Steel size 3.2 mm. 5 kg. each	Box			
6	Stainless Auger Bit dia. 1/2 ″	Piece			
6	Fiber Grinding Plate dia. 7 ″	Plate			
6	Fiber Cutting Plate dia. 14 ″	Plate			
10	Epoxy Color with Mixing Chemical and Tinner	Set			
8	Black Oil Color volume 3.785 lit	Gallon			
8	Primer Oil Color Rustless (Grey) volume 3.785 lit	Gallon			
2	Mixing Pine Oil for Color volume 18 lits	Bucket			
2	Mixing Tinner for Color volume 18 lits	Bucket			
4	Oxigen Gas in Pipe 1,500 Lbs	Pipe			
2	Acetylene Gas in Pipe 500 Lbs	Pipe			
12	Rust Shining Wire Brush	Piece			
12	Painting Brush size 4″	Piece			
12	Letheroid Glove	Pair			
	Total				

The Project for Flood Countermeasures for Thailand Agricultural Sector

<u>'Guideline for Disaster Resilient Agriculture and Agricultural Community'</u>

Technical Paper Series No. 7

Improvement of Dike for Preventing Flood Damage

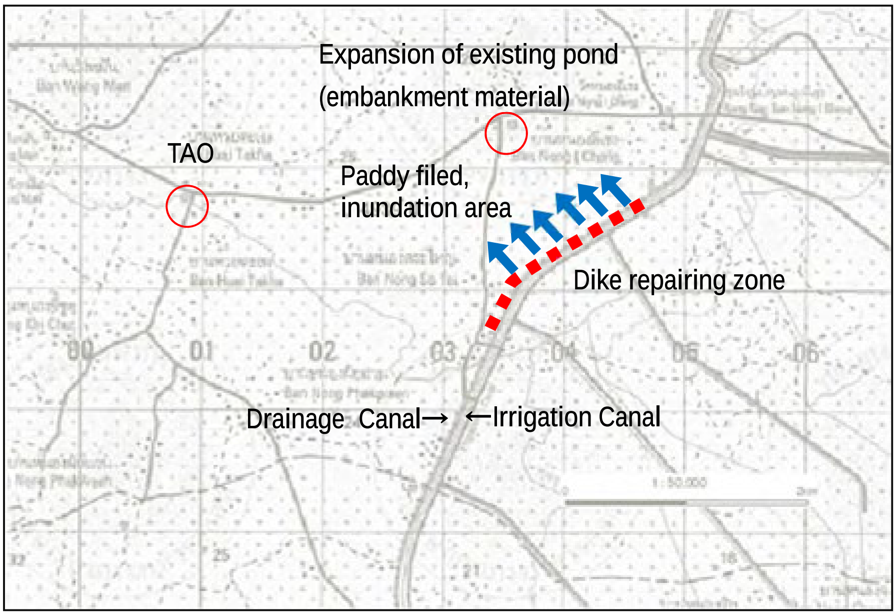
Prepared by JICA Project Team and TAO Wang Man

Improvement of Dike for Prevention of Flood Damage

1. Introduction

The Thun Watsing irrigation canal with a drainage canal pumping up from the Chao Phraya river runs from north-northeast to south and was constructed by RID more than 30 years ago. T. Wang Man located on the right bank side of the canal and needs irrigation for paddy fields; of about 3,400rai is practiced, which is the only one large scale irrigation system in this TAO. During the 2011 Flood, about 7,700 rai or 184 farm households of paddy, sugarcane and casaba fields were damaged due to overflowing from the lower part of the drainage canal dike. However, the paddy fields in the area of about 3,400 rai or 88 farm households are damaged by flood every year. People and TAO officers in the Tambon gave a high priority to rehabilitate the dike in cooperation with JICA Study Team when the Participatory Disaster Resilient Planning Workshop was held in September, 2012.

Location of the dike repair work and flood damage area is shown in following figure.



2. Objectives

About 3,400rai or 88 farms household of paddy fields will be protected from annual flooding by raising the dike crest of the drainage canal. Also through the implementation of the dike repairing, the ability of TAO offices for management of work and quality control of embankment will be enhanced through on-the Job-Training.

3. Component of the project

The component of dike repairing consists of the following 3 items.

(i) Stripping back of the dike surface: about 5,200m^2

(ii) Embankment of dike which is lower portion of 1.3km out of 6.4km in length, embankment volume is estimated at about 7,400m^3.

(iii) Pavement of laterite, about 399m^3.

4. Project cost and Implementation Schedule

(1) Project Cost

Preparation of the typical cross-section of the dike repairing, and quantity survey of the embankment volume was carried out by TAO civil engineering section supported by the Study Team and the project cost was estimated at 500,000 Bt.

(2) Implementation Schedule

Implementation of the dike raising should be done during the dry season from February to March. The work consists of stripping back the dike/road surface and embankment of the dike and laterite pavement only, so that the work can be completed within one month.

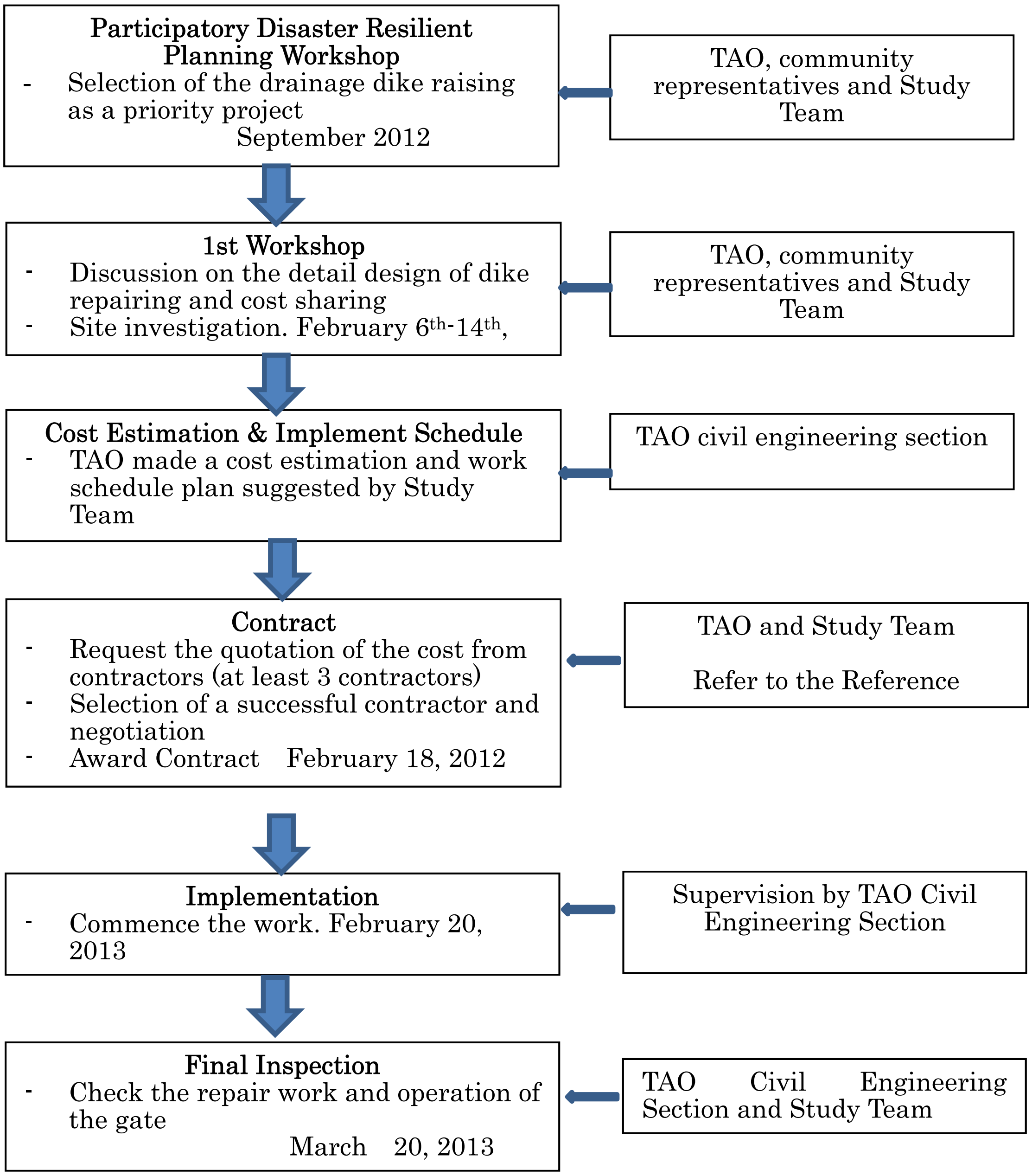
Implementation schedule is shown in table below.

Implementation Schedule

Component	Dec	Jan	Feb	Mar
Preparation of design, construction schedule and cost		▬▬▬		
Agreement between JICA ST & Contractor			▲	
Implementation			▬▬▬	▬
Final Inspection				▲
Technology transfer to the TAO staff			▬ ▬	▬ ▪

5. Procedure of the Implementation

Process from the making of a plan to implementation of the earthwork is shown in the figure below. In each step, the civil engineering section had taken responsibilities under its own initiative.



6. Impact and Adaptability as a Flood Countermeasure

The Wang Man TAO and beneficiary farmers had requested the repair of the dike to the related agencies many times so far, but it had never been approved or undertaken. Under this situation, JICA supported the implementation of the Project quickly and the people in TAO have greatly appreciated the JICA support. Through the planning, making a cost estimation and implementation, impacts of the project were found as below.

i) Through the planning to implement the project, ability of TAO staff for management of work and quality control of an embankment was enhanced.

ii) Additional water resources were developed because an existing TAO farm pond was used as a borrow pit area.
iii) About 3,400rai or 88 farms household of paddy fields will be protected from annual flooding.
iv) Provincial RID suggested that additional flood protection measures will be necessary to prevent flood flow from the western part to the Thun Watsing irrigation canal.
v) Solidarity among TAO staff and people in TAO was strengthened concerning flood countermeasures.
vi) People in TAO are now much more interested in water resources development to mitigate flood and drought problems due to JICA support of the project.

7. Prerequisite Conditions

RID provincial office instead of JICA Study Team should give advice on the technical aspects, such as designing of the typical cross section of dike repairing to the TAO.

The benefitting farmers should provide the manpower, and a small part of their farmland for dike repairing without charge, so as to reduce the project cost as much as possible.

The local administration promotion department is one of the sources of funds to implement these and similar projects.

8. Role of Government Agencies and Other Stakeholders

TAO has a responsibility for making a plan, land acquisition, cost estimation, contract performance and supervision of the project and also for finding the source of funds, not only TAO funds, but also provincial sources. RID provincial office will provide the technical support on the engineering aspects, if necessary.

9. Lessons Learned from Pilot Activities

People in TAO are now much more interested in the water resources development to mitigate flood and drought problems due to JICA support given to the project.

Similar simple projects will be easy for TAO to plan, implement and maintain the facilities. However, structural objects such as construction or repairing the gates and weirs which need technical knowledge and experience and will be difficult for TAO only, so, the assistance of RID provincial office will be essential.

10. References

Typical section of dike repairing ; Thai version only

Contract documents ; Thai version only

สัญญาก่อสร้างถนนคันกั้นน้ำ

ระหว่าง ________________________และ ____

สัญญาฉบับนี้ทำขึ้นวันที่_______เดือน___________พ.ศ.______ระหว่าง _________________ตำแหน่ง

หัวหน้าคณะที่ปรึกษาซึ่งต่อไปนี้จะเรียกว่า “ผู้ว่าจ้าง” ฝ่ายหนึ่ง กับ_________________ ซึ่งต่อไปนี้จะเรียกว่า “ผู้รับจ้าง”

อีกฝ่ายหนึ่ง โดยทั้งสองฝ่ายมีข้อตกลงกันดังต่อไปนี้

1.	มูลค่างานก่อสร้าง	_______________________________________บาท
2.	วันสิ้นสุดสัญญา	__________________________
3.	สถานที่ก่อสร้าง	

ข้อ 1 คำจำกัดความ

ผู้ว่าจ้าง หมายถึง __________________________________และผู้รับมอบอำนาจ โครงการ

หมายถึง ____

____และผู้รับจ้างหมายถึง___________________

ข้อ 2 ขอบเขตของงาน

ก่อสร้างถนนคันกั้นน้ำ บริเวณ____ ตำบล

อำเภอ______________________________ จังหวัด______________________

โดยเสริมดินขนาดกว้างประมาณ ____________เมตร ระยะทางประมาณ ____________เมตร

สูงเฉลี่ย ______ ___________เมตร พร้อมปูผิวลูกรังหนาเฉลี่ย _______________เมตร

ตลอดความยาว ดังแบบก่อสร้างที่แสดงไว้ในเอกสารแนบที่ 1 ให้แล้วเสร็จภายใน

วันหลังจากเริ่มงาน

ข้อ 3 การก่อสร้าง และการตรวจสอบงาน

เพื่อประโยชน์แห่งความร่วมมือตามข้อตกลงนี้

ให้ผู้แทนหรือผู้ได้รับมอบหมายจากผู้แทนของทั้งสองฝ่ายเป็นผู้ดำเนินงาน

ประสานงานและตกลงกันในรายละเอียดดังนี้

3.1 “โครงการ” รับผิดชอบในเรื่องค่าใช้จ่ายเพื่อให้การดำเนินงานก่อสร้างถนนคันกั้นน้ำเป็นไปตามวัตถุประสงค์และเจตนารมณ์ของสัญญานี้

3.2 “ตำบล__________________” รับผิดชอบในการดำเนินกิจกรรมในระยะต่างๆ ดังนี้

<u>ก่อนการก่อสร้าง</u>

- มอบหมายงานให้เจ้าหน้าที่ผู้รับผิดชอบโครงการ
- ประสานงาน จัดประชุมชี้แจงงานก่อสร้างกับชุมชน เพื่อให้ชุมชนมีส่วนร่วมและเตรียมงานในส่วนที่เกี่ยวข้องกับพื้นที่ของตนเอง (ถ้ามี)
- จัดเตรียมแบบก่อสร้างคันดิน และแบบแสดงบ่อดินถมที่นำมาใช้ในงาน
- จัดหาผู้รับจ้างในพื้นที่เพื่อดำเนินงานก่อสร้าง

<u>ระหว่างการก่อสร้าง</u>

- ดูแลรักษาความปลอดภัยในพื้นที่ที่ทำการก่อสร้าง

- ทำการตรวจสอบ

  ควบคุมคุณภาพงานก่อสร้างให้ถูกต้องแข็งแรงตามมาตรฐานงานก่อสร้างทั่วไป

  และเร่งรัดงานให้แล้วเสร็จตามระยะเวลาที่กำหนดภายใน ________ วัน

- ทำการเก็บข้อมูลรูปถ่ายขั้นตอนการก่อสร้างต่างๆ ตั้งแต่เริ่มต้นจนแล้วเสร็จ

  แล้วจัดทำเป็นเอกสารส่งมอบให้ทางโครงการ

<u>หลังการก่อสร้าง</u>

- ทำการตรวจสอบความสมบูรณ์เรียบร้อยของงานก่อสร้าง

  เพื่ออนุมัติผลงานตามงวดงานต่างๆ

- บำรุงดูแลรักษาแบบมีส่วนร่วมกับชุมชนเพื่อให้ถนนคันกั้นน้ำที่สร้างขึ้นใหม่นี้ใช้

  ประโยชน์เพื่อการป้องกันน้ำท่วมได้ตามวัตถุประสงค์

  และมีอายุการใช้งานที่เหมาะสม

ข้อ 4 การจ่ายเงินงวดงาน

- “โครงการ” รับผิดชอบในเรื่องค่าใช้จ่าย รวมทั้งสิ้น ______________________________ บาท สำหรับค่าเช่าเครื่องจักรได้แก่ รถขุด รถบรรทุกดิน และรถไถ ค่าน้ำมัน และค่าดำเนินการในการก่อสร้างถนนคันกั้นน้ำ โดยแบ่งเป็นสามงวด ดังนี้

งวดที่ 1 - 40% เท่ากับ _______________ บาท หลังจากทำการตกลงว่าจ้างผู้รับจ้าง

งวดที่ 2 - 40% เท่ากับ _____________________________________ บาท หลังจากงานก่อสร้างแล้วเสร็จอย่างน้อย 70 %

งวดที่ 3 - 20% เท่ากับ _______________ บาท หลังจากงานก่อสร้างแล้วเสร็จทั้งหมด

โดยโครงการจะทำการจ่ายเงินแต่ละงวดงานหลังจากได้รับหนังสือขอเบิกเงินจากผู้รับจ้างภายในระยะเวลาไ

ม่เกิน 10 วัน (วันทำงาน) หลังจากได้รับเงินแล้วผู้รับจ้างต้องจัดส่งใบเสร็จรับเงินให้แก่โครงการทันท

- โครงการจะจ่ายเงินผ่านบัญชี__________________ ดังรายละเอียดข้างล่างนี้

บัญชี : ธนาคาร_

ชื่อบัญชี :

เลขที่บัญชี: สาขา :

ข้อ 5 การยกเลิกข้อตกลง

ก า ร ย ก เ ลิ ก ข้ อ ต ก ล ง นี้ ให้กระทำได้โดยฝ่ายใดฝ่ายหนึ่งแจ้งให้อีกฝ่ายหนึ่งทราบล่วงหน้าเป็นลายลักษณ์อักษร เป็นเวลาไม่น้อยกว่าสิบห้าวัน แต่ทั้งนี้ ต้องไม่กระทบกระเทือนถึงกิจกรรมหรือเรื่องที่ดำเนินการค้างอยู่ โดยให้ดำเนินการจนแล้วเสร็จต่อไป

ข้อ 6 การเรียกร้อง

การเรียกร้องใดๆ ที่เกี่ยวข้องกับการก่อสร้างถนนคันกั้นน้ำโดยผู้รับจ้าง ต้องดำเนินการแจ้งถึงผู้ว่าจ้างภายใน 15 วันหลังจากเกิดเหตุการณ์ มิฉะนั้นจะถือว่าไม่มีการเรียกร้องใดๆ

ข้อ 7 การแจ้งให้ทราบ

การแจ้งให้ทราบข้อมูลต่างๆที่จำเป็นและเกี่ยวข้องกันตามสัญญา

ต้องกระทำเป็นลายลักษณ์อักษรและส่งโดยวิธีการต่างๆ ได้แก่ ทางบุคคล ทางไปรษณีย์ หรือทางโทรสาร ไปตามที่อยู่ข้างล่างนี้

<u>ผู้ว่าจ้าง</u>

<u>ผู้รับจ้าง</u>

สัญญานี้ทำขึ้นไว้เป็นสองฉบับ มีข้อความถูกต้องตรงกันทุกประการ ทั้งสองฝ่ายได้อ่านและเข้าใจข้อความในบันทึกข้อตกลงนี้โดยตลอดแล้ว จึงได้ลงลายมือชื่อไว้เป็นสำคัญต่อหน้าพยาน และต่างถือไว้ฝ่ายละฉบับ

ลงนาม ณ วันที่ __________ เดือน__________ พ.ศ.____________ .____

ลงชื่อ …………………………………………..

หัวหน้าคณะที่ปรึกษา

ลงชื่อ …………………………………………..

ผู้รับจ้าง

The Project for Flood Countermeasures for Thailand Agricultural Sector

<u>'Guideline for Disaster Resilient Agriculture and Agricultural Community'</u>

Technical Paper Series No. 8

Inter Tambon Micro Watershed Water Resources Development Plan for the Wang Man River Basin

Prepared by JICA Project Team and TAO Wang Man

Inter Tambon Micro Watershed Water Resources Development and Management Plan for the Wang Man River Basin

1. Introduction

In the upstream area of the Chao Phraya River, small scale irrigation or rain-fed agriculture practices are dominant because of only a few large scale irrigation schemes. Small scale water resources such as rivers, canals, ponds are not functioning well, due to a lack of maintenance and the water depth of these facilities has become shallow because of sedimentation introduced by soil runoff. As a result, the inhabitants have suffered from flood and drought damage on several occasions over the past few years.

JICA supported the project for "Improvement of dike for prevention from flood damage" in Tambon Wang Man in 2013. Through the implementation of the project, the people in the Tambon became much more interested in how to mitigate flood and drought damage. The result is a water resources development plan as a monkey cheek development that has been prepared and initiated by TAO Wang Man in collaboration with the representatives of villages supported by JICA.

Through the formulation of a water resources development plan, to secure and manage the water resources in the Tambon effectively, they found that in order to make a watershed water resources development and management plan it is essential and important to collaborate with other TAOs in the watershed.

Wang Man River is located at northern part of Chainat province, one of the small sub-basins in Tha Chin River basin and flows from east to west then confluent (joins with) the Thung Wat Sing Drainage canal. The river bed gradient is about 1:1,000 and very steep. Flash flood therefore occurs frequently and erodes (astride) the river course and both river banks. There are 6 Tambons in the Wang Man River basin, namely Wang Takhian, Nong Ma Mong, Saphan Hin, Kut Chok and Wang Man. Wang Man is located at the lowest point downstream. All of the Tambons are suffering from both flood and drought once or twice every few years.

There are a lot of Tambons which rely on water for agriculture and depend on small scale water resources. These Tambons are damaged by flood and drought frequently. This micro watershed water resources development and management plan is very important and useful for these Tambons in the upper Chao Phraya River basin as a model of monkey cheek development. This development is not only to reduce the flood and drought damage in their own areas, but also to reduce the flood damage to other areas which are located further downstream.

2. Objective

Objective of the guideline is the reduction of the regular flood and drought damage in the Wang Man River basin in order to develop and manage the water resources properly. This requires the collaboration and an Inter Tambon relationship, relating to the River basin and the rehabilitation of deteriorated existing small water resources to increase their storage capacity.

3. Composition of the Guideline

This guideline is divided into two phases. Phase 1 is to prepare a water resources development plan in Tambon Wang Man and organize an inter tambon committee to formulate a water resources development and management plan in the Wang Man River basin. JICA Study Team has supported Phase1 up to the time limit of the Study period. Phase 2 is to formulate the water resources development and management plan in the Wang Man River basin and implementation of its priority projects initiated by the Inter Tambon committee. The scope of work for Phase 1 and Phase 2 is described below.

Phase1:

Preparation of a water resources development plan in Tambon Wang Man and organizing the Inter Tambon committee to formulate a water resources development and management plan in the Wang Man River basin

Scope of work is as follows;

- To identify all of the water resources facilities by local people with their participation
- To conduct GPS survey at existing water resources and irrigation facilities
- To prepare a water resources map for the Tambon
- Discuss the possible options for water resources improvement between the Tambons.
- Conduct a study tour to an advanced TAO of inter Tambon water development project
- Establishment of an Inter Tambon water resources development and management committee (IT-WRDMC) in the Wang Man River basin
- Conclude the memorandum of cooperation among Inter Tambon to formulate a water resources development and management plan in the Wang Man River basin

Phase2:

Formulation of a water resources development and management plan in the Wang Man River basin and implementation of its priority projects

Scope of work is as follows;

- To strengthen the inter Tambon water resources development and management committee (IT-WRDMC).
- To identify water resources facilities by using the participation of the local residents in 5 Tambons
- GPS survey for water resources and irrigation facilities in all 5 Tambons
- To prepare a water resources map in 5 Tambons
- To formulate a water resources development and &management plan at 6 Tambons
- To formulate a water resources development and &management plan in the Wang Man River basin
- To prioritize and select the feasible projects and prepare an implementation schedule
- Submission of the proposal to the PAO
- Implementation of the priority projects

4. Phase 1: Preparation of a water resources development plan in Tambon Wang Man and organizing an inter tambon committee to formulate a water resources development and management plan in the Wang Man River basin

4.1 Procedure for the formulation of a water resources development and management plan in the case of Tambon Wang Man as Phase 1

The procedure of the development and management plan consist of 6 activities namely, (i) PRA workshop, (ii) Field Survey, (iii) Workshop/Discussion, (iv) GPS Survey, (v) Inter Tambon Meeting/PDLA Meeting, (vi) Study Tour to advanced Inter Tambon Project Area.

(1) PRA Workshop

A PRA workshop or similar meeting should be held prior to formulating the water resources development plan in the presence of TAO staff, representatives of villages and governmental agencies concerned with the project. They have to confirm details and location of the natural resources and the socio-economic situation in the Tambon then discuss the current situation of the flood and drought damage and proposed countermeasures.

(2) Field Survey

Field surveys trips will be conducted by the consultant and TAO staff by a visit to the site and study the situation of the existing water resources facilities utilization. Based on the 1st field survey results, a follow-up survey will be carried out, if necessary. Through the site surveys, the following issues should be clearly specified.

Intake Structure constructed by SSIP Weedy canal

- To confirm the existing condition of all natural water resources situation such as rivers, swamps, depression areas, etc.
- To confirm the location and dimension of the facilities such as canals, ponds, SSIP facilities (and other governmental agencies concerned,) and other implemented agencies such as RID, DLD, DWR, etc.
- Provide details of flood cause and damage, flow direction, water level, inundation days, and the scale of damage in the flood season.
- Provide details of drought cause and damage in the area.

After the field survey, a location map of water resources facilities will be prepared.

(3) Workshop/Discussion

Prior to a workshop/ discussion regarding the water resources development in the Tambon, TAO staff /Consultant should confirm whether or not the development plan in and around the TAO is prepared by governmental agencies concerned such as RID, DWR, DLD, PAO, etc.

After that, the TAO will initiate the holding of a workshop for confirmation of the existing water resources at each village. The representatives of each village make a map of existing water resources in their villages. After making the map, the representative of each village presents the map and situation of flood and drought damage. In order to formulate a water resources development plan in the Tambon, exchange of the information among villages will be very important and useful. Direction of the flood flow and water flow chart of the rivers/canals, and location of the water resources in the Tambon Wang Man are shown in Figures 1and 2 respectively.

In order to preside over a workshop or meeting which requires smooth operation and completion on time, a facilitator will seek consultants, or NGOs who have a lot of experience and knowledge of the participatory approach process.

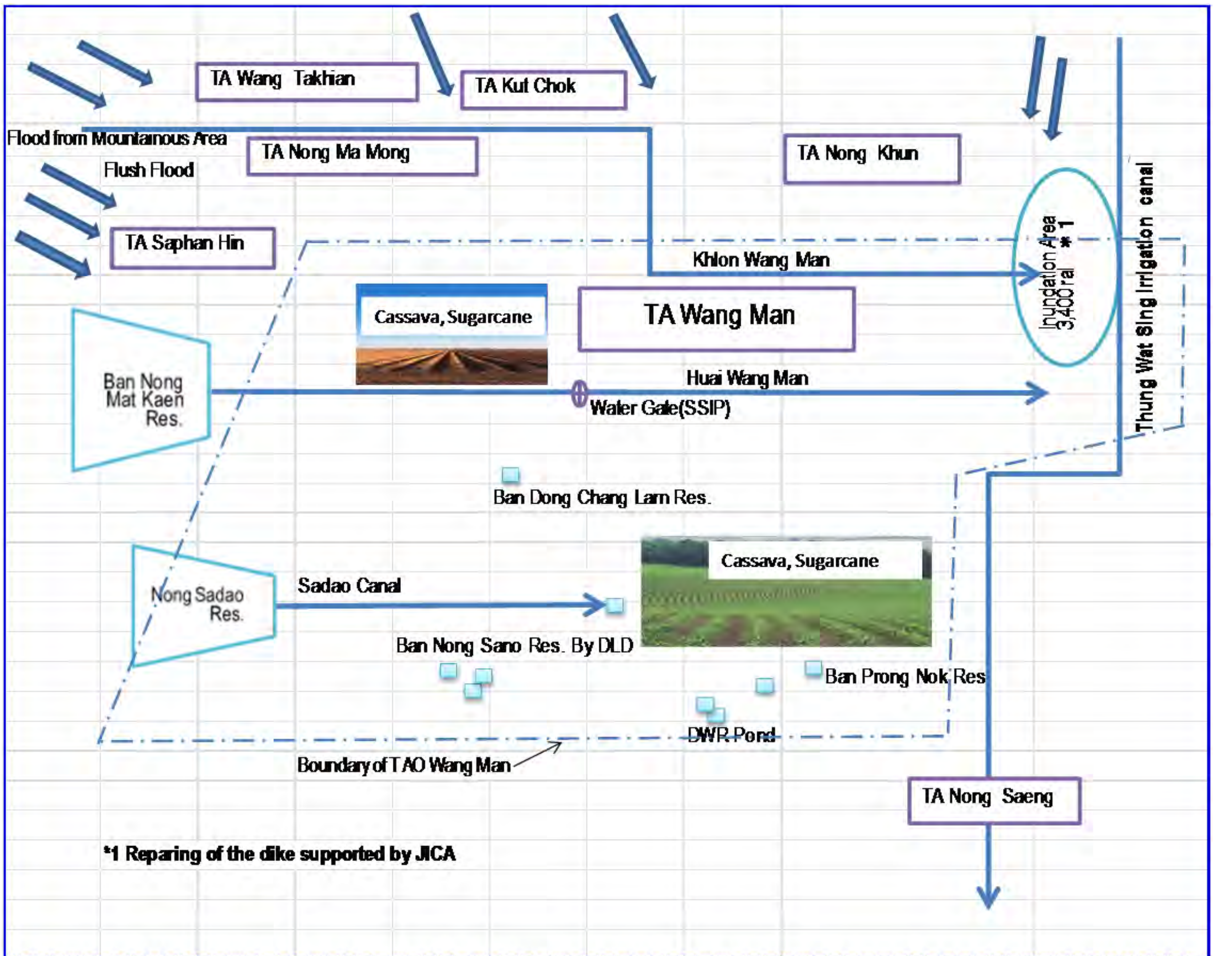


Figure 1 Water Flow Chart in Tambon Mang Man

Figure 2 Location of the water resources in Tambon Wang Man

(4) GPS Survey

Based on the information and map prepared by local residents, a GPS survey is conducted to clearly identify the location and water storage capacity any existing water resources facilities. An inventory list including coordinates, dimension and pictures of the facilities is prepared. These outputs are very useful to formulate water resources development plan. To conduct a GPS survey, it takes 4-5 days of site survey and about 20 days of office work in the Tambon. An example of an inventory is shown in Table below.

(5) Inter Tambon Meeting/PDLA Meeting

1) Inter Tambon Meeting

An inter Tambon Meeting will be organized with the presence of representatives of all of the Tambons related to the Wang Wan River basin initiated by the most advanced TAO, concerning the promotion of water resources development strongly or PAO. The first matter is for each Tambon to explain the current situation of water resources and potentiality as well as flood & drought damage. Then participants discuss how to develop and manage water resources in watershed including project promotion organization. Actually, Provincial Department of Local Administration Office (PLAO) has a responsibility to promote Inter Tambon projects.

2) PDLA meeting

The results of the Inter Tambon meeting should be reported to the PDLA (Provincial Department of Local Administration Office under the Ministry of Interior) which has a responsibility to promote Inter Tambon projects. If the PDLA officer understands and agrees with the watershed development plan, a PDLA meeting will be convened in the presence of the representatives of Inter Tambon, and related agencies such as RID, DWR, DLD, etc. The main objective is to establish an Inter Tambon Water Resources Development and Management Committee (Tentative name). In the meeting the role and responsibilities of the members of IT-WRDMC will be decided. The Chart below shows the IT-WRDMC organization chart.

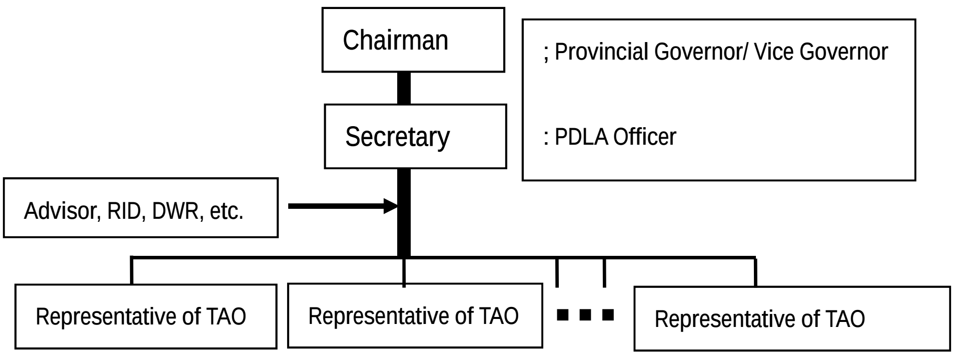


Figure 3 IT-WRDMC Organizational Chart

(6) Study Tour to an advanced Inter Tambon Project Area and contract of MOU

1) Study Tour

In order to know the entire process, from making a plan to implementing the project, source of funds, and organization for supervision and monitoring, etc., a study tour to an advanced Inter Tambon project is recommended. Participants of the study tour will consist of the IT-WRDMC members.

2) Contract the Minute of Understanding (MOU)

After the study tour, PDLA, TAOs in Inter Tambon, and related governmental agencies concerned in the micro watershed water resources development will conclude the MOU. The Role and responsibility of each agency and IT-WRDMC should be confirmed and identified.

(7) Implementing Schedule of the Phase1. Study of the case of Tambon Wang Man

To formulate the water resource development plan in Tambon Wang Man, JICA Study Team had support from the process of site survey to the establishment of IT-WRDMC as Phase 1 up until the time limit of the JICA Study period. The Table below shows the schedule of the Phase 1 study and process of the main activities. Further activities such as Phase 2 from the formulation of Inter Tambon water resources development plan to implementing its priority project should be commenced by IT-WRDMC under its own initiative.

Implementing Schedule of Phase1

Component	Feb	Mar.	Apr.	May	Jun
Coordination by JICA Study Team					
Water Resources Survey by JICA and Wang Man TAO					
Community Water Resources Workshop by Village Leaders					
GPS survey supported by JICA Study Team Submission of the Data and Information to TAO Inventory list of facilities, Topographic Map, etc. to TAO					
Inter Tambon Meeting					
PDLA Meeting					
Study Tour to advanced Inter Tambon Project area					
To establish Inter Tambon Water Resources Development and Management Committee (ITWRDMC) To set up the Committee Member, Role and Responsibility To conclude a mutual agreement (MOU) to develop water resources in Wang Man River basin					

Procedures of the main activities in Tambon Wang Man in Phase 1 are shown in Table below.

Participatory Disaster Resilient Planning Workshop - To understand the current situation of flood and drought damage - To select priority projects Sept 2012	TAO, community representatives and Study Team
Field Survey - To visit the site and study the situation of the existing water resources facilities utilization Beginning Feb 2013 - Additional survey based on 1st Field Survey	TAO and Study Team **Location map** for existing water resources facilities was prepared
Workshop/Discussion - To confirm the development plan in and around the Tambon Wang Man by RID Chainat provincial office Beginning Mar 2013 - To prepare existing water resources facilities map and flood/drought situation by each village representative - Discussion how to mitigate flood and drought damage	TAO, Villages representatives, PACO, RID and Study Team **Existing water resources facilities map** at each
GPS Survey - GPS survey of existing water resources was carried out Mid-March 2013	GPS survey by Study Team **Inventory list** and **location map** of existing water
Inter Tambon Meeting/PDLA Meeting - To discuss how to develop and manage water resources in watershed - To establish Inter Tambon water resources development and management committee. Beginning to	Representatives of TAOs in the Wang Man River basin, PDLA & Study
Study Tour to advanced Inter Tambon Project Area - To study how to develop and manage water resources in watershed - To conclude the MOU for development of the watershed in Wang Man River basin Mid-March 2013	Representatives of TAOs in the Wang Man River basin, PDLA& Study Team

4.2 Impact and Adaptability of Flood Countermeasure

- ❖ The local residents have become much more interested in the water resources development to mitigate flood and drought problems through implementing a dike rehabilitation project supported by JICA.
- ❖ TAO and local residents understood the current situation of deteriorated or insufficient use of the existing water resources facilities through the field survey with JICA Study Team. They have also studied the effective use of these facilities within their villages. Accordingly information-sharing

among residents has been strengthened.

- ❖ The participants have recognized the necessity to formulate the micro watershed water resources development and management plan as monkey cheek development. Because the effective water use and control of a river against flood and drought damages cannot be solved in only one Tambon, there should be collaboration between all the Tambons related to the watershed.

4.3 Prerequisite Conditions

- ❖ To formulate a water resources development plan as a monkey cheek, participatory manners initiated by the TAO is essential and it is necessary to be supported from outside agencies.
- ❖ It is very important to make clear the effectiveness of the plan, priority of the project, and source of finance.
- ❖ Required cost.

The cost of implementing Phase1 amounted to 170,000Baht. Refer to Project Sheet WM-WRM-CW-RMP-01

4.4 Role of Government Agencies and Other Stakeholders

- ❖ TAO is the core body for implementing the project and ensuring the essential participation of local residents.
- ❖ To formulate a monkey cheek development plan in the Tambon, support from outside bodies such as PAO, Consultants, and HAII, etc., is necessary.
- ❖ DLD, DWR, RID and the Royal Thai Army, etc., will support the implementation of the plan.

4.5 Lessons Learned from Pilot Activities

- ❖ It is essential for collaboration between TAO and local residents to formulate the monkey cheek development plan at a community level.
- ❖ To formulate a plan effectively, facilitator of the workshop will be supported by NGO, Consultant, HAII, etc.
- ❖ To formulate a plan, technical assistance by RID is essential.
- ❖ To implement a plan, financial support from DWR, DLD, RID, etc., is indispensable.

4.6 References

- Community Monkey Cheek Development Plan, (Technical Paper Series No. 5)

5. Phase 2: Formulation of a water resources development and management plan in Wang Man River basin and implementation of its priority projects

5.1 Procedure of the Study

The procedure of the Phase 2 study consists of following 6 steps. The process of the flow is shown in Table below.

(1) Workshop/Discussion

Based on the study tour results, members, roles and responsibilities of the Inter Tambon Water Resources Development Committee (IT-WRDC) should be discussed in the presence of PAO, PDLA, RID, and representatives of Inter Tambon. The meeting will be presided over by the PDLA officer.

(2) Field Survey

Each Tambon in the Wang Man River basin will have a workshop to identify the water resources in each of the villages and water resources map is to be made in the presence of representatives of the villages. A field survey will then be carried out to understand the current situation of the water resources facilities. Coordination and facilitation of the meeting and field survey is to be conducted by a consultant and TAO staff.

(3) GPS Survey

A GPS survey of each Tambon will be conducted by the consultant to finalize the location map of water resources based on the village's map prepared in the field survey. In order to formulate a water resources development plan at each Tambon, inventory lists including the coordinates and dimension of the water resources facilities will be prepared. Maps and inventory lists are very useful to formulate the water resources development plan.

(4) Inter Tambon Committee Meeting (1)

Based on the GPS survey, each Tambon will formulate the water resources development plan including the planning map, project name and its estimated cost and financial sources, priority projects, implementation schedule, etc., prior to the Inter Tambon Committee meeting. Following this the first Inter Tambon Committee meeting will be held in the presence of agencies concerned with the watershed development plan in Wang Man River basin initiated by the IT-WRMDC. The Inter Tambon watershed water resources development plan will be formulated including planning map, project name and its estimated cost and funds.

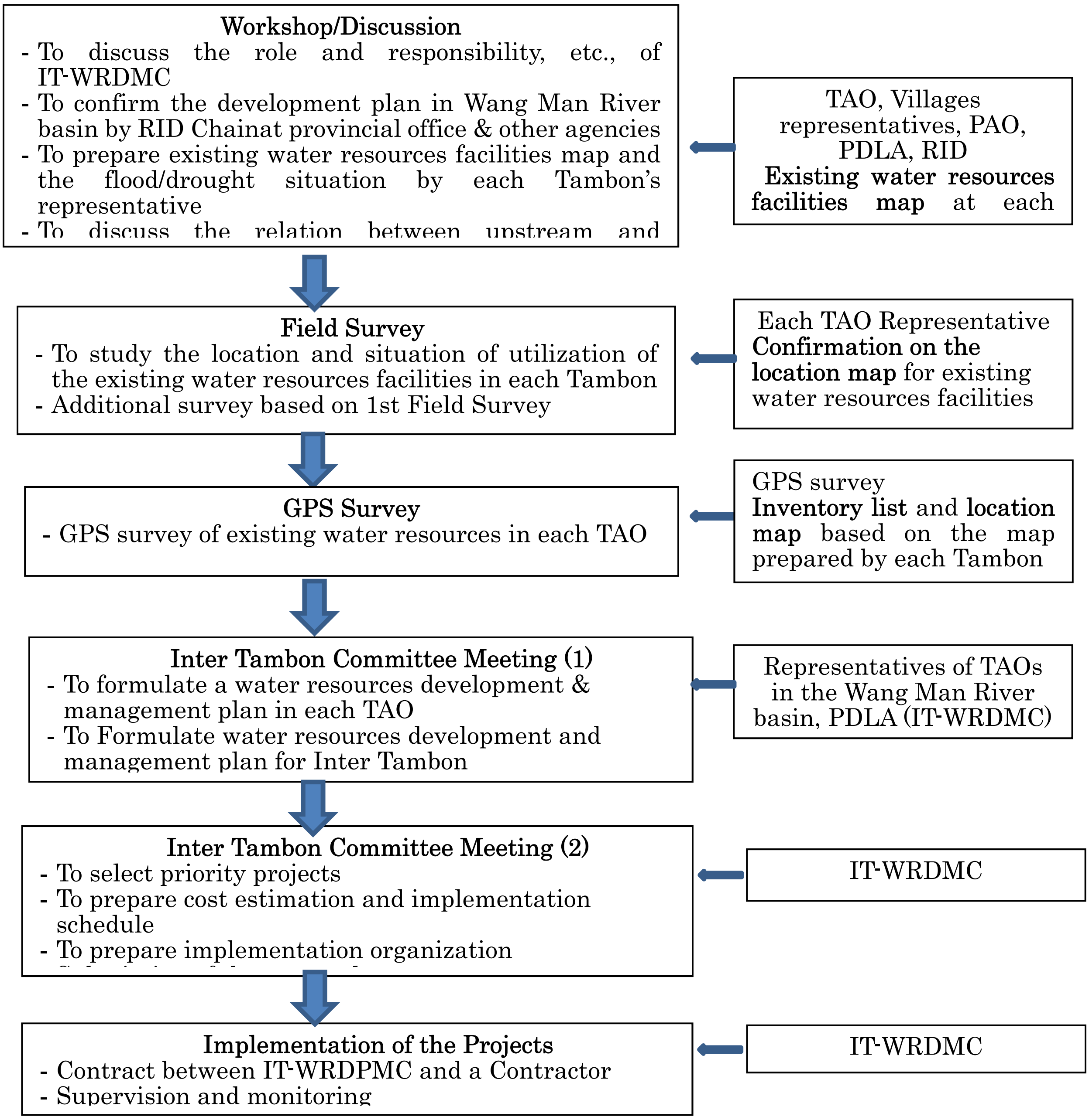
(5) Inter Tambon Committee Meeting (2)

Based on the Inter Tambon watershed development plan, priority projects will be selected and prepared for the cost estimation, funds, and implementation schedule. After that, the organizing of the implementing will be discussed. A final proposal will be prepared and submitted to the PAO initiated by IT-WRMDC

(6) Implementation of the Project

If the proposal is approved by PAO, tendering documents will be prepared and a contract between IT-WRDMC and a successful contractor will be drawn up. The implementation of the project, its supervision and the monitoring of works will be executed by IT-WRDMC. A flow chart of the process is shown in Figure below.

Procedure of the Inter Tambon water resources development plan in Wang Man River basin in Phase 2



5.2 To formulate water resources development plan at each Tambon

Based on the GPS results, and water resources map, a water resources development and management plan will be formulated with the involvement of local residents, initiated by TAO. Components of the plan will include in the following;

1) Construction and rehabilitation of ponds including intake and outlet structures including governmental agencies planning such as RID, DWR, DLD, etc.
2) Rehabilitation of rivers, swamps and canals, such as dredging, bank protection works, etc.

3) Conductive canals between pond and pond or river/canal and pond.
4) Rehabilitation of irrigation facilities such as weirs, regulators constructed by SSIP and other agencies.
5) Development of farming plans including soil improvement by small scale irrigation to reduce drought damage.

Detailed design, quantity survey and cost estimation will be carried out/initiated by TAO and also the volume of storage of water will be estimated. A farming plan using irrigation will be developed to reduce damage during droughts. Project name, location, quantity, water storage capacity, cost, implementing schedule, and financial source, etc., will be drawn up. Based on this list, the order of priority for the projects will decided after discussing them in the workshops.

5.3 To formulate water resources development plan in the Wang Man River basin

Based on the water resources development plan prepared by each Tambon, a water resources development plan for the Wang Man River basin will be formulated. First of all, 2 or 3 priority projects related to the Wang Man River basin proposed by each TAO are identified. After that, necessary and urgent projects will be discussed and decided by the participants. In addition, a farming plan model including soil improvement by an irrigation system as a model will be developed because farming in the area is currently very vulnerable to drought due to the shortage of irrigation water. Monoculture agriculture such as cassava and sugarcane, as well as unfertile soil are associated problems. In order to formulate a plan for the watershed, workshops will be held, initiated by the IT-WRDMC. Necessary components are as follows,;

1) Construction and rehabilitation of ponds and swamps including intake and outlet structures
2) Rehabilitation of rivers, swamps and canals, such as dredging, bank protection works, etc.
3) Conductive canals between pond and pond or river/canal and pond
4) Development of a farming plan as a model including soil improvement by small scale irrigation to reduce drought damage

Detailed design, quantity survey and cost estimation will be carried out and initiated by IT-WRDMC. They will also estimate the volume of water storage required. An irrigated farming plan will be developed as a model to disseminate to the Tambons. The project name, location, quantity, water storage capacity, cost, implementing schedule, and financial source, etc., will be drawn up.

5.4 Selection of the priority projects

Based on the list mentioned above, the priority of the projects will be decided upon by discussing them during the workshops. A priority project should be small scale, construction cost shall not exceed 3 million Baht, and its period for completion must be less than 2 years.. In all cases, the, selection criteria should be discussed with PAO, prior to the deciding on the priority of projects.

5.5 Project Implementation

After approval by PAO, a contract between IT-WRDMC and the successful tender will be made through a legal tendering process. Then an implementing organization will be set up and the supervision and monitoring will be carried out by IT-WRDMC.

5.6 Implementation schedule of the Project

An example of the suggested implementation schedule of a project is shown in Table below. The services of Seven (7) experts required for the tasks on Rural Development (1), (2), Water Resources Development and Irrigation (1), (2), Agriculture /Soil Improvement (1), (2)and GPS are proposed.

Implementing Schedule of Phase2

Component	1st Year												2nd Year												MM
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
Coordination by Consultant																									
1) Rural Development Expert (1)																									6
2) Rural Development Expert (2)																									8
3) Water Resources Development and Irrigation Expert (1)																									5
4) Water Resources Development and Irrigation Expert (2)																									6
5) Agriculture/Soil Improvement Exper (1)																									5
6) Agriculture/Soil Improvement Exper (2)																									6
7) GPS Surveyor																									3
1.Strengthening the Inter Tambon Water Resources Development and Management Committee (ITWRDMC)																									
2.Formulation of water resources development plan at each Tambon																									
1) Field Survey at 5 Tambons																									
2) GPS Survey at 5 Tambons																									
3) Formulation of water resources development plan at each Tambon																									
3. Formulation of water resources development plan in Wang Man River basin																									
4. Selection of Priority Projects																									
5. Implementation																									
6. Evaluation Workshop Interim and Final																									
▲ : Workshop																									

The Project for Flood Countermeasures for Thailand Agricultural Sector

<u>'Guideline for Disaster Resilient Agriculture and Agricultural Community'</u>

Technical Paper Series No. 9

Paddy Cultivation by Three Different Planting Methods

Prepared by JICA Project Team and Rice Department

Paddy Cultivation by Three Different Planting Methods

1. Introduction (Objectives)

To avoid the flood, shortening the cultivation period is of the most effective countermeasures in paddy cultivation. To achieve this, two major approaches can be taken, 1) use short-maturing varieties that can be harvested 90-100 days after sowing, and 2) transplanting seedlings. Transplanting can be managed by machine and parachuting methods. A transplanting machine can be used where such service providers exist and the physical condition of the paddy is stable enough for machines to operate in. If the use of a machine is not suited, parachuting is then recommended.

By transplanting, problems of Brown Plant Hopper (BPH) and weedy rice can be also addressed. As the growth stage of paddy already exceeds that of the weeds at the time seedlings are transplanted, they can easily surpass the growth of weeds. Also, as paddies are established with enough space between each row, application of herbicide and pesticide is easier and more effective than densely-established paddy under a broadcasting method. The use of the application of transplanting may be challenged by its high cost. Therefore, at the end of the project, a cost/benefit analysis is conducted to see the comparative advantages of each method against a conventional one.

2. Contents of Technical Information

In this chapter of this paper, a description of the technical contents is introduced. Firstly, the concept of this comparison is mentioned, secondly, the comparison of the three planting methods including advantages and disadvantages of each method is shown, and thirdly, chemical fertilizer and agricultural chemical applying is described.

2.1 Concept

To avoid flood damage to rice production by an agricultural technique, we can consider the use of a variety of rice that has a short maturing cycle, a variety that is resistant to flood and changing the cropping pattern, etc. The planting method could be one of the countermeasures of flood damage, due to the shorten period where it is growing in the paddy, as it could mature and be harvested before the flood arrives. There are three major types of planting methods in central Thailand such as Broadcasting (BC), Parachuting (PC) and Transplanting by machine (TP). The PC and TP methods have a nursery period outside the paddy. Thus, these methods could be considered to shorten the growing period in the paddy.

In addition, the problem of weed infestation with the rice is a serious problem in central Thailand. The back ground to the problem is the expansion of the BC method. The weedy rice brings a lower yield and the labor cost to remove the weeds is quite high. At the present time weedy rice is the biggest problem of rice cultivation. If we can introduce the TP or PC methods, weedy rice control would be easier. Another advantage is that the TP and PC methods could help prevent disease spreading and insect outbreak due to the space between each plant.

2.2 Comparison of the three planting methods

There are three planting methods, BC, PC and TP and their individual characteristics of their planting method is shown below.

1) Broadcasting

The BC method is the most widely applied method in the area. After 2 days of soaking the seed, the seed is simply spread over the paddy by machine. The recommended seed amount of sowing by the Rice Research Center is 20kg per rai. The advantages and disadvantages are as follows:

Fig.1 *Germinated seed*

- **Advantage**

  1) Planting cost is lower than other methods.
  2) Suppliers are found easily.
  3) The land does not need to be level so the land preparation cost is much less
  4) Farmers are most familiar with this method.

Fig.2 *Seed sowing by machine*

Disadvantage

  1) Weedy rice or weed control is difficult.
  2) The labor cost of removing weeds is high.
  3) Diseases and insects spread easily.
  4) The amount of seed, fertilizer and agricultural chemicals are higher than with other methods.
  5) The growing period in the paddy is longer than other methods which have a nursery period.

Fig.3 *Seedling for*

2) Parachuting

The use of the PC method is about to increase in the area. The seedling is grown in the tray which can make 450 seedlings. The recommended seed amount by the Rice Research Center is 10 to 15 kg per rai. The plant is distributed across the paddy by throwing, after soaking it for 10-15 days.

Fig.4 *Parachuting*

- **Advantage**

  1) It is easy to separate the weeds and remove them.
  2) Because of the increased space between the plants, agricultural chemicals could be applied easily and these chemicals are therefore more effective.
  3) The supplier can start the supplying easily due to the low investment cost.
  4) The end product can be used/sold as seedlings due to high quality and low percentage of contamination of weeds in the rice.

- **Disadvantage**

  1) Planting cost is higher than BC.

2) There are fewer numbers of trained parachuting suppliers.

3) The supplier's quality is different. Farmers need to choose carefully.

4) In cases of hiring a supplier who is located far from the farmer's paddy, the added transportation cost is high.

5) The total growing days, including the nursery period, are longer than BC.

3) Machine Transplanting

The TP method is considered the most improved planting method. The seedling is grown in a plastic tray as nursery. The recommended seed amount by the Rice Research Center is 10 to 15kg per rai. A seedling sheet, after 15-20 days of seed soaking, is used for transplanting.

Fig.5 *Seedling sheet*

- **Advantage**

  1) Weedy rice and weed control is the easiest of all the methods because the plant is planted in a straight line. It is easily to find the weeds and remove them.

  2) Because of the space between the plants, agricultural chemicals could be applied easily and these chemicals and their use are more effective.

  3) The final product could be sold as seed due to high quality and low contamination of weeds in the rice.

Fig.6 *Transplanting by*

- **Disadvantage**

  1) Planting cost is higher than BC.

  2) Land leveling and water management has to be more precise than the other methods.

  3) The machine should be chosen depending on the soil type. If the mud in the field is deep, the flowing type machine should be used.

  4) The total growing days, including the nursery period, are longer than BC.

2.3 Fertilizer Use

Chemical fertilizer should be applied two or three times for one cropping. The first application of fertilizer, after 30 days from seed soaking, is compound fertilizer. The fertilizer shall be chosen to suit the soil type depending on whether it is used on a clay type soil or sandy soil. For clay type soil, the mixing ratio of fertilizer is 16, 20, 0, nitrogen, phosphorus, potassium, respectively. For sandy soil, the mixing ratio of fertilizer is 16, 16, 8. The amount of first application is 30kg per rai. The second application, after 45 days from seed soaking, is urea. The amount is 15kg per rai. The third application, after 60 days from seed soaking, depends on the condition of the rice plant. If the leaf collar is dilute, a third application is needed. The third application is also of urea and the amount is 5 to 15 kg per rai.

2.4 Agricultural Chemicals

Agricultural chemicals should be used at the appropriate time. For example, to prevent the fungi disease at germination stage, fungicide (Mancozeb) is mixed in with the seed. Herbicide is used two times for BC field and one time for PC and TP fields. For a BC field, the first application of herbicides is applied one or two days after sowing the seed and the second application is one week later. In the case of PC and TP it is applied after planting.

Fig.7 *Fungicide (Mancozeb)*

A pest known as "Golden apple snail" eats seedlings. It is one of the biggest problems in the area. To prevent the snail attack, saponin is used at the time of plowing the field. The saponin is made from tea leaf, thus it is better for the environment than other chemical shell killers.

Other chemicals used depend on the paddy plant condition. In addition, farmers should know about causes of disease and the effective use of agricultural chemicals. Disease is caused by virus, fungus and bacteria, therefore the user should know the disease type and which chemical is correct and effective.

Fig.8 *Saponin*

3. Impact and Adaptability as Flood Countermeasure

Because of the nursery period, the PC and TP methods can shorten the period of the rice in paddy by about 1 week. Although its impact is limited, the PC and TP methods are an effective flood countermeasure because they do slightly shorten the cultivation period. It can be an effective tool for farmers to moderate the schedule especially in such a case when previous cultivation was delayed. Moreover, transplanting methods have an advantage in weed management at the early stage of the cultivation.

At this moment, the BC method is widely used due to low investment cost and the easiness of paddy management, but it is difficult to control the amount of weeds in the rice. In the flood prone area, there is a flooding period every year. The weedy rice seed is in the paddy at the same time as the flooding water is present. This means that the flood prone areas are also more prone to weeds, as the weeds are further distributed by the flood water. In fact, the weeds common in the rice field are of a group of weeds that shows similar characteristics to rice cultivar, and have therefore become problematic particularly in the paddy where the BC method has been repeatedly used. The use of transplanting methods, rather than BC, can be promoted both as a means to deal with weed problems and a means to shorten the cultivation period.

4. Prerequisite Conditions

When using the PC or TP method, the biggest problem is the shortage of service providers. The BC method has dominated in its use for more than 10 years in the central plain of Thailand. Most of the farmers use a service provider for planting. If the provider is far from the planting farm, the cost of transportation will become higher. The establishment of more locally located service providers is an important thing to promote the PC or TP methods.

Another problem of using the PC or TP method is land ownership. Most paddy farmers are renting paddy land for each crop season from the land owner. For the PC and TP methods, it is preferable for the field to be flat. According the present owning situation, farmers avoid putting investment into the field for such things as land leveling, canal making and land reformation. By changing the rental regulation, e.g., multi-year contracts would help the situation and make the introduction of the PC and TP methods easier.

5. Role of Government Agencies and Other Stakeholders

Rice Department and the Rice Research Center recommend using the early variety or flood resistant variety, for a countermeasure of the flood damage.

Fig.9 *Training at Pitsanulok Rice Research*

Each Rice Research Center has an annual plan to lecture the farmers. The Rice Research Center at Ayutthaya, promotes the parachuting method to avoid a spread of disease and insect. The Rice Research Center in Phitsanulok has training about good quality seed production in order to establish and maintain a community seed bank every year. In the training, farmers can experience not only knowledge but actual techniques. Furthermore, farmers can contact the rice research center for help and advice at any time.

DOAE provides seed for the community seed bank. With this kind of support, if the applied farmer can sell his seed as production seed, he can get support continuously during a 4 crop season.

6. Lessons Learned from Pilot Activities

From November 2012 to April 2013, a pilot project activity on comparison of the three planting methods was implemented under the JICA project, "the Project for Flood Countermeasures for Thailand Agriculture Sector". This pilot activity was implemented in three Tambons in three provinces where the flood of 2011 had serious effects. They were Tambon Nakhon Pa Mak, Pitsanulok, Tambon KhaoKaeo, Chainat and Gop Chao, Ayutthaya. As a result of the pilot activities during its half year implementation in those Tambons, some valuable lessons have been learned.

<u>Cultivation Period</u>

- The average of total days, from start to finish, of the BC method is 105.7 days, which is the shortest among the three methods (PC 115.9 days, TP 114.0 days). However, the period of the crop in the paddy of the PC method is the shortest (95.9 days). Followed by the TP method (96.9days). The longest period is that of the BC method (103.7days) on average. The short tendency was clearly found using RD41, RD47 and RD31 varieties

<u>Yield and Yield components</u>

Table1 Comparison of Yield and Yield component among the three planting methods

Components	BC	PC	TP
No. of panicle / m2	442.8	356.7	387.1
Grain weight / rai (kg)	618.5	693.6	707.2
1,000 grain weight (g)	1.1.1. 28.0	1.1.2. 27.5	1.1.3. 28.4
% of ripended grains	84.5%	79.9%	77.9%

Source: JICA study team

- The Result of average yield and yield components are shown in Table1. The TP method field showed the highest yield (707.2 kg / rai), the second was the PC method (693.6 kg/rai), and the last was the BC method (618.5kg /rai). In some BC fields where weed and weedy rice were well managed by labor, they scored a high yield. On the other hand, some TP and PC fields scored a low yield. The main reason for low yield of these fields was through to be the farmer's lack of cultivation knowledge such as land leveling, water management, supplemental planting, etc.

- On the BC field, the number of panicle / m^2 and percentage of ripened grains are the highest, and 1000 grain weight is middle of the three. Therefore, the reason for low yield on a BC field was considered to bet the small number. of spikelets / panicle. To avoid this, the fertilizer application should be about 32days before the heading period; however this application may have a negative effect on causing a lower percentage of ripened grains.

<u>Disease, Insect and Weed</u>

- Although, the frequency of disease and insect were higher at the BC field than other fields, an expert from the Rice Research Center advised farmers on the importance of using the appropriate agricultural chemicals. Thus, the damage among the three planting methods was not much different.

- The number of weeds was higher in the BC field, even when herbicide was used more than in other planting methods. Hence, the labor cost for weeding was higher.

<u>Cost and Benefit</u>

Table2 Comparison of Total Input and Total Income and the Balance among three planting methods

Category	BC	PC	TP
Total Input Cost	4385.2	5814.9	5281.8
Total Income	8096.9	8932.4	9495.2
Balance	3711.7	3117.5	4213.4

Source: JICA study team

- According to the results of the pilot project, TP was rated with the highest profit than the other two methods. The planting cost of the BC method (50-60 Bath per rai) was less, than other methods but the amount of seed, agricultural chemicals especially herbicide was higher. Additionally, the labor cost for weeding was considerably higher. The yield and quality were low, so the product could only be sold for use at the local rice mill.

- On the other hand, the cost of the TP planting method was high. 1100-1400 Bath per rai, but the required applications of agricultural chemical was less than the BC method. As the seed contained fewer weeds and was of higher quality, it could be sold for seed or used for local community house consumption which brings higher prices. This indicated that the balance was highly positive.
- The PC method's balance was the lowest of the three. Although the yield was as high as the TP method and had a planting cost, 1300-1500 Bath, the planting seedling condition was worse. Hence the supplemental planting cost became higher. If the seedling condition is better, the balance could be considered as same as the TP method.

Fig.10 *Seedling of parachuting method*

7. Conclusion and Recommendations

Concerning the issues discussed above, the following recommendations are made. First of all, although its impact is limited (10 to 15 days), transplanting is an effective flood countermeasure as to shorten the cultivation period on the main field. It can be an effective tool for farmers to moderate the schedule especially in the case where the previous cultivation was delayed. Moreover, transplanting methods have an advantage in weed management at the early stage of the cultivation. The weeds common in the rice field are of a group of weeds that shows similar characteristics to rice cultivar, and have therefore become problematic particularly in the paddy where the BC method has been repeatedly used

Therefore, transplanting methods can be promoted both as a means to deal with weed problems and a means to shorten the cultivation period. In consideration with the adaptability of the technology, shortening 10 to 15 days may not be attractive enough for many farmers. However, its benefit in weed control may be persuasive enough for them to change their farming system. Thus, when promoting the transplanting methods, its comprehensive functions should be thoroughly addressed.

In principle, transplanting by machine is recommendable for its capacity being able to manage/service a larger field as well as addressing the foreseeable lack of labor force due to a decrease of numbers in the young generation, particularly in rural areas. However, still the mechanization in paddy sector, particularly the dissemination of transplanting machine is still at an early stage. Also, there are some areas where a transplanting machine is still applicable because of soft foundation of the land or due to inappropriate land preparation. Thus, as a short term plan, or as for a transition stage, parachuting should be promoted first, because it requires less cost to facilitate.

It was found that the availability of service providers for transplanting by machine or parachuting are still limited. Thus, the development of service providers in this field should also be an important matter. One of the recommendations for the government sector is to support advancement of this process especially for training in parachuting. Considering the job opportunities, it is better to train existing service providers who are specialized in broadcasting (for direct sowing), rather than nurturing new professionals. Fortunately, there are already some service providers of parachuting available in some provinces.

The Rice Research Center or DOAE should take a leading role in training. Also, as a short-term strategy, they should continue promoting the extension services for quality control of seedlings, control of the amount of seedlings, selection of quality seeds, etc. In this regard, there is a new trial in Ayutthaya province where organic rice production by transplanting method is being promoted for value addition.

In this particular case, the system is to ask consumers to invest some amount of money for cultivation and they would receive the benefit of higher quality rice after the cultivation, also ensuring the production of organic rice. This kind of arrangement cannot be the mainstream of the paddy cultivation system in the central plain area, but it may stimulate some farmers' mindset for trying new cultivation methods.

The Project for Flood Countermeasures for Thailand Agricultural Sector

<u>'Guideline for Disaster Resilient Agriculture and Agricultural Community'</u>

Technical Paper Series No. 10

Safe Vegetable Production for Diversification

Prepared by JICA Project Team

Safe Vegetable Production for Diversification

1. Introduction

A flood causes unfavorable consequences both for producers and consumers of agricultural products. For consumers, it suddenly becomes difficult to purchase fresh vegetables due to the increased cost caused by a lack of supply or interrupted accessibility to the market; in heavily flooded areas, people sometimes have to use a boat to get to a place to buy food. The lack of supply affects even non-flooded areas; the price of fresh vegetables hiked in the northeast even where the flood was not prevailing in 2011, simply because the supply chain of agricultural commodities nowadays is inter-regional.

From the producers' side, flood also brings about catastrophic damages. In fact, by the flood of 2011, the worst flooding in decades, approximately 9.01 million rai of farmland had been inundated for months, causing a reported total loss of 51 billion baht.[3]. For individual paddy farmers, that can be interpreted as equal to a loss of the total input costs and labor costs invested for several months. Due to the total loss of their investment, some farmers faced a lot of difficulty in finding the resources or funds to commence their next paddy even though the flood had already disappeared.

As a means to reduce the risk of flood damages, diversification of the farming portfolio of a farmer's household is recommended. It is generally known that mono-cropping of any one crop entails a higher level of risks, which may be incurred by a price fluctuation, outbreak of pest and disease, or natural calamities including flood. Diversification of crops is therefore generally recommended to any farmer. Considering a flood, the types of crops that can be cultivated in a relatively short period, namely vegetables, are recommended as they require a relatively small amount of investment cost, therefore, implying a smaller loss in case of a flood.

Another consideration is that, this technical guideline promotes safe vegetable cultivation and marketing, depending fully on the philosophy of "sufficiency economy" that His Majesty the King has referred to in his speeches. Along with the philosophy of sufficiency economy, integrated agriculture has been promoted in Thailand. In integrated agriculture, each farmer's household is encouraged to produce as many types of agricultural commodities as possible for their own home consumption. Here, promotion of integrated agriculture can be simplified as an introduction of safe vegetable production to diversify the farming portfolio especially for paddy-oriented farmers who are dominant in the flood prone areas.

Once a huge flood occurs, it is difficult to stop it or avoid the damage from it. The recovery process should be commenced as soon as flood is over. Although it is desirable to restart paddy cultivation for paddy farmers, it is not always possible due to a lack of funding, remaining inundation in the lowland, and a lack of seeds and inputs. In this context, short-cycle crops such as vegetables, which also require a relatively lower investment cost, can provide farmers with an alternative opportunity to earn cash quickly. By revolving such small but quick cash crops, farmers can strengthen their capital for re-cultivation of paddy at a later time. In reality, the introduction of vegetables can be a good source of

[3] http://www.bangkokpost.com/learning/learning-from-news/266566/floods-damage-to-farms-crops

income for daily expenses such as school fees/electricity/water supply and also for home consumption even during ordinary years. If a good marketing channel is established, restart of the farm using vegetable production after a flood can be smoothly facilitated.

2. Contents of Technical Information

In this chapter of this guideline, specific technical contents are introduced. To begin with, a development road map is shown, through which farmers can learn specific techniques through this process to learn. The use of a net house is recommended for safe vegetable cultivation in which improved seedling preparation, the use of bio-extract, a botanical repellent, and use of microbial materials are also addressed. The outline of a green market is also introduced.

2.1. Concept

The sufficiency economy is the main concept, encouraging farmers to decrease expenditure by producing safe vegetables with zero or less chemical input, primarily for home consumption. Then, the remainder of the product is sold in the green market. A green market is the mechanism to distribute safe/healthy vegetables to other farmers. As safe vegetable cultivation alone may not completely stimulate farmers, it is better to combine safe vegetable production and green market activity into one process. In fact, safe vegetables or organic vegetables have been promoted in Thai society for a long time and therefore Thai people would continue to appreciate the concept and advantages of safe vegetables.

2.2. Planning (Development Roadmap)

The activities of safe vegetable production and green market promotion should be conducted through a learning process together. The first step is to draw a line of works, or a learning process, as the plan for farmers' groups. It is totally up to the farmers themselves to decide whether or not they would undertake a green market establishment or only safe vegetable production. Based on past experience, many farmers' groups prefer establishing a green market too. What is important is to show the whole picture of the process, by which farmers can have a clear vision of where to go and how to get there. With this vision and a process of works, farmers will be able to manage their schedule of activities properly.

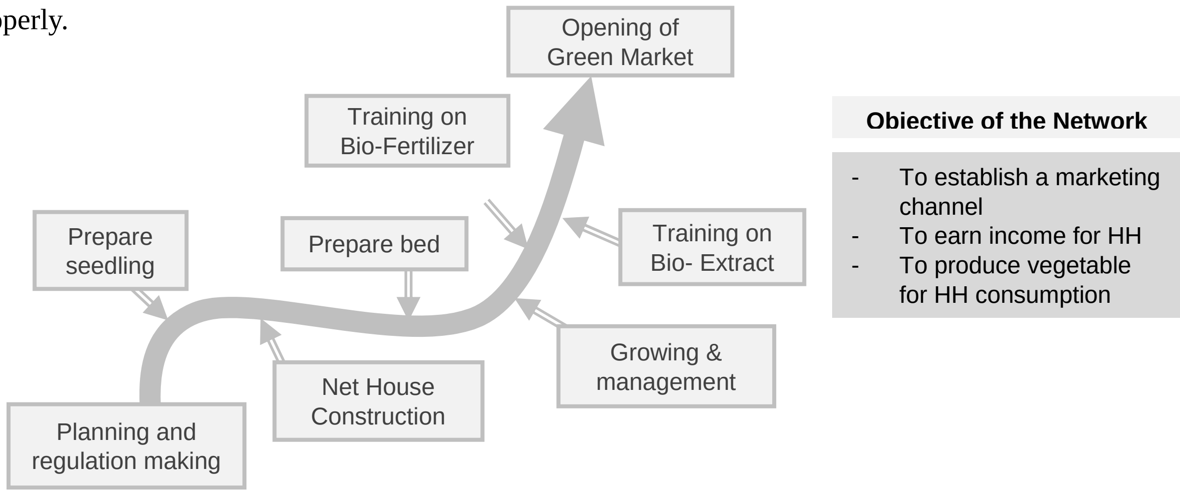


Figure2.1 Road Map for Safe Vegetable Production and Green Market Promotion

In the ideal case, it is recommended to carry out an exposure trip to an existing green market for farmers to visualize what they are trying to do. After that, the first meeting is held to discuss key points as shown in the Table below:

Table2.1 Typical Contents in the Planning Workshop

Agenda	Contents	Information
Presentation on the Importance of a Green Market	- Analysis of situation on vegetable consumption in the community. - Exchange of the experience on a green market or summarize the exposure trip.	- Community members purchase vegetable from outside more than 60%, especially leaf vegetables.
Process of Achieving a Green Market	- Presentation of road map of safe vegetable production and a green market promotion to get a basic understanding of the process and items to achieve green market establishment. - Step up approach along the Sufficiency Economy concept: 1) household consumption, 2) sale of the remaining produce to the community, and 3) ship for sale to high-end market.	- Media: video, summarize by discussion. - Improvement of the quality of safe vegetables: keep longer, fresh and non-toxic, etc. - Safe vegetables are unique in terms of the marketing aspect.
Planning and Regulation Making	- Selection of the participants for learning about the activity - Draft plan: type and quality of vegetables to be sold in the green market.	- Set the date of opening the green market
Make Schedule	- Date to start learning about seedling preparation.	- Set the date when participants learn about seedling preparation.

Source: JICA Project Team, based on the pilot project

Based on the pilot activity under the “Project for Flood Countermeasure for Thailand Agricultural Sector,” it takes around 55 days to 65 days from the planning to the actual opening of the green market, with facilitation assisted by an experienced Thai consultant. In the process, new technologies are to be introduced and promoted, but farmers especially those who have prior experience may have their own way of doing things. Therefore, it is necessary to discuss how useful the new technologies are.

Here are some tips for facilitators or officers concerned: it is not easy for outsiders to change the farmers’ way of farming. In order to get farmers to accept new ideas and methods, any outsiders have to act as a coach, a facilitator, or a friend instead of teacher. In this concern, a recommendable approach for further extension is to establish a learning center located on farmers’ farm plots, by which other farmers can learn technologies from the farmer as a “friend.”

2.3. Use of Net House for Quality Vegetable Production

A net house is one of the useful tools for safe vegetable cultivation for two major reasons: 1) change of microclimate, strong sunshine and high temperature can be moderated, especially during the hot summer; and 2) it can protect vegetables from the physical impact of rain during the rainy season. In short, a net house will help farmers to be able to cultivate vegetables throughout the whole year. There are three typical types of net houses. Type-A, B and C (see pictures below).

Type A

- Closed by plastic net on the walls, preventing insects from entering, although small insects can still enter
- Small amounts of weed are found
- Good ventilation
- Price ~ 60,000 Baht (including labor cost) or 474 Baht/sq.m
- Size: 6.5 mX19.5m m (126.5 sq.m)

Type B

- Main structure is made of wooden poles or bamboos
- Less insects can enter the house
- Sun light can be mitigated
- Soil moisture can be retained
- Price ~10,000 Baht (excluding labor cost) or 95 Baht/sq.m
- Size: 6m .X 18 m (108 sq.m)

Type C

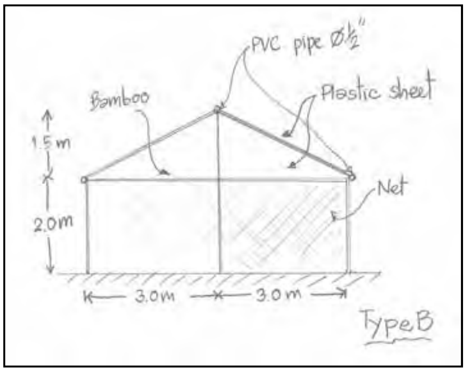
- Roofing with saran net only
- Insect prevention is not possible
- Keep soil moisture longer
- Good ventilation
- Price ~ 9,500 Baht (excluding labor cost) or 40 Baht/sq.m
- Size: 6m x 40m (240 sq.m)

Figure 2.2 Outline of Net Houses Type A, B and C

<u>Comparison of the three types of net houses</u>

Type-A is suitable for farmers who produce and sell quality seedlings in the market, because the cost of this type is comparatively high. Type-B and C are appropriate for those who grow vegetables for local consumption. In reality, type-C is the most applicable because farmers can construct it by themselves with a lower investment cost. If budget permits, type-B is the most suitable for vegetable cultivation during rainy season as it covers the whole area of the vegetable plots. It should be noted that, type-C is also applicable even in the rainy season as it can prevent up to 50% of rain entering using saran net. The detailed cost and design of type-B and type-C is shown below.

<u>Type B</u>

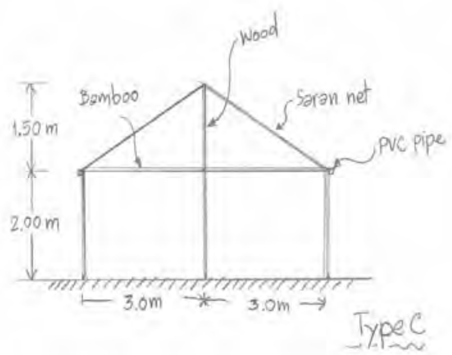


List of materials for construction Net House Type B (Size 6m x 18m)

No	Part	Material	Amount	@	T Baht
1	Pole	Wood ⦰4-5" x2.5m	16	70	1,120
2	Pole	Wood ⦰4-5"x 4m	8	100	800
3	Rafter ([illegible])	Bamboo ⦰ 3" x6m	8	30	240
4	Strangle pole	Wood ⦰ 3" x6m	6	40	240
5	Ridgepole(อกไก่)	Wood ⦰ 3"x 6m	3	40	120
6	Rafter (จันทัน)	Bamboo ⦰2" x4m	44	10	440
7	Roof	Plastic sheet 4m	40	75	3,000
8	Plastic sheet locker	PVC pipe ½"	20	35	700
9	Net	Net 32 hole/sq.inc.	50	50	2,500
9	Clip lock PVC	Locker	100	4	400
10	Other				440
Total					10,000

Remark; average cost per sq.mtr = 92.6 Baht

Type C



List of materials for construction Net House Type C (Size 6m x 40m)

No	Part	Material	Amount	@	T Baht
1	Pole	Wood ⦸4-5" x2.5m	34	70	2,380
2	Pole	Wood ⦸4-5"x 4m	17	100	1,700
3	Rafter (ขื่อ)	Bamboo ⦸ 3" x6m	9	30	270
4	Strangle pole	Wood ⦸ 3" x6m	14	40	560
5	Ridgepole(อกไก่)	Wood ⦸ 3"x 6m	7	40	280
6	Rafter (จันทัน)	Bamboo ⦸2" x4m	100	10	1,000
7	Roof	Saran net 50%	1 role	1600	1,600
8	Plastic sheet locker	PVC pipe ½"	20	35	700
9	Clip lock PVC	Locker	100	4	400
10	Other				610
Total					9,500

Remark; average cost per sq.mtr = 39.8 Baht

2.4. Seedling Preparation

Usually, farmers prepare seedlings on the seedbed and transplant them to the main plot later. Using this method, it requires 3-7 more days for the recovery. Thus, using a tray is recommended to cultivate healthy plants in a shorter time. One factor determining the germination rate and the results of the quality of seedlings is the type of media they are grown in. Soft and fertile soil should be used. In practice, it is good to try using various media locally available and, if applicable, use the ones sold in the market, like peat moss.

In summary, there are three major types of seedling preparation: prepared in tray, direct seeding in the holes of the seedbed and broadcasting on the seedbed. A typical example is shown below:

Table2.2 Seedling Preparation Method

Method	Material	Suitable Vegetable
1. Tray	- 3 portions of gardening soil (buy from market) and 1 portion of pig compost (KLH) - 1 portion of burned bagasse (sugarcane residue)and 1 portion of fertile soil (NPM)	Pak choy, green pakchoy, kale, Chinese cabbage, green cabbage, etc.
2. Direct seeding in holes	- Use seedbed	Pakchoy, green pakchoy
3. Broadcasting	- Use seedbed	Coriander, lettuce and morning glory

Source: JICA Project Team (2012) based on the pilot activities in Pathumthani (KLH) and Phitsanulok (NPM).

For those who train the farmers, the following process should be a reference.

Process of Training

a) Review the entire plan: most of the participants at the planning stage are usually the leaders. So, in this stage, share the information with other farmers.

b) Discuss the advantages of using a tray or new media:

- Disadvantage of preparing seedlings on seedbed is the damage to root systems when transplanting. As a result, it takes 3-7 days extra to recover and restart growing.
- When using a tray, there is essentially no damage to root systems and seedlings can grow

without any idling time.

- Types of trials need to be decided: type of media, the amount of each material.

c) Plan the amount of seedlings to be produced:

- Discuss types of vegetables to grow: leaf vegetables are suitable for marketing in the community.
- Confirm the seedling preparation methods for each type of vegetable: some vegetables are suited to a tray, while some are suited to direct seeding in the seedbed.
- Calculate the size of net house and decide the arrangement of beds: each net house should have at least four beds so that vegetables can be harvested in four weeks. For example, one bed is for 30 m^2, to be in a 120m^2 net house.
- It is suggested that the type of vegetable in one row of the bed should be changed every time (rotation), which can reduce the risk of diseases.
- If many farmers from many villages are concerned, allocate the main vegetables to each village to avoid the duplication of the same vegetables being produced and sold in the market.

When introducing the new method, farmers tend to conceive an over expectation. Thus, it is better to approach farmers, confirming that this is just a trial and an opportunity to learn together what kind of method is suitable. If the trial does not go well, then, the facilitator and the group members need to meet again to find out what was wrong, and then do another trial with different media. In this process, farmers need to be a kind of researcher for themselves. In comparison, those farmers who do not have much experience tend to accept new technology and teaching them is much easier.

2.5. Bio-Extract (Botanical Repellant)

For safe vegetable cultivation, one of the most challenging issues is insect control. In addition to using a net house which can reduce the invasion of insects, application of natural repellent, or bio-extract, is recommended. Bio-extract, distilled water that is boiled with various herbs can be produced using traditional liquor-making technology available in a local setting. By spraying the bio-extract after diluting it with water at a ratio of 20-100cc to 20 liters of water (depending on the age of vegetable), the appearance of insects can be reduced.

1) Making Bio-Extract

This activity starts with the collection of herbal materials that have a repellent effect. First, ask farmers to find out which plants have few or no insects, and to draw up a list of those plants available in the community. To do this, find some farmers who have knowledge about local herbs. They can share that information with the group members. Again, find and use the plants that have few or no insects around them, which are obviously likely to have repellent effects.

All the herbal plants listed in the meeting are collected in one place and cut into small pieces so that herbal substances can be thoroughly extracted into the bio-liquid.
To deepen the understanding, discuss with farmers: "what kinds of plants are usable?", "which part of the plants should be used?", and "how it will affect the insects?"

Table2.3 Typical Ingredients Used for Bio-Extract (Botanical Repellent)

Example of Ingredients Tried Out in Two Farmers Groups

Klong Ha, Pathumthani	Singhanat, Ayutthaya	
- Eucalyptus leaf - Cassod tree leaf (Sennasiamea) - Neem tree - Bitter bush (Chromolaenaodorata) - Derris, Tuba root - Others (English not available)	- Eucalyptus leaf - Milk bush (Euphorbia tirucalli) - Galangal - Galangal leaf - Cassod tree leaf (Sennasiamea) - Neem tree - Bitter bush(Chromolaenaodorata) - Durian Belanda leaf (Soursop) - Tobacco leaves - Ylang-ylang (Canangaodorata)	- Derris (Tuba root) - Cloth of gold (Lantana camara), (Wild sage) - Milk bush (Euphorbia tirucalli) - Lemon grass - Redbird Cactus (Euphorbia tithymaloides) - Papaya leaf - Passion fruit leaf

Once the herbs are collected, they are chopped into small pieces and then boiled and distilled using a distiller like the one shown below. In the main tank, herbs and water are put inside and boiled in the tank. On top of the main tank, a pan filled with water is put so that excessive vapor is cooled down to prevent an explosion. Next to the main tank, a sub tank is installed that is filled with cold water. The main tank and the sub tank are connected with a steel pipe in which vapor will move from the main tank to the sub tank. The pipe runs in the shape of a spiral in the sub tank, where the pipe is cooled down, and goes through the wall of the sub tank—that is the terminal of the distilled water.

2) Using Bio-Extract

Usually, bio-extract is an acid liquid with a pH of 3.2 as with the one produced with the ingredients listed up in the Table for Singhanat. In addition to this acidity, an irritating smell, mint-like smell, and stinking smell function, act as a repellant against typical insects. For application, bio-extract should be diluted with water at a ratio of 20-100cc of extract per 20 liters of water and sprayed every three days or so. If it is too concentrated, it could have a negative effect on the crops. Based on field trials, aphids, mealy bug and thrips are well controlled with the bio-extract. It is better to rotate with other natural repellants like wood vinegar, preventing insects getting used to/immune to it.

2.6. Soil Improvement using Compost with Microbial Materials

Thai Farmers commonly apply animal dung as an organic fertilizer, but they sometimes claim that “when we use animal dung, it causes high temperature in soil and the root of the vegetable is burned.” In this regard, the LDD promotes a series of soil improvement agents called “Po Do.”

“Po Do 12”is a group of micro-organism which can fix nitrogen in the form of ammonium (mainly by Azotobacter chroococcum) and produce organic acid that releases inorganic phosphate and potassium as usable nutrients for the plant (mainly by Bacillus megaterium). In addition, it can produce a kind of hormone that stimulates root growth. “Po Do 3” is a group of micro-organism (Trichoderma sp. and Bacillus sp.), which can control pathogenic micro-organism of the root lot. So, incorporating both “Po Do 3” and “Po Do 12” with compost, it can help improve the efficiency of the compost to be utilized for vegetable cultivation as well as protection of the vegetable from pathogens.

- Making process
    1. Compost: 100 kg
    2. Pour 5 liters of water to 1kg of rice bran mixed with Po Do 3 and 12 (1 package each)
    3. Mix it for about 5 minutes
    4. Pour it on a heap of compost
    5. Mix thoroughly and add water to make the moisture content about 60 %
    6. Cover it with a plastic sheet and keep it for 7 days before using

2.7. Green Market

It is strongly recommended to combine the activities of safe vegetable cultivation and green market promotion. First of all, the green market is a tool to distribute safe-vegetables to other people in the community. Through marketing the surplus of vegetables, farmers can earn an additional income for buying food, paying for school fees and clothes, etc. Furthermore, even if the community encounters a flood, farmers can restart cultivating vegetables with an insurance of already having an established selling channel. For more detail about the green market development, please refer to the separate technical paper on marketing.

3. Impact and Adaptability as a Flood Countermeasure

Although safe vegetable cultivation cannot be a direct measure to control or mitigate flooding, it can be a non-structural measure to cope with damages incurred by flood. In essence, the advantages of safe-vegetable cultivation in terms of a flood countermeasure can be divided into two major functions: 1) risk reduction during flood and 2) quick recovery from the damage of flood.

1) Risk Reduction during Flood

A key point of safe vegetable cultivation in risk reduction is its low cost of inputs. By reducing the need for the use of chemical inputs, such as chemical fertilizer, herbicide, and insecticide, for safety reason, the input cost can be naturally reduced. The reduced cost can be directly interpreted to a reduced risk of loss in the event of a flood. Simply, the less the investment is, the less the risk is when a loss is incurred by flood. Although individual farmers cannot control or stop a flood, they can control the expected amount of loss—that is the essence of the risk reduction concept.

Risk reduction is not only about safe vegetable cultivation per se. A combination of different crops can also minimize the risk of a total loss of the investment cost for individual farmer households. For example, even when the harvest of paddy cannot be managed before the flood comes, vegetables with a shorter growing period may be harvested. Or, even if paddy planted in lowland cannot avoid the flood, vegetables that are planted on higher ground should be safe from the flood.

2) Quick Recovery from the Damage of Flood

Even with the best effort, natural calamities sometimes go beyond the expectation of mankind and bring about significant damages. In the event of a big flood like the one in 2011, even the vegetables planted on relatively high ground cannot avoid the flood. In that case, it is important to consider how to recover from the damage of flood quickly and smoothly.

In this regard, the safe vegetable cultivation is a useful approach for quick recovery for two major reasons as compared to paddy cultivation that is the prevailing form of agriculture, in central Thailand along the Chao Phraya River. Firstly, it can be managed with a shorter period of around 4 weeks, compared to around 100days for paddy cultivation, by which small but quick cash can be generated in a shorter time. Secondly, the investment cost of safe vegetable cultivation, especially on a scale for home consumption, is minimal: 400 Baht/ 10 m^2 as compared to around 6,000Baht/rai for paddy cultivation. This makes it applicable even for those who have a limited cash flow.

In addition, there are two very important factors that are needed in preparation for farmers to restart the safe vegetable cultivation soon after a flood: a) being accustomed to safe vegetable cultivation in ordinary years, and b) already having an established marketing route. These are the keys to success.

a) Being accustomed to the cultivation during ordinary years

Vegetable cultivation is not a big challenge for most of the farmers unless targeting the high-end market in a big scale. Yet, it would also be too ambitious to undertake it once a flood occurred. As a matter of flood countermeasure, therefore, it is recommended to start vegetable cultivation on a small scale mainly for home consumption, by which farmers can get accustomed to the techniques of safe vegetable cultivation. Once getting used to it, farmers can easily re-start it with minimal effort and more certainty. Thus, it is essential to conduct trials and gain experience in ordinary conditions.

b) Having an established marketing route

It is generally said that farmers are born to be conservative and are hesitant to try something new. For farmers who do not have prior experience in safe vegetable cultivation, therefore, it might be, first of all, bothering to start it. But, if they realized it is worth trying, the story is different. In this regard, in addition to having an alternative source of food for home consumption, getting an additional income source can be a good incentive for them. To pave the road for continuous income generation, having an established marketing route is indispensable. Once farmers establish a place to sell and get to know customers, they can easily envisage a recovery path from the damage of flood. So, establishment of a marketing channel or establishment of a market itself should come along with the safe vegetable cultivation activity.

3) Adaptability of the Technology

At the field level, adaptability is restricted by the farmers' perception of technical and financial difficulty. Simply, the easier the technology is, the higher the adaptability is; similarly, the cheaper the cost is, the higher the expected level of adaptation is.

On average, the investment cost of safe vegetable cultivation is reasonable, 400-800baht/10m^2 that would generate as much as 2,400 baht/time. What is more, farmers can design the size of the plot, timing of cultivation, type of vegetables, and method of cultivation based solely on their own preferences, essentially, there is no need to coordinate with others. It can be a promoting factor for entry to this activity.

In addition, although it is proposed as a countermeasure to cope with flood, it is not a special means that can put an end to the problem such as the construction of dykes. Safe vegetable cultivation can be an effective income generation activity in ordinary days and then, in the case of flood, it can be also a useful measure to deal with floods. Better applicability in ordinary days helps increase the adaptability of the activity.

Furthermore, once it is done by a group of farmers, adaptability can be further strengthened. Many farmers who have conducted safe vegetable production and marketing by a group, have claimed that growing vegetables is first of all fun and then helps on-farm management, harvesting and post-harvest handling altogether becomes a lot of fun when done in a group, whilst chatting and laughing. Once it is put on a track, safe vegetable cultivation can be a kind of social activity for farmers in addition to an income generation activity.

4. Prerequisite Conditions

Safe vegetable cultivation is promoted under the philosophy of sufficiency economy that guides Thai people to build a reasonable immune system against shocks from outside, through pursuing a certain level of self-sufficiency. By definition, therefore, safe vegetable cultivation does not depend much on outside conditions. This is the strong point of the approach. It can be organized by an individual farmer household on its own.

It certainly requires some resources such as seeds, fertile soil, and clean water. Thus, it is much more preferable if all the necessary resources can be obtained in the community. Most notably, sources for making compost, namely cow dung, pig dung and chicken dung, should available in the local community or take some steps to make it accessible. Based on the pilot project of JICA project, it was found that pig dung is more convenient to use as compost because of its moderate fertility. But it is not always available, especially in semi-urban areas where animal husbandry is not popular.

In such a case, organizing a purchasing route from an outside community would be a good idea for preparation. Or perhaps starting their own small scale pig raising function would be helpful. Also, obtaining quality seeds is important. Fortunately, unlike heavy materials, seeds can be purchased quite easily at a local market. Even when a flood occurs, farmers can obtain the seeds in sufficient time, because it actually takes weeks or months before flood reaches that area since the initial notice of anticipated flooding.

5. Role of Government Agencies and Other Stakeholders

As noted, it is the principle of safe vegetable production for farmers to reasonably pursue self-reliance. For the promotion or extension of the activity, advanced farmers should take the initiative to other farmers; they can be a learning center for this approach and specific techniques associated. In fact, one of participant farmers in the JICA pilot project in Tambon Klong Ha, Pathumthani claimed that other farmers can learn techniques from her instead of government agencies. Furthermore, a group of farmers in Tambon Nakhon Pa Mak, Phitsanulok also said that anyone can join their group, try together, and learn together—this is the advantage of participatory learning and action.

Accordingly the roles of government sector should be, or can realistically be, limited to technical guidance or facilitation. Practically, the role of government sector is to facilitate the grouping of farmers, link groups to other existing groups, and help in establishing the green market in and around the community.

As of the year 2013, the Ministry of Agriculture and Cooperative (MOAC) is promoting the establishment of learning centers at village levels where farmers can learn from each other. Also, Tambon Administration Office (TAO) usually maintains a set amount of budget allocated for promotion of sufficiency economy. Thus, those activities listed above can be facilitated using those budgets by the ministry, province or Tambons. As for the wider association of farmers' groups, moreover, provinces should take an initiative as provincial governments know more about the numbers of stakeholders in a wider area in the province.

6. Lessons Learned from the Pilot Activities

From December 2012 to April 2013, a pilot project activity on safe vegetable production and marketing was implemented under the JICA project, "the Project for Flood Countermeasures for Thailand Agriculture Sector." This pilot activity was implemented in three Tambons in three provinces where the flood of 2011 occurred. Tambon Nakhon Pa Mak, Phitsanulok, Tambon Gop Chao, Ayutthaya, and Tambon Klong Ha, Pathumthani. Based on four months of experience in those Tambons, some valuable lessons have been learned and are introduced below.

<u>Green Market</u>

- A green market was opened in only a two-month period without delay from the original schedule due to a clear understanding of the process shared by the participants. It suggests that the establishment of a small-scale green market is not so difficult if the vision is well shared among the members.
- At the green market, farmers had already gained the confidence to continue. By the end of the pilot activity, they have become able to sell much faster than other vendors in the market. It is because the villagers (consumers) had already acknowledged that the group was selling safe vegetables. Safe vegetables can be a good branding tool to increase demand and sales.
- In comparison between Klong Ha, an urbanized area, and Nakhon Pa Mak, a rural community, the villagers in Nakhon Pa Mak are rather more conscious on healthy foods than the villagers in Klong Ha. It was originally assumed that urban people would be more concerned with health issues and spend much money for organic vegetables. This outcome shows that even a rural community has potential for high sales volume of safe vegetables.
- There is a big demand for leaf vegetables within the community as they are scarce, compared to fruit vegetables that can easily be brought in from outside.

<u>Seedling Preparation</u>

- As for seedling preparation, only one farmer out of three farmers who learned the new technology continued the method of preparing seedlings in trays. Because the quality of media (soil and burn husk) used was not as good as expected, due to a lack of nutrition. However, according to the cultivation in a school plot, the seedlings prepared in a tray had actually outperformed the ones prepared in a seedbed, implying that seedling preparation in the tray can still have good potential and should be promoted with improved media.

- Some types of vegetables are better suited to direct seeding on the seedbed, such as Green Pak Choi, Pak Choi, and Kale, and broadcasting, such as Morning Glory and Coriander.

Net houses

- Type-A and C had been given credit due to better ventilation as compared to type-B which closes the surrounding of the house by plastic net and the height of the roof is lower (3.5 m).
- Type-A has better performance in terms of insect prevention and weed control than the other two types. Yet, even the type-A net house could not prevent small insects such as aphid from entering. Also, the high investment cost is a negative point of type-A. Thus, type-A net house is suitable for quality seedling preparation or as a learning center.
- It was concluded that type-B and C can be easily replicated due to good cost effectiveness. In fact, one farmer had already started establishing another net house.
- Based on the experience in the Northeast (not in this pilot activity), type-B was functional especially during rainy season.
- Farmers can work the whole day under a net house due to the reduction of direct sunlight on them.

Bio-extract as a natural repellent

- Making and using bio-extract, a newly introduced technology, gained much popularity among the technologies introduced in the pilot activity. One farmer stated that DOAE should promote vegetable cultivation with this kind of useful technology.
- There might be different technologies required for different soil types, season, and water availability. Thus, DOAE should have a comprehensive technical package on all aspects, including bio-extract.
- The proportion of materials required for bio-extract can vary from place to place. It is a key point asking the farmers what kind of plants attract less insects in the natural environment and use those plants as a material for bio-extract. Also, it is better to make it with the materials available in the local area rather than buying materials from outside.
- Rather than showing very precise information about what is included in a standard extract, it is better to encourage farmers to try using materials available with such characters as: 1) bitter, 2) sour, 3) strong smell like tobacco, 4) irritating smell like lemon grass, and 5) wax to fix it to the leaf like eucalyptus.
- DOA is trying to analyze the function of each herb included in the extract.

Impact during flood

- Vegetable production is essential especially during flood as villagers often have to use a boat to get to food and water supplies that are cut-off during the inundation.
- Ms. Oi, a participating farmer, now gets at least 100 baht every day by selling safe vegetables in the community. When the green market is operating, she can expect 400-500 Bt/time every week.

So, income generation is a key advantage, not only during emergency situations.

Timing of Implementation

- Safe vegetable cultivation should be done in normal times before the flood comes, by which farmers can, first of all, enjoy an additional income from safe vegetable cultivation.
- During the flood, it is highly beneficial for farmers both for home consumption and selling because it is difficult to purchase vegetable and the price becomes quite high.
- As many farmers cultivate paddy as the primary crop, vegetables can be a good alternative income source for starting up after the flood.

Development Approach (combination with the green market)

- It was far more effective to combine safe vegetable cultivation and establishment of a green market as the sales of vegetables greatly motivate the farmers to continue cultivation.

Learning Process

- The activity was organized as a learning process wherein project team had provided technical know-how to the farmers and farmers gradually obtained a clearer vision of what they can/should do through trial and error.
- It was initiated with an opening discussion on the following topics: 1) usefulness of vegetable cultivation, 2) process of implementation, 2) effectiveness of a net house and the types, 3) importance of cultivating vegetables throughout the year, 4) challenges in a hot summer and rainy season wherein net house is useful, and 5) introduction of fundamental technologies such as bio-extract, compost, and seedling preparation.

Learning by the Group

- In Nakhon Pa Mak, most of participant farmers were relatives. By working as a group, farmers were able to learn from each other. It is far more effective than learning individually.

Prior Experience

- While farmers in Klong Ha of Pathumthani did not have particular experience in vegetable cultivation, participant farmers in Nakhon Pa Mak (NPM) had some previous experiences, resulting in some differences in the performance of vegetable cultivation. For example, some member farmers in NPM installed sprinklers, without any instruction by the project team.
- However, Ms. Oi believes watering by hand is better, although a sprinkler is not that expensive.
- Even with prior experience in vegetable cultivation, farmers do not necessarily know everything. As for watering, for example, they did not know that spinach does not like to have much water applied. This is a particular case and requires prior knowledge. So, the learning process should be ongoing.
- Prior experience also caused some difficulties in monitoring the activity. In addition to the compost suggested by the project team, some farmers appear to have applied chemical fertilizer as well, resulting in a huge size of leaf.

Investment Cost

- Required cost for an initial investment of a net house type C is not much (2,500Bt per 60 sq.m), in which saran net alone costs about 1,200-1,600Bt/roll of saran net (100 m x 2 m), depending on the size of the house.
- Even with a small investment cost, farmers can fetch a certain amount of income from vegetable cultivation and selling. For example, a farmer in Gop Chao gets 1,200Bt/9m^2/time. After only a few times of selling, the initial cost can be easily recovered.
- Now, farmers have much confidence to expand their farming options by themselves.

Type of Vegetables

- Fruits vegetables are not suitable under the saran net as they require more sunshine compared to leaf vegetables.

Further Extension

- Some farmers already started net house vegetable cultivation on a small scale (for example 4m by 8m). There are already three to four cases of type-C net houses in village No. 13(NPM).
- It was found that one of new farmers uses a saran net with a shading rate of 70% (by which only 30% of light can penetrate through the net). This rate is not suitable for vegetable cultivation. Thus, for the further extension of the technology, leader farmers should be able to provide technical guidance to other farmers.
- During the trial, many villagers had asked if the net house is a chicken house or alike and observed inside to learn what was being done. It proved that installing a net house functions as a demonstration plot.

Linkage with existing group

- In the study tour conducted in the pilot project, the member farmers visited Ms. Nit who sells vegetables to the provincial hospital of Phitsanulok, sometimes earning as much as 15,000 Bt/day. As a result of discussion, she suggested the farmer leader ship their banana flowers and other vegetables to her place and she will sell them in the hospital. The members are satisfied with the prices offered by Ms. Nit, which are higher than market.

Role of Agencies

- Tambon administration office (TAO) usually allocates a certain amount of the budget every year for the promotion of sufficiency economy philosophy. Thus, safe vegetable cultivation can be promoted using this budget.
- In the pilot project, a secondary school was also involved in the safe-vegetable cultivation activity. In the long run, education of the young generation on the topic of safe vegetable cultivation as a means for sufficiency economy is useful for wider extension.
- Extension of the green market should be done in two steps: 1) a study tour to see an existing market, and 2) support in the starting up of the green market.
- To do so, a leaflet or booklet can be a useful medium to introduce the basic function of net house vegetable cultivation, and should include information on the advantages of the roof shape, applicable types of vegetables, etc.

- DOAE has a program to promote green market.

Sustainability

- Sustainability depends on whether or not farmers can get additional income from the activity. In this concern, the combination of safe vegetable cultivation and having a green market is a good strategy for the enhancement of sustainability.
- It is envisaged that the market channel can be further expanded in the future to other places e.g., outside community, public health station, hospitals, and schools.

Issues and challenges

- Farmers cannot produce the matching amount of vegetables that the market needs at the green market. Thus, production planning is necessary in the remaining time for the pilot project. At the beginning, it was suggested that the plot be divided into four portions to be able to continuously ship the vegetables. But, the farmers started all their crops at once, which suggest that a learning process is further needed.
- Acceptance of new technology is sometimes challenged. For example, spinach was suggested in a soil with relatively high pH, but the farmer did not believe it at the beginning; however he accepted it later, as a result of the process of trial and error.
- In Nakhon Pa Mak, flood is not a big problem because the people live mostly on higher ground. Therefore, they can continue to cultivate vegetables nearby their houses.

7. References

Related to safe vegetable production and marketing, there are a set of readily available documents published by the government. Notably included are the guidelines and leaflets listed below:

❖ “Guideline for Safe Vegetable Production and Marketing, Based on an Experience in the Follow-up Activities of the PRO-IAD/1”Agricultural Land Reform Office (ALRO) and Japan International Cooperation Agency (JICA) (November 2012): this guideline had been utilized for an introduction of safe vegetable cultivation under a net house in the pilot activity of the project.

The Project for Flood Countermeasures for Thailand Agricultural Sector

‘Guideline for Disaster Resilient Agriculture and Agricultural Community’

Technical Paper Series No.11

Floating Vegetable Cultivation During a Flood

Prepared by JICA Project Team

Floating Vegetable Cultivation during Flood

1. Introduction

During a flood, access to fresh foods, such as vegetables, becomes quite restricted. In heavily flooded areas, people even rely on food aid from other areas. Even outside the flooded areas, access to vegetables is usually limited during flood time due to limited logistics, supply shortage, and an increase in prices. For farmers who are both producers and consumers, it is more logical to produce perishable foods by themselves for home consumption and also establish an emergency vegetable production system at the household level.

During a flood, it is better to use such cropping methods that can be utilized during water inundated situations. This technical guideline introduces an example of using a floating raft for cultivation of vegetables. The use of floating raft can be applied to vegetable cultivation during a flood and even during the normal time on any water surface like a farm pond or a river, if farmers wish to increase their area available for cultivation. To be more practical in Thailand context, the raft should be made of locally available materials such as bamboo, empty bottles and/or polystyrene foam. The types of vegetables selected should be relatively tolerant to high moisture e.g. Pak Bung (morning glory).

To be sure, it might be difficult for farmers who do not have much experience in vegetable cultivation to attempt this unorthodox type of cultivation method at first. Therefore it is recommended to practice and use this floating raft concept in normal times in order to accumulate the technical know-how and experience, so that they can easily use the technique in a time of flooding or emergency situations. For technical guidance on safe vegetable cultivation for flood adaptation, refer to the set of technical guidelines prepared in this project.

Note that enabling vegetable cultivation even during a flood is quite in line with the philosophy of a self-sufficient economy. Cultivating vegetables on a raft may have only a small impact but it will remind farmers of the philosophy of self-sufficiency—cultivating a strong heart too.

2. Contents of Technical Information

In this chapter of the guideline, specific techniques in preparation of floating vegetable cultivation methods are introduced, which includes types of floating materials, preparation of soils, choice of vegetables, and micro-farming management.

2.1. Floating Materials

Floating vegetables can be managed in several methods. In Thailand there are some examples of floating vegetable cultivations, as trials, in Pakpanang river basin, and Nakornsrithammaraj Province. In these areas, farmers make a floating bed exclusively for producing fresh water (lily) hyacinth, size 2 m x 8 m x 1 m; 2 tons in weight. In Srisa Asoka of Ubonrachathani, for another example, farmers make sacks filled with foam using a saran net to form the floating base of the rafts, on the top of which water hyacinth and good soil are prepared.

In the pilot activity of the JICA flood countermeasure project, a trial of floating vegetable cultivation was conducted at Tambon Gop Chao of Ayutthaya Province as an alternative measure to promote vegetable cultivation in the middle of a flooding period. To make a floating raft, a large block of foam (size 1.2 m x 3 m x 0.3 m) was employed as a raft and small foam boxes were put on the raft in which the vegetables were planted. (size 39 cm x 54 cm x 21 cm).

A prototype of a floating bed: vegetables are being cultivated without the influence of excessive water.

2.2. Preparation of Soils for Seedbed

In the floating vegetable cultivation, vegetables are planted in foam boxes which are placed put on the floating material that provides buoyancy. As the growing medium is a closed environment, the quality of the soil in the boxes is a key element for successful cultivation. In the pilot activity, four different types of soils were prepared using various materials such as burned husk, chopped coconut shell, quality soil, soil under a rain tree (pea family), pig composts and cow dung.

Table 2.1: Soil Types used for Floating Vegetable Cultivation

Trial	Material	Vegetable	Result
1	- Burn husk 1 portion - Coconut shell 1 portion - Compost ½ kg - Rain tree soil 1 portion	- Kale - Green Pak Choy	Achieve the best production
2	- Coconut shell 1 portion - Good soil 1 portion - Compost ½ kg - Rain tree soil 1 portion	- Green Pak Choy	Achieve a good production
3	- Coconut shell 1 portion - Good soil 1 portion - Cow dung ½ portion - Rain tree soil 1 portion	- Kale - Green Pak Choy	Found some fungi which might have come from the cow dung.
4	- Good soil 1 portion - Burn husk 1 portion	- Kale - Morning Glory	Growth rate not so good because of low nutrition.

Trial	Material	Vegetable	Result
	- Cow dung ½ portion - Rain tree soil 1 portion		(only local materials are used)

2.3. Choice of Vegetables

When cultivating under wet conditions, it is safe to choose such types of vegetables that are relatively tolerant against high moisture, typically morning glory. The required growing period is also a factor to consider. The longer the cultivation period is, the higher the risk of disease infection under wet conditions. Because of this, fruit vegetables are not recommended. On the other hand, when cultivating in the foam boxes that prevent water from coming in, farmers can have wider options. In the case of pilot activity morning glory, green pak choy, and kale were selected and all of them were successfully harvested. It was however found that kale needs a longer time than usual due probably to a lack of nutrition.

2.4. Micro Farm Management

When planting vegetables in the small foam boxes, spacing should be carefully managed. Otherwise, the vegetables themselves compete with each other. During an emergency situation caused during flooding, it is recommended to thin out some individual crops and consume them along with the growth of these vegetables. The technique is to remove every second plant in the same row to provide more space for the remaining crops to grow. As a rough indicator, thinning can be started about 2-3 weeks after planting.

2.5. Issues and Challenges

Floating vegetable cultivation may become necessary only during flooding. Thus, it is difficult for farmers to get used to it and improve the techniques necessary and specific to this method. In this regard, safe vegetable cultivation on the common ground should be promoted during ordinary years in normal conditions without flooding. By accumulating knowledge and skills in vegetable cultivation in general, farmers can easily adapt it in the case of an emergency. The preparation of floating materials can be difficult in some rural areas. However, a flood usually approaches quite slowly, taking days and weeks to reach the area after it is announced. Therefore, farmers will have enough time to purchase and prepare the materials before the flood arrives.

3. Impact and Adaptability as a Flood Countermeasure

Impact

Although floating vegetable cultivation cannot be a direct measure to control or mitigate flooding, it can be a useful non-structural measure to cope with floods. In essence, any farmer’s household can secure a certain amount of fresh foods even when their farmlands are inundated. According to those who actually conducted floating vegetable cultivation, it was confirmed that floating vegetable cultivation can supplement enough foods for farmers to survive.

Adaptability

With regard to adaptability, a contributing factor of floating vegetable cultivation is that it can be managed by a farmer's household without much support from outside. Farmers can design the size of the plot, timing of cultivation, type of vegetables, and method of cultivation based solely on their own preferences—reducing an entry barrier. On the other hand, the cost could be a controversial factor. It costs about 2,000 baht/floating media and 39 baht/foam box (12 boxes). It depends on the individual farmer's perception if they thought it would be reasonable to undertake this method or not.

Another factor is a technical difficulty. As far as home consumption is concerned, vegetable cultivation is not too complicated for most farmers. Yet, it might be a bit difficult to successfully conduct floating vegetable cultivation for the first time without prior experience in vegetable cultivation. Therefore, it is recommended to start vegetable cultivation on a small scale mainly for home consumption, by which farmers can get accustomed to the techniques of vegetable cultivation. Once the farmers get used to it, they can easily modify it to floating cultivation with minimal effort and more certainty. It is therefore essential to start using this technique in ordinary circumstances to enrich adaptability.

4. Prerequisite Conditions

As this method can be conducted in quite a small scale, there are not many prerequisite conditions for this activity. It does require some certain types of materials such as seeds, fertile soil, and compost. Thus, it is much more preferable if all the necessary resources can be obtained in the local community. Preferably, the materials required for making the compost, namely cow dung, pig dung and chicken dung, should be available locally. In addition, polystyrene foam should also be accessible in the market near the community. In practice, even if mint foam cannot be obtained nearby, alternative materials such as bamboo and empty bottles could also be used.

5. Role of Government Agencies and Other Stakeholders

This activity should be managed by farmers themselves under a concept of self-reliance. For the promotion or extension of the activity, advanced farmers should take this initiative to other farmers; they can be a learning center for this type of cultivation. Realistically, this activity should be promoted as a subordinate component of safe vegetable cultivation techniques or a component of educational campaign of flood countermeasures by Tambon Administration Offices (TAOs).

6. Lessons Learned from the Pilot Activities

A trial on floating vegetable cultivation was implemented from February to April 2013, as a sub-component of "safe vegetable production and marketing project" under the JICA "Project for Flood Countermeasures for Thailand Agricultural Sector." Based on some weeks of experience in this pilot project, some valuable lessons have been learned:

- Because the size of a foam box is small (39 cm x 54 cm x 21 cm), only a limited number of vegetables can be cultivated in one box. For proper management of the vegetables, the density of the plants should be carefully controlled; otherwise, it becomes too dense when the each plant gets bigger.

- In practice, it is good to consume some plants of vegetables according to the pace of the vegetables' growth.
- When using saran net for making shade, vegetables should be put under the net only for the initial stage of the growth as they are susceptible during their young stage. After vegetables become a certain size, the growth of vegetables might be suppressed by the net. At a later stage in the plants growth nets that have milder shading rate e.g. 50% could be used.
- Everything can be prepared once a warning of flood has been announced in the community, as it usually takes some time until the flood actually reaches the area.
- Without enough previous experience in vegetable cultivation, floating vegetable cultivation may not be managed well, especially under emergency conditions.
- Morning glory is well suited to this kind of cultivation technique which is associated with a lot of water. Morning glory is also a good vegetable to sell as it is a popular foodstuff for common Thai cuisine.
- In Thailand, a flood usually comes quite gradually, therefore, there are fewer risks for the floating boxes to be swept away by strong water currents unless the area is located in a complex geographical condition or faced with a breakage of riverbank, dike or dam.

Note that this kind of technique alone cannot be the answer to all the problems associated with a food shortage during flooding. Incorporating this kind of activity into the regular farming systems of farmer households or to include it as a subset of countermeasures against floods, the farmer or community can enhance its resilience against problems that present themselves during disasters, including floods.

7. References

Floating vegetable cultivation has been also conducted, promoted, and/or surveyed by several institutes of Thailand. Vegetable cultivation on bamboo raft was reported by a "best practice survey" carried out under the said JICA project. Here are some specific examples:

1. Mr. Kimhuad Jomyuth from Rajathani asok: Ubonrachathani:
   http://www.youtube.com/watch?v=sQqc_xrlEFU

   A floating raft is made by putting small pieces of foam into sacks, which are then bound together by a saran net. On the raft, water hyacinth is accumulated and then the soil is put on top. In this system, cucumber, long bean, tomato, and other leaf vegetables are cultivated by a community of a Buddhist group.

2. Myanmar Floating Garden: http://wichai.net/blogs/?p=13424

   This is a case of a floating vegetable garden in the lagoon of Myanmar. Bunches of grasses, called "saisoon" in the local language, and are accumulated on the water surface with a size of approximately 1m in width by 10 m in length; and fixed in place by bamboo poles. Fertile soil taken from the bottom of the lagoon is put on top of the grasses and used for growing tomato plants which reach about 50 cm in height.

The Project for Flood Countermeasures for Thailand Agricultural Sector

<u>'Guideline for Disaster Resilient Agriculture and Agricultural Community'</u>

Technical Paper Series No. 12

Aquaponics/ Hydroponics for Flooding Period

Prepared by JICA Project Team

Aquaponics/ Hydroponics for Flooding Period

1. Introduction

The horticultural cultivating facilities of Aquaponics and Hydroponics Systems are gradually developing in Thailand. The hydroponics system has been popular among the growers supplying to supermarkets, hotels or restaurants. The sets of hydroponics systems are commercially sold by several companies and they provide technical services with sales of special liquid fertilizer. Meanwhile, the aquaponics has just started to be researched by Khon Kaen University and private bodies. Both systems are suitable for specific areas limited in land and water resources and poor soil conditions. Generally, the available lands in the flood areas are quite limited to produce vegetables; therefore intensive vegetable production can be a way of risk reduction during flood periods in the isolated areas.

The simplified mechanism is shown in Fig-1. In the system, fish, vegetables and bacteria stay in a symbiotic relationship; which means a small ecosystem is created. The vegetables take nutrients from wastes of the fish. The water should be recycled and a purification system is important. The balance between the fish feed and nutrient intake of the vegetable should also be considered.

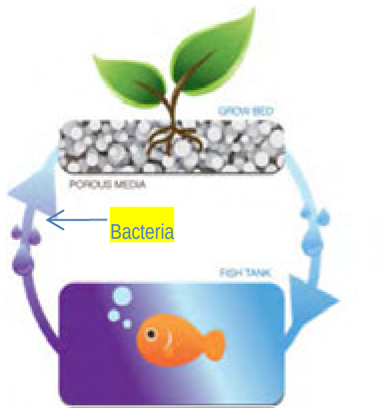


Fig-1 Mechanism of Aquaponics

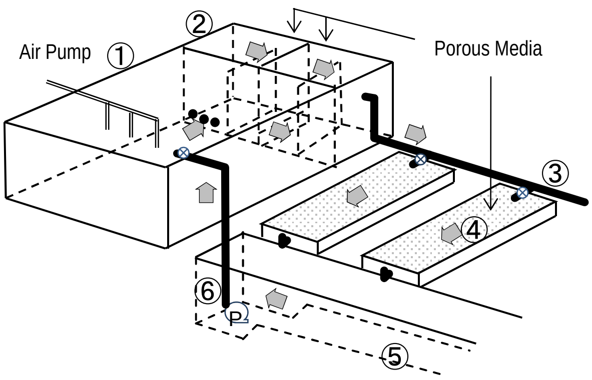
There are many different configurations of aquaponics systems nowadays in the world as shown in the Attachment-1. The components common to any aquaponic system are the fish tank and a plant bed. The variables include the filtration components, plumbing components, the type of plant bed and the amount and frequency of water circulation and aeration. Generally speaking, the systems that utilize some filtration to remove the solid fish wastes will have a higher production of fish and plants.

The main input required for an aquaponic system is the fish feed. More than 50% of the wastes produced by the fish in the form of ammonia are secreted in the urine through the gills. The remainder of the wastes, excreted as faeces, undergoes a process called mineralization which occurs when heterotrophic bacteria consume fish wastes, decaying plant matter and un-eaten food, converting all three to ammonia and other compounds.

In the pilot project, the adaptability of the auaponics system to the inhabitants in the flood areas was verified.

2. Contents of Technical Information

2-1. Design of Aquaponics System



The introduced aquaponics system in the pilot project consists of ①Fish Pond, ②Water Filter (Bio Filter), ③Connecting Pipe, ④Grow Bed Plot, ⑤Returned Water Gutter and ⑥Submerged Pump with Discharge Pipe. The fish pond has the dimension of 4m in width×5m in length×1m in height. About 20 ton of water can be utilized in the pond. In this capacity, a school of more than 1,000 fish (tilapia) can be cultivated. An air pump should be installed to maintain lower biochemical oxygen demand (BOD) in the water. The waste water passes through a porous media with biological reaction of bacteria, which can be activated and remove the odors of ammonium (NH_3) and hydrogen sulfide (H_2S). $NH_3$is converted to NO_3 by *Nitrobacter*or *Nitrosomonous spp*. For filtering waste water, this biological treatment is cheaper and easier than physical or chemical methods. The porous media has a filtering function for large particles of wastes and growing function for microorganisms for the breakdown of solved wastes.

The height of the outlet from the water filters to the connecting pipe is set at the water level of the fish pond. The pipe end has manual valves attached, which can control the water supply volume to the grow bed plots. The grow bed plots have the dimensions of 1m in width × 5m in length × 0.2m in height and filled with the porous media. The growing media should have a high water holding capacity and be made of insolubilized substances such as bio-act stones (rice husk ash made particles) or hydotron (ceramic balls). The L-shape drain pipes are adjustable to control the water level inside the grow bed plots.

In the end of the returned water gutter, a small submerged pump is installed. It only requires a 100-250W capacity for circulation of the water. The pump selected should be by 5m total water head; otherwise a valve for the discharge pipe is required. It is possible to install a photovoltaic power unit even in non-electrified areas. The layout of the introduced aquaponic system is shown in Attachment-1.

2-2. Recommended Fish Types and Vegetables

The fish and vegetables should firstly be selected according to local demands. The fish breeds should be resistant to negative conditions such as, the change of temperature, high EC (Electrical Conductivity) and low pH.

For selection of vegetables, it is recommended to plant herbal plants in order to avoid pest damages, if the system is not located inside a net house. In the flood areas, small insects such as midges, thrips and white flies attack the young leaves of vegetables. The farmers, who understand the techniques associated with bio-control, can plant general vegetables and fruits such as lettuce, sweet pepper, chili, mini tomato, eggplant, cucumber, guard and even papaya.

		
Tilapia	Large Mouth Bass	Catfish

Fig-3 Adaptable Inland Fishes for Aquaponics System

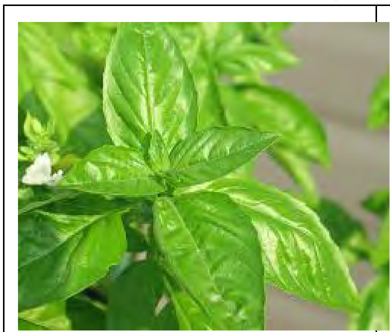
		
Sweet/Holy Basils	Watercress	Mint

Fig-4 Adaptable Vegetables for Aquaponics System

2-3. Lessons Learnt from the Pilot Project

About the fish raising;

- In the villages of flood areas, the age of the inhabitants is generally older. The daily operation should be simple and easy for workers, even for the aged persons; therefore the technology of the aquaponics system is acceptable.
- A Red Tilapia grows from 2cm (1g) to 10cm (150g) in 8 weeks. Feed Conversion Ratio (FCR=) was 2.8, which shows a good result.
- The fish feeds were purchased from local merchants. Since the main expenditure is the cost of feeds, any locally-available sources should be exploited; larva of insects, rice bran, vegetables, etc. A maggot (worm of the common fly) can be a good source of protein for fish.
- After 8 weeks, the new generation of fingerlings was found. A net type of fence should be installed in the fish ponds to protect the juveniles from the adult fish.

About the vegetable cultivation;

- The leafy vegetables such as spinach and leaf lettuce are not suitable in the flood areas due to the high occurrence of pests. The herbs commonly used in Thai cuisine are durable for pests. Installation of a net house is an option to consider when planting common vegetables.
- Nutrient balance between fish waste and vegetable intake should be considered. During the first 4 weeks, 3 grow bed plots out of 6 plots are used. After 4 weeks, the remaining plots are used.

About the system;

- It is not necessary to operate the submerge pump for 24 hours a day. It is enough to operate it for 2-4 hours/day depending on the fish growth.
- It is takes 4 weeks to neutralize alkalinity of cements and porous media of the structures of the aquaponics system after it is first constructed. When there is evidence of algae growing on the surface of the porous media it is a good indicator of neutralization of circulated water and concrete surface.
- The fish pond should be made of reinforced concrete for long durability. The largest force loads to the lowest parts of walls.
- It is confirmed that the use of microorganisms has advantages on; plant growth promotion, removal of odor (the flies do not bring pathogenic bacteria) and assisting in water purification. The recommended microorganisms for the aquaponics system are EM^{TM}or LDD-6 with LDD-2.
- The cost for porous media reflects on redeeming the initial investment. Development of cheaper materials would be the key factor to extend the aquaponics technology.

3. Application and Limitation

Sustainability of the system can be evaluated by the easiness of operation for local inhabitants and the benefit-cost (B/C) ratio. The daily operating method is quite simple; i) provision of a suitable volume of feed, ii) turning on and off the power of the submerged pump and air pump and iii) monitoring plant growth. Additionally, the works of iv) multiplication and application of microorganisms, v) changing the water every month, vi) security and vii) harvest of products are required.

B/C ratio is calculated at 1.82 as shown in Appendix-3 in this technical paper. For sensitivity analysis, 3 cases are calculated. High death rate of fish is more critical than price increase of feeds. In order to avoid the risk of diseases attacking the fish, monitoring the water quality is important. If the initial cost for the porous media decreases, the return period would be shortened.

The comparison with a hydroponics system is shown below:

Table-1 B/C Ratio and Sensitivity Analysis

Case	Condition	B/C Ratio
Basic Case	Death Rate at 15%	1.82
Case-1	Variable Cost at 10 % up	1.74
Case-2	Death Rate at 30%	1.36
Case-3	Variable Cost at 10 % up and Death Rate at 30%	1.27

Remark:
1) Starting from 1,000 head of fingerlings of Red Tilapia
2) 3 times harvest per year
3) Vegetables for self-consumption
4) Depreciation period for 10 years
5) Discount Rate = 5%

Table-2 Comparison of Aquaponics and Hydroponics Systems

Comparison Item	AQUAPONICS	HYDROPONICS
1. Initial Cost	Higher	Lower
2. Commercialization in Thailand	Under developing	Developed, the kits sold by manufacturers
3. Products	Inland fishes and vegetables, easy to sell at local markets	Limited kinds of vegetables, difficult to sell at local markets
4. Daily Operation	Easy	Easy but the operator should be trained
5. Operation Cost	Lower	Higher

6. Return Period of Investment	Longer. About 5 years	Shorter. About 3-6 months under contract farming
7. Major Risk	Death of fish	Continuity in market demands, Pests
8. Adaptability in Flood Areas	Adaptable	Adaptable

Source: JICA Project Team

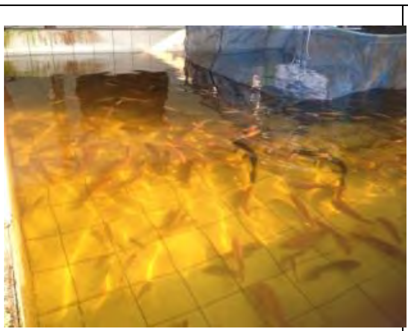
It is difficult comparing the two systems, but the aquaponics system is adaptable to the aged inhabitants due to easiness in operation and slighter risk. The hydroponics system should have continuous market demands. The inputs of feeds and nutrient consumption should be monitored and studied more by the research agencies. The professor of Khon Kaen University and Bio Porous Co. in Chainat are leading the development of the aquaponics system in Thailand. Further improvement and lowering of initial costs would be required.

The site for installation of the system should be located on ground at least higher than the level the 2011 flood reached. There needs to be a good source of water for the ponds, power supply and a place safe from the theft of the fish.

4. Impact as Flood Countermeasure

During the flood period, the villages were isolated from the regular food distribution system. A large majority of inhabitants refused to evacuate due to security threats to their properties, if their farms were left un-attended. From the viewpoint of food security, a small scale food production system operated by villagers should be developed. The aquaponics system is one of options to diversify the food production and the supply channel. The adaptability of this type of farming is suited to aged persons starting production.

The micro-scale aquaponics system, called "Backyard Aquaponics", has the advantages of a small initial investment and outright ownership for inhabitants. However, the balance of fish waste and vegetable nutrient intake is more sensitive than that in ponds operating on a large scale.

		
Grow bed plots in Aquaponics System, the Pilot Project, Chainat	Fish pond in Aquaponics System, Bio Porous Co., Chainat	Water filter using porous media, the Pilot Project, Chainat

		
Healthy growth of mint, the Pilot Project, Chainat	Backyard Aquaponics System, Bio Porous Co., Chainat	Hydroponics System, Khon Kaen

Fig-5 Aquaponics and Hydroponics Systems in Thailand

5. Role of Government Agencies and Stakeholders

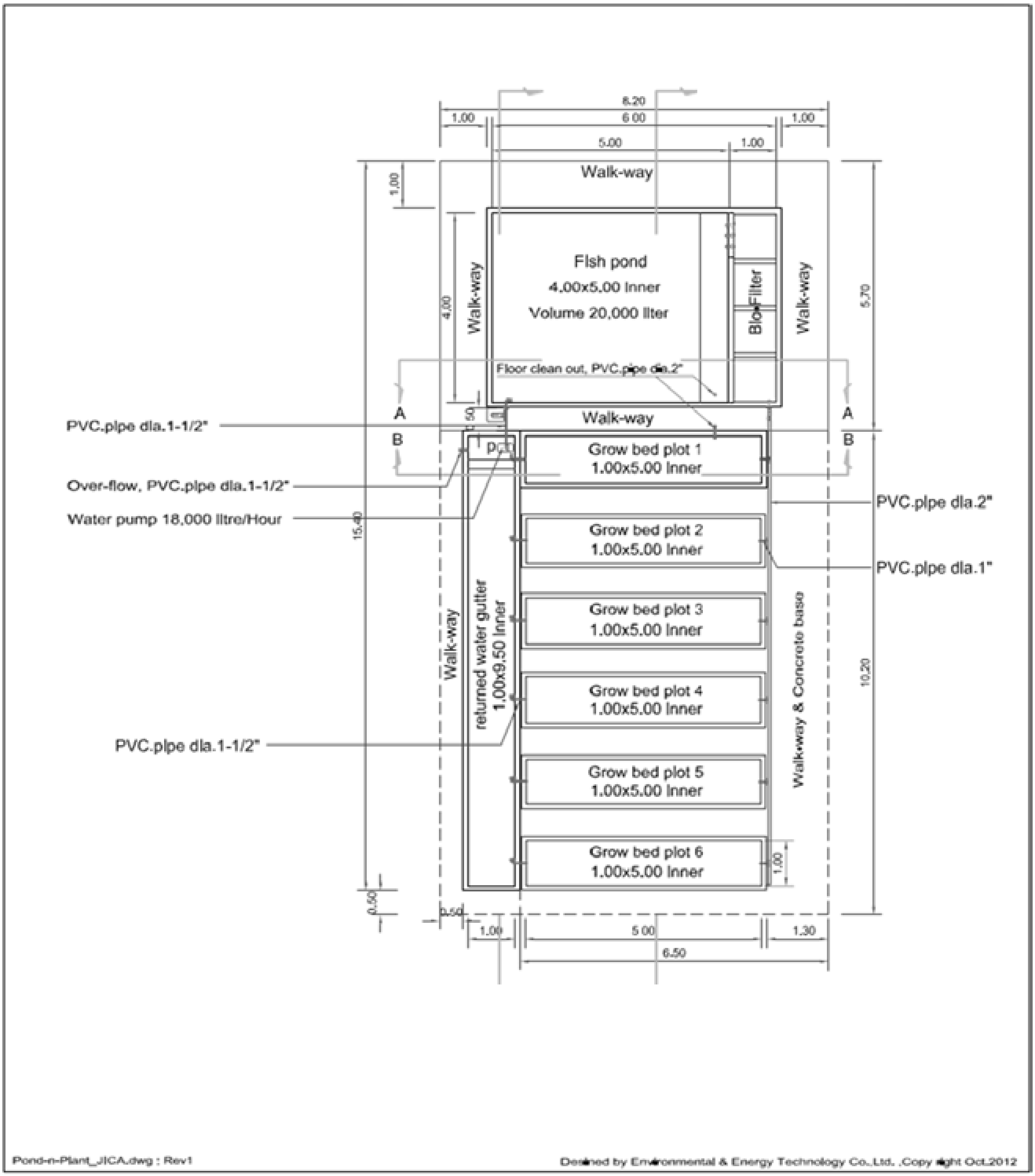
The subjects of the aquaponics system can be summarized as follows:

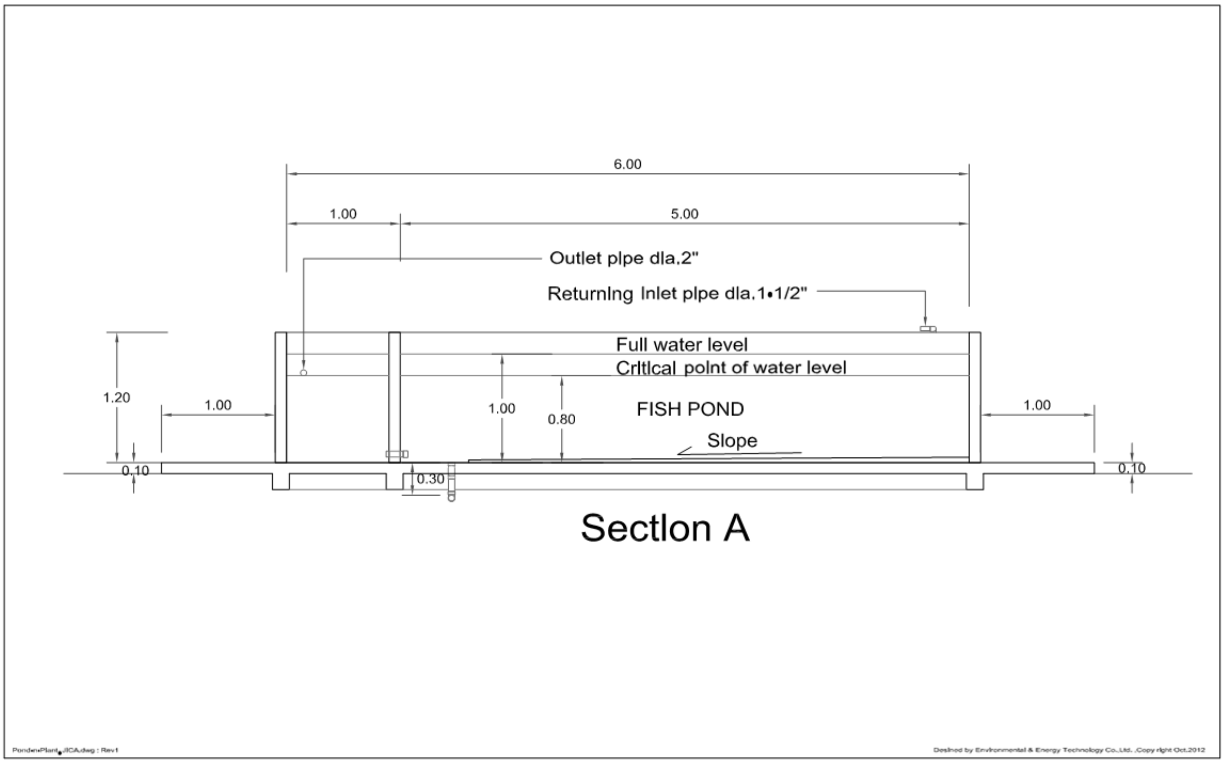
(1) Development of a low cost porous media
(2) Improvement of fish feeds with balanced nutrients
(3) Durable design and materials for use in constructing the fish pond at a lower cost
(4) Comparison study of suitable designs acceptable by local inhabitants
(5) Protection program to establish a lower death ratio of the fish

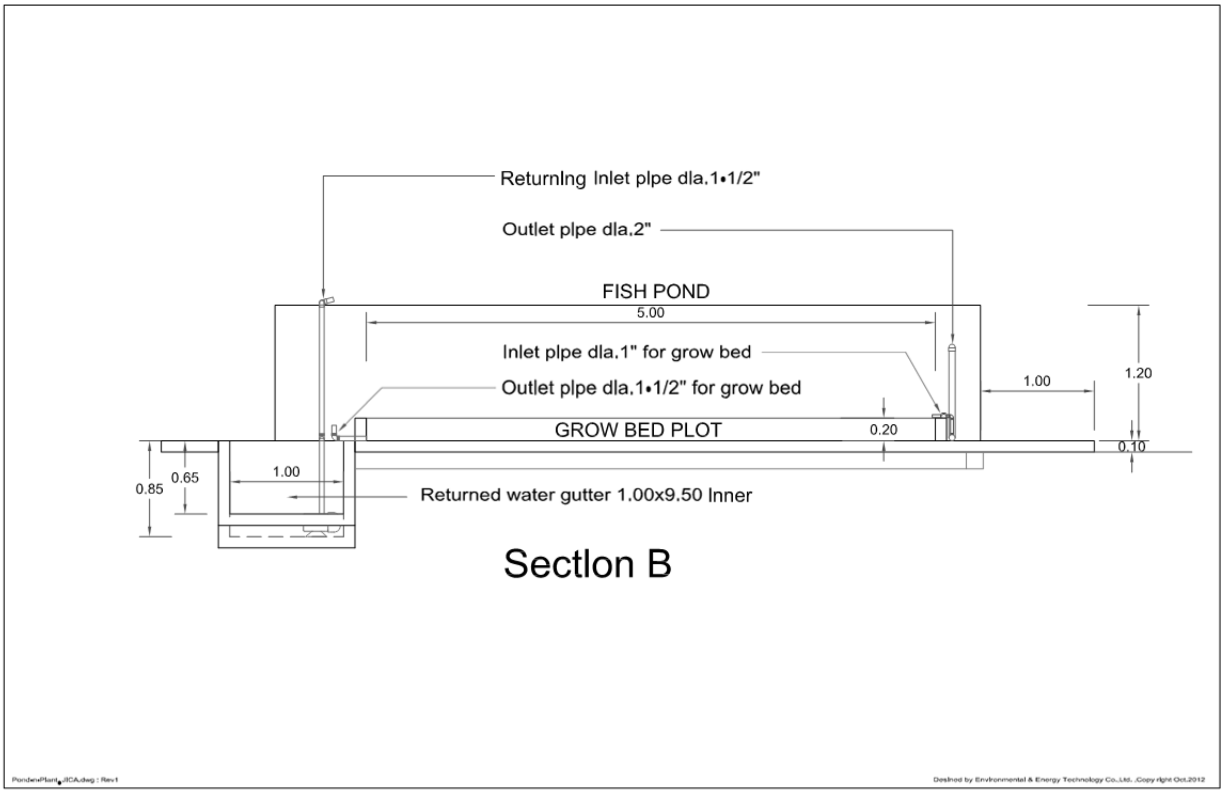
The academic researchers and the private companies will lead to improve the aquaponics system. Now, Chainat Provincial Fishery Department has stated their interest. The role of the department is research of fish growth and advice to local inhabitants in the flood areas under the cooperation of the academic researchers and the private companies. The professor of the Faculty of Agriculture, Khon Kaen University, is one of the leading researchers in Thailand.

Appendix-1: Several Types of Aquaponics System

Appendix-2: Layout of Aquaponics System in the Pilot Project







Appendix-3: Financial Analysis and Sensitivity Analysis

Conditions of Analysis

Food production even during flood or inundated periods in low lands under the condition of a shortage of clean water is the purpose of this activity and its beneficiaries will be kindergarten and primary school pupils in the village No.3, T. Khao Kaeo, A.Sappaya, C.Chainat. The aquaponics system is managed by the village committee. The wages of operators are not included in this analysis, but the members of the committee can harvest the product instead of receiving payment. Thus, sales of vegetables are not included in the benefits.

1. Cost

1.1 Initial Cost

The initial cost is total 286,759 THB, and consists of i) Porous media made of rice husk ash at150, 000 THB, Structure of fish tank and growing beds at 122,421 THB and equipment at 87,907 THB. Three sizes of Bio-act stones for Porous media in growing beds and water filtering are calculated at 25THB/kg on average. The roof for the fish pond is excluded.

Table-A-1 Initial Cost

Item	Amount (THB)
1. Porous Media	150,000
2. Structure	122,421
3. Equipment	87,907
Total	286,759

1.2 Variable Cost

It takes 4 months for one cycle of breeding Red Tilapia until they are ready to sell. In a 20 ton fish tank, more than 1,000 fish can be cultivated. The variable cost of aquaculture is calculated at 11,937 THB as shown in Table-A-2. This data is provided by the Provincial Fishery Department Officer. This cost consists of fingerlings, fish feeds available in local markets and electricity power charges.

Table-A-2 Variable Cost (1 cycle)

Item	Unit Price (THB)	Quantity	Unit	Amount (THB)
1. Red Tilapia fingerling (size 2-3 cm)	2	1,000	pcs	2,000
2. Feed (small fish/after breed 1 month)	500	1	bag/20kg	500
3. Feed (medium-big fish/after breed 3 month)	480	12	bag/20kg	5,760
4. Electricity charge (For 1 crop: 4 months)				
- Submerged Pump, RESUN PG-18000 (1x250W)	24.000	120	days	2,880
- Air Pump, YAMANO AP-10 (1x10W)	0.958	120	days	115
- Light, Philips Lifemax TLD (3x36W)	5.183	120	days	622
- Water Pump (1x250W), 1 time/month	15.000	4	days	60
	total cost			11,937

Table-A-3Feeding Cost (1 cycle)

Fish Size	Feed (kg/day)	Average Fish Weight (g/head)	Total Weight (kg/tank) at Death Ratio=15%	Feeding Day (day)	(Reference) FCR (Feed Conversion Ratio)	(Reference) Feed Cost (THB/day)
Small	0.75	120	85.00	30	3.00	18.75
Medium to large	2.55	650	552.50	90	2.30	61.20

Conditions:

1) 1 cycle = 4 months or 3 cycles/year
2) Vegetables will be consumed by community or operators.
3) In this calculation, labor cost is excluded, because working time is only 15-30-minutes per day.
4) In order to secure ecological balance in the system, EM (Effective Microorganisms^{TM}) sold in the local market is multiplied by combining with molasses at 20 times in anaerobic condition. But its cost is ignorable.

2. Income

The main income will be from fish production. From the study, income from fish production, 4 months after feeding the fish they have a total weight of 552.2 kg. Red Tilapia price, medium size, is 70 THB/kg. Total income is 38,675 THB. After less variable cost, gross income is 26,738 THB/cycle or 80,214 THB/year. Refer to the Table-A-4.

Table-A-4Net Income from Fish

Calculation Items	Quantity	Unit
Red Tilapia price, medium size	70	THB/kg
Average weight per head after 4 months	0.65	kg/head
Number of fish fingerlings	1,000	head
Death rate	15	%
Total weight of alive fish	552.5	kg
Gross income	38,675	THB/cycle
Variable Cost	-11,937	THB/cycle
Net income (one cycle, 4 months)	26,738	THB/cycle
Net income (one year, 3 times per year)	80,214	THB/year

Source: Estimation by the Officer of Provincial Fishery Department,

3. Benefit/ Cost Ratio and Sensitivity Analysis

It is assumed the discount rate of 5%, the operation and maintenance cost of 3% of the initial cost and the depreciation period of 10 years for calculation of B/C ratio. For sensitivity analysis, the following 3 cases are estimated:

Case-1 Variable cost increases at 10%.

Case-2 Death Rate of fish increases at 30%.

Case-3 Variable cost increases at 10% and Death Rate of fish increased at 30% at the same time.

Table-A-5 B/C Ratio in the Basic Condition (unit: THB)

Year	Initial Investment	O & M Cost (3%)	Total Cost	Net Income
1	286,759	8,603	295,362	80,214
2		8,603	8,603	80,214
3		8,603	8,603	80,214
4		8,603	8,603	80,214
5		8,603	8,603	80,214
6		8,603	8,603	80,214
7		8,603	8,603	80,214
8		8,603	8,603	80,214
9		8,603	8,603	80,214
10		8,603	8,603	80,214
Total	286,759	86,028	372,787	802,140
NPV	273,104	66,428	339,532	619,391
Discount Rate = 5%			B/C Ratio	1.82

The B/C ratio under normal conditions is 1.82 as calculated in Table-A-5. Case-1, -2 and -3 are 1.74, 1.36 and 1.27 respectively. Thus, a high death rate of fish is a strong influence on the sustainable cash flow.

The Project for Flood Countermeasures for Thailand Agricultural Sector

‘Guideline for Disaster Resilient Agriculture and Agricultural Community’

Technical Paper Series No. 13

Recovery of Orchid Sub-Sector through Collaboration between Government, Academia and Private Bodies

Prepared by JICA Project Team, Department of Agricultural Extension, Land Development Department, Department of Agriculture, and Kasetsart University (Department of Horticulture, Facultry of Agriculture in Kamphaeng Saen Campus)

Recovery of Orchid Sub-Sector through Collaboration between Government, Academia and Private Bodies

1. Introduction

Thailand has been the largest and most expanding producer and exporter of orchids for the past 40 years. The annual export amount was 2,095 million THB (FOB Bangkok) in 2012, though the peak export amount was 2,411 million THB in 2008. Half of the total production volume is consumed in the domestic markets. The main product is cut flowers of Dendrobium spp. Other varieties such as Mokara, Vanda and Ascocenda are also produced mainly as pot flowers. The export declined in 2012 mainly due to flood damage. It takes more than 2 years from the initial transplanting of orchids at nurseries (10-month age) to reach the harvest stage of cut flowers.

Most orchid growers testified that "Flood water level increased suddenly from the leg neck to the top of a head, and there was no time to evacuate the orchids to higher places, and flood water covered the flowers for 3 months." This was caused by the breakup of dikes of Tha Chin River. It was recorded that, 37% of orchid gardens in the area, or 52% of production had been damaged in Nakhon Pathom Province. In the lower areas of Tha Chin River, Samut Sakhon Province, direct damages from the 2011 flood were avoided due to relatively higher land levels, but the farmers faced the problems of a shortage of farm inputs for growing orchids.

Table-1 Area and Production of Orchid Cut Flower by Province

Province	Harvested Area (rai)				Production (ton)			
	2010 (A)	2011 (flood)	2012 (B)	Change (B/A)	2010 (A)	2011 (flood)	2012 (B)	Change (B/A)
Nakhon Pathom	8,173	7,382	5,129	63%	21,201	15,536	10,073	48%
Samut Sakhon	5,296	5,195	5,542	105%	13,913	12,146	11,533	83%
Bangkok	2,487	2,314	1,318	53%	6,014	4,901	2,708	45%
Nonthaburi	1,026	949	689	67%	2,388	1,966	1,271	53%
Central Plain (7 provinces)	21,335	20,394	17,217	81%	51,662	43,108	34,011	66%
Whole Country	22,217	21,339	18,169	82%	54,026	45,750	36,702	68%

Source: Agricultural Statistics of Thailand 2556, OAE

Through interviews with orchid farmers and the workshops, the following constraints have been identified.

1) Shortage of orchid growing media
2) Shortage of cash (working capital) to manage orchid gardens and high input costs such as chemical fertilizer and pesticide/fungicide
3) Appearance of pests and diseases especially in inundated areas such as thrips, midges, spider mites and black spot disease
4) Difficulty on finding skilled workers and high costs for obtaining a working visa when employing foreign workers
5) Lack of capital to invest to recover facilities; purchasing such as plastic nets, concrete

columns, concrete shelves, PVC pipes, sprinklers, wires, and other materials

6) Limited numbers of available excavators and operators to construct dikes around orchid growing fields

7) Shortage of available orchid nurseries (produced by tissue-culture)

8) Influence of economic crisis in EU countries

MOAC compensated 180,000THB/rai for pot flower facilities and 80,000 THB/rai to cut flower facilities under the urgent relief countermeasure to flood suffering farmers in order to rehabilitate orchid facilities. Further to that., MOAC provided orchid tissue-culture nurseries at 160 pcs/farm owner. However, this support was not sufficient to facilitate a total recovery. It requires 600,000-800,000 THB/rai at least to reconstruct orchid facilities. The orchid farmers loan low interest agricultural credits from BAAC.

The pilot project had been designed considering possible support from MOAC, Kasetsart University and private parties connected with the orchid industries. MOAC has developed technologies on biological fertilization and biological control, but they have never been applied to orchids. Kasetsart University had researched several new growing media instead of coconut husks. The private companies have laboratories for tissue-culture for various varieties of Dendrobium spp. to meet market demands. The objectives of the pilot project are for evaluation of alternative media for growing the orchids, reduction of chemical fertilizer and reduction of pest damage, corresponding to the above-mentioned constraints stated in points 1) to 3).

Technology and materials contributed by the stakeholders are shown in the following table.

Table-2 Works for the Pilot Project by Stakeholder

Stakeholder		Contribution to the Pilot Project
Kasetsart University (KU)	Department of Horticulture, Faculty of Agriculture in Kamphaeng Saen Campus	Experimental study on alternative growing media of cut flower orchids
Ministry of Agriculture and Cooperatives (MOAC)	Department of Vegetables, Flowers and Herbs Bureau of Agricultural Product Promotion Department of Agricultural Extension (DOAE)	Coordination of stakeholders and dissemination of technical information to farmers through provincial officer
	Division of Soil Biotechnology, Land Development Department (LDD)	Application of bacteria and fungi for bio-fertilization to assist nutrient intakes on non-organic growing media
	Agricultural Production Science Research and Development Office, Department of Agriculture (DOA)	Inoculation of Arbuscular Mycorrhiza (AM) to develop rhizosphere to become tolerant to stresses by pathogenic bacteria (black spot diseases), temperature and water
Private Bodies	Air Orchids & Lab Ltd. in Nakon Pathom Province	Provision of orchid nurseries, information dissemination to orchid farmers in Banglen District, Nakhon Pathom Province
	Supa Orchid & Interlab Ltd. in Samut Sakhon Province	Provision of knowledge on tissue-culture of orchid nurseries and marketable varieties
	BioPorus Ltd. affiliated with Environment and Energy Co. Ltd. in Chainat Province	Provision of Bio-act stone made of ash, which is the byproduct of rice husk power plant, as a growing media
	MTEC (public company under National Metal and Material Center of National Science and Technology Development Agency)	Provision of non-woven fabric materials as a growing media

For implementation of this study, three orchid farmers were selected by the DOAE provincial office. The selected farmers have provided spaces in their facilities and grow orchids using conventional methods. For evaluation of new growing media and biological approaches, it is not easy to implement by only using individual farmers. By using a combination of the latest horticultural technologies owned by MOAC, the University and private bodies, the revitalization from flood damage will be accelerated.

2. Three Experiments for Orchid Growing

Experiments have been conducted in three agencies. KU compared several growing media. LDD applied microorganisms with different volume of chemical fertilizer. DOA inoculated Arbuscular Mycorrhiza with different volume of chemical fertilizer.

Table-2Different Growing Media and Input of Microorganisms to Orchid

Farm	Implementing Agency		
	KU	LDD	DOA
Puttipong Farm	Coconut husk, Bio-act stone, non-woven (2 types), concrete block + Chemical fertilizer 100%	Coconut husk and Bio-act stone LDD-2,3, 7 & 12 + Chemical fertilizer 100%, 75% and 50%	Coconut husk, Bio-act stone and concrete block DOA-Arbuscular Mycorrhiza + Chemical fertilizer 100% and 50%
Aneke Farm	Coconut husk, Bio-act stone, non-woven (2 types), concrete block + Chemical fertilizer 100%	Coconut husk and Bio-act stone + LDD-2,3, 7 & 12 + Chemical fertilizer 100%, 75% and 50%	Coconut husk and Bio-act stone + DOA-Arbuscular Mycorrhiza + Chemical fertilizer 100% and 50%
Adul Farm	Coconut husk, Bio-act stone, non-woven (2 types), concrete block + Chemical fertilizer 100%	Coconut husk and Bio-act stone + LDD-2,3, 7 & 12 + Chemical fertilizer 100%, 75% and 50%	Coconut husk and Bio-act stone + DOA-Arbuscular Mycorrhiza + Chemical fertilizer 100% and 50%

2-1 Alternative Growing Media

1) Materials and Method

The trials were conducted in the lay-out of the Randomized Complete Block experimental design. The treatments comprised of 5 growing media namely; coconut husk, concrete block, Bio-act stone (1-5 mm in diameter), non-woven fabric B1 (30% cotton and 30% polyester with the density of 300 gram), non-woven fabric B3 (40% cotton and 20% polyester with the density of 300gram).

The trials were conducted at three orchid farms located in Bang Len District, Nakhon Pathom province, namely Puttipong farm, Adul farm and Aneke farm. Dendrobium sonia 'Ear Sakul' was used as a plant material in this experiment. The Puttipong and Anake farms used 10 month old orchid nurseries obtained from tissue-culture propagation as the planting material while Adul farm used orchid planting material from stem cutting. Coconut husk media was obtained from the local agricultural supplier.

Concrete blocks were obtained from the local hardware store. Bio-act stones were obtained from BioPorus Company Ltd. in Chinat province. Non-woven fabric material was obtained from National Metal and Materials Technology Center, National Science and Technology Development Agency. Transplanting was conducted in November, 2012 at all farms. In this experiment, one block consisted of 32 orchid nurseries. Four orchid nurseries were transplanted into a piece of coconut husk media, a concrete block and a plastic basket containing 2.5 liters of Bio-act stones. Hence, eight blocks of these three media formed one experimental unit. For non-woven media, sixteen orchid nurseries were transplanted on a piece of non-woven fabric in the size of 0.5×1.2 m and two pieces formed one experimental unit. After transplanting, normal cultural practices consisting of irrigation and fertilization application and chemical spray were performed by each farmer. The plant growth analysis was conducted at 1 week and also at 4 months after transplanting. Stem growth (height, gird diameter, leaf number, leaf area and total stem number) and fresh and dry weight of the whole plant were recorded. Yield (inflorescence number) and quality (inflorescence length and flower numbers) should be monitored for at least another 8 months.

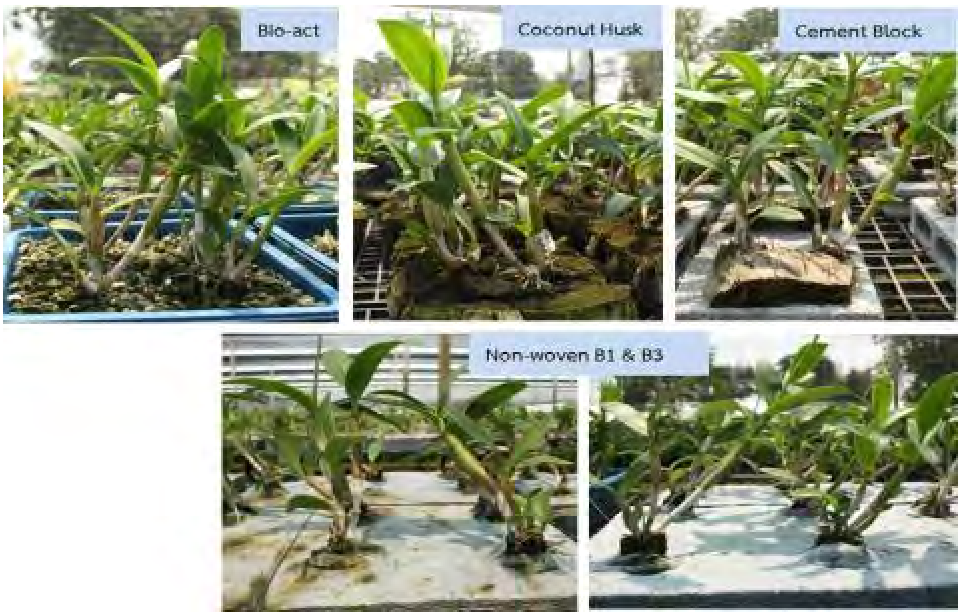


Fig-1 Growth of Dendrobium orchids at the Putthipong farm 4 months after transplanting tissue-cultured plantlets on Bio-act stone, coco-husk media, cement block, and non-woven B1 and B3, respectively.

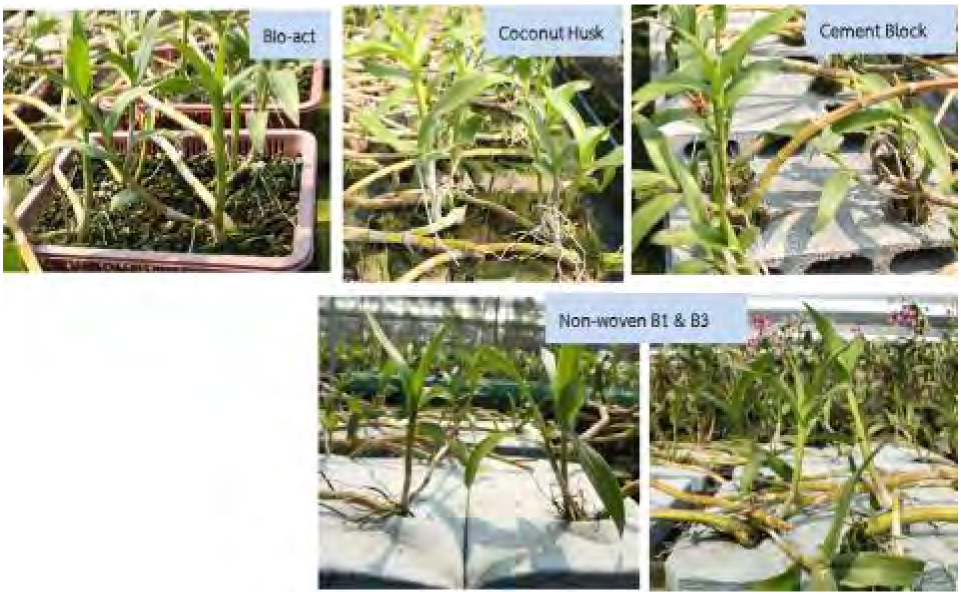


Fig-2 Growth of Dendrobium orchids at Adul farm 4 months after transplanting stem-cuttings on Bio-act stone, coco-husk media, concrete block, and non-woven B1 and B3, respectively.

2) Results

The result of growth analysis revealed that there were statistical differences in growth of the Dendrobium orchid due to the effect of growing media found at the 4th month stage (as of the end of March 2013). The growth of orchid plants grown in the bio-act stone, coconut husk and concrete block were not significantly different, but they were faster in growth than non-woven fabrics and similar results were also found among all three orchid farms.

Nevertheless, the highest value of the growth parameters was found when orchid plants were grown in bio-act media, while the lowest values were mostly found when plants grown in non-woven B3. This difference in growth is probably, in some extent, related to the aeration property of the media. Dendrobium orchid has semi-aerial root system and requires a good aeration environment. Therefore, the bio-act stone which has a greatest aeration property gave the highest growth while both non-woven fabrics which had the lowest aeration gave the lowest growth.

This different tendency in the result is also found between the two non-woven fabrics. The non-woven fabric B1 that contains 30% of cotton which has a lesser moisture absorption property, gave the relatively better growth results than the non-woven fabric B3 which contains 40% of cotton and has a greater moisture absorption property. It is assumed that another reason is that bio-act stone and coconut husk can develop natural fungi to exchange nutrient between plant roots and fungi, and retain moisture.

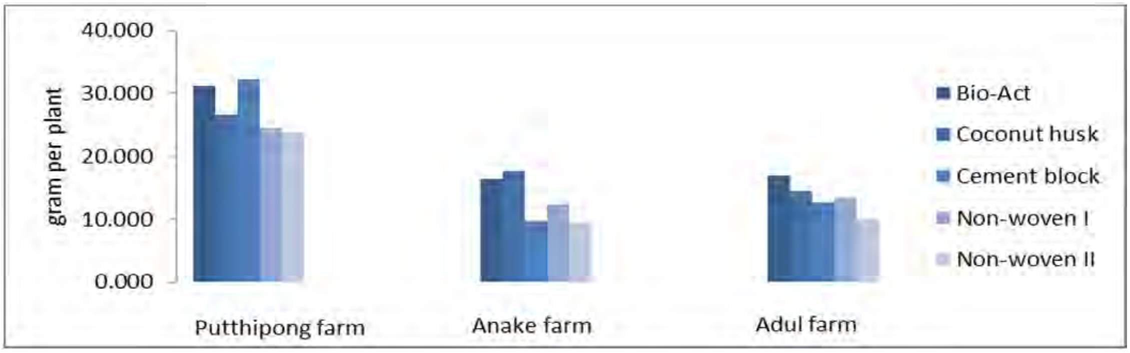


Fig-3 Leaf Wet Weight of Dendrobiun Orchids in Different Locations on Different Growing

Fig-4 Stem Wet Weight of Dendrobium Orchids in Different Locations on Different Growing

A Bio-act stone is an inorganic material produced by burning rice husk ash at 1200°C, which is a by-product from a rice husk power plant. The patent of the production method is owned by MTEC. Before using it, as a pre-treatment it has to be soaked in water to adjust the alkalinity. The Bio-act stone has physical features of light weight, high porosity and excellent moisture and nutrient holding capacity.

Fig-5 Development of Orchid Roots in Different Growing Media

Additionally, it can be used as growing media for both cut-orchids and pot-orchids. The plants need watering and fertilizer application as in a regular farmer's practice. However, a suitable container for holding the bio-act stone should be developed instead of the usual weak plastic containers used in standard potting as they are required to stand strong ultra-violet ray from the sun and slightly acid conditions.A concrete block is an inorganic material too, generally used in construction. Recently, orchid growers are using the concrete blocks as a growing media for cut-orchid production, because the price of this material is cheaper than the coconut husk and they have a longer durability.

Fig-6 Preparation of concrete block and transplanting into the concrete block

For cut flower orchid cultivation, the concrete block should be drilled on the top surface to make four round-holes before transplanting the orchid nurseries into each hole. Orchid plants grown in concrete blocks require a higher frequency of irrigation than that of the normal irrigation practice, since they have a lower moisture holding capacity as compared with coconut husks and bio-act stones.

2-2. LDD Microorganisms

1) Materials and Methods

Supper LDD-3 is a group of antagonistic microorganisms which can control and inhibit plant pathogens for both upland and low land crops, especially root rot disease of economic crops such as durian, orange, pineapple, cassava, sugar cane, maize, legume crop, rice, vegetable crop and ornamental flower. They consist of Trichoderma viride and Bacillus subtilis.Bio-fertilizer LDD-12, which is a group of effective microorganisms that can produce nutrient elements or convert insoluble inorganic compounds into a soluble form to increase fertility and produce plant hormones including gibberellin, auxin and cytokineto to enhance plant growth. They consist of free-living nitrogen-fixing bacteria, phosphate solubilizing bacteria, potassium solubilizing bacteria and plant growth promoting rhizobacteria. The raw materials for multiplication of Supper LDD-3 and Bio-fertilizer LDD-12 for orchid are, compost 180kg, rock phosphate 60kg, perlite 60kg, rice bran 3kg, Supper LDD-3 3 packages andBio-fertilizer LDD-12 1 package. Perlite can be the quality source of potassium for plants in lower costs.

Microbial activator Supper LDD-2 is a group with extra properties to produce bio-extract from fresh and organic wastes, such as the residues from fruit and vegetable by a fermentation process, and increases the efficiency of protein and lipid decomposition. The recommended raw materials for production of bio-extract for orchid consists of the top part of morning glory 20kg, bitter gourd 20kg, pumpkin 20 kg, sugar 5kg, water 10liters and Supper LDD-2 1 package. This product is not suitable for use with a coconut husk growing media due to an acceleration of decomposition.

Microbial activator LDD-7 is a group of microorganisms which can active the process of fermentation and digestion of herbs for producing insect repellants against thrips, midges and other pests. The recommended raw materials for production of insect pest repellant consist of chili 10kg, galangal 10kg, tobacco leaf 20kg, sugar 5kg, rice bran 100g, water 60liters and Supper LDD-7 1 package.

The procedure of preparation that was developed during the pilot project is shown in the next page.

The detailed information of microorganisms for agricultural usage is stated in another technical paper.

Table-3 Procedure of Effective Utilization of LDD Microorganisms

Function	Micro-organisms	Step
Nitrogen fixing and control of pathogenic bacteria/ fungi	LDD-3&12	• Mix LDD-3, LDD-12 and rice bran in water 20 liters and stir for 5 minutes. • Mix compost, rock phosphate and perlite. • Pour the solution into compost pile and mix together. • Such materials are piled as rectangular blocks 50 cm. height and stored in a shady place. • Cover the pile and maintain moisture content at 60-70% for 7 days.
		
Plant growth promotion	LDD-2	• Chop raw materials into small pieces and put in the tank. • Dissolve sugar and LDD-2 1 package in water and stir for 5 minutes. • Pour the LDD-2 solution into fermentation tank and mix together. • Close a cover and put the tank in a shady place, and stir these substances every day for about 4 weeks. • During the fermenting process, microbial growth can be observed from the biofilm of yeast within 1-3 days, CO_2 bubbles in the solutions and alcoholic smelling.
		
Insect repellent	LDD-7	• Chop herb into small pieces put in the tank. • Dissolve sugar, rice bran and super LDD-7 1 package in water, stir 5 min. • Pour super LDD-7 solution into fermentation tank and mix together. • Close a cover and put the tank in a shady area, stir these substances every day. Fermentation time is about 26-30 days.
		

2) Results

The results of differences between coconut husk and Bio-act stones under applying conditions of LDD microorganisms showed that the growth of the pseaudobulb has no significant difference until 4 months from the time of transplanting. LDD microorganisms can act in growing media even in non-organic materials, if suitable moisture and aeration can be maintained.

Using Bio-act stones, it was found that the growth in areas such as the amount of recent pseudobulb, diameter, number of leaves, leaf width and length has no significance difference except the height that control treatment is higher.

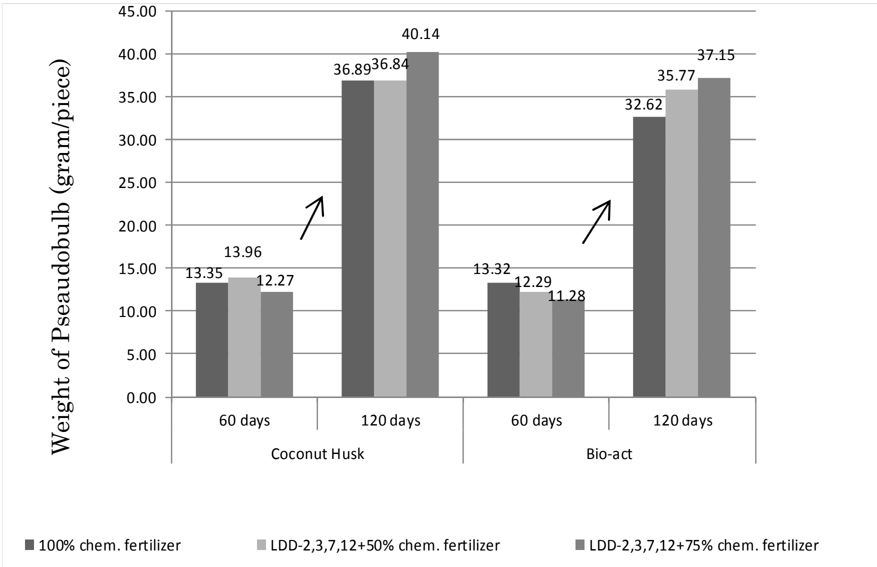


Fig-6 Comparison of Effectiveness of LDD Microorganisms in Different Media

The comparison of the recent pseudobulb weights indicates that LDD products cannot show their effectiveness visually in the initial 90 days, but they promote plant growth after 120 days. It means the bio-fertilizer can affect slowly.

LDD products for cut flower orchid cultivation can reduce the requirement of chemical fertilizer by 28% as shown in Table-4. Additionally, chemical pesticide and fungicide were not required during the pilot project.

Therefore, the production cost will be reduced in total. But it is necessary to monitor economic impacts until the harvest of cut flowers. The selling price of cut flowers is different according to the length of the stem of the flowers and number of flowers per stem.

Table-4 Farm Input Cost for Orchid Production for 4 Months

Treatment	Case-1: Purchasing Chemical Compound Fertilizer		Case-2: Self-Blending Chemical Fertilizer		Conditions:
	Farm Input Costs (Bahts/rai)	Cost Reduction Ratio (%)	Farm Input Costs (Bahts/rai)	Cost Reduction Ratio (%)	• Chemical compound fertilizer 72 baht/kg, 100 g : water 20 lit • Liquid fertilizer LDD-2 8.5 baht/liter, 40 ml : water 20 lit • Repellent LDD-7 15 baht/liter, 100 ml : water 20 lit • Bio-fertilizer LDD-3 & 12 2.5 baht/kg, 15 g for one orchid • Pesticide such as Methomyl 750 baht/kg, 10 g : water 20 lit
Chem.100%	3,763.20	-	3,200.00	-	
LDD+Chem.50%	1,907.12	49	1,854.32	42	
LDD+Chem.75%	2,367.92	37	2,315.12	28	

Source: Division of Soil Microbiology, LDD

2-3. DOA Mycorrhizae

1) Materials and Methods

Mycorrhizal fungi, also known as arbuscular mycorrhiza (AM), are species of fungi that intimately associate with plant roots forming a symbiotic relationship, with the plant providing sugars for the fungi and the fungi providing nutrients such as phosphorus to the plants. Mycorrhizal fungi can absorb, accumulate and transport large quantities of phosphate within their hyphae and release it to plant cells in the root system. Plants inoculated with AM have been shown to be more tolerant to some root diseases.

The inoculation method to orchid nurseries is very simple. Apply DOA Mycorriza at 3g per plant and spray water and liquid fertilizer onto the leaves for 2 weeks in order to infect and stabilize the spores of Mycorrhiza. Transplant the inoculated orchid nurseries to the growing media. The details regarding isolation and quantification of AM are stated in the Attachment of this technical paper.

Fig-7 Simplified Process on Inoculation of Mycorrhiza

2) Results

The experiments were conducted in 3 different growing media and different amounts of chemical fertilizer. T1 at 100% Fertilizer, T2 Fertilizer at 100% with AM and T3 at 50% Fertilizer with AM.

Remarks:
The photos are taken after 90days after transplanting at Putthipong Farm.

T1 : Chemical Fertilizer 100%
T2 : Chemical Fertilizer 100% + Mycorrhiza
T3 : Chemical Fertilizer 50% + Mycorrhiza

Fig-8 Comparison of Orchid Growth in Different Media with/without Mycorrhiza

The growth of orchid shows the difference between coconut husks, new media of Bio-act stones and concrete blocks. Without an application of AM, the orchid cannot grow well. It might be caused by slightly alkaline conditions from cement or ash of rice husks. AM provides tolerance to pH for orchid roots. There is no significant difference in growth between applications of 50% of chemical fertilizer and 100%. It means AM helps to absorb chemical compound efficiently.

However, it was confirmed that the infection ratio of AM was low at 5.52-7.22% in orchid roots. 120 days after transplanting, 2 processes of slide methods namely Wet Sieving and Decanting and Sucrose Centrifugation were conducted in order to find the infection of AM in Vesicle and Arbuscularfungus bodies in the roots, and used to count the number of spores in the planting media. The details of the analyzing methods are stated in the Attachment.

Table-5 Infection Ratio of Mycorrhiza

Analyzed Body	Puttipong Farm	Anake Farm	Adul Farm
Growing Media			
Concrete Block	4 spores	-	-
Bio-act Stone	-	3 spores	8 spores
Orchid Roots	5.84%	5.52%	7.22%

Effectiveness of AM is clearer in a non-organic growing media compared to conventional media (coconut husks). Therefore, a high ratio of infection of AM to orchid roots is an important improvement.

3. Applicability and Limitation

The growing media instead of coconut husks can be summarized as follows:

Table-6 Comparison of Growing Media and Microorganisms

Comparison Items	Coconut Husk	Bio-act Stone	Concrete Block	Non-Woven	Remarks
(1) Cost	7-13 THB/bunch	31 THB/2.5lit	7 THB/pc	Not in sale	per 4 pcs nurseries, price at Bang Len District
(2) Affection by flood in Price	Fluctuated	None	None	None	
(3) Pseudostem Growth	Fast	Fast	Medium	Slow	Pseoudostem: First flower stem
(4) Weight of Plant	Heavy	Heavy	Medium	Light	
(5) Leaf Number/ Leaf Area	High	High	Medium	Low	
(6) Root Growth	Medium	Fast	Medium	Slow	
(7) Moisture Keeping	High	High	Low	Very low	Also liquid fertilizer
(8) Breakdown of Media	1.5-2 years	4 years or more	4 years or more	4 years or more	One life cycle of *Dendrobium* is 4 years.
(9) Damage to Media by Flood	Serious	None	None	None	
(10) Disease in Media	Possibly contaminated	Clean	Clean	Clean	Coconut husks are infected by pathogenic fungi in some cases.
(11) Symbiotic with LDD Microorganisms	High	High	Medium	Medium	
(12) Littering of Stems	High	High	Medium	Low	
(13) Symbiotic with Mycorrhiza	Medium	High	High	Unknown	
(14) Reduction of Chemical Fertilizers and Pesticides by Application of Bio-Fertilizer	High	High	High	High	Reduction will be at least 25% of conventional applying volume.

Source: KU, LDD & DOA

Bio-act stones show excellent results in plant growth when using LDD microorganisms or DOA Mycorrhiza. The price is still high, but the producer of Bio-act is modifying their process of manufacturing to reduce energy costs. The farmers tend to prefer using concrete blocks due to low costs, but it is recommended to use LDD microorganisms and DOA Mycorrhiza to promote plant growth. Non-woven medium is not suitable to use for orchid cultivation due to a faster drying-up of moisture which then requires more frequent sprinkling.

Farmers previously had never applied LDD microorganisms, because they were afraid that microorganisms would accelerate the breakdown speed of the coconut husks. However, if they use non-organic materials for growing media, it is recommended to use microorganisms.

For DOA Mycorrhiza, it is recommended to isolate its strains from the roots of natural orchids. DOAE, as a coordinator of the project, is requested to continue to monitor until the harvest of cut flowers to confirm the shape and number of flowers, number of pseudobulb, preserving periods and the occurrence of pest damages.

A coconut husk is currently the most widely used planting material for cut orchid production in Thailand. After the 2011 flood, demand for coconut husk consumption has rapidly increased which caused the price to almost double from 7THB to 13 THB per bunch. Several orchid farmers have invested a larger than usual amount of money to buy coconut husk for re-planting orchid nursery in their farms. Furthermore, the coconut husk, an organic material, easily decomposes and poses the problem of becoming a primary source for pests, weeds and diseases to accumulate in. The farmers have to change this plant material or conduct re-planting after three or four years, otherwise the plants cannot grow well or even stay healthy.

Developing alternative planting material for orchids is important for further aspects of orchid production. From the research results, there were some potential materials identified that can be used for orchid cultivation for cut flowers instead of the coconut husks such as a concrete block and a bio-act stone. The concrete block is cheaper than the coconut husk and easy to find in the local markets while the bio-act stones promoted better growth of orchid. At the moment, the price of the bio-act stones is not stable yet because it has not sold on a large scale in the commercial market like the concrete block. In the future, if there are high demands for the bio-act for orchid production, the price of this material will definitely decrease.

4. Impact as Flood Countermeasure

The effect of flood damages in 2011 continue even into the beginning of 2013. The harvest areas lost for orchid cut flower in Nakhon Pathom Province was about 3,000 rai, due to the 2011 flood. Total damage in 7 provinces in Central Plain Region amounted to approximately 10,000 rai, according to DOAE. The recovery of the orchid industry is still on-going. In order to acceleate this recovery, the cooperation between several departments of MOAC, universities and private interests was evaluated as a meaningful approach by the farmers who participated in the workshop held on 27 March, 2013.

Fig-8 Flood Damages

The majority of individual farmers do not have accessibility to new technologies to recover their production in lower costs. Some farmers already started using concrete blocks with application of microorganisms. The volunteer farmers that participated in this research stated that they would be happy to to accept any farmer that wanted to visit their farms to view or learn the application methods of new growing media and microorganisms. The learning system of passing information and knowledge from farmer to farmer would be practical and reliable for the orchid industry.

Kasetsart University Kamphaeng Saen Campus is located in Nakhon Pathom Province, which is the center of the orchid producing areas. The professors and the researchers in Department of Horticulture have the networks with orchid farmers and the companies producing new growing media. The latest technologies have been developed by DOAE for bio-control technology, LDD for soil microbiology and DOA for symbiotic microbiology with plants. The combination of technologies can assist towards the recovery form flood damages, but a reliable relationship with farmers is always important.

In the pilot project, the following process was taken in order to establish the framework and to implement activities:

(1) Information exchange with DOAE regarding flood damage to orchid farmers
(2) Site survey, interviews with orchid farmers and identification of constraints
(3) Discussions with key persons of LDD, DOA, KU and the private parties to assist recovery of the orchid industries coordinated by DOAE
(4) Formation of necessary activities and input discussed with DOAE
(5) Holding the workshop to hold discussions with orchid farmers and related private parties
(6) Implementation of the pilot project assisted by LDD, DOA and KU
(7) Monitoring by farmers themselves and all stakeholders
(8) Holding the seminar regarding progress of the pilot project inviting all stakeholders coordinated by DOAE
(9) Technological transfer from the volunteer farmers of the pilot project to general orchid farmers assisted by Provincial Agricultural Extensionists (DOAE provincial officers)

The technical approaches using new growing media and microorganisms supported by the relating departments of MOAC, universities and private parties do not show immediate impact, but they do create a network of academic, governemnt and private bodies to support recovery from flood damages incurred by orchid farmers. The provision of relief materials and financial compensation are not the only solutions to help the recovery of the orchid industry.

5. Role of Government Agencies and Stakeholders

To assist with the acceleration of recovery of the orchid industry form flood damages, DOAE has an important role to coordinate with other agencies. The main constraints of farmers are the reduction of their costs or lowering of investment costs to recover production. After the flood, the farm gate price was rapidly increased due to the shortage in production. The economic crisis in the EU and the disaster in Japan (the biggest importer) have greatly reduced export amounts, while the domestic demands are expanding for use in Buddhism ceremonies and as use as decorations. The farm gate prices will be stable in the lower side. Therefore, low cost production methods are very acceptable for farmers now.

LDD products and DOA Mychorrhiza are some of the possible solutions to reduce the use of chemical fertilizer and pesticides/fungicides. The increased number of pests after floods, such as midge, thrips and fungal diseases are reduced, if farmers use bio-fertilizer. These latest biotechnologies will be accepted by farmers. But it is requested that Agricultural Production Science Research and Development Office of DOA includes the cut flower orchid as one of the target areas of produce to develop. It is recommended to multiply Mycorrhiza, which are isolated strains from natural orchids. Propagation of Mycorrhiza is conducted by a special method, not by the fermentation of plants, such as LDD products. The damage caused by midge is very serious causing flower pod drop syndrome. This special specie of midges are found in Nakhon Pathom, which deposit their eggs in the flower pod. The larva grow in the pods and take nutrients and moisture from the flower pod. The application of Beauveria bassiana developed by DOAE is recommended to control small insects together with LDD-7 and herb extracts. Additionally, the application of microbiology will be of benefit to the farmers and even the Japanese consumers, who are the largest importers. A commonly-used pesticide, Methomyl, has high lethal dose at 17mg/kg-body for rat.

Box: History of Kasetsart University on Orchid Industry Development and Human Resources Network

Commercialization of orchid industry lies in the pioneering works done by the late Prof. Dr. Rapee Sagarik of Kasetsart University, who firstly introduced orchid tissue-culture techniques to Thailand about 35 years ago. Dr. Rapee and his colleague researchers have trained many the university students in the seed propagation and tissue culture techniques that are essential for modern commercial orchid production. Dr. Rapee group has also been instrumental in assisting private companies to install proper laboratories. This work has been so effective that most of the current managers and scientific staff members of leading orchid producers are Kasetsart graduates. In addition to having received their essential training from Kasetsart University, many of these graduates maintain close relationships with other faculty researchers and obtain valuable assistance from them to solve orchid industry problems.

Kasetsart University is historically involved in the orchid industry and is famous for propagation of seeds and tissue-culture referring to the article of in the box at the right. Farmers in Nakhon Pathom Province trust deeply in technical statements from KU. A necessity or the development of alternative growing media has been focused since the amount of damage caused by the 2011 flood. The researcher commented that important factors for new growing media are aerial supply and moisture keeping. Also, it was proved that microorganisms can act on non-organic media. KU has a role as a source of new technologies. The private manufacturers of new growing media should consider reduction of their production costs and therefore a reduction in selling prices.

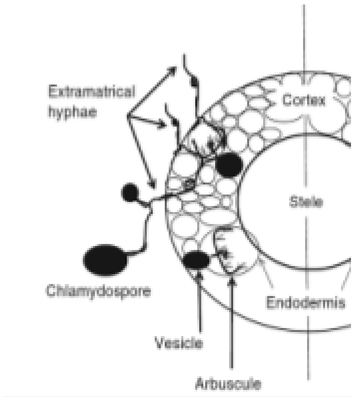
The private companies of tissue-culture laboratories such as Supa Orchids & Interlab Co. Ltd., Bankok Flowers Center Co. Ltd. and Air Orchid & Lab are the main suppliers to the orchid nurseries. They are requested to avoid any shortages in supply of orchid nurseries. Farmers started breeding by stems, but the quality of the flowers can not be guaranteeed.

The National Research Council provides the knowledge in breeding the sprouts to the orchid farmers. Their target is 1,000,000 sprouts. But orchids can easily produce mutants; for example, some mutants have their leaves in the flower stems instead of in the flower pod.

The orchid industry in Thailand accounts 3-4 billion THB in total both domestic and export markets. Quick recovery from damage caused by the 2011 flood can be achieved by collaboration of new technologies and researchers. Then reliable information transfer by farmer to farmer will prove to be most effective.

Attachment: Isolation and Quantification of Arbuscular Mycorrhiza (AM)

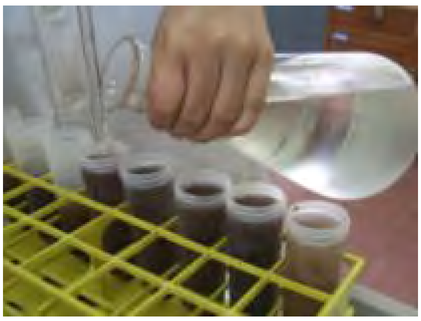
In Thailand, AM bio-fertilizer has been investigated and researched for more than thirty years. Initially the AM bio-fertilizer production was developed for use with economic fruit trees such as durian, longan, sweet tamarind, orange, lemon, pineapple, mangosteen and papaya. Bio-fertilizer can now be used for rubber tree, oil palm, asparagus and chilli. AM fungi need the symbiotic association with plants for proliferation. Therefore, culturing AM fungi is to inoculate AM fungi to host plants and to grow the inoculated plant for the AM fungal inoculums. The spores collected form soils can be used. The AM inoculums contain spore numbers of more than 25 spores per gram.



Numerous methods for the extraction of AM spores from soil exist in theory. Many of them are based on 'Wet Sieving' according to Gerdemann and Nicolson (1963) and Sucrose Centrifugation as used for the extraction of nematodes (Jenkins, 1964).

1. Isolation of AM spores from soil

① Mix a volume of soil (100 g) in water (400 ml), stir for 1 minute and allow heavier particles to settle for a few seconds.
② Pour liquid through a coarse soil-sieve (750 µm) to remove large pieces of organic debris.
③ Pass the suspension through this sieve. Wash the sieve in a stream of water to ensure that all small particles have passed through a sieve.
④ Pass the suspension through a sieve, fine enough, and retain the desired spores, which sizes are usually 63-250 µm.
⑤ Pour the sieved materials to centrifuge in test tubes. Centrifuge the spores and debris for 3minutes at 2,000 rpm. The centrifugal separator should be a horizontal sieving type.
⑥ Drain supernatant and pour prepared sucrose solution (50 % sucrose) to mix the spores and debris in centrifuge tube (50 ml).
⑦ Centrifuge the tubes for 1 minute at 2,000 rpm.
⑧ Pour supernatant through a fine sieve (63 µm) and then rinse the spores on the sieve by tap water many times until no sucrose solution.
⑨ Squeeze the spores on sieve to petri dish and then observe the spores under stereomicroscope.



Prepared paper by S. Thamsurakul, Soil Sc. Div., Dept. of Agriculture, Chatuchak, Bangkok

2. Determination of AM for colonization to plant roots

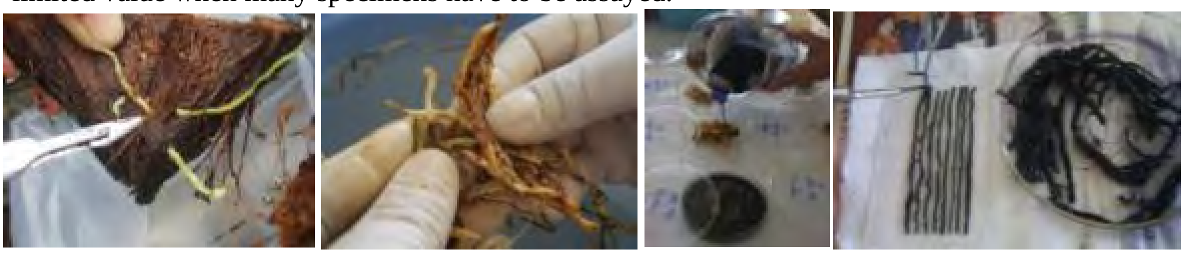
2-1. Clearing and staining of roots

Standard procedure (total AM colonization) is a modification of a common mycological staining procedure. Trypan Blue ($C_{34}H_{24}N_6Na_4O_{14}S_4$), acid fuchsine or Chlorazol Black E (CBE) in lactoglycerol is used to stain roots that have been cleared by heating in KOH (Phillips and Hayman 1970).

① Wash the roots and then warm the root in 10 % KOH at 80-90°C for 10-20 minutes depending on the kind of root plants.
② Rinse the roots in Normal HCl or tap water thoroughly in order to remove KOH.
③ Stain the roots by Trypan blue lactic-glycerol solution (Lactic acid 400ml, Glycerol 400ml, distilled water 40 ml and Trypan blue 0.05 % w/v) for overnight or 5 minutes at 90°C on the hot plate.
④ Dissect the roots in to pieces and set on slides to observe with the stereomicroscope.

2-2. Quantification of stained AM structure

By the Slide Method, the root segments, approximately 1cm long each, are selected at random from a stained sample and mounted on microscopic slides in groups of 10. Work indicates that from 30 to 100 root segments from each sample should be used for this method. Length of cortical colonization is assessed (at 100 or 250×) in millimeters for each root segment, averaged for 10 segments in a group, and expressed as a percentage of root length colonized. This method gives an assay based on total root length and takes into consideration the percentage of roots colonized, as well as the intensity of colonization. While time consuming, this method quantifies the mycorrhizal development. Using the higher magnification microscope, the fungal structures are distinctive. This procedure may be of limited value when many specimens have to be assayed.



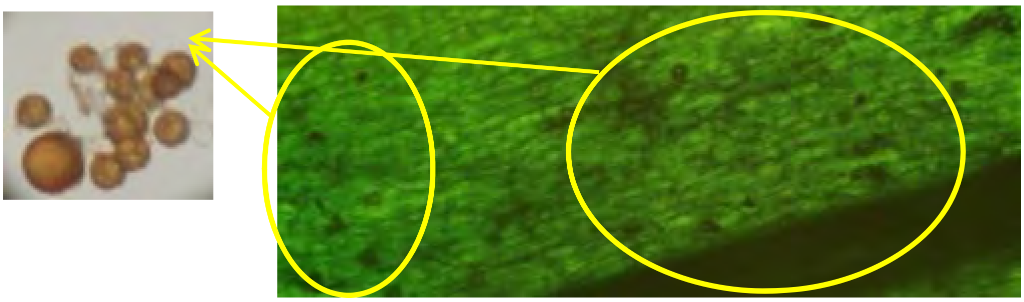


Fig-9 Quantification of AM found in Orchid Root in the Pilot Project

The Project for Flood Countermeasures for Thailand Agricultural Sector

'Guideline for Disaster Resilient Agriculture and Agricultural Community'

Technical Paper Series No. 14

Bio-Fertilizer and Bio-Control in Flood Risk Areas

Prepared by JICA Project Team,

Department of Agricultural Extension, and

Land Development Department

Bio-Fertilizer and Bio-Control in Flood Risk Areas

1. Introduction

The flood risk areas in the Central Plain are rich in deposits of minerals. But soil treatment and physical improvement are required after damage by more than 10-30 days of flood depending on the durability holding of each plant in deep water.

For paddy fields, the straw should be plowed in and fermented in the soil within 7 days after drainage of flood water. If there are immature paddy grains in the fields, all plants should be plowed in and fermented in the soil to avoid propagation of pathogenic fungi. After long-term flooding, there tends to be indications of yellow leaf symptom due to difference of nitrogenous compounds and phosphate. The lower paddy fields in the areas become rich in organic matters and minerals.

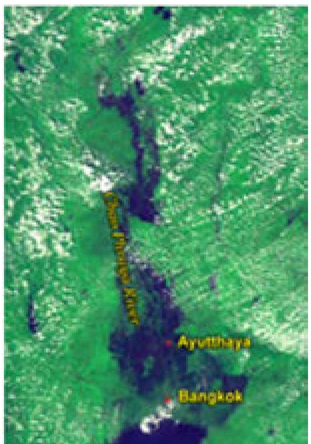


Fig-1 Flooded central plain 1 Nov.,2011 Source: JAXA

For orchards, the construction of dikes around fields with a drain system is one solution. The civil works such as removal of mud or excavation of a drain should be carried out within 1 week, but it is not easy to arrange the machinery for individual farmers. When flood water flows in unavoidably, the small particles of clay in the flood water accumulate on the top soil, which can restrict respiration of the plant roots and decrease aerobic bacteria and fungi in the soils. Many fruit gardens have been damaged by these events. Some surviving trees such as pomelo, guava and mango had shown the symptoms of dieback due to infection of wilt bacteria after the flood water had dried up.

Fig-2 Acid Sulfate Area Source: Geo-environment and Pedogenesis of Acid Sulfate Soil in Thailand

The soils in the flood risk areas have the aspects of clay, salty clay to salty clay loam. Since the particles of soils are very fine to moderately fine, and the drainage coefficient and the permeability are low, they cause negative impact on the development of a plant's roots. Exchangeable minerals of chemical fertilizers cannot reach the rhizospheric soil, which reduces the efficiency of the fertilizer. Another serious phenomenon in clay soils is the capillarity action of sulfuric ions, which forms the Acid Sulfate Soils (ASS) with high levels of acidity at 1.0-4.0 as shown in Fig-2. The ASS areas are located at the lower Central Plain from Ayutthaya to Nakhon Pathom - Pathun Thani - Chachoengsao along Chao Phraya River, Than Chi River and Bang Pakong River. The other flood risk areas, the Upper Central plain (the northern areas from Angton to Uttaradit along Chao Phraya River); also have aspects of low pH at 3.0-5.0. The mechanism of Acid Sulfate Soil/Acid Soil and influence to plants are described in the Attachment-1.

The massive application of chemical fertilizer in flood risk areas creates the phenomenon of fixation of clayish soil particles and the lowering of the fertilization efficiency, as well, the acceleration of soil acidification during the drying up of soils after inundation from flood water. Therefore, the effective methods of using bio-fertilizer are important for quick recovery from the flood damage. Pests can propagate and attack the weakening crops caused by malnutrition in essential minerals, over supply of nitrogen (urea) and propagation of pathogenic fungi in the rhizosphere. The repeated use of chemical pesticides/fungicides also leads to destroy biological diversification in soils. Some insects such as Brown Planthopper (BPH) can outbreak after floods, and they have become resistant to specific pesticides such as Neonicotinoid.

2. Contents of Technical Information

2-1. Capacity Development of Paddy and Horticultural Farmers

In highly acidic soils, the inputs of microorganisms are very effective to adapt soil conditions for plants. Importantly, the negative effect of using chemical pesticides repeatedly is that the microorganism in soils and beneficial insects will be reduced.

The leading farmers and domestic high-end consumers pay strict attention to the reduction of chemical pesticide used in farming. The viewpoint from the producer’s side is that the soils after being affected by flood or inundation in fields should be improved from solidified soils. The input costs of chemical fertilizer and chemical pesticide/herbicide/fungicide are always causing a reduction to the farmers’ income. Some pests easily gain resistance ability or develop an immunity system to chemical pesticides such as Brown planthopper. For paddy, the symptoms of orange color spot disease are commonly found and caused by *Cochliobolus miyabeanus*, where pathogenic fungus originating from soils as a result of microbiological competition in the anaerobic condition. The fruits such as mango and guava in lowlands are affected by fungal diseases after more than 10 days of inundation.

From the marketing side, the chemical residue and contamination of pests on vegetables and fruits causes serious problems. The Food Inspection Group of EU Committee banned 22 kinds of Thai vegetables from February, 2011 to January, 2012. DOA Plant Standard and Certification Office allowed exporting to EU to only 22 pack houses out of the 80 existing pack houses as of March, 2013. The pests discovered by EU quarantine inspectors are white flies, fruit flies, thrips and leaf miners. On the other hand, in domestic markets except super market supply chains, most consumers pay attention to freshness and price.

Farmers know the importance of the reduction of the use of chemical pesticides due to higher costs and health issues, but they worry about an insufficient labor force, difficulty of biological technology and extra costs. An efficient and reasonable distribution system of bio-fertilizer and bio-control agents would be of great benefit to the farmers.

For recovery of the farmers’ incomes in flood damaged areas, it is confirmed that the packaged training programs combined with the latest micro-biotechnology and local knowledge are most effective. The coordination of DOAE, DOA and LDD is important to be able to conduct this kind of training. The recommended training to leader farmers will consist of;

i) Application of available materials of bio-fertilizer and bio-control (LDD and DOA),
ii) Identification of pests and useful insects in the participatory method (DOAE)
iii) Multiplication of insect pathogenic fungi (DOAE),

iv) Production of bio-repellent using natural herbs or wood vinegar (DOAE), and
v) Seminar on Q-GAP in the case of supply to high-end consumers (DOA and DOAE)

Additionally, this training given to farmers will contribute practical activities that were part of the toward Green Economy in Rio+20 meeting (2012), which uses sustainable agriculture to create biological diversification, in flood damaged areas or retention areas.

2-2. Utilization of Microbiological Inputs (Training Program-1)

Microbiological inputs have functions known for the promoting of nutrient absorbing abilities, development of the immune system and depression of damage caused by pests. LDD Soil Microbiological Group produces and releases microorganisms for soil improvement, plant growth promotion and wastewater treatment. They are certified as safe for human and animals. The functions of LDD products are shown below:-

Table-1 List of LDD Products

Function	Product Name	Functions
Fertilization	Super LDD-1 (100g pack)	To decompose cellulose, lipid and lignin of plant residues and animal wastes and speed up the decomposing process in compost making
Fertilization	Super LDD-2 (25g pack)	To synthesize enzyme and plant growth hormone such as auxin, gibberellin and cytokinin by the fermentation of fruits in liquid fertilizer
Plant Protection	Super LDD-3 (25g pack)	To control soil-borne pathogens and nematodes
Water Quality Improvement	LDD-6 (25g pack or liquid)	To decompose organic matters in flood water or waste water, to improve BOD (biological oxygen demands) of water and to control larvae mosquitoes*
Plant Protection	LDD-7 (25g pack or liquid)	To repel insects using fermented herbs
Fertilization	LDD-9 (100g pack)	To solubilize unavailable phosphate into available phosphate in soils.
Fertilization	LDD-11 (100g pack)	To fixate nitrogen in the rhizosphere of legumes as a green manure. There are 2 kinds of packages.
Fertilization	LDD-12 (100g pack)	To fixate nitrogen and to solubilize phosphate and potassium compounds.

Note: LDD-4, 5, 8 and 10 have not been produced due to high costs. LDD 4 and 10 were the materials for organic fertilizer.
Remarks: * New LDD-6 adding *Bacillus* spp. to produce inhibitor of apoptosis protein for larvae mosquitoes will be released after May 2013.

LDD Soil Microbial Products was tested in a total of 2 rai at 8 vegetable farms with setting control plots from Nov 2012 to February 2013 in Ayutthaya. The target products were sweet basil and morning glory. The yield of plants where there was an application of LDD Microbial Products was higher in plants in control plots in same cases reaching a maximum of 150%. In terms of the improvement in soil conditions, all farmers appreciated the aggregate structure of hard clayish soils due to the high content of the remaining organic matters in soils. But the pH of soils did not show any difference. The nutritional absorbance of Potassium was excellent even in low pH conditions. The increase of absorption of Sulfur is also important in ASS areas.

For vegetable production, the training on application of LDD-2, LDD-3, LDD-7 and LDD-12 was conducted in the pilot project. The detailed results are shown in the Attchement-2.

- LDD-2 was fermented with ripe fruit, vegetable and molasses.
- LDD-3 and LDD-12 were mixed into organic compost.
- LDD-7 was fermented with herbs and molasses as an insect repellent.
- If the soils do not contain enough phosphate, LDD-9 can be added to compost.

2-3. Identification of Pests (Training Program-2)

The identification of pests is a very important process to understand their living patterns. The common pests confirmed by farmers and entomologists are as follows;

Diamond back moth (หนอนใยผัก)、Common cutworm (หนอนกระทู้ผัก)、Beet armyworm (หนอนกระทู้หอม)、Vegetable flea beetle (ด้วงหมัดผัก)、Thripidae (เพลี้ยไฟ)、Leaf roller (หนอนม้วนใบ)、Rose beetle (ด้วงกุหลาบ)、Downy mildew (ราน้ำค้าง)、Sooty mold (โรคราดำ)、
Loose smut (โรคราเขม่า)、Aphid (เพลี้ยอ่อน)、White fly (แมลงหวี่ขาว)、Rice Tungro disease or yellow orange leaf disease (โรคใบสีส้ม)、Brown spot disease (โรคใบจุดสีน้ำตาล)

The expert on pest control suggests the importance on reading labels. The chemical pesticides have different effects depending on manufacturers. If the farmers continue to use the same pesticide, the pests will gain the resistance to the effect of the chemical. Farmers are requested to report immediately to DOAE Pest Management Centers when they find any unidentified pests. The Bio-control method has no immediate reactions, but it continues to have effects in the long term.

Fig-3 Participatory Entomological Identification

2-4. Multiplication of Insect Pathogenic Fungus (*Beauveria bassiana*) (Training Program-3)

Beauveria bassiana is a common soil-borne fungus that occurs worldwide. It attacks a wide range of both immature and adult insects. Regarding the working mechanism, the hyphae of fungus penetrate the crustacean shells of the insect, and then the hyphae grow, robbing moisture and nutrients in the body of the insect. With the subsequent production of a toxic enzyme, it makes the insect die. In addition, the hyphae grow on the surface of the insect which will infect other insects coming in contact with the spores. A temperature range from 20-27°C and the relative humidity at 50% or more provides vigorous breeding of fungus. Essential equipment for multiplication by the farmer requires a clean bench and an autoclave. Other materials required can be arranged by the farmers themselves; maize as the medium for the culture, alcohol lamp, plastic mouthpiece of a bottle, inoculation rod, cotton pad, elastic band, gas/cooking stove, anti-heat polyethylene bag and disinfectant alcohol. The strains of the fungus can be obtained from Pest Management Center at provincial levels. The process of multiplication is shown in the following table:

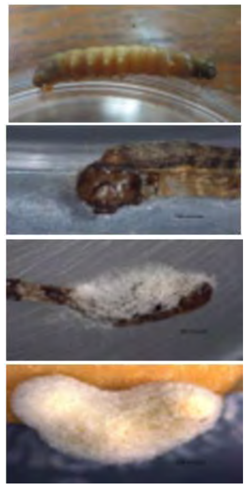


Fig-4 Infection process

Table-2 Process of Multiplication of *Beauveria bassiana*

1	Preparation of growing media		Clean maize grains (no grubs or moths, take out any contaminants, then leave 70-80 kg of maize grains, add water to soak and leave overnight (approx. 12-15 hours).
2	Drying of growing media		After soaking well, dry maize grains on a wire rack until moisture is removed.
3	Packing of growing media		Fill dried maize grains in the heat resistant plastic bags at 1 kg per bag, insert the bottleneck and cover with cotton and seal closed with rubber bands.
4	Sterilizatio n		Put the bags filled with maize grains into the 200 liter autoclave that can contain about 70-80 bags. Start boiling with water for 3 hours. After cooling, turn the valve to release the steam pressure.
5	Cooling at ambient temperature		Take out the maize grain bags from the autoclave.
6	Inoculation of Beauveria		Inoculate *Beauveria* the maize grains on a self-made Clean Bench using the seed fungus given by the Pest Control Center. One flat bottle of the seed fungus can be inoculated to approx. 50 bags or more.

7	Multiplication		Keep the inoculated maize grains in a shady and cool place for approx. 15 days.
8	Application		For 1 rai application, Pour 2 bags of (1kg) into 20 lit of clean water and filter them. Spray the liquid in the EVENING. Note: Chainat Pest Control Center promotes the installation of T-shaped bamboo-made traps of *Beauveria* for prevention of insects.

The farmers can learn the technique of multiplication methods at Learning Centers. The most critical point is to avoid contamination of the fungi, so this must be done on a clean bench. *Beauveria bassiana* has wide spectrum of attack to 63 pests including White Fly, Thrips, Cotton Bollworm, Aphid, Asiatic Cirus Psyllid, Brown Planthopper, Rice leafhopper, Red Spider Mite, etc. The seed fungus can be obtained from the following DOAE agencies:

Table-3 Breeders of *Beauveria bassiana*

Agency	Branch	Contact
DOAE	Pest Management Division	02-579-3664
Pest Management Center	Chainat	0-5642-1525
	Suphanburi	0-3548-1126
	Chonburi	0-3823-1271
	Khon Kaen	0-4324-6771
	Nakorn Ratchasima	0-4446-5081
	Chiangmai	0-5324-8072
	Phitsanulok	0-5521-1699
	Songkhla	0-7423-9250
	Surat Thani	0-7731-1525

DAOE develops *Metarhizium anisopliae* for the same biological reaction. But it takes 2 months for multiplication. The expert on bio-control in DOAE recommends using *Beuveria bassiana* for general farmers.

Fig-5 Simple Steam

2-5. Bio-Repellent (Training Program-4)

<u>Bio-Extract</u>

Thai farmers have gained experience and traditional knowledge on using natural plants for medicinal and agricultural uses. The extracts from some plants can be used for insect repellent. It is better to work together with farmer groups rather than individuals. The leaders of groups collect information about the locally available plants and their effectiveness by researching using a traditional herb dictionary or the internet. The collected plants are cut into small pieces and the extract is obtained by a steam distillation method. The materials are shown in the Attachment-3.

Wood Vinegar

Using old timbers and natural woods, the farmers can obtain wood charcoal vinegar. A steel drum with a small air intake slide is made and is fixed in place in concrete blocks. A 2” metal pipe about 8-10m long is then connected. A hole is made to where the wood vinegar is extracted.

Fig-6 Liquid extracted by

The bio-repellent of bio-extract and wood vinegar can be applied by diluting it in water at a rate of 500-1000 times. The effectiveness of these bio-repellent should be monitored by producers themselves.

2-6. Available Materials for Bio-Fertilizer and Bio-Control

In Thailand, micro-biotechnology including useful bacteria and fungi are developed by LDD, DOA, DOAE, Universities and private bodies. The functions of each product and combination of their uses in the pilot project are shown in the table below. The users should be informed that some symbiotic bacteria/fungi such as Rhizobium and Mycorrhiza only have effects on a limited variety of crops.

Table-4 Key Materials of Bio-Fertilizer and Bio-Control under the Pilot Projects

Producer	Products	Function	Major Contents	Use in the Project		
				Paddy	Veg	Orchid
LDD, Soil Microbiology Group	Super LDD-1	Activation for solid compost making	Cellulolytic fungi (*Scytalidium* sp., *Corynascus* sp., *Cheatomium* sp. *and Copulariopsis* sp.), Cellulolytic actinomycetes (*Streptomyces* sp.) and Lipid degrading bacteria (*Bacillus* sp.)	☑	□	□
	Super LDD-2	Activation for liquid fertilizer making	Yeast (*Pichia* sp.), *Lactobacillus* sp.,Proteolytic bacteria (*Bacillus* sp. Lipolytic bacteria (*Bacillus* sp.) and Phosphate solubilizing bacteria (*Burkhoderia* sp.)	☑	☑	☑
	Super LDD-3	Control of soil-borne plant pathogens	*Trichoderma* sp. *and Bacillus subtilis*	☑	☑	☑
	LDD-6	Treatment of waste water and reducing odor	Yeast (*Saccharomyces* sp.), *Lactobacillus* sp., Proteolytic bacteria (*Bacillus* sp.) and Lipolytic bacteria (*Bacillus* sp.)	□	□	□
	LDD-7	Activation for insect repellent of herbs	Yeast (*Saccharomyces* sp.), *Lactobacillus* sp. and Acetobacter (*Gluconobacter* sp..)	□	☑	☑
	LDD-9	Dissolvent of unavailable phosphorus	Phosphate solubilizing bacteria (*Burkhoderia* sp.)	□	□	□
	LDD-11	Activation for growing leguminous green manure	Rhizobium (using for *Saccharumofficinarum*and *Sunhemp*) and Phosphate solubilizing bacteria (*Burkhoderia* sp.)	□	□	□
	LDD-12	Nitrogen fixing and Solubilization of Phosphate and Potassium	Nitrogen fixing bacteria (*Azotobacter tropocalis*), Phosphate solubilizing bacteria (*Burkhoderi aunamae*), Potassium solubilizing bacteria (*Bacillus subtilis*) and Plant growth promoting rhizobacteria (*Azotobacter chroococcum*)	☑	☑	☑
	(New)	Decomposing of organic matters in	Photosynthetic bacteria (*Rodobacter* sp.), which was developed by the Project	☑	□	□

		soils				
DOA , Plant Microbiology Group	Arbuscular Mycorrhiza	Activator for rhizospheric development	Mycorrhiza (Ectomycorrhiza)	□	□	☑
	PGPR1	Activator for rhizospheric development	*Azospirillum sp., Azotobacter sp. and Beijerinckia sp.*	□	□	□
	Rhizobium	Nitrogen fixing for legumes	*Rhizobium sp.*	□	□	□
	Phosphate Solubilizing Bacteria	Solubilization of Phosphate	*Penicillium pinophilum*	□	□	□
DOAE, Pest Management Center	Beauveria	Killing insects in all stages	*Beauveria bassiana*	☑	☑	□
	Metarhizium	Killing insects in all stages	*Metarhizium flavoviride, Metarhizium anisopliae*	□	□	□
	Trichoderma	Control of soil-borne plant pathogens	*Trichoderma sp.*	□	□	□
	Predators	Enemy of pests	Green Lacewing, Earwigs(produced by Biological Control Group, Div of Pest Management, Bureau of Agricultural Product Quality Development, DOAE) Trichogramma, Predaceous Sting Bug, Assassin Bug, Ladybird beetles (produced by Regional Pest Management Centers)	□	□	□
Others Private	EM-1 or EM	General purposes including decomposing	Yeast (*Saccharomyces sp.*), *Lactobacillus* and Phototrophic bacteria (*Rodopsudomonas palustris*)	□	□	☑
	BT	Killing insects in larvae stages	*Bacillus thuriegensis*	□	□	□
	MicroField (Made in Chantaburi)	Activator for rhizospheric development	Yeast (*Saccharomyces cerevisiae, Rhodotorula rubra*), Fungis (*Aspergillus sp., Fusarium sp., Rhizopus sp.*), Bacteria (*Aerobacter sp., Nitrosomonas sp., Nitrobacter sp., Pedio Coccus spp, Achromobacter sp. , Bacillus sp.*)	□	□	□
	Bio-repellent	Alleviation of insect attacks	Extract of herbs or wood vinegar	□	☑	☑

Legend: Bio-fertilizer □Bio-control Others

Source: JICA Team, 2013

3. Application and Limitation

Although the series of bio-fertilizers is quite beneficial in promoting plant growth and yields, it will be useless where there is incorrect application and unsuitable environmental conditions (temperature and humidity). In order to apply bio-fertilizer, the following factors should be considered.

(1) Type of Crops

Prior to using bio-fertilizers, the correct selection of products should be made based on the types of crops. For example, LDD-11 and Rhizobium bio-fertilizer are suitable for use with legumes only. Each type of legume needs different strains of Rhizobium that have different qualifications. Arbuscular Mycorrhiza is not active to paddy except in cases of upland paddy due to the wet fields, which leads to anaerobic conditions in soils, and is not symbiotic with the plants of Brassicaceae family such as cabbage, mustard, broccoli/cauliflower and radish.

(2) Type of Necessary Plant Nutrients

Each type of bio-fertilizer gives different plant nutrients. So, the user needs to know which nutrients to give in the case of each certain type of plant. The bio-fertilizer produced these days mostly contain these following plant nutrients.

- Rhizobium Bio-fertilizer helps fixing nitrogen in the air that plants can utilize as a replacement of the chemical nitrogen fertilizers.
- LDD-12 and PGPR (Plant Growth Promoting Rhizobacter) such as Azotobacter, Beijerinckia and Azospirillum provides solved nitrogen compounds to the plants by fixing nitrogen in the air instead of using a chemical fertilizer.
- Mycorrhiza help to absorb the nutrients from the soil like Phosphate and can be used with many types of plants such as farm plants, fruits, flowers, some vegetables, rubber trees, fast growing plants and pines. More than 80% of plants on the earth are living in a symbiotic relation with Mycorrhiza.
- LDD-9 and Phosphate solubilizing bacteria such as Burkhoderia, Pseudomonas and Penicillium help to solubilize unavailable phosphate in soils. By utilization of unavailable phosphate, input amounts of chemical fertilizer can be reduced.

(3) Soil Properties

Before using bio-fertilizers, farmers should know the soil properties for each crop and be aware of the effects of using bio-fertilizers such as the acid-alkaline reaction, soil humidity, etc. Different types and strains of bacteria have different tolerances for each acid-alkaline condition. Some strains of the Rhizobium can grow well in the acid conditions. But if we use it in the alkaline soils, that will lower its property of fixing nitrogen and will result in inefficient replacement of the chemical nitrogen. The chemical, physical and biological properties of the soils are important factors for the growth of microorganisms.

(4) Proper Humidity in Soil

Water content in the soil is also important for the microorganisms of bio-fertilizers. Some types of microorganisms live well in inundated conditions such as Blue-Green Algae, which cannot grow in dry areas. The Rhizobium and Mycorrhiza however are opposite to the Blue-Green Algae, and these bio-fertilizers cannot fix nitrogen in anaerobic conditions. Therefore, before using bio-fertilizers, it is necessary to pay attention to the humidity in the soil.

(5) Chemical Substances for Agriculture

When using bio-fertilizers for crop production, there are some conditions where caution on using some chemical substances used in agriculture such as herbicides, pesticides as they have properties that may obstruct the microorganisms in bio-fertilizers.

(6) Amount of Some Plant Nutrients in Soil

In soils containing a high volume of organic matter, a high volume of plant nutrients such as Nitrogen can be found. Therefore, some types of bio-fertilizers seldom reveal the clear results after the application. For example, using LDD-11and Rhizobium bio-fertilizer with legumes planted on the virgin soil, the bacteria will be abundant and contain a high volume of organic matter.

(7) Recommended Application Methods of Bio-fertilizer and Bio-control by Crop

Paddy:

Table-5 Paddy: Recommended Inputs of Bio-fertilizer per Rai

Plowing	Water Intake	Paddling	Sowing or Trans-planting (0)	Basic Fertilizer Application (30days)	Plant Protection (50days)	Supplementary Fertilizer Application (60days)	Harvesting
- Plow in Plant residue - LDD-3 (25g) & 12 (100g) with compost (250kg)*	- Photo-synthetic Bacteria (1lit) - LDD-2 & 6 (2.5lit each)**	Keep flatness of fields		- NPK Fertilizer - Bio-extract LDD-2 (25lit, diluted at 1:500) - Pest repellent LDD-7 (100lit, diluted at 1:100) **	- Bio-extract LDD-2 (25lit, diluted at 1:500) - Repellent LDD-7 (100lit, diluted at 1:100) - Beauveria	-NPK Fertilizer, - Bio-extract LDD-2 (25lit, diluted at 1:500) - Repellent LDD-7 (100lit, diluted at 1:100)	Do not burn plant residue

Note: * The compost should be prepared 1 month prior to use and added with LDD-3 and LDD-12.

**LDD-2 and LDD-7 shall be fermented with ripe fruits and repellent herbs respectively with molasses and water 1 month prior to use. The fermented liquid by LDD-2 and fruits is called Bio-extract LDD-2, and the fermented liquid by LDD-7 and herbs is called Bio- repellent LDD-7.

Vegetables:

Table-6 Vegetables: Recommended Inputs of Bio-fertilizer per Rai

Plowing	Sowing or Trans-planting	Basic Fertilizer Application	Plant Protection	Supplementary Fertilizer Application	Harvesting
-Plow in plant residue - Manure 1 ton - LDD-3 (25g) & 12 (100g) with compost (250kg)*		- NPK Fertilizer - Bio-extract LDD-2 (25lit, diluted at 1:100)**	- Bio-repellent LDD-7 (25lit, diluted at 1:100)*** - Bio-extract LDD-2 (25lit, diluted at 1:100)** - Beauveria solution	- Bio-extract LDD-2 (25lit, diluted at 1:500)	If pathogenic symptom is found, put a plastic sheet on the ground surface to reduce bacteria and nematodes.

Note: * The compost shall be prepared 1 month prior to use. The recommended raw materials of compost are animal waste, rock phosphate, pearlite or dolomite and rice bran, and then added to LDD-3 and LDD-12.

**LDD-2 shall be fermented with ripe fruits and molasses and water 1 month prior to use.

***LDD-7 shall be fermented with repellent herbs and molasses and water 1 month prior to use.

Fruits and Industrial Crops

Table-7 Fruits and Industrial Crops: Recommended Inputs of Bio-fertilizer per Rai

Land Preparation	Nursery	Trans-planting	Basic Fertilizer Application	Plant Protection	Supplementary Fertilizer Application	Harvesting
Plow in plant residue	Inoculate Mycorrhiza* (6g/pc) and cover with charcoal husks	PGPR1 (500g)*with compost or LDD-3 (25g) & 12 (100g) with compost (300kg)	- NPK Fertilizer - Bio-extract LDD-2 (50lit, diluted at 1:500)	- LDD-7 (50lit, diluted at 1:100) - Beauveria, Bio-extract (1lit), or Bt**	Phosphate Solubilizing Bacteria (500g)* or LDD-9 (100g)	Fermented fruits, which cannot be sold, can be good materials for liquid fertilizer. Cover with charcoal husk or fallen leaves.

Note: * The products of DOA (Arbuscular Mycorrhiza, PGPR1, PSB and Rhizobium) are mainly developed for Coffee, Rubber Tree, Palm Tree, Fruit Tree, Legumes, Maize/Millet and some vegetables. The bacteria have different symbiotic relation to each crop. Please confirm to DOA Agricultural Production Science Research and Development Office in Rhizobium Building 2F in Bang Kaen, Krungthep (02-579-7522/3).

** Bt means *Bacillus thuringiensis*, which has a short usage period and effective on larvae stage of insects.

*** EM is also effective to use with Arbuscular Mycorrhiza.

Ornamental Plant (Orchid):

Table-8 Orchid: Recommended Inputs of Bio-fertilizer per Rai

Preparation of Growing Media	Nursery	Trans-planting	Basic Fertilizer Application	Plant Protection	Supplementary Fertilizer Application (Every 2 weeks)	Harvesting
Bio-Act or Concrete Block with coconut husk	Normally, farmers purchase from nursery (baby orchid) laboratory companies.	Inoculate Arbuscular Mycorrhiza (6g/pc).	- NPK Fertilizer - LDD-12 (15g/plant) - Bio-extract LDD-2 (20lit)	LDD-7 (10lit) and Bio-extract (1lit) Enemy insects **	- NPK Fertilizer - LDD-12 (15g/plant) - Bio-extract LDD-2 (20lit)	The damaged flower pods by thrips larvae should be removed.

Note: * It is suggested the fertilizer (300kg) contains animal waste (180kg), rock phosphate (60kg), pearlite (60kg), rice bran (3kg), LDD-3 (300g) and LDD-12 (25g).

** Enemy insects are *Trichogramma* (Parasitoid wasp) for all kinds of insect eggs and *Phytoseiulus macropilis* (Predator spider mite) for Spider Mites, which are available at DOAE Pest Management Division or Regional Pest Management Centers.

4. Impact and Flood Countermeasure

For a quick recovery from damage caused by a flood, the application of bio-fertilizer and bio-control is very effective. The farmers should consider the soil pH relating to nutritional absorbance for crops, the presence of clay that may be covering the top soil, fertilization by organic matters and sustainable plant protection from harmful insects and pathogenic bacteria in the soil.

Mycorrhiza

For paddy production, the farmers are mostly concerned with selling prices, yields and reducing production costs. The practice of introducing microorganisms can reduce the required volume of chemical fertilizer.

For vegetable production, it is very difficult to cultivate in acidic soils with less than a pH5.0. Adjustment of the soil pH using dolomite or other lime is effective, but a high volume needs to be applied. Also, microorganisms with organic matters will support to absorb nutrients for plants growing in a low pH condition.

For fruit production, many farmers have experienced suffering from i) tree dying by wilt, ii) inundation (two weeks or more), iii) extremely high temperature due to environmental changes and iv) shortage of water in the dry season. Arbuscular Mycorrhiza provides an ability to be more resistant to pathogen, high temperature and excess /shortage of water.

For orchid production, most of farmers need cash for rehabilitation of their trees from damage caused by the flood and they are also faced with lower selling prices in the EU and Japanese Markets. Therefore, any reduction in the cost of production is of benefit to the orchid farmers.

It is clear that in agricultural production, the acceleration of recovery from the damage caused by flood, can be achieved by the application of biological approaches in the Central Plain Region.

5. Role of Government Agencies and Stakeholders

There are several advantages when biological treatment methods are used in plant growth, these include promoting in acid soils, improvement of soil texture especially in clay soils, higher yields, less use of chemical fertilizers, drastic reduction of chemical fungicides and pesticides, longer preserving periods of fruits and vegetables after harvesting, safer working conditions for farmers and healthier/safer food for the consumer. But the effect on the crops will be slower than that of using only chemicals. Farmers need basic knowledge about microbiology and the utilization of local resources.

The recommendations to improve on the current situation are as follows:

(1) Diversification of distribution channels of LDD products

Currently, there are two distribution channels; LDD HQ→LDD Regional Officers→Voluntary Soil Doctors (about 70,000 persons in the whole country) →Farmers and LDD HQ→LDD Regional Officers→Self-sufficiency Economy Learning Centers→Farmers. In reality, many farmers want easier access to obtain LDD products. Therefore, alternative distribution channels to the leading farmers and Self-sufficiency Economy Learning Centers should be expanded.

(2) Information dissemination to farmers

Voluntary Soil Doctors in Tambon levels have obligations to conduct simple soil analysis and instruct on the use of LDD products. They have special training sessions twice per a year at LDD regional office levels. However, information of LDD products has not been extended in all food risk areas, even though there are many excellent Soil Doctors. Releasing the minimum budget to the excellent Soil Doctors as a lecture will accelerate information dissemination to the leading farmers. These training opportunities may initiate a new distribution system to individual farmers.

(3) Coordination of technical training relating to bio-fertilizer and bio-control

DOAE has the coordinating function for farmers of vegetables, fruits and ornamental flowers. Comprehensive training on microbiological methods can save time for the target farmers. Implementation of package training programs should be planned. The handbook published by the JICA Team can be referred to as a guide.

(4) Sharing information with Rice Department

Microbiological approaches are not strongly considered by the Rice Department officers. LDD bio-fertilizer and DOAE bio-control methods should be experienced by Regional Rice Research Centers as the first step.

(5) Development of new effective microorganisms

・Improvement of LDD-6 containing Photosynthetic bacteria for paddy fields

Although Photosynthetic bacteria have been developed during the pilot project, the effectiveness could not be proved. More experiments for paddy should be conducted, and then the results of the combination of their use with other LDD products should be shared with Rice Research Centers.

・Multiplication of Orchid Mycorrhiza Fungi

The original DOA Arbuscular Mycorrhiza is a mixture of many strains in isolated roots of various crops. Therefore, it takes time for adaptation (mutant) to orchid roots. LDD isolated 2 strains of Orchid Mycorrhiza from a natural forest during the pilot project. DOA has advanced skills for multiplication of Mycorrhiza. It is assumed the efficiency will improve after inoculation to orchid roots. The majority of farmers in Ban Len Sub-district, Nakhon Pathom, have become very interested in to introducing Mycorrhiza to their farms.

・Technical improvement of Beauveria

Beauveria has a wide spectrum effect to many pests, but the fungus should come in direct contact with the skin of pests. Also, the fungus can only activate at more than 50% relative humidity. Therefore, improvement on its adhesive function and surviving at less than 50% RH should be researched. In Japan, Beauveria extract coated with a mineral oil (BotaniGuard ES®) are commercially marketed.

Attachment-1: Acid Sulfate Soil and Acid Soil

Thailand is influenced by seasonal monsoons which bring heavy rains resulting in a rainfall of 1,000-4,000mm/year. 80% of the total yearly rain water falls during May to October. In the central plain of Chao Phraya River, organic matter and minerals with small particles of soil accumulate in the inundated fields. The flood causes damage to human properties and infrastructures, but the flood water also brings beneficial substances for agriculture. The main limitation on agricultural production in flooding and retention areas is Acid Sulfate Soil (ASS) that remains on the surface layers of the soil.

The surface soils have high levels of acidity at pH 3-5 due to the reaction of sulfate ion and ferric iron. The mechanism of acidification of ASS is shown in Fig-2. After the water dries up, acidification of soils progresses in aerobic conditions. *Thiobacillus ferrooxidans* and *Thiobacillus thiooxidans* derive energy from oxidation of ferrous iron (Fe^{2+}) to ferric iron (Fe^{3+}), and reduced-sulfur compounds to sulfuric acid. Fine sulfur deposits may accumulate in the cell wall of the bacteria. Other byproducts of the metabolism (sulfuric acid) are sometimes associated with the oxidative corrosion of concrete and pipes. Finally, aluminum ion (Al^{3+}) which is a harmful substance for plants will be released and causes high levels of soil acidity.

ASS occurs naturally. Soils and sediments are rich in quantities of sulfide minerals, which will change to iron pyrite (FeS_2). These soil layers have the potential to generate sulfuric acid when the FeS_2 material is exposed to oxygen, causing serious environmental hazards. This transition soil is called Potential Acid Sulfate Soil. The formation of oxidation of ASS is a constant and continual process of the natural sulfur cycle system. There are a number of activities that can lead to oxidation of these soils, including flood water, mitigation drains, dredging, coastal sand, mining, road construction, urban development, aquaculture and agricultural plantation.

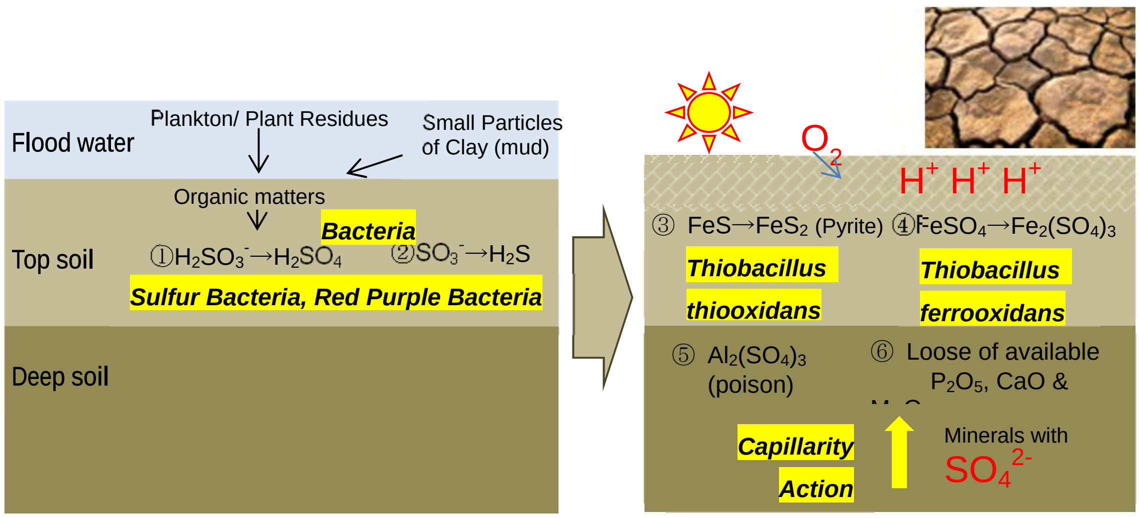


Fig-A-1 Mechanism of Acidification of ASS

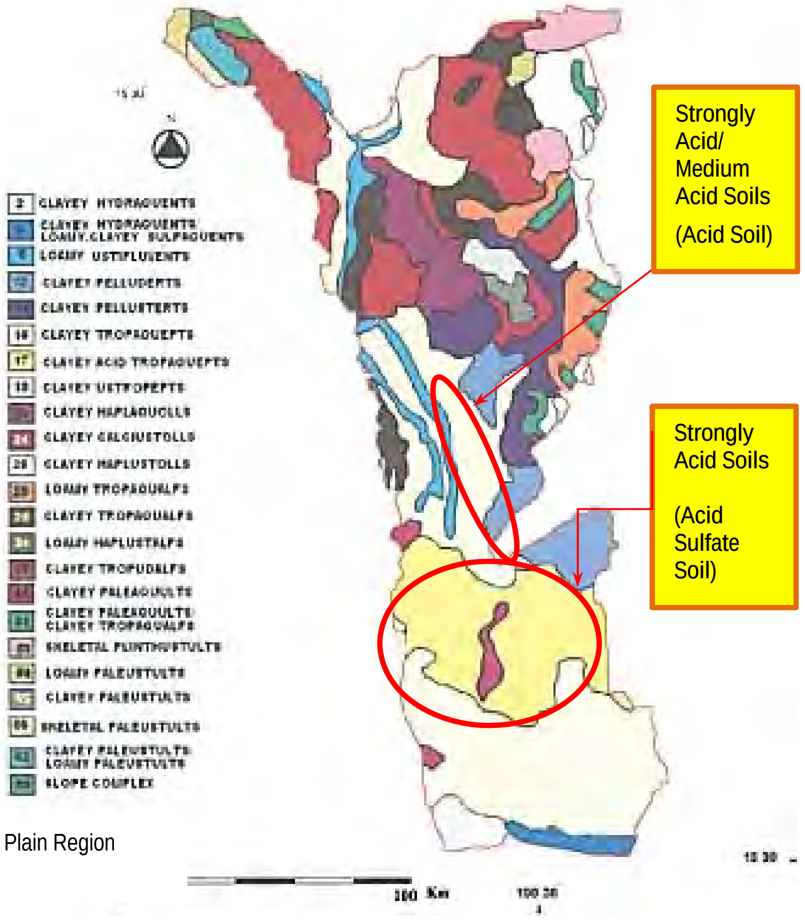


Fig-A-2 General Soil Map in Central Plain Region
Source; Soil Survey Division, LDD

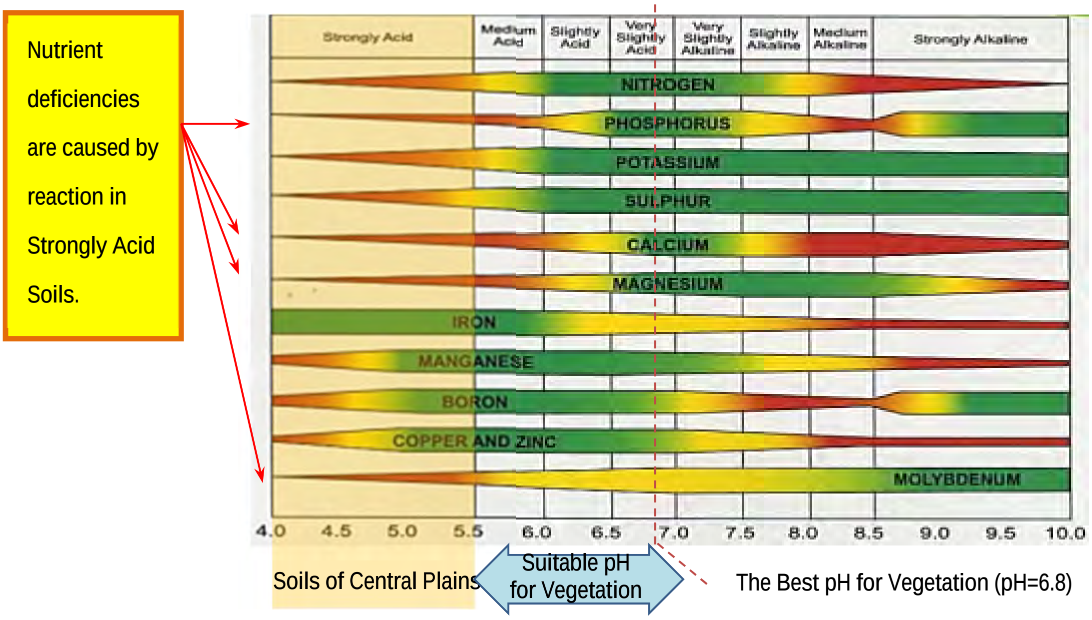


Fig-A-3 Relationship of Soil pH and Nutrients Deficiency

Attachment-2 : The Results of the Pilot Project for Safe Vegetable Production using Bio-fertilizer and Bio-control method at Singhanat, Latbruang, Ayutthaya

Table-A-1 Results of Soil Analysis

Crop: Morning Glory (Chinese var.)

Farm	Fertilizer*	Sampl-ing	pH	EC (dS/m)	Chemical Component Analysis (mg/kg)						Plant Growth			
					N org. matter	P	K	Ca	Mg	S	Height (cm)	Chloro-phyll (SPAD)	Wet Weight (kg/rai)	Dry Weight (kg/rai)
-1 Udon	100 %	Original	5.9	0.675	2690	246	210	5964	457	208	43.21	38.19	2992	148
		Harvest	6.1	0.552	2650	293	192	5875	360	525				
	75% +bio	Original	6.0	0.776	3550	71	378	5141	523	833	52.41	32.70	3696	218
		Seeding	6.2	1.174	7060	1269	836	5937	797	208				
		Harvest	6.1	0.307	3480	673	156	6157	529	182				
-2 Prapoon	100 %	Original	5.0	0.307	3520	179	216	3140	719	208	40.36	43.35	2706	158
		Harvest	4.7	0.403	3690	265	168	3335	714	229				
	75% +bio	Original	5.0	0.522	4780	705	408	3234	698	417	48.44	45.91	3360	188
		Seeding	4.9	0.661	4440	518	420	3935	786	417				
		Harvest	4.6	0.538	4150	467	96	3492	662	233				
-3 Watrapon	100 %	Original	4.6	1.332	2020	36	228	4626	738	1875	49.40	43.02	3074	172
		Harvest	4.2	1.200	2350	54	396	4313	683	1695				
	75% +bio	Original	4.4	0.313	3450	63	222	3188	528	1250	47.27	42.90	2680	134
		Seeding	5.4	0.495	4010	475	324	6061	618	208				
		Harvest	4.9	0.383	3360	318	168	4574	536	72				
-4 Watraa	100 %	Original	4.7	0.178	3850	890	252	3921	555	917	41.41	41.67	2427	130
		Harvest	5.2	0.288	3810	1107	174	3317	564	216				
	75% +bio	Original	5.6	1.148	3420	808	246	5418	784	583	46.25	43.64	2953	178
		Seeding	5.6	1.333	4310	1251	426	6428	885	1083				
		Harvest	6.0	0.347	4450	1303	192	4945	778	242				

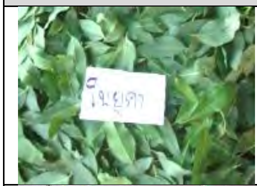
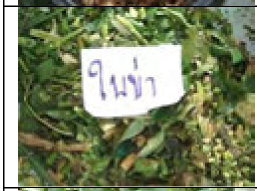
Source: Division of Soil Biotechnology, LDD

Note :
- The figures with shades show the results of application of bio-fertilizer.
- In the column of 'Fertilizer', '100%' means application of chemical fertilizer only as control plots. NPK 46-0-0 was applied 8 days after seeding, and 15-15-15 was applied after 15 days.

- '75%+bio' means application of chemical fertilizer at the rate of 75% with bio-fertilizer of LDD-2 fermented liquid, 3 and 12, and bio-control by LDD-7 fermented liquid.
- For soil sampling, 'Original' means the soil before cultivation, 'Seeding' means after improvement of the soil by LDD-3 and LDD-12, and 'Harvest' means the soil after harvest of the plants.

Attachment-3 : Materials of Bio-extract

Table-A-2 Materials of Bio-extract for Repellent, Pesticide and Fungicide available in Central Plain Region

Materials	Plant Name	Materials	Plant Name
	ใบยูคาลิปตัส (Eucalyptus leaf)		ใบทุเรียนแขก (Durian Belanda leaf, Soursop)
	พญาไร้ใบ (Milk bush, Euphorbia tirucalli)		ยาสูบ (Tobacco)
	ข่า (Galangal)		กระดังงา (Ylang-ylang Cananga odorata)
	ใบข่า (Galangal leaf)		หางไหลแดง (Derris, Tuba root)
	ใบขี้เหล็ก (Kassod tree leaf, Senna siamea)		ผกากรอง (Cloth of gold, Lantana camara, Wild sage)
	สะเดา (Neem tree)		ตะไคร้หอม (Lemon grass)
	สาปเสือ (Bitter bush, Chromolaena odorata		ใบมะละกอ (Papaya leaf)

Remarks: If the following plants are available in the areas, the farmers can mix;

ต้นแสยก (Redbird Cactus, Euphorbia tithymaloides), ใบเสาวรส (Passion fruit leaf), กระดุมทอง (Singapore daisy) and หว่านน้ำ (Mytle Grass, Sweet Flag).

The Project for Flood Countermeasures for Thailand Agricultural Sector

‘Guideline for Disaster Resilient Agriculture and Agricultural Community’

Technical Paper Series No. 15

Feed Storage for Livestock during Flood

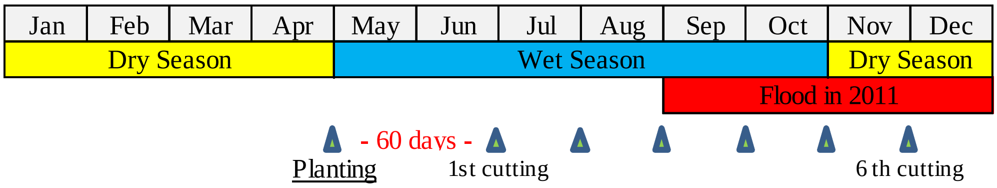
Prepared by JICA Project Team, Department of Livestock Development,

and King Mongkut's Institute of Technology Ladkrabang

A. Feed Storage for Livestock during Flood

1. Introduction

Considering that the most serious issue on animal husbandry in the 2011 flood was a shortage of animal feed, it is necessary to promote feed storage especially at a community level to cope with likely disasters in the future. It is recommended to make hay and silage during every cutting, however, climate condition must be taken into consideration.



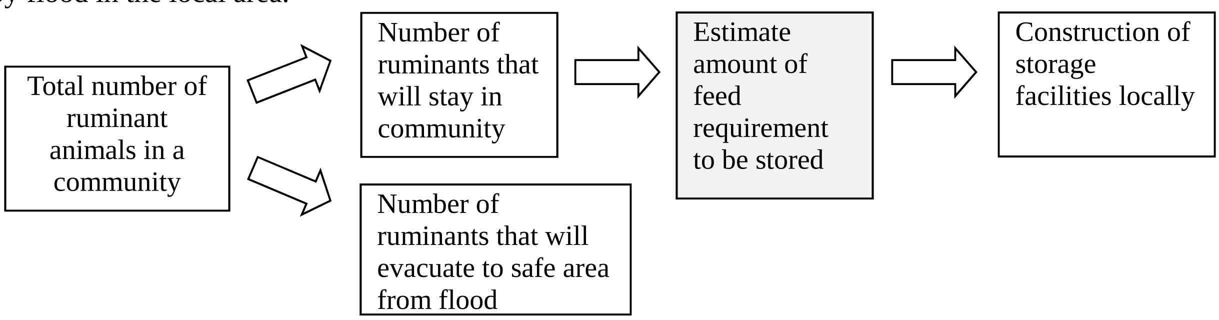
Forage Production and Hay/Silage Making

2. Contents of Technical Information

1) How to Estimate the Scale of Feed Storage

a. Identification of non-flooding areas and areas prone to flooding

At each community level where land may be affected by flood, mapping by people/farmers under control of TAO will be necessary to identify: 1) location of livestock farmers by animal type, 2) livestock farmers who will not be affected by flood, 3) the higher ground areas which are not affected by flood in the local area.



b. Identification of the Number of Targeted Ruminants

After identifying the number of targeted ruminants, those numbers have to be converted into the Livestock Unit (LU) to estimate the volume of feed to be stored in each community. LUs in Thailand are as follows:

Livestock	Livestock Unit (LU)	LU (FAO)
Cattle	1.00	0.65
Buffalo	1.00	0.70
Goat/sheep	0.15	0.10
Pig	0.38	0.25
Poultry	0.02	0.01

LU that will stay in a community even in a disaster can be calculated as shown below:

Livestock	No. of Livestock staying in a community ①	LU ②	LU=①x②
Cattle		1.00	
Buffalo		1.00	
Goat/sheep		0.15	
Total	-	-	***A***

c. Estimation of Feed Requirement to be Stored at Community Level

Generally a cattle equivalent to one LU requires 12 to 15kg of hay per day:

Items	LU=a Cattle
Assumption of body weight(kg/head)	500
Feed requirement per body weight in fresh (%)	12%
Feed requirement in fresh (kg/head/day)	60
Feed requirement in hay (kg/head/day) *	13.5

Based on the estimated number of LU in 2), hay requirement can be calculated as shown in the table below.

Estimated LU	Hay Requirement per LU (kg/LU/day)	Hay Requirement per Day B=Ax13.5	Flood Period (days) *	Hay to be Stored (ton) D=BxC/1000
A	13.5	***B***	***C***	***D***

Note: *: Flooding period shall be calculated based on figures from the 2011 flood or simulation analysis

d. Estimation of the Amount of Hay Storage

Assuming that a community plans to construct a feed storage facility for 100 LU (livestock unit) to cope with a flood period of 60 days, the scale of storage can be estimated as shown below:

Conditions	Assumption
Intake of hay per day	13.5 kg/day/LU
Flood period	60 days (to be varied depending on areas)
Number of (LU)	100 LU(100 cattle)
Requirement of hay	81.0 ton
Cubic volume of hay per ton	3.9 m^3/ton
Estimated cubic volume of hay	315.9 m^3
Height of hay bale’s heap	4.0m
Required floor area	79.21 m^2

Considering the nature of water inundation, it is recommended to construct several storage facilities scattered over several locations on higher ground within the community, rather than in one place, which will assist with effective and convenient transportation of stored hay bales when a disaster occurs.

e. Construction Materials and Costs

Based on the installed feed storage unit at Tambon Wang Man which is 8.9m x 8.9m, the cost per square meter is estimated at THB2,200. The structure of a standard type of feed storage model is as follows:

- Floor: reinforced concrete. 10 to 15 cm in thickness
- Roofing: Galvanized iron roof
- Roof truss: Steel frame
- Column: Precast reinforced concrete column. 15cm x 15cm

3. Application and Limitation

For a community where a flood is not predicted, the necessity for installation of feed storage is not so high compared with a community that will probably be flooded. However, in the event of a large scale flood such as in 2011, it would be difficult for every community to cope with feed shortage independently. It is recommended to be prepared for possible disasters including drought with mutual help at a national level involving DLD's ANRDCs. Under this concept, each community is required to have stored feed prepared, even in normal years.

4. Impacts as Flood Countermeasure

The proposed feed storage will contribute to strengthen feed supply in a time of disaster, which will keep ruminant animals healthy and productive, and help maintain livestock farmers' income, especially at smaller farming levels. Feed storage facilities constructed at non-flooding communities will be able to support livestock farmers in the flooded areas by sending them stored hay/silage. Similarly, feed storage facilities which hold a large capacity at DLD's ANRDCs will be able to support livestock farmers when a disaster occurs.

5. Role of Government Agencies/Stakeholders

The first step of supplying prepared feed storage in a time of disaster is to identify priority areas, to which stored feed shall be delivered. These areas can be identified based on the simulation study about predictable flooding areas, water depth and flooding period. DLD and other departments concerned should cooperate with each other to study in detail and to prepare detailed disaster maps to identify these priority areas. The government needs to allocate necessary budget for feed storing according to the said study, to construct feed storage facilities and replace/repair any deteriorated agricultural machinery at ANRDCs. DLD should continue holding training programs for livestock farmers putting DLD's experience to use, to increase feed storing at a community level as well as assisting the farmers 'capacity at building on livestock management. DLD should also monitor the quantity/quality of stored feed at the 29 ANRDCs. Both provincial and district DLDs should work together to survey and to monitor existing and planned feed storages at community level and make regular reports to the concerned ANRDCs and DLD HQ.

B. Forage Crop Production

1. Introduction

DLD has been promoting cultivation of Pangola grass for low land such as paddy field and Pakchong-1 for upland respectively. Pangola grass contains high protein of about 6 to 8 % and is suitable for feeding fresh or processing into hay and silage for storing. Pakchong-1 is a kind of grass which grows to a height of 4.0m and above, and contains 5 to 8 % protein and is also suitable not only for feeding fresh but also silage for storing. Feed Cost: Hay bales of Pangola grass are marketed at THB 100/Bale of 18 to 20kg and silage of Pakchong-1 at THB 54/ bag of 20 kg. Demand for Pangola hay can be anticipated for rabbits and race horses.

Profitability of Pangola grass cultivation

The flowing table shows the comparison of profit between Pangola grass and Paddy. Both in irrigated area and non-irrigated areas, Pangola grass shows a higher profit than paddy.

Comparison Table of Cost and Return (2004/05)

	Irrigated Area		Non-Irrigated Area	
	Pangola Grass	Paddy	Pangola Grass	Paddy
1. Variable costs	3,965.89	5,049.00	1,324.46	1,707.01
Wage cost	2,681.57	2,231.55	858.15	928.98
Material cost	1,245.25	2,712.45	453.07	743.71
Depreciation cost	39.07	105.00	13.24	34.32
2. Fixed costs	1,340.59	1,332.91	420.20	412.05
Land hiring cost	1,301.94	1,238.32	278.99	301.13
Depreciation cost	38.65	94.59	141.21	110.92
Total (THB/rai)	5,267.83	6,287.32	1,603.45	2,008.14
3. Yield per rai(kg/rai)	3,844.78	1,589.09	1,199.69	455.64
4. Unit sale price (THB/kg)	2.24	5.66	2.25	5.60
5. Gross income (THB/rai)	8,612.31	8,994.25	2,699.30	2,551.58
6. Net Income (THB/rai)	3,344.48	2,706.93	1,095.85	543.44
Pangola/paddy	1.24	1.00	2.02	1.00

Source. Chainat Center, DLD

2. Contents of Technical Information

1) Pangola Grass

	Pangola Grass
Suitable land for cultivation	Low land
Planting method	Seedlings
Appropriate time to plant	All year round
Application of seedlings	200 to 250 kg/rai
Application of fertilizers (15-15-15)	125 to 140kg/rai/year
Application of fertilizers (46-0-0)	110 to 140kg/rai/year
Application of compost	2,000 to 4,000 kg/rai/time x 3 to 4 times a year
First Cutting	After 60 to 70 days of planting
2nd cutting and subsequently	Every 45 to 50 days after cutting
Suitable height of cutting	3 to 5 cm above the ground
Topdressing after cutting	15 to 25 kg/rai/cutting (15-15-15)
Cutting per year	Normally 5 to 6 times a year
Expected Yield in fresh	18 to 24 ton/rai/year
Expected Yield in hay	4,000 to 6,000 kg/rai/year
Utilization	In fresh & in hay
Longevity	5 to 6 years
When flood water recedes	Immediately apply urea at 25 to 50kg/rai

In order to make good quality Pangola grass hay, dry the cut grass for 2 to 3 days until the moisture content drops to 13 to 15%, and then make hay bales using a baler machine. Store hay bales in a well-ventilated area in order to keep them in good condition.


Planting

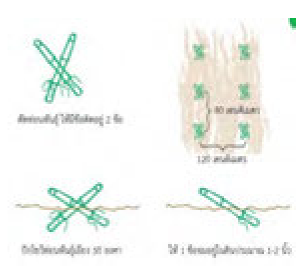

Harvesting


Baling by hay baler


Storing hay

2) Pakchong-1

	Pakchong-1
Suitable land for cultivation	Upland
Planting method	Seedlings
Appropriate time to plant	Early of rainy season
Application of seedlings	120cm x 80 cm interval
Application of fertilizers (15-15-15)	50 to 100kg/rai/year
Application of fertilizers (46-0-0)	-
Application of compost	800 to 1,600kg/rai/time x 5 to 6 harvests a year
First Cutting	75 days after planting
2^{nd} cutting and subsequently	Every 45 to 60 days after cutting
Suitable height of cutting	Closest point above the ground
Topdressing after cutting	10 to 20kg/rai (urea)
Cutting per year	Normally 5 to 6 times a year
Expected Yield in fresh	More than 77 ton /rai/year
Expected Yield in hay	-
Utilization	In fresh & silage
Longevity	6 to 8 years
When flood water recedes	-

			
Planting methods	Harvesting	Packing chopped grasses	Storing silage

It is very important when packing silage to make sure there is adequate air inside the plastic bags or plastic containers by using a vacuum blower which provides for better lactic fermentation.

3. Application and Limitation

Pangola grass can grow well in lowland such as paddy field. On the contrary Pakchong-1 is cultivated mainly on upland which receives an annual rainfall of 800mm and grows well if irrigation is available. Pakchong-1 is suitable in a wide range of soils including red loam and mildly saline soil and more suitable for silage making than Pangola grass due to its higher sugar content. Pangola grass and Pakchong-1 are propagated from seedlings.

4. Impacts as Flood Countermeasure

Generally rice straw which contains low nutritional value is fed to cattle to meet the feeling of fullness. On the contrary Pangola grass and Pakchong-1 and other forage crops contain a higher nutritional value of proteins and vitamins etc., and both can be stored as hay or silage to assist in times of disaster bought on by flooding or drought. In addition, cultivation of both forage crops brings higher benefit to farmers than paddy because of a higher demand for hay and silage by livestock farmers. In a time of disaster, ruminants will be able to maintain body health and be productive by feeding stored hay and silage made of Pangola grass and Pakchong-1. This will contribute to maintaining a regular cash income for livestock farmers even during flooding and drought conditions where feed would normally be hard to obtain.

5. Role of Government Agencies/Stakeholders

The government is required to allocate necessary budget for promoting Pangola Grass and Pakchong-1 coupled with the promotion of the construction and filling of feed storage facilities, especially at a community level. ANRDCs under DLD HQ are required to have initiative to train and demonstrate forage crop cultivation in various land conditions as well as producing and supplying the seeds/seedlings.

The Project for Flood Countermeasures for Thailand Agricultural Sector

‘Guideline for Disaster Resilient Agriculture and Agricultural Community’

Technical Paper Series No. 16

Goat Raising Tolerant to Flooding

Prepared by JICA Project Team, Department of Livestock Development,

and King Mongkut's Institute of Technology Ladkrabang

Goat Raising Tolerant to Flooding

1. Introduction

About five (5) % of the populations in Thailand are Muslim people mainly living in the southern part of the country in provinces such as Pattani, Yara and Narathiwat where more than 80% of the residents are Muslims. Muslim people have also formed communities in other areas of Thailand. In their communities, demands for goat meat, milk and milk products are high. These products are commonly in demand even in Bangkok. Goat milk's quality is similar to that of human's milk and therefore good for infants and children.

Goats are raised extensively by grazing and bring farmers a second income to supplement their main income source. Goat raising is suitable in dry areas rather than wet areas due to their characteristics. The proposed goat raising style combined with housing located on a raised floor will contribute to establishing a community more resilient to floods.

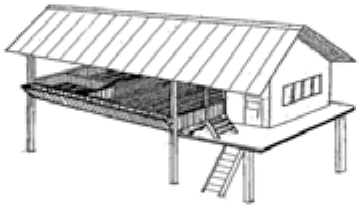
2. Contents of Technical Information

1) Optimum goat housing against flooding

Goat raisers know that good housing makes goats healthier and more productive and also facilitates better management. An ideal goat house is one that can provide maximum comfort for the goats. It can protect goats from flooding, strong winds, heavy rains, and predatory animals. The proposed goat house is well-ventilated, easy to clean and with adequate floor space. A mature goat needs a minimum floor space of 1.86 square meters.

2) Goat house design requirements

- Space required for one head of adult goat: 1.86sq.m
- Height above water level of the loafing floor: 1.0 to 1.5 m in non-flooding area and 1.5 to 2.0m floor in areas that are prone to flooding.
- Material of goat house:
    - Column support：precast concrete pile with square 10cm to 15 cm on a side or square timber of 15cm to 20cm.
    - Loafing floor: wooden slat with 5cm width & 1.0cm thickness lay with 1.0cm gaps between each slat for better ventilation and for allowing the urine and droppings (dung) to fall through the gap in the floor boards to the ground below, which keeps the area clean for the goats.
    - Roofing: corrugated galvanized iron sheets or wooden slats.



FLOOR PLAN FOR A GOAT HOUSE

Goat house in Singhanat

Loafing floor of wooden slat

Housing for a milk producing herd should be partitioned so that the kids, pregnant does, milking does and bucks are kept separate. The pen for kids should be adjacent to that of their mothers. The bucks must be kept away from the milking does to prevent milk from absorbing the smell of the bucks.

3) Costs for Housing

The cost of a goat house with a raised floor is estimated at THB 5,500/sq. m. In the pilot activity this cost included all materials and labour. The cost can be reduced if lower priced materials such as bamboo and wood are used.

4) Breeding and Feeding Models

i) Breeding

- Maturity of buck: 10 to 12months
- Time of breeding:18 months (permanent 2 teeth)
- Puberty of doe:8 to 10 months (10month preferable)
- Duration of heat:1 to 3 days
- Best service time:2 days (within heat)
- Gestation period:145 to 155 days (150 days on average)
- Oestrous cycle:18 to 21 days
- Kidding rates: single - 66.7 % and twin – 33.3 %
- Weaning period of kids:45 days (average)
- Age for marketing:buck-18 months

ii) Feeding

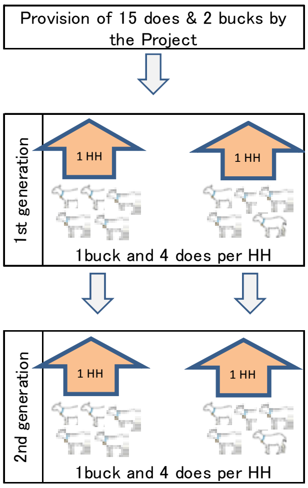
- Feed consumption:4 % of live body weight
- Feed consumption/day :1 kg /day/ head (in the case of 25kg live body weight)

3. Application and Limitation

i) Integration of Dwelling Environment for Goat

Goats prefer a dry area and are not suitable for raising in a wet area. In addition, demand for goat meat and milk is limited to the areas where Muslim people are living. Therefore, marketing and land conditions should be studied carefully when planning goat raising. On land that is prone to flooding, it is recommendable to build the floor 1.5 to 2.0m above ground level or a height that is above the water line in extreme flooding to keep the stock safe and dry.

ii) Goat Revolving System



In order to expand the benefit from the original milking goats provided by the Project to other villagers who want to raise milk goats, a revolving system is recommended. After raising kids born from the original bucks, 1 buck and 4 does will be distributed to the 1st generation. Then, the beneficiaries of the 1st generation are required to hand over 1 buck and 4 does to the 2nd generation beneficiaries. To make this system operational, supervision by the organized livestock group is necessary at the community level. Provincial and District DLD offices are required to support the system for sustainable operation. The time for delivery of kids should be planned for when the kids have grown to 8 to 10 months of age, when they are in sexual maturity. When selecting beneficiaries, it is recommendable to choose the ones who have constructed a goat house with a raised floor similar to the model goat house outlined in this paper. They should also be a member of an organized livestock group.

4. Benefits and Flood Countermeasure

Goat raising in the proposed housing with a raised floor will bring farmers a stable income during a flood period by keeping goats healthy and productive, which will strengthen farm households to make them resistant to flood impact. Raising milk goats will become a new source of income through marketing the milk and or processing it into other products such as cheese, yoghurt and soap. These products can be made by the farmers as they only require using simple equipment and techniques.

5. Role of Government Agencies/Stakeholders

There are already goat advanced farms in several areas including Kanchanaburi, Nakhon Sawan. These display a good model of goat raising under various land and marketing conditions. The DLD is required to survey applicable technology of feeding, marketing, processing and housing etc., to extend advanced technologies, and to prepare a technical manual on goat and sheep raisin

The Project for Flood Countermeasures for Thailand Agricultural Sector

<u>'Guideline for Disaster Resilient Agriculture and Agricultural Community'</u>

Technical Paper Series No. 17

Making Biogas as an Alternative Energy Source using Animal Waste

Prepared by JICA Project Team, Department of Livestock Development,

and King Mongkut's Institute of Technology Ladkrabang

Making Biogas as an Alternative Energy Source using Animal Waste

1. Introduction

In rural areas cattle and pigs are raised regardless of the conditions of flooding or non-flooding. These animals can produce a renewable energy source for cooking and lighting. However, cattle dung and pig dung being produced every day are not used effectively despite its potentiality as a renewable energy source. By installing a biogas facility on high ground in the backyard of a farm house, renewable biogas would be able to be used effectively even during the flooding period. It also has the benefit of saving costs for the household and contributes to the saving of other resources normally used for fuel, such as forestry products.

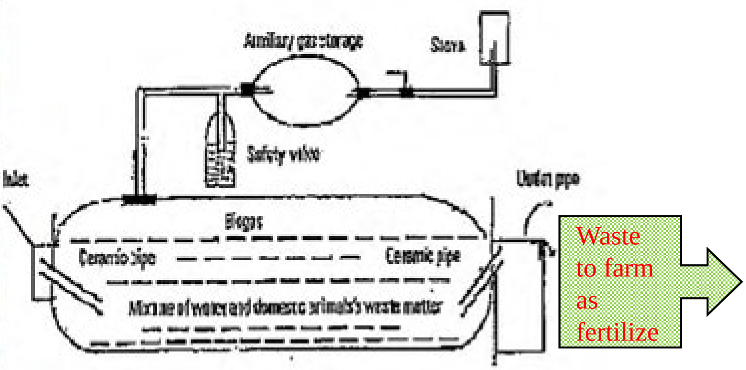
The effectiveness of the biogas facility is obtained by using by-products of animal raising and economization. The waste after fermentation can be used as organic fertilizer for soil improvement, and a family can save expenses for cooking fuel of between THB 600 to 900 a month according to the result of a biogas facility installed at Tambon Wang Man. The facility installed in the Tambon of Wang Man and Singhanat can be used for seven (7) years.

2. Contents of Technical Information

1) Structure of the Biogas Facility

The type of biogas facility typically needed for one family would be about 4.1m (L) x 1.4m (W) x 0.8m (H) in size. The structure of the proposed biogas facility is very simple, consisting of inlet and outlet pipes with 0.4m diameter and 0.8m height connected with a precast plastic container which is installed in a pit with a depth of 80cm, as shown below. The life expectancy is about seven (7) years.


Digging pit for installation



2) Site Selection for Installation

Considering convenience for putting the ingredients of cattle dung or pig dung into the facility, it should be installed near the cattle shed or pig house, and should be installed on high ground so as to stay above the water line during a flood.

3) Operation and Maintenance

Prior to utilization of biogas, it takes about 7-15 days for fermentation when using pig dung and 25-30 days when using cattle dung. Subsequently the plant requires regular supply of dung for sustainable use of biogas. The quantity of dung required is also different depending on the type. 50 kg of pig dung with 40 liters of water every 15 days if using pig dung. And if using cow dung, half a bucket of cow dung together with one bucket of water per day. When the process is complete, the waste is removed and can be used for cultivation as a source of organic fertilizer.

4) Costs

The cost necessary for the proposed biogas facility is estimated at about THB 8,000 per unit excluding the cost of excavating the pit. Investment for the facility can be recovered in 11 months (8,000/750=10.7).

3. Application and Limitation

The technology of biogas utilization can be applicable anywhere in the rural areas where cattle (dairy cow, beef cattle and buffalo) and pigs are raised. It is recommended to use village funds with a low interest rate available in a community if the investment of THB 8,000 is considered to be a big expense for farmer. It is better for year-round operation to install the biogas facility on high ground to avoid being flooded during water inundation. The biogas is not practical in flood prone areas, and animal dung would have to be purchased if there is no source of dung on the farm. If this facility is used where there is a large scale hog farm, it has the capacity to provide energy to the surrounding community, as is practiced in some places in Khon Khen.

4. Impacts as Flood Countermeasure

The proposed biogas facility applicable for a family will have a positive impact of reducing expenditure on fuel costs between THB 600 to 900 (THB 750 on average) a month. In addition, utilization of renewable biogas will contribute to the preservation of forest resources indirectly through reduction of the use of firewood. The small scale biogas facility will become a model case of effective use of animal waste/by-product produced in small to middle scale livestock farms. During the inundation period in the flood season, the biogas is useful for cooking and lighting for households compared to the LPG which is difficult to access when the area is inundated.

5. Role of Government Agencies/Stakeholders

DLD already has experience in the installation, operation and management of the small to middle scale biogas facilities. In fact there are some biogas facilities in ANRDC under DLD. Therefore, 29 ANRDC is required to extend biogas utilization technology further in areas where cattle and pigs are raised as the JICA Study Team implemented in Tambon Wang Man and Singhanat. The installation and use of larger facilities for more biogas power generation for big livestock farms is recommended. It is possible to expand the use of biogas when applying the program of zero-waste policy in PACO and Sufficiency Economy.

The Project for Flood Countermeasures for Thailand Agricultural Sector

<u>'Guideline for Disaster Resilient Agriculture and Agricultural Community'</u>

Technical Paper Series No. 18

Bamboo Variety and Local Knowledge to Use Bamboo for Flood Protection

Prepared by JICA Project Team and

Center of Excellence for Bamboos, Kasetsart University

Bamboo Variety and Local Knowledge to Use Bamboo for Flood Protection

1. Introduction and Objectives

Thailand is regarded as one of the centers of distribution of bamboos in the world (Dransfield, 1994). However, the numbers of bamboo species used domestically are limited to only some common ones such as *Dendrocalamus asper*, *D. membranaceus*, *Gigantochloa albociliata*, *Thyrsostachys siamensis* and *Bambusa bambos*. There may be more potential bamboos that can be better used for different purposes. It was estimated that there are 15-20 genera and 80-100 species of bamboos growing naturally in Thailand (Sungkaew et al., 2011). Knowledge on what bamboo species can tolerate the flood and local wisdom in using bamboos for flood countermeasures is still limited. Therefore, review and survey on this issue is urgently needed.

The objective of the survey is to review the potential of bamboo by their different varieties and investigate the local methods to use it for flood countermeasures. The survey contains four contents as follows;

(1) To conduct literature review on local bamboo varieties and prepare a list and category of bamboos;

(2) To collect information on how to use bamboos in local areas. Consolidate local knowledge on utilization from literature and interview of communities proposed by the Institute;

(3) To collect information on tolerance to flood. Consolidate local knowledge on tolerance to flood and information of the actual situation during the 2011 flood in central, lower, North and Northeast regions;

(4) To conduct a survey and interview concerned with selected local knowledge as flood countermeasures, and

(5) To review processed products of bamboo in different forms which are currently available in Thailand.

This technical paper describes general information, results and considerations of the bamboo survey.

2. Methodology

(1) Literature reviews or an interview on local bamboo varieties was conducted and a list and category of bamboos was compiled.

(2) Surveying and collection of the potential different bamboo specimens will be carried out in the flood-prone areas particularly in Phitsanulok, Chainat, and Phra Nakhon Si Ayutthaya Provinces.

Bamboos in other regions for example riparian forests along the Mun River of northeastern and the Tapi River of southern Thailand were also investigated.

(3) Information on; 1) how to use bamboos in local areas and 2) tolerance to flood, was collected

(4) Local knowledge on; 1) utilization from literature and interview in communities and 2) tolerance to flood and information during the actual situation of the 2011 flood in those three provinces, were consolidated.

(5) Collection of information on the value of each processed product from bamboo and its utilization. Price of products, process of value adding, variety of bamboo suitable for particular processing information was gathered.

3. Results of the Surveys

3.1 Review and survey of the potential different bamboo species and local wisdom on how to use bamboos for flood countermeasures

Twenty four survey points were conducted in five regions of Thailand as follows (see map in Figure 1):

(1) Northern region (6 survey points)

In Uttaradit province (1 survey point), we selected tambon Wang Kaphi (Mueang district-47G: 0616940/1938910) to be a survey point, the flood level was around 10-20 centimeters high in 2011. This area was affected by flooding for 1-1.5 months. After the flood, two bamboo species were found thriving in the area. They were Pai Si suk (*Bambusa blumeana* Schult.f.) and Pai Sang mon (*Dendrocalamus* sp.)

In Phitsanulok province (2 survey points), Tambon Chum Saeng Songkhram (Bang Takam district-48Q: 0612465/1860737) and tambon Nakhon Pamak Bang (Bang Krathum district-47Q: 0644272/1833848) were the survey areas. The flood level was around 1.5-2 meters high in 2011. These areas had been submerged for 2-5 months. Four bamboos were found to be flood tolerant species. They were Pai Pa (*B. bambos* (L.) Voss), Pai Kim sung(*B. beecheyana* Munro), Pai Si suk, Pai Khiew (*B. vulgaris* Schrad.) and *Unknown species* or Pai Liang.

In Phichit province (2 survey points), Tambon Pai Luang (Taphan Hin district-47Q: 0650188/1790819) and tambon Phum (Bang Mun Nak district-47Q: 0653278/1773083) were the survey areas. The flood level was around 0.3-1.5 meters high in 2011. These areas had been submerged for 1-3 months. Only Pai Si suk was found to be a flood tolerant species.

In Nakhon Sawan province (1 survey point), we selected Tambon Takhiean-luean (Muang district-47P: 614026/1727626) as the survey area. The flood level was around 1 meter high in 2011. This area was affected by flooding for 3 months. Only Pai Si suk was found to be a flood tolerant species.

(2) Northeastern region (5 survey points)

Five survey points were selected; tambon Sa-kae (Satuk district, Buri Rum province-48P: 0324569/1696320), tambon Yang Sawang (Rattana Buri distrct, Surin province-**48**P: 392379/1689119), tambon Khong chiam (Khong chiam district, Ubon Ratchathani province-48P: 550641/1689601), tambon Chanod (Wan Yai district, Mukdahan province-48Q: 471156/1849560) **,**and tambon Chaiyaburi (Tha Uten district, Nakhon Phanom province-48Q: 442777/1950897). The flood level was around 1-6 meters high in the rainy season. These areas were affected by flooding for 1-2.5 months. Three bamboo species; Pai Pa (*B. bambos* (L.) Voss), Pai Si suk (*B. blumeana* Schult.f.) and Pai Kasa (*B.* cf. *flexuosa*) were found thriving in these areas.

(3) Central region (11 survey points)

In Phra Nakhon Si Ayutthaya (Ayutthaya) province (3 survey points), we selected tambon Kob Chao (Bang Ban district-47P: 0658883/1587389), tambon Singhanat (Lad Bau Luang district-47P: 651525/1564939) and tambon Phai Phra (Bang Sai district-47P: 0655222/1572189) to be survey points, the flood level was around 1-2 meters high in 2011. These areas had been submerged for 2-4 months. Two bamboo species were found thriving in the area. There were Pai Si suk and Pai Kim Sung.

In Chainat province (3 survey points), tambon Wung Man (Wat Sing district-47P: 0599749/1679321), tambon Makham Tao (Wat Sing district-47P: 0612530/1686020) and tambon Khao Kaew (Sapphaya district-47P: 0639197/1674728) were the selected survey areas. The flood level was around 0.5-2 meters high. These areas had been submerged for 1 week to 4 months. Three bamboos were found to be flood tolerant species. There were Pai Si suk, Pai Kim sung and Pai Liang.

In Prachin Buri province (2 survey points), we selected two villages (Wung Hang and Nong Iamn in tambon Wung Hang (Kabin Buri district-47P: 0794124/1548613) as the survey areas. The flood level was around 1 meter high. The areas had been submerged for 2 weeks to 1 month. Three bamboos; Pai Si suk, Pai Ruak (*Thyrsostachys siamensis* Gamble) Pai Thong (*Schizostachyum brachycladum* (Kurz) Kurz) and Pai Liang were found to be flood tolerant species.

In Ang Thong province (1 survey point), we selected Chai Yo district-47P: 0654501/1623079) as the survey area. The flood level was around 1-2 meters high in 2011. This area was affected by flooding for 4 months. Pai Si suk and Pai Kim sung were found to be a flood tolerant species

In Nakhon Pathom province (2 survey points), we selected two tambons (tambon Salaya, Bhauddha Monthon district-47P: 642786/1523384 and tambon Bang Thasi, Bang Len district-47P: 0633821/1548088) as the survey points, the flood level was around 1 to 2 meters high. These areas were affected by flooding for 1-2 months; six different bamboo species were found thriving in the areas of survey. They were Pai Pa, Pai Kim sung, Pai Khiew, Pai Lammalok, Pai Ruak and Pai Si suk.

(4) Eastern region (1 survey point)

In this region, we selected tambon Thep Nimit (Khao Saming district-48P: 0220540/1777311) Trat province as the survey point. The flood level was around 50 centimeters high. It was affected by flooding for 1 month. Three bamboos; Pai Si suk, Pai Khiew Khao Saming (*B. beecheyana*) and Pai Lammalok (*B. longispiculata* Gamble) were found to be flood tolerant species.

(5) Southern region (1 survey point)

We selected tambon Phanom (Phanom district-47P: 483881/981658) Surat Thani province as the survey point. The flood level was around 30 centimeters high. It has been submerged for 1 week. Two bamboos; Pai Pa and Pai Dampra (*Gigantochloa ligulata* Gamble) were found to be flood tolerant species.

Bamboo species names, local names, origin, habitat, and local use are listed in Table 1. The local methods of using bamboos for flood countermeasures are shown in Table 2. Brief descriptions for the species and pictures of their habit and habitat are provided. We also classified bamboos into three categories according to their limits of tolerance to flooding (Table 3).

3.2 Findings of flood tolerant species and local knowledge/methods to use bamboo as flood countermeasures

There were no existing technical reports on what bamboo species can tolerate the flood in Thailand. The list of all bamboos given here are from the surveys. Even though many varieties of bamboos can be found in many different habitats in Thailand and people have known how to use them since ancient times, there has never been information gathered or recorded on which bamboo species can tolerate the flood and how people can utilize bamboo during the flood (Rungnapa et al., 2002; Sungkaew et al., 2011).

From the surveys, 11 different bamboo species, in total, were found thriving and healthy in the areas surveyed, after the floods. They were Pai Pa (*Bambusa bambos* (L.) Voss), Pai Kim sung (*B. beecheyana* Munro), Pai Si suk (*B. blumeana* Schult.f.), Pai Kasa (*B.* cf. *flexuosa* Munro), Pai Lammalok (*B. longispiculata* Gamble), Pai Khiew (*B. vulgaris* Schrad.), Pai Sang mon (*Dendrocalamus* sp.), Pai Dam pra (*Gigantochloa ligulata* Gamble), Pai Thong (*Schizostachyum brachycladum* (Kurz) Kurz), Pai Ruak (*Thyrsostachys siamensis* Gamble), and Pai Lieang (Unknown).

The most tolerant to the flood is the genus *Bambusa* (*e.g.* Pai Pa, Pai Kim sung, Pai Si suk, Pai Kasa, Pai Lammalok, and Pai Khiew). These six bamboo species of *Bambusa* can be regarded as high potential bamboo species to be used as flood countermeasures. This is due to their flood tolerance and the observation that they can usually stand submersion for longer than 1 month during a flood.

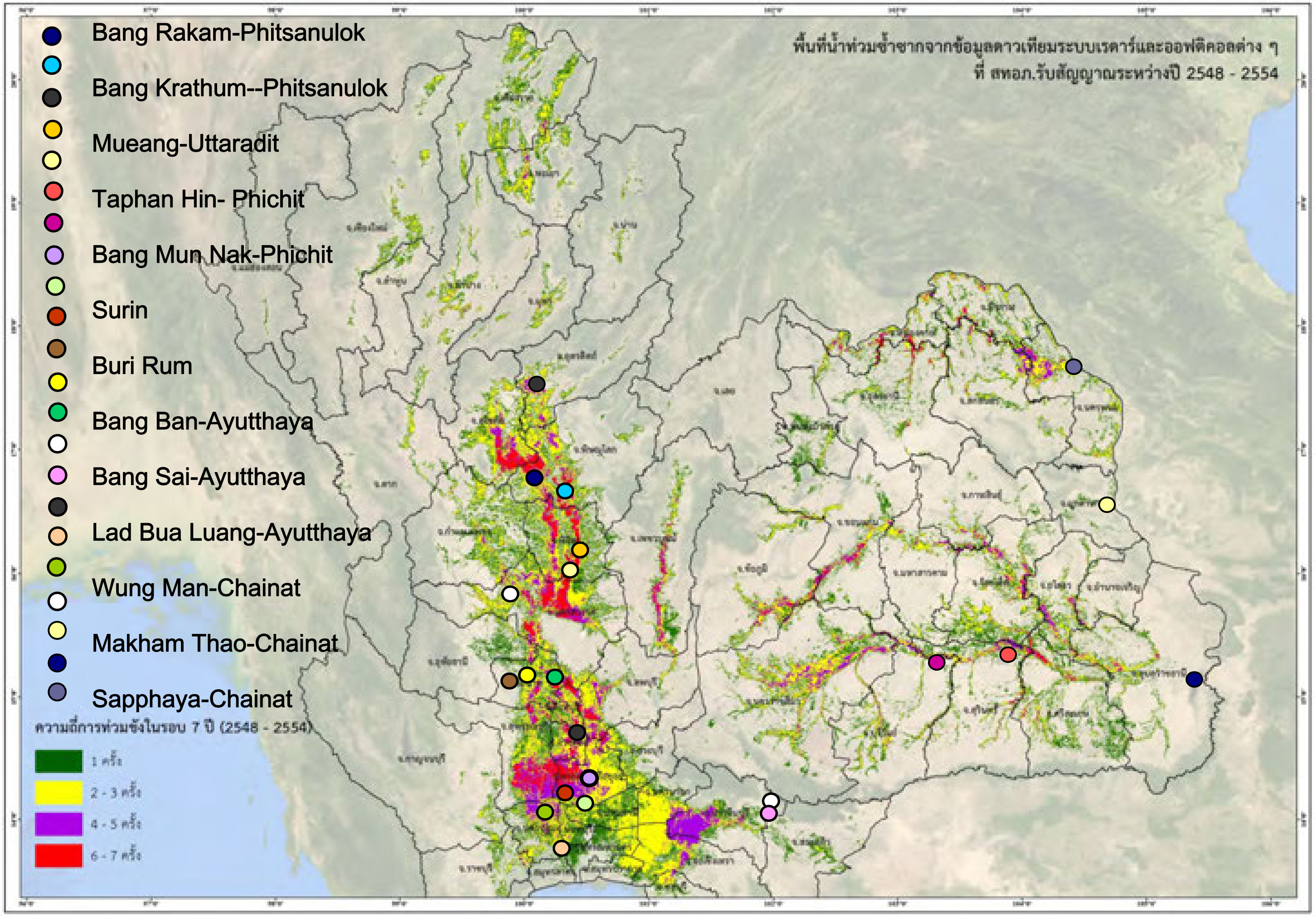


Figure 1 Thailand flood map (except eastern and southern regions, adapted from http://flood.gistda.or.th)

Table 1 Classification of differences between bamboo species, origin, habitat and local uses

Species*	Local name	Origin	Habitat	Local uses	Provinces	Flood tolerance
Bambusa bambos (L.) Voss	Pai Pa, Pai Nham	Native	Cultivated, usually found close to a river	Construction, handicraft, fence, fuel, Shoots (as food)	Nakhon Pathom Phitsanulok Surat thani Ubon Ratchathani Mukdahan	2 months 5 months 1 week 2 months 1-2.5 months
B. beecheyana Munro	Pai Kim sung, Pai Tong Luem Laeng	Exotic Introduced from China?	Cultivated	Shoots (as food) Charcoal Chopsticks Barbeque skewers Incense Sticks	Nakhon Pathom Ang Thong Ayutthaya Chainat Phitsanulok Trat	2 months 4 months 1-4 months 4 months 5 months 1 month
B. blumeana Schult.f.	Pai Si suk	Native?	Cultivated, usually found close to the river	Shoots (as food), construction, handicraft, fence, culm (the stem) as a food container (Khao Lam), thin bamboo-strips used as rope	Nakhon Pathom Ang Thong Ayutthaya Chainat Prachin Buri Phitsanulok Uttaradit Phichit Nakhon Sawan Trat Buri Rum	2 months 4 months 1 month 1-2 months 1 month 5 months 1 month 3 months 3 months 1 months 2 months

Table 1. (continued)

Species*	Local name	Origin	Habitat	Local uses	Provinces	Flood tolerance
Bambusa cf. *flexuosa* Munro	Pai Kasa, Pai Pa, Pai Lueai, Pai Pum, Pai Nam	Native	Riverbanks and riparian forests	Shoots (as food), preventing stream and riverbank erosion	Surin Buri Rum Nakhon Phanom	1-2.5 months 2 months 1-2.5 months
Bambusa longispiculata Gamble	*Pai Lammalok*	*Native*	*Cultivated*	*Plant supports, mussel farming, blocking waves, furniture*	*Nakhon Pathom* *Trat*	*2 months* *1 month*
B. vulgaris Schrad.	*Pai Khiew*	*Native*	*Cultivated*	*Construction, fence*	*Nakhon Pathom* *Phitsanulok*	*2 months* *5 months*
Dendrocalamus sp.	*Pai Sang mon*	*Exotic*	*Cultivated*	*Ornamental Furniture*	*Uttaradit*	*2 weeks*
Gigantochloa ligulata Gamble	*Pai Dam pra*	*Native*	*Cultivated, edge of plantation areas or near pond or roadsides*	*Handicraft, leaf for food wrapping*	*Surat Thani*	*1 week*
Schizostachyum brachycladum (Kurz) Kurz	*Pai Thong*	*Native*	*Cultivated*	*Ornamental plant*	*Prachin Buri*	*1 month*
Thyrsostachys siamensis Gamble	*Pai Ruak*	*Native*	*Cultivated*	*Shoots (as food), construction, handicraft, fence, furniture*	*Nakhon Pathom* *Prachin Buri*	*2 months* *1 month*
Unknown	*Pai Liang*	*Native?*	*Cultivated*	*Shoots (as food), construction, handicraft, fence*	*Prachin Buri* *Chainat* *Phitsanulok*	*2 weeks to 1 months* *1 month* *2 months*

*Species descriptions given as **Attachment -1**

Table 2 The local methods of using bamboos as flood countermeasures

Species	Local name	Local methods of using bamboos as flood countermeasures
Bambusa bambos (L.) Voss	Pai Pa, Pai Nham	Shoots (as food)
		Fishing contraption, handicraft, flood resistant fencing or wave blocking, raft, bridge, house construction
B. beecheyana Munro	Pai Kim sung, Pai Tong Luem Laeng	Shoots (as food)
		Raft, bridge, house construction
B. blumeana Schult.f.	Pai Si suk	Shoots (as food)
		Raft, bridge, house construction, thin bamboo-strips used as rope, fishing contraption, flood resistant fencing or wave blocking
B. cf. *flexuosa* Munro	Pai Kasa, Pai Pa, Pai Lueai, Pai Pum, Pai Nam	Shoots (as food)
		Thin bamboo-strips used as rope
B. longispiculata Gamble	Pai Lammalok	Raft, bridge, house construction
B. vulgaris Schrad.	Pai Khiew	Raft, bridge, house construction
Dendrocalamus sp.	Pai Sang mon	-
Gigantochloa ligulata Gamble	Pai Dam pra	Handicraft, leaf for food wrapping
Schizostachyum brachycladum (Kurz) Kurz	Pai Thong	-
Thyrsostachys siamensis Gamble	Pai Ruak	Shoots (as food)
		Raft, bridge, house construction
Unknown	Pai Liang	Shoots (as food)
		Raft, bridge, house construction

Table 3 Bamboo categories, classified by their limits of tolerance to flooding

No.	Species	Local name	Bamboo categories*
1	*Bambusa bambos* (L.) Voss	Pai Pa, Pai Nham	2
2	*B. beecheyana* Munro	Pai Kim sung, Pai Tong Luem Laeng	2
3	*B. blumeana* Schult.f.	Pai Si suk	2
4	*B.* cf. *flexuosa* Munro	Pai Kasa, Pai Pa, Pai Lueai, Pai Pum, Pai Nam	2
5	*B. longispiculata* Gamble	Pai Lammalok	2
6	*B. vulgaris* Schrad.	Pai Khiew	2
7	*Dendrocalamus sp.*	Pai Sang mon	1
8	*Gigantochloa ligulata* Gamble	Pai Dam pra	**1**
9	*Schizostachyum brachycladum* (Kurz) Kurz	Pai Thong	1
10	*Thyrsostachys siamensis* Gamble	Pai Ruak	1
11	Unknown	Pai Liang	1

*Bamboo categories, classified by their tolerance to flooding with regard to the period spent in water.
(flood level at 0.3-1.5 meters high)
1 = intolerant i.e. less than 1 month
2 = tolerant i.e. greater **ntha**1 month

4. Processed bamboo products

In Thailand, bamboo has become involved a great deal in the people's lifestyle and forms a close relationship with local people. It is an inexpensive raw material that is easy to get and utilize. There are many factories or groups of people dealing with several kinds of processed bamboo production in Thailand. Some produce bamboo houses, bamboo furniture and decorating products for home and garden use. Some produce bamboo products for exportation and many had shifted to bamboo-based industries producing chopsticks, tooth picks, bamboo blinds, bamboo screens, bamboo trays, bamboo boards, charcoal, and other uses. Since bamboo has played an important role in the Thai society for a long time, many bamboo product producers still like to produce profitable bamboo handicrafts or bamboo basketry, the arts of which have been adopted from their former generations. For the Thai community, bamboo has been proved to be a potential source of cash with low production costs. The development and utilization of bamboo in Thailand from these communities are demonstrated in OTOP products. “OTOP” stands for ‘**O**ne **T**ambon (meaning sub-district) **O**ne **P**roduct’. It is a local entrepreneurship stimulus program which aims to support the unique locally made and marketed products of each Thai sub-district all over Thailand. At present, these products have become high value-added export products of Thailand.

Currently, the different uses of bamboos found in Thailand and value adding by processing, comprise of bamboo furniture, bamboo floor, bamboo arbor, bamboo house, bamboo charcoal and bamboo charcoal products, bamboo basketry, woven bamboo bag, bamboo craft, bamboo vase, bamboo lamp, bamboo lantern, ceramics coated with woven bamboo, bamboo earring and barrette, bamboo watch box, canned bamboo shoot, coiled bamboo product, bamboo fiber, bamboo fish trap and bamboo umbrella, and others.

5. Conclusion and recommendation

Even though they have the bamboos growing in the flooding areas, people these days, almost ignore the potential to use the bamboo as a flood countermeasure. Information from the interviews, however, showed that some of them (mostly of old generation of more than 50 years of age) still keep the knowledge on local methods of utilizing bamboos during the flood. These local ways include uses such as (see also in Table 2); 1) bamboo shoot for food, 2) bamboo culm for house construction, particularly for making temporary shelters during the flood, 3) bamboo culm for making utensils *e.g.* basketry, many kinds of fish traps, 4) bamboo culm for making rafts and bridges, and 5) bamboo plants growing as the wind-breaks and bamboo plants that reinforce the soil which helps to protect soil erosion along the river banks, *etc.*

According to the study ***Bambusa blumeana*** and ***Bambusa beecheyana*** would be the most potential bamboo species to be recommended to grow in the area that is prone to flood. They can last, based on the surveys, in the flood for up to 5 months (see Table 1). However, *B. blumeana* is a thorny bamboo. Thus, finding the one with less thorns or soft thorns would be better suited for use. *Bambusa blumeana*, of uncertain origin, is a bamboo of Thai culture and has been around since ancient times. People usually grow them as the fences around their villages and to show their territory and also to use as windbreaks, and also to make houses and utensils for everyday life. It can usually be found along the banks of rivers or canals and that helps to prevent soil erosion. Its shoot is edible but, nowadays, it is hardly ever seen selling in any market. *Bambusa beecheyana*, may have been introduced from China, and it started to be well-known to Thais about 20 years ago. It has very thick culm walls and is very suitable for charcoal and vinegar production. Its young shoot is also quite popular and the “in season” price is around 10-20 baht/Kg while that of “out of season” price can be as high as 50 baht/Kg.

Attachment -1 Variety of Bamboo

Thai name: **Pai Pa, Pai Nham**
Botanical name: ***Bambusa bombos* (L.) Voss**

Synonyms: ***Arundo bambos* L., *Bambusa arundinacea* (Retzius) Willdenow**

Common name: **Giant thorny bamboo**

A medium to large bamboo, with pachymorph rhizome system. **Culms** compact, 10-25 m tall, tips arching; internodes 15-45 cm long, 5-15 cm in diameter; walls 1-3 cm thick; young culms with white powder; mature culms dark green or grayish-green; with a thicket of spiny branches at the clump-base; nodes more or less swollen, with rootlets at lower ones. **Branch complements** branching all nodes, lower part with leafless and spiny branches, leafy branches start from the mid-culms, several branches per node, middle branch dominant, with 2 sub-dominant branches, the rests smaller and similar in size, usually un-rooted. **Foliage leaves**: lanceolate or linear, 5-15 cm by 0.5-1.5 cm. **Culm sheaths** greenish-yellow, with purple streaks, covered sparsely with brown hairs or glabrous. **Culm-sheath blades** dome-shaped or broadly deltoid, erect to spreading, with dense dark brown to black hairs inside. **Culm-sheath auricles** broadly lobed, usually asymmetry, with dense dark brown hairs inside, rims occasionally hairy. **Culm-sheath ligule** 1-2 mm high, margin with long hairs. **Pseudospikelets** 1-2 cm long, without glumes, 3-4 perfect florets and 1-2 reduced florets; rachilla internodes elongated and disarticulating below the florets; lodicules 3; stamens 6, filaments free, anthers yellow; stigmas 3.

Ecology and distribution: Scattered along streams in mixed deciduous forest or dry evergreen forest.

Use: Planted as living fences. Culms for constructions, pulp and plywood industries, weaving, traditionally used in sticky rice cooking (Khao-larm). Young shoots are edible.

Thai name: **Pai Kim sung, Pai Tong Luem Laeng**

Botanical name: ***Bambusa beecheyana* Munro**

Common names: **Beechey bamboo, Silk-ball bamboo**

A medium bamboo, with pachymorph rhizome system. **Culms** up to 15 m tall; internodes 25-45 cm long, 7-12 cm in diameter; walls 1.5-2 cm thick; young culms covered with white powder, below the node with a ring of brown hairs; mature culms dark green, more or less zigzag, lower nodes with aerial roots. **Branch complements** branching from mid-culm upwards, 3 to many branches per node, only the middle one dominant, or the middle one dominant and accompanied by 2 sub-dominant branches from its base, the rest smaller and similar in size. **Foliage leaves** oblong-lanceolate, 10-30 cm by 1.5-5 cm. **Culm sheaths** yellow or greenish-yellow, glabrous or sparsely hairy. **Culm-sheath blades** ovate or oblong-lanceolate, erect to spreading. **Culm-sheath auricles** inconspicuous or small lobes with few bristles. **Culm-sheath ligules** about 0.5-1 cm high, margin dentate.

Ecology and distribution: Native to southern China. Introduced to Thailand for its edible shoots.

Use: Culms for construction. Its shoots are edible.

Thai names: **Pai Si suk, Mai Si-suk**

Botanical name: ***Bambusa blumeana*** **J.H. Schultes**

Common names: **Spiny bamboo, Thorny bamboo, Thorny branch bamboo**

A Medium to large bamboo, with pachymorph rhizome system, very similar to the Giant Thorny bamboo (*B. bambos*). **Culms** erect, very dense, 10-25 m tall; internodes 15-50 cm long, 5-15 cm in diameter; walls 1-3.5 cm thick; young culms with thin white powder and with a ring of dark brown hairs just below the node; mature culms green or yellowish-green; with a thicket of greenish-yellow spiny branches at the clump-base; nodes swollen, with rootlets at lower ones. **Branch complements** branching all nodes or almost all, leafy branches starting from mid-culm upwards, several branches per node, middle branch dominant, with 2 sub-dominant branches, the rest smaller and similar in size. **Foliage leaves** lanceolate-linear, 7-20 cm by 1-2.5 cm. **Culm sheaths** yellow, yellowish-green or orange-green, glabrous or covered with brown hairs, densely towards the base. **Culm-sheath blades** lanceolate, dome-shaped or narrowly deltoid, erect to spreading, with sparse hairs inside. **Culm-sheath auricles** broadly lobed, continuing from the culm-sheath blade, slightly wavy, covered with brown hairs. **Culm-sheath ligules** 5 mm high, margin with long hairs. **Pseudospikelets** 1.5-3 cm long, 0-1 glume, 3-7 perfect florets and 1-3 reduced florets; rachilla internodes elongated and disarticulating below the florets; lodicules 3; stamens 6, filaments free, anthers yellow; stigmas 3.

Ecology and distribution: Uncertain origin, but it is believed to be native in Sumatra, Java to Borneo.

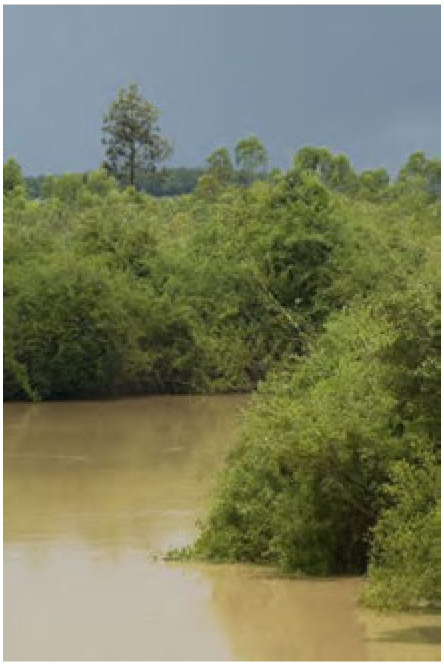
Use: Cultivated as living fences or wind-breaks. Culms for constructions, basketry, traditionally used in sticky rice cooking (Khao-larm). Young shoots are edible.

Thai names: **Pai Kasa, Pai Pa, Pai Lueai, Pai Pum, Pai Nam**

Botanical name: ***Bambusa cf. flexuosa* Munro**

Common names: **Lesser Thorny bamboo**

A small to medium bamboo, with pachymorph rhizome system, very similar to the Giant Thorny bamboo (*B. bambos*). **Culms** basally flexuose, very dense, 6-7 m tall; internodes 20-30 cm long, 5-6 cm in diameter; walls thick, nearly solid; young culms with thin white powder and with a ring of dark brown hairs just below the node; mature culms green; with a thicket of greenish-yellow spiny branches at the clump-base; nodes swollen, with rootlets at the lower ones. **Branch complements** branching all nodes or almost all, leafy branches starting from mid-culm upwards, several branches per node, middle branch dominant, with 2 sub-dominant branches, the rest smaller and similar in size. **Foliage leaves** lanceolate-linear, 7-11 cm by 1-1.5 cm. **Culm sheaths** yellowish-green or purplish-green, glabrous or covered with brown hairs, sometime with yellow to white strips. **Culm-sheath blades** narrowly deltoid, erect to spreading. **Culm-sheath auricles** inconspicuous. **Culm-sheath ligules** 5 mm high, margin with long hairs.



Ecology and distribution: Native, usually found growing along riverbanks and in floodplain areas in the Northeastern area.

Use: Young shoots are edible. Preventing stream and riverbank erosion, blocking flood flow during rainy season, provide cooling, shade for fish breeding areas and material for making handicrafts.

Thai name: **Pai Lam Malok**

Botanical name: ***Bambusa longispiculata*** **Gamble ex Brandis**

Common names: **Mahal bamboo**

A medium bamboo, with pachymorph rhizome system. **Culms** 110-12 m tall; with straight culm and loose clump, tips arching; internodes 35-45 cm long, 4-7 cm in diameter; walls about 1 cm thick; young culms covered with white powder, below the node with a ring of brown hairs; mature culms dark green, lower nodes with aerial roots. **Branch complements** branching from mid-culm upwards, 3 to many branches per node, only the middle one dominant. **Foliage leaves** oblong-lanceolate, 9-15 cm by 1-1.5 cm. **Culm sheaths** yellow or greenish-yellow, covered with white wax and brownish to black hairs. **Culm-sheath blades** dome shape or broadly deltoid, yellowish-green to orange, erect. **Culm-sheath auricles** broadly conspicuous lobed, margins glabrous to hairy. **Culm-sheath ligules** short rim, margin hairy.

Ecology and distribution: Native to tropical and sub-tropical Asia.

Use: Culms for construction, fence, poles. Cultivated for ornamental use.

Thai name: **Pai Khiew**

Botanical name: ***Bambusa vulgaris*** **Schrader ex Wendland**

Common name: **Common bamboo**

A medium bamboo, with pachymorph rhizome system. **Culms:** erect, dense or loose, 10-20 m tall, tips arched outwards; internodes 20-45 cm long, 5-10 cm in diameter; walls 1-2 cm thick; mature culms

dark green and shiny; occasionally with rootlets at lower nodes. **Branch complements:** branching low or from mid-culm upwards, several branches per node, middle one dominant, usually un-rooted. **Foliage leaves:** linear or lanceolate, 5-25 cm by 1-3.5 cm. **Culm sheaths:** green, covered with dark brown to black hairs. **Culm-sheath blades:** broadly deltoid to broadly lanceolate, erect to slightly spreading. **Culm-sheath auricles:** broadly conspicuous lobed, 1-2 cm high, covered with pale brown hairs. **Culm-sheath ligules:** about 5 mm high, margin with scattered bristles.

Ecology and distribution: Native to tropical and sub-tropical Asia.

Use: Culms for construction, poles. Cultivated for ornamental use.

Notes: Both of its green form (Pai Khiew) and the other 2 cultivars; Pai Lhuang (Yellow bamboo, *B. vulgaris* cv. Vittata (Riviere & Riviere) McClure and Pai Nam-tao (Buddha,s Belly bamboo, *B. vulgaris* cv. Wamin McClure, can tolerate the flood.

Thai name: **Pai Sang mon**

Botanical name: ***Dendrocalamus* sp.**

Common name: **-**

A medium to large bamboo, with pachymorph rhizome system. **Culms** 15-20 m tall; internodes 30-35 cm long, lower internodes often abnormally shot, 5-15 cm in diameter; walls thick; young culms covered with white powder, lower nodes with aerial roots. **Branch complements** branching from mid-culm upwards, 3 to many branches per node, only the middle one dominant, or the middle one dominant and accompanied by 2 sub-dominant branches from its base, the rest smaller and similar in size. **Foliage leaves** oblong-lanceolate, 10-20 cm by 1-3 cm. **Culm sheaths** green to grayish-green, covered with white wax and dark purplish-brown to black hairs. **Culm-sheath blades** purplish-green, lanceolate, erect to spreading. **Culm-sheath auricles** wavy with few bristles. **Culm-sheath ligules** membranous, margin dentate.

Ecology and distribution: Uncertain origin. Introduced to Thailand.

Use: Culms for construction, furniture and cultivated for ornamental**.use**

Thai name: **Pai Dam pra**

Botanical name: ***Gigantochloa ligulata*** **Gamble**

Common name: -

A small bamboo, with pachymorph rhizome system. **Culms** very dense, 6-9 m tall, tips arched outwards; internodes 20-40 cm long, 2-5 cm in diameter; walls thick or solid; young culms covered with strigose hairs, occasionally yellow streaked yellowish-green. **Branch complements** branching from lower-culm upwards, many branches per node, only the middle one dominant, the rest smaller and similar in size, sometimes with aerial roots. **Foliage leaves** lanceolate, 15-40 cm by 4-7 cm. **Culm sheaths** green to greenish-yellow, covered with dark brown hairs. **Culm-sheath blades** dark green to purplish-green, lanceolate, erect to spreading. **Culm-sheath auricles** inconspicuous. **Culm-sheath ligules** membranous, 2-3 cm long, margin laciniate.

Ecology and distribution: Native to tropical Asia.

Use: Culms used for making handles. Leaves used for wrapping. Shoots for food.

Thai name: **Pai Thong**

Botanical name: ***Schizostachyum brachycladum*** **Kurz**

Common name: Golden bamboo, Scared Bali bamboo

A small to medium bamboo, with pachymorph rhizome system. **Culms:** erect, dense, 7-20 m tall, erect; internodes 25-50 cm long, 5-8 cm in diameter; walls thin; young culms covered with white powder or glabrous; mature culms green or yellow completely, occasionally yellow streaked green; lower nodes without adventitious roots. **Branch complements:** branching low or from mid-culm upwards, many branches per node, all slender and sub-equal in size, usually without aerial roots. **Foliage leaves:** lanceolate, oblong or linear, 10-35 cm by 2-5.5 cm. **Culm sheaths:** greenish-brown to yellow, covered with brown hairs. **Culm-sheath blades:** dome-shaped or ovate, inflated at base, erect. **Culm-sheath auricles:** small lobes, margins bristly. **Culm-sheath ligules:** about 2 mm high, margin ciliate to sub-entire. **Pseudospikelets:** 1-2 cm long, glumes none, 1-2 perfect florets and end up with a barren rachilla extension; rachilla internodes elongated and disarticulating below the florets; lodicules 3; stamens 6, filaments free, anthers maroon; stigmas 3.




Ecology and distribution: Found from peninsular Thailand to Java. This species has 2 forms, the green-culmed form (Pai Po) and the yellow-culmed form (Pai Thong). The former form usually occurs in tropical rain forests while the later form is normally found in cultivation.

Use: The yellow-culmed form is very popular for planting as an ornamental plant.

Thai names: **Pai Ruak, Mai Ruak**
Botanical name : ***Thyrsostachys siamensis*** **Gamble**
Common names : **Monastery bamboo, Siamese bamboo, Thai bamboo Umbrella bamboo, Thai umbrella bamboo**

A small bamboo, with pachymorph rhizome system. **Culms** erect, very dense, 3-10 m tall, usually covered with persistent old culm sheaths; internodes 10-30 cm long, 2-5 cm in diameter; walls thick, usually solid in lower internodes; mature culms grayish-green; usually without rootlets at lower nodes.

Branch complements branching from mid-culm upwards, 3-5 branches per node, middle branch dominant, with 2 sub-dominant branches, the rests smaller and similar in size, un-rooted. **Foliage leaves** narrowly linear, 5-15 cm by 0.5-0.8 cm. **Culm sheaths** pale brown to purplish-green, often with dark streaks, covered with white or gray hairs. **Culm-sheath blades** triangular to lanceolate, erect. **Culm-sheath auricles** inconspicuous or absent. **Culm-sheath ligules** very short, margin lacerate. **Pseudospikelets** 1-1.5 cm long, 1-2 glumes, 2 perfect florets; rachilla very short and disarticulating below the florets; palea of the lower floret deeply-divided; lodicules 3; stamens 6, filaments free, anthers greenish-yellow, stigma 1.

Ecology and distribution: Commonly found in mixed deciduous forest, occasionally in deciduous dipterocarps forest, in northern, western and northeastern Thailand. Also found in Burma.

Use: A very useful bamboo. Culms used for construction, poles, pulp and paper, furniture, handicrafts, umbrellas and broom handles, *etc.* Shoots are edible, and very popular. Cultivated as an ornamental plant.

Thai names: **Pai Lieang, Pai Sang Prai**
Botanical name: *Unknown*

A small to medium bamboo, with pachymorph rhizome system. ***Culms*****:** erect, dense or loose, 7-12 m tall, tips arching; internodes 15-35 cm long, 3-5 cm in diameter; walls thick; young culms with thin white powder, above and below node with rings of white hairs mixed with white powder; mature culms green to yellowish-green; lower internodes hairy or glabrous; lower nodes usually without rootlets, sometimes present at the very low nodes near the ground. ***Branch complements*****:** branching from mid-culm upwards, several branches per node, middle branch dominant but not much larger than the rest ones, usually un-rooted. ***Foliage leaves*****:** lanceolate or linear, 10-20 cm by 0.7-1 cm. ***Culm sheaths*****:** yellowish-green to yellow, covered with brown hairs or glabrous. ***Culm-sheath blades*****:** triangular to lanceolate, dull green to purplish-green, erect**.** ***Culm-sheath auricles*****:** not well developed, or presented as the small plicate or wavy lobes, bristly to glabrous. ***Culm-sheath ligules*****:** *ca.* 0.5 cm high, margin lacerate.

Ecology and distribution: Origin unknown, maybe a hybrid. Cultivated all over the country.

Use: A versatile bamboo species. Culms for construction, poles, furniture, *etc.* It is one of the most popular ornamental bamboos in Thailand. The young shoots are edible.

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The Project for Flood Countermeasures for Thailand Agricultural Sector

<u>'Guideline for Disaster Resilient Agriculture and Agricultural Community'</u>

Technical Paper Series No. 19

Bamboo Utilization in the Form of Powder, Charcoal and Vinegar and Its Proposed Applications in Agriculture

Prepared by JICA Project Team and

Center of Exellency for Bamboos, Kasetsart University

The Project for Flood Countermeasures for Thailand Agricultural Sector

Bamboo Utilization in the form of *Powder, Charcoal and Vinegar* and Its Proposed Applications in Agriculture

1. Introduction (Objectives)

To utilize bamboo in the form of powder is a relatively concept new for Thailand. The bamboo powder can be used in a variety of ways *e.g.*, for fertilizer, feed for livestock, or even cosmetics. Using bamboo as feed for livestock is of interest particularly to those people in the flood areas, since it is difficult to find other forage, especially from pastures, to feed their animals during the flood.

Bamboo charcoal and vinegar are only well-known to some people in Thailand. Bamboo charcoal (so-called Biochar) can be used not just for cooking but also for other purposes such as water purification, air purifier *etc.* Bamboo charcoal is better than other wood charcoals as it has more surface area, bringing an increase in its ability to attract and hold (absorb) a variety of chemicals, minerals, radio waves, and other harmful substances. Likewise, bamboo vinegar, a by-product from bamboo charcoal production, can also be used for different purposes, depending on the concentration, for improvement of soil quality, elimination of pests, plant growth control (as it is able to accelerate the development of roots, stems, tubers, leaves, flowers, and fruit *etc.*). Thus, instead of using other woods to produce charcoal, replacing those woods with bamboos would be ideal not only to save the trees but also, because of its very fast growth rate (in some species of bamboo it is up to 1 meter high/day) it can compete against all other fast-growing tree species.

This technical paper emphasizes new uses of bamboo in the form of powder, charcoal and vinegar. The information shown here is based on the results both from the experiments and also from existing information available.

2. Technical Information

2.1 Study on bamboo in powder form

Dr. Masatoshi Watanabe (Secretary General, Japan Bamboo Association, *personal communication*) mentioned that the bamboo powder can be used in a variety of ways *e.g.* for feed for livestock, fertilizer, or even for cosmetics. In the flood-prone areas, using the bamboo powder as feed for livestock or fertilizer is of great interest because people have difficulties finding other forage, especially from pastures, to feed their animals during the flood. It can also save their money for buying fertilizer to treat theirs crops after the flood. The study on the potential of using bamboo species is concentrates mostly on its use for feed. Some preliminary studies on its use as a fertilizer made from bamboo powder look promising.

Methodology

Steps for making the food for livestock are as follows (Dr. Krailas Kiyothong, specialist on Animal Husbandry, *personal communication*);

1) The powder is obtained by scratching the powder from the bamboo culm (preferably the 1-year-old culm) using a bamboo powder machine.

2) The bamboo powder is mixed with molasses (optional) in a plastic bag and the air is sucked out of the bag using a vacuum cleaner.

3) The mixture is left at room temperature and under the shade for 21 days.

4) The silage is then ready to feed the livestock.

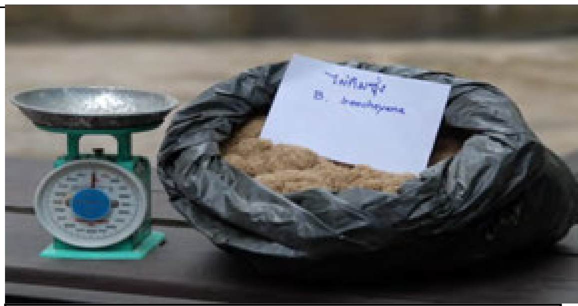
Tests to be conducted

The nutrient content and the cost-benefit of bamboo powder as feed for livestock will be analyzed. The results of that analysis will be shown later in this paper. The impact of soil improvement by applying bamboo powder will be preliminary tested.

Results

Two potential bamboo species, *Bambusa beecheyana* and *B. blumeana* are chosen for the study.Steps for making silage are shown in Figure 1.

Bamboo powder from the culm of *B. blumeana* in a plastic bag



Bamboo powder from the culm of *B. beecheyana* in a plastic bag

Remove the air, using a vacuum cleaner

The bag is sealed and left at room temperature for 3 weeks

The bamboo powder silage is ready to be eaten

A sample of the silage will be taken for the analysis of nutrient, both for feed and fertilizer

A sample of the silage will be taken for the analysis of nutrient, both for feed and fertilizer

Figure 1 Steps for making silage from bamboo powderThe Cost-benefit analysis for making silage of bamboo powder for feed can be calculated as follows:

This calculation is for making a 30 Kg. bag of bamboo powder silage.

1. Fresh bamboo (10 baht/culm)	30 baht
2. Labor cost	**30** baht
3. Electricity (based on the average/unit of the year 2013**(**3.76x5 units)	18.8 baht
4. Depreciation rate of the bamboo powder machine (60,000x0.00118)	**70.8** baht
5. Depreciation rate of the vacuum cleaner (4,500x0.00118)	**5.31** baht
6. High grade plastic bag and rope	**2** baht
Total	**156.91 baht**
Average	**5.23 baht/Kg**

**Depreciation rate followed JICA*

Results of the important nutritive values for livestock analyzed by the Animal Nutrition Laboratory, Department of Animal Science, Faculty of Agriculture, Kasetsart University, using the Proximate analysis followed the method of Association of official analytical chemists (A.O.A.C., 2000), are shown here. The values analyzed were as follows;

1/ Moisture
2/ Crude Protein
3/ Crude fat or ether extract, EE
4/ Ash
5/Crude fiber, CF
6/Nitrogen free extract, NFE, which is obtained from the calculation using the formula; % NFE = 100-[%Moisture+%Ash+%CP+%EE+%CF].

The results compared to those values of the rice straw, are shown below in Table 1.

The results of some important nutritional value (for using bamboo powder as fertilizer), particularly N, P, and K, analyzed by the Soil-Fertilizer-Environment Scientific Development Project, Department of Soil Science, Faculty of Agriculture, Kasetsart University, are shown below in Table 2.

Table 1 Nutritive values for livestock obtained from bamboo powder (before making silage)

Nutritive value	**Result (%)**			**Method used**
	Bambusa blumeana [% compared with rice straw]	**Bambusa beecheyana [% compared with rice straw]**	**rice straw***	
.1Moisture	**6.03** [70]	**5.7** [66]	**8.60**	AOAC (2000), Chapter 4 p.1#4.1.03, 100-Dry Matter
.2Crude protein, CP	**2.63** [32]	**1.94** [24]	**8.14**	AOAC (2000), Chapter 4 p.27#4.2.09
.3Crude fat or Ether extract, EE)	not found [0]	not found [0]	**1.78**	AOAC (2000), Chapter 4 p.33#4.5.01
.4Ash	4.83 [28]	3 [18]	16.98	AOAC (2000), Chapter 4 p.5#4.1.10
.5Crude fiber, CF	42.25 [153]	43.33 [157]	27.66	AOAC (2000), Chapter 4 p.36#4.6.02
.6Nitrogen free extract, NFE	44.46 [106]	46.03 [110]	41.84	% NFE = 100-[%Moisture+%Ash+%CP+%EE+%CF]
Average	**64**	**62**		**(% compared with rice straw, excluding Moisture)**

*Source: Bureau of Animal Nutrition Development, Department of Livestock Development (http://www.dld.go.th/nutrition/Research_Knowlage/RESEARCH/research_full//**2527**R**.1-2701**pdf)

Table 2 Nutritional value of bamboo powder (for use as fertilizer)

Nutritional value	**Result (%)**		
	Bambusa blumeana [% compared with rice stubble]	**Bambusa beecheyana [% compared with rice stubble]**	**rice stubble***
.1Total Nitrogen, **N**	0.27 [53]	**0.25** [49]	**8.60**
.2Available P_2O_5, **P**	**0.09** [64]	**0.12** [86]	**8.14**
.3Water Soluble K_2O, **K**	**0.74** [48]	**0.81** [52]	**1.78**
Average	**55**	**62**	**(% compared with rice stubble)**

*Source: http//:www.dailynews.co.th/agriculture/163781

2.2 Study on bamboo in the form of bamboo charcoal and vinegar

Because the supply of wood to use for charcoal production is becoming harder to come by these days, the use of bamboo as a material for charcoal production, is an interesting alternative, not only just to save the trees but because of its very fast growth rate (up to 1 meter high/day for some species) bamboo can compete against all other fast-growing tree species as well. Bamboo charcoal can be used not only for cooking but also for other purposes such as water purification, air purifier etc. Bamboo charcoal is better than wood charcoal as it has a larger surface area so it has the ability to attract and hold (absorb) a variety of chemicals, minerals, radio waves, and other harmful substances. Bamboo vinegar can be obtained, as the by-product, from the production of bamboo charcoal. It can also be used for different purposes depending on the concentration used. It has the potential for use in improvement of soil quality, elimination of pests, plant growth control (being able to accelerate the development of roots, stems, tubers, leaves, flowers, and fruit *etc.*).

For agricultural application, wood charcoal is usually considered of more benefit as soil conditioner than as fertilizer. This is due to its low nutrient content. However, application of charcoal for soil improvement increases nutrient stocks in the rooting zone of crops, reduces nutrient leaching, and improves crop production on acid and highly weathered tropical soils. Charcoal and its ash, which have a high content of alkali and inorganic salts, seem to promote the growth activity of agricultural plants. To quantify the effects the bamboo charcoal, organic and inorganic fertilization on soil fertility and crop production needs to be studied. However, as the utilization of bamboo as charcoal is still quite new for Thailand, a lot of research needs to be done. Some physical properties of bamboo charcoal such as its hardness, moisture content, porosity, bulk density, heat content, smoke, ash, and approximated analysis property should be studied.

Methodology

Since *Bambusa blumeana* and *B. beecheyana*, have a high potential for surviving in water inundated areas in Thailand, these two bamboo species were chosen to produce bamboo charcoal in this study.

For bamboo charcoal production (see also Figure 2), bamboo charcoal was prepared by the advanced carbonization process at a temperature between 400-600 °C in a modified charcoal kiln (the twin kilns of paired 200 liter oil drums with horizontal arrangement, Figure 5) of Dr. Nikhom Laemsak (*personal communication*).

In general practice, bamboo should be left to dry in normal air conditions for 2 weeks to reduce its moisture content before sending it to the kiln in order to decrease the operating time and the firewood required as the energy source, and to be able to control the kiln temperature much easier. After 2-3 days/cycle, depending on the wood moisture and the time management, the bamboos were successfully carbonized and wood vinegar was also obtained.

The results showed the carbonaceous solid with a fixed carbon content of 70% or more can be achieved.. The charcoal from these bamboos will be utilized as soil adjustment.

Laboratory experiments were conducted to examine the physical property of bamboo charcoal including its hardness, moisture content, porosity, bulk density, heat content, smoke, ash, and approximated analysis property.

To determine the feasibility of using bamboo charcoal as a soil conditioner, the experimental design is indicated as follows (see also Figure 3):

1) Earth soil samples will be air dried and will pass through a 2 mm sieve to provide uniform conditions, and then three samples will be taken at the beginning of the experiment to determine their properties including pH and Macro Nutrient (P, K, Ca, Mg, Organic Carbon, C/N ratio)

2) In this study, 3x2x2 in CRD (Completely Randomized Design) with 3 repeats will be used. The main factors include:

First 3 factors for testing the result of bamboo charcoal:

A-1) Neutral (only earth soil)

A-2) Earth soil + slow release fertilizer (N-P-K) (15-15-15) with 1% (w/w)

A-3) Earth soil + fertilizer (N-P-K) (15-15-15) (1% w/w) + bamboo charcoal 1000 g/m^2 (rough-crushed charcoal, 5-10 cm in size). For A-3), this soil media needs to be stocked for 1 week before planting.

Next 2 factors for investigating the effect of wood vinegar:

B-1) Watering with water-diluted wood vinegar (1:500) once a week

B-2) No application of wood vinegar

Last 2 factors for nutrient leaching test:

C-1) Soil with fast-growing tree

C-2) Soil with no fast-growing tree

In total, therefore, 72 samples must be prepared (3x2x2x3x2).

3) The recording of the growth of the trees and the change in color of trees' leaves every week.

4) The 72 samples will be separated into 2 groups. The first group is for the growth test such as tree height, diameter at root collar, tree volume, above-ground dry mass, under-ground dry mass, number

of leaves. The second group is for soil media testing to determine; bulk density analysis (using core method), Porosity (using Three Phase Meter), Nutrient analysis (using CNHOS Tester), and soil pH.

5) To analyze all parameters, ANOVA with Duncan method will be applied.

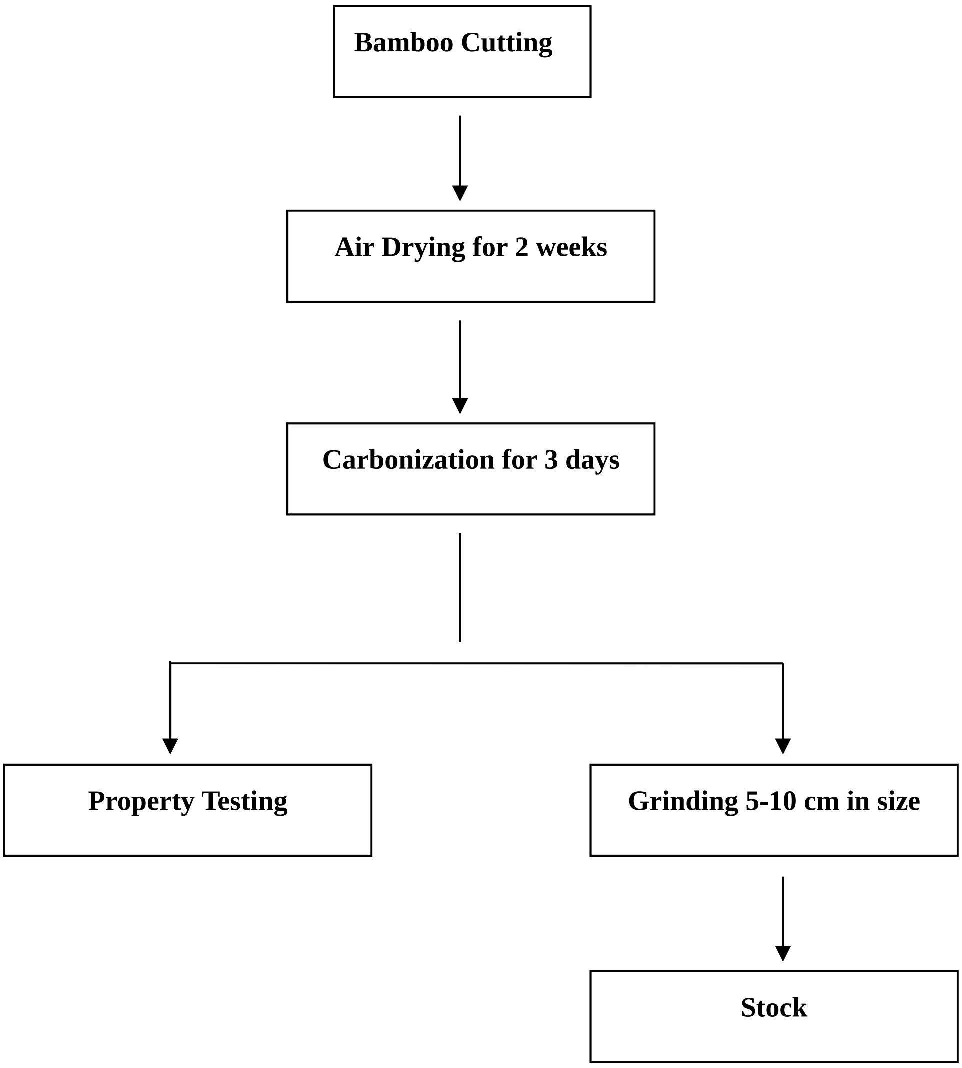


Figure 2 Steps for bamboo charcoal production and analysis

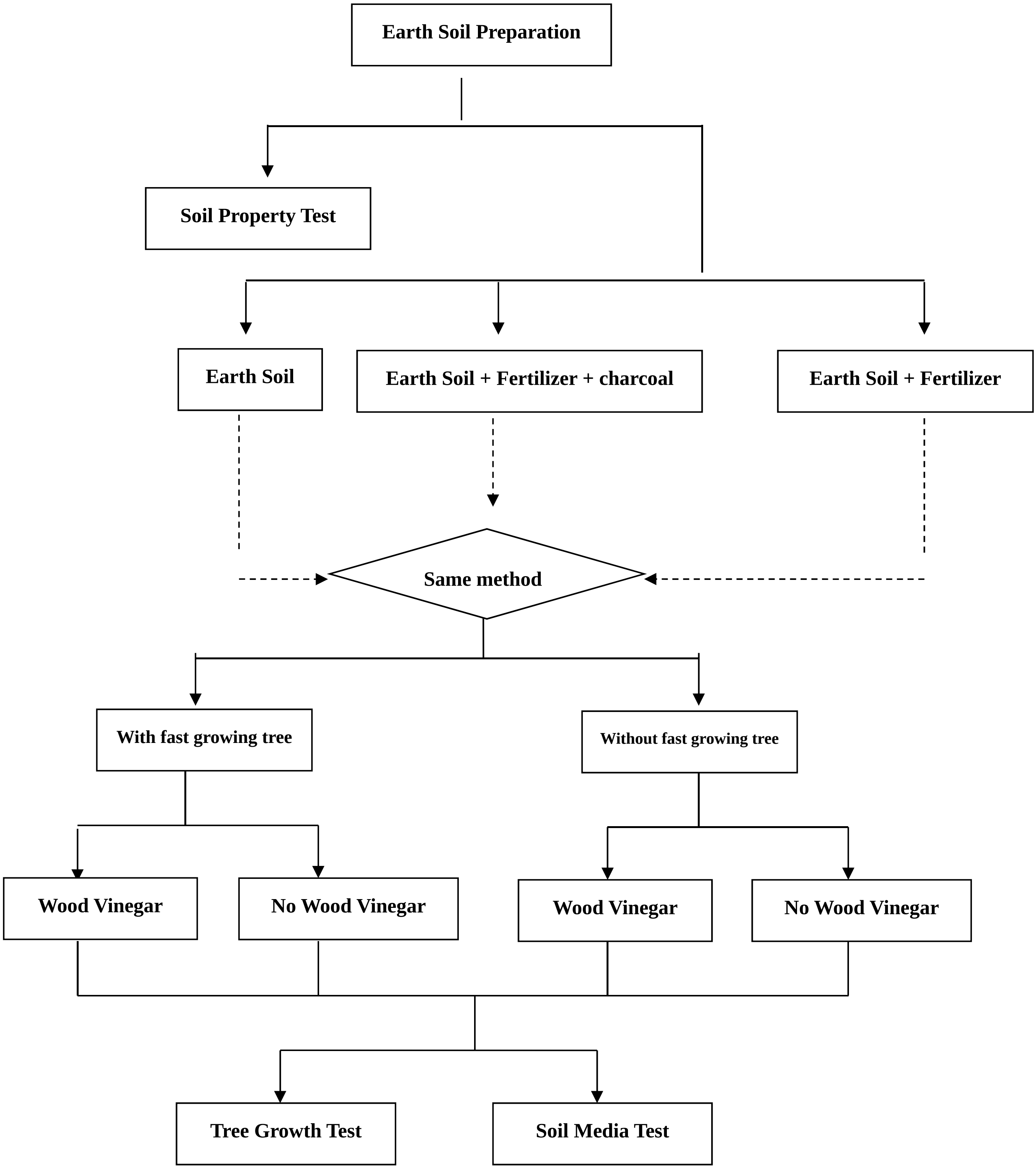


Figure 3 Experimental design for using bamboo charcoal as soil conditioner

Results

From the experimental design, the bamboo charcoals from *Bambusa blumeana* and *B. beecheyana*, were produced (see also Figure 4) by using the twin kilns of paired 200 liter oil drums with horizontal arrangement (4 oil drums in total, Figure 5). Bamboo culms (stems) with 1.5-3 inches in diameter and 6-9 meters long were chosen. Each bamboo culm weighed roughly 20 kilograms under fresh condition. After air drying for 2 weeks, the moisture content of these bamboos was reduced to about 60%. The bamboo must be cut to shorten its length from 6-9 meters to 80-85 centimeters for suitable loading into the drum. From the field study, one oil drum needed about 7 culms of bamboo. After 2 days for charcoal-making, about 20-22 kilograms of bamboo charcoals were obtained (approximately 80-88 kilograms charcoal/cycle could be produced). Also, about 2 liters of wood vinegar was collected (nearly 8 liters/cycle).

Figure4 Bamboo charcoal from *Bambusa blumeana* (left) and *B. beecheyana* (right)

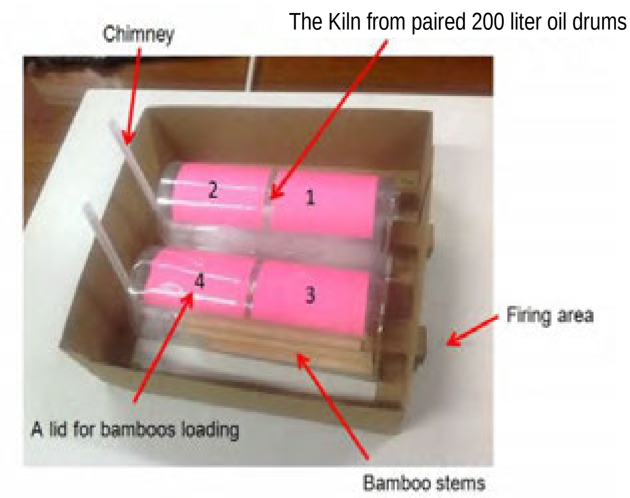


Figure 5 The model of twin kilns of paired 200 liter oil drums laid in a horizontal arrangement

The properties and utilization of bamboo charcoal

Normally, the quality of charcoal relies theoretically on 2 main factors, wood species and carbonized process. For making high quality and quantity charcoal, the temperature at the initial stage should be raised up slowly. And after that, the temperature before stopping the reaction (discontinuing air flow through the kiln) should be high enough (may be higher than 700 °C) in order to give produce premium grade charcoal. To boost the final temperature, the firing area (in front of the kiln) must be opened for 30-40 minutes, and then the air will flow to combust with some parts of charcoal inside the kiln giving the exothermal. After the previous stages, the kiln will be completely closed and left to cool down. Once the temperature inside the kiln is below 50 °C the kiln can be opened to unload the charcoal.

Charcoal produced from the carbonization process at a temperature of about 400 °C will have a strength property of only level 5-6. But when the final temperature is raised up to roughly 700 °C, the strength property will increase to a level of 9-10.. For the charcoal crushing test, the small pieces of charcoal can simply be processed by simple tools like hammer. The results showed that getting small pieces of charcoal by hand is better than using a machine because the machine produced a powder that was too fine and difficult to use. By using a hammer, the powder of the charcoal was also produced, but bigger in size. This kind of powder can be mixed with earth soil and animal manure easily and can be used as fertilizer.

To use charcoal as soil adjustment or soil conditioner, it is recommended to mix 1 kilogram of charcoal with the soil having the area of 1 square meter (about 1.6 ton/rai) especially during primary soil preparation (e.g. by hand hoeing or disk tilling). This method can be done before crop establishment (Figure**6**). For small trees or bushes the charcoal can also be applied around their base in a 50 centimeter radius (Figure**7**).

Figure 6 Applying charcoal to a forest plantation (left) and to an annual crop (right).

Figure 7 Applying charcoal around the base of bushes or small trees

From literature reviews which are easily available on the internet, it is confirmed that using charcoal as soil conditioner/adjustment is very beneficial to the agricultural sector not only for enhancing the productivity but also for reducing fertilizer leaching (Figure 8 and 9).

Benefits of using charcoal as a soil conditioner include:

1) Reduce leaching of nitrogen into ground water
2) Possible reduction of emissions of nitrous oxide
3) Increase in the exchange capacity resulting in improvement of soil fertility
4) Moderating of soil acidity
5) Increase in water retention
6) Increase in the number of beneficial soil microbes (Figure 10)

Figure 8 Charcoal applying for agro-forestry (left) and soil with charcoal and fertilizer, showing a better growth result (right)

Figure 9 Comparison between a plant growing in Normal earth soil (left) and one growing in soil mixed with charcoal (right)

Source: http://ahualoa.net/ag/notes_biochar.html

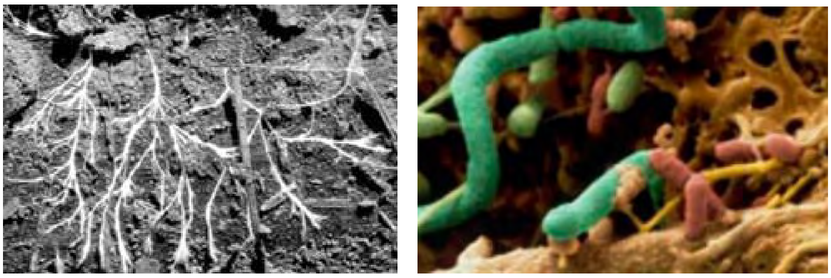


Figure 10 Microbial activities on porous surface of charcoal

The powder left from the charcoal crushing process is a valuable bi-product. This bamboo charcoal powder can be mixed with normal animal feed and bamboo wood vinegar to produce high nutrient silage. To prepare this silage, 30% of bamboo charcoal is mixed with 70% of clear bamboo wood vinegar (powder size about 1 mm. in diameter is suitable for chicken, while that of 2-3 mm. is for pig and cattle). After that, the mixed substance will be mixed in with the normal animal feed at a ratio 1:100.

Modified silage, using charcoal powder, has the following benefits when added to animal feed:

1) To ferment grass to be a high nutrient silage
2) To add further valuable nutrients to the normal animal feed
3) To assist the digestion system of animals
4) To reduce gas in stomach and intestine of animals
5) To prevent diarrhea and related intestine diseases in animals
6) To reduce the bad smell from animal manure and organic fertilizer made from animal manure.
7) To enhance productivity, both chicken meat and eggs
8) To improve quality, both chicken meat and eggs

The bamboo wood vinegar property and the utilizations

The wood vinegar from bamboo charcoal production should not be used directly after it is produced. It must be left standing for sedimentation to take place and bring about the separation of the greases, water, and tars. Usually, this process takes time about 90 days. The crude vinegar will be separated into 3 parts. The top part/layer is a clear liquid. The middle part, which has a similar color to tea, is the useful vinegar (Figure 11) which has high value and can be applied in many manners. The bottom part has a high viscosity and black color, known as tar. To speed up the sedimentation process, charcoal powder about 5% of the weight of the vinegar should be added. The sedimentation time will be halved from 90 days to about 45 days; because the light clear liquid and tars will be absorbed by the charcoal powder then the powder will fall to the bottom of the vinegar container.

Figure 11 High quality bamboo wood vinegar in the bottles

The results from testing the bamboo vinegars from *Bambusa blumeana* and *B. beecheyana* showed that at the beginning, the pH of the vinegars was about 2.8-3. During the sedimentation process, the pH was continuously decreasing to about 2.1-2.2. After that, the pH was quite stable. As for the specific density test, it is found that the vinegar had a specific density nearly 1.0 (about 1.007-1.013). The vinegar also had a smell like burning smoke. The vinegar generally consists of water (about 85%), organic acids (about 12%), and other compositions (3%). Due to its high acidity, during the vinegar collection process, contact with any metal equipment should be avoided. It is important that after the sedimentation process, the vinegar should be percolated before utilization.

As mentioned earlier, the vinegar can be applied in many manners, both for household and industrial purposes. Some of those uses include, but are not limited to the following:

Industrial applications:

1. To use in product for reducing body odor chemical
2. To use in products for cloth softening solutions
3. To use in smoked-dry industry

4. To apply in cloth-dying industry
5. To utilize as a wood preserver
6. To produce skin-care medicine

Household applications:

1. At 100% concentration, it can be used to cure chronic sore
2. By diluting to 1 part vinegar:20 parts water, it can be used for killing termites and ants
3. By diluting to 1 part vinegar: 50 parts water, it can be used for spraying to prevent termites, ants, and other poison insects
4. By diluting to 1 part vinegar: 50 parts water, it can be used for spraying on garbage to reduce undesired odor and to drive out flies. Also, the solution can be sprayed to reduce bad smells in the kitchen, bathroom, high humidity areas, and animal cages
5. By diluting to 1 part vinegar: 50 parts water, the solution can be used to produce organic fertilizer for flowers and garden trees

In the case of agricultural applications, the vinegar can be used as an antibacterial microbe agent owing to its high acidity and corrosion properties. Moreover, the important microorganisms can breed to get increase their population by using nutrients from wood vinegar. However, before utilization, the vinegar must be diluted with water at a rate of 1:200 parts water.

Some other examples of its applications include:

1. Dilute 1 part vinegar: 20 parts water then spray onto the soil for killing undesired microorganisms and soil insects. This should be done 10 days before cultivation as the high acidity in the vinegar will react with alkali substances in the soil producing carbon monoxide (CO), which has a bad effect on the growth of crops
2. Dilute 1 part vinegar : 200 parts water and spray on tree leaves and stems every 7-15 days in order to kill undesired insect and fungi
3. Dilute 1 part vinegar : 500 parts water and spray on to infantile fruits to enhance their size
4. Dilute 1 part vinegar : 500 parts water and spray on before harvesting to increase fructose in fruits
5. Dilute 1 part vinegar : 500 parts water and use to absorb chemical and liquid fertilizer
6. Mix with charcoal powder and animal feed to produce high quality silage

   Mix with biomass to produce high quality bio-fertilizer, The detailed rates for application/dilution for use with other vegetables etc., are shown in the table below:

Table3 Examples of wood vinegar applications for vegetables

Species	Protect/Defend	Ratio	How to use
Tomato	Earthworm	1:500	spray to stem
	Fungi	1:200	spray to leave
	root decay	1:200	spray to stem
Cucumber	Fungi	1:200	spray to leave
	root decay	1:200	spray to stem
Strawberry	Earthworm	1:200	spray to stem
green pepper	Earthworm	1:1,500	normal watered
Cabbage	threaten insects	1:1,500	normal watered
Parsley	threaten insects	1:1,500	normal watered
Chili	falling of bouquet	1:300	spray to stem
Corn	threaten insects	1:300	spray to stem
short rotation vegetable		1:500	normal watered
Bean		1:500	spray 2-3 times/month
shallot and garlic		1:800	

Figure 12 Examples of diluted bamboo vinegar under various ratios

Break-Even Analysis for bamboo charcoal production

<u>Revenue from bamboo charcoal production</u>

For each cycle of bamboo charcoal production, it was estimated that about 1,600 baht/cycle would be obtained (reference data between 2012 and 2013)

1. About 20 kilograms of charcoal/oil drum would be attained (or about 80 kilogram/cycle). The price of charcoals at producing area is about 12-15 baht/kilogram. However, if the packaging is successfully developed (see figure below as example), the price of charcoals can be lifted to 80 baht/kilogram. Therefore, the revenue from charcoal = 20 X 4 X 12 = 960 baht/cycle.

2. For wood vinegar, about 2 liters/oil drum (8 liters/cycle) with the price of 80 baht/liter should be obtained. As mentioned with the charcoal, when the package is well designed, the price should be about 150-180 baht/liter. Therefore, the revenue from the vinegar = 2 X 4 X 80 = 640 Baht

This result showed that the price/unit of the vinegar is better than that of charcoal

3. Small pieces and powder of charcoal that are left after charcoal production can be used for agricultural purposes.

Costs for bamboo charcoal production

In each cycle of bamboo production, the cost is estimated about 1,600 baht/cycle. (reference data between 2012 and 2013).

Table 4. Fixed cost for the kiln construction

Items	Baht/Unit	Total	Remarks
200 liter oil drum (4 units)	400-600	2,000	average price
Asbestos elbow (2 units)	50	100	
Asbestos pipe (2 units)	150	300	
Sand (2 m^2)	700	1,400	
Cement block (80 units)	7	560	
Earth brick (100 units)	1.25	125	
Green bamboo pole (2 units)	30	60	
Portland cement (3 units)	85-125	285	average price 95
Others		1,000	
Labor cost (4 days, 2 persons)	300	2,400	
Total		**8,230**	

Remark: this cost can be reduced by using alternative local materials

Variable cost from the charcoal production

1. Bamboo culms with 1.5-3 inches in diameter and 6-9 meters long were chosen. Each bamboo weighed roughly 20 kilograms under fresh condition. After air drying for 2 weeks, the moisture content of these bamboos was reduced to about 60%. The bamboo had to be cut to shorten its length from 6-9 meters to 80-85 centimeters so that it could fit into the drum. The field study results showed that, one oil drum needed about 7 stems of bamboo with the price of 20 baht/culm (stem)**, .**therefore, the cost of bamboo raw material = 7 X 4 X 20 = 560 baht/cycle

2. Labor is cost 300 baht/day. Normally, each cycle needs 2 days. **.**Therefore, the labor cost = 1 X 300 X 2 = 600 baht/cycle

3. For firewood needed for the carbonization process, branches or small wood can be gathered from sources nearby, so there is no cost for the firewood.

To sum it up, the cost per cycle of charcoal production is about 1,160 baht/cycle. However, this cost can be reduced when the farmer or owner reduces the labor cost by processing it himself.

Break-Even Analysis

From the previous data, the calculation showed that all the costs could be recovered after the 19th operating cycle as follows:

Break-even point = Fixed Cost/(Revenue per cycle-variable cost per cycle)

= 8,230/(1,600-1,160)

= 18.7 (roughly 19th)

From this data, the recovery time is clearly less than the replacement time of the 200 liter oil drums used in the processing. If the charcoal production operates 12 times/month, the cost will be returned in 2 months. After that, the farmer/owner will get the profit about 5,280 baht/month.

5. Conclusion and recommendation

As for feed (particularly for ruminants), either fresh bamboo powder or bamboo powder silage can be used to feed the livestock. **Bamboo powder contains nutritive values about a half (or a bit more) than that of rice straw)** *B. blumeana*=**%64**, *B. beecheyana*= **%62**respectively. Thus, during the flooding time, when other forages are difficult to find, bamboo powder can potentially be used to subsidize the feed unobtainable. However, you may need to double the quantity of bamboo powder to get quality up to the same level of rice straw.

There are some considerations to be aware of when you have to use bamboo powder as feed. If the grain of the powder is too big or the texture of the powder is too rough or too fibrous, this may affect the palatability for the livestock. They may not eat the powder, particularly in the first test. However, if you let the livestock get used to the powder or mix the powder with the food they will eventually become familiar with the new type of feed and should be able to eat the bamboo powder.

As for fertilizer, bamboo powder contains the primary macronutrients **)**N,P,K) but only about half as much as that of rice stubble **)** *B. blumeana*=**%55**, *B. beecheyana*= **%62** respectively. Therefore, it may not have a potential to be directly used as fertilizer but may be good enough to be a filler.

Bamboo charcoal production is not a difficult task to undertake and people can do it by themselves effectively if they follow the steps in this study. It can also help people gain extra income. Bamboo charcoal has many uses other than just using it for cooking. It can be used in many ways as mentioned earlier and using bamboo charcoal as a soil conditioner is among them. Usually 1 kilogram of the charcoal mixed with the soil of 1 square meter (about 1.6 ton/rai) is recommended, especially during primary soil preparation.

The vinegar from bamboo charcoal production can be used for many purposes depending on the concentration. After diluting the vinegar at various rates with water, it has many functions that farmers and consumers are not yet aware of, including reducing bad smell in animal cages or farms. The rate and method of application of the vinegar to protect vegetables from insects and diseases is clearly outlined above in Table 3. It is important to remember that crude vinegar should not be utilized directly after collection. It must be left for about 90 days for sedimentation prior to use.

‘Guideline for Disaster Resilient Agriculture and Agricultural Community’

Technical Paper Series No.20

Fish Capturing and Processing in Flood Prone Areas

Prepared by JICA Project Team and

Faculty of Agriculture, Natural Resources and Environment,

Naresuan University

Fish Capturing and Processing in Flood Prone Areas

1. Introduction

Although the damage to the agricultural sector by the flood in 2011 was very serious in the rural community, it was reported that production of fish varieties had greatly increased during the flood period in several areas. Thus, it would be important to understand the possibility of utilizing the available resources of fish during and after the flood period. Based on this concept, JICA project team in collaboration with Naresuan University, the research institute located in Phitsanulok Province conducted a fish resource survey in two flood prone areas, namely, Phitsanulok Province, Chainat Province, and Phra Nakhon Si Ayutthaya Province.

This technical paper presents general information, results and matters for consideration relating to the fish resource survey.

2. Results of Fish Survey

2.1 Outline of Fish Survey

JICA Project Team and Naresuan University carried out the following activities in four target areas.

1. Conduct a resource survey of local fish varieties in two model areas
2. Check local fish varieties by group interview
3. Compare amount, duration of catching and prices of fish in 2011 flood, 2012 rainy season and a normal year
4. Review the utilization of local fish
5. Survey value chain of both fresh fish and processed fish products and analyze/estimate economic value obtained by each stakeholder

Objectives, target area and survey methods are described below:

Objectives:

To review the potential of fish production and their value during a flood period through a survey on fish variety and value, and by collection of secondary data information in Phitsanulok Province, Chainat Province and Phra Nakhon Si Ayutthaya Province in the Kingdom of Thailand.

Target Area:

Survey activities were implemented in four tambons from three provinces including two tambons in Phitsanulok Province: (1) Tambon Chum SaengSognkram, Amphoe Bang Rakam and (2) Tambon Nakhon Pa Mak, Amphoe Bang Kratum; (3) Chainat Province: Tambon KhaoKaeo, Amphoe Supphaya; and (4) Phra Nakhon Si Ayutthaya Province: Tambon Gop Chao, Amphoe Bang Ban.

Methods:

The survey was conducted on different days during two months from November to December 2012, in four tambons by collecting secondary data/information using focus group undertaking a questionnaire interview. At least 40 participants were selected by the representative of each tambon and invited to join the survey. Forty-five people from Tambon Chum SaengSognkram, 51 people from Tambon Nakhon Pa Mak, 42 people from Tambon KhaoKaeo, and 24 people from Tambon Gop Chao engaged in the survey activity. The questionnaire was designed to obtain information about local fish varieties, amount, market, value chain of fresh fish and processed fish products.

2.1Fish Resource Survey Result

1) Fishery Activities in the Four Tambons

Tambon ChumSaengSongkram is located along the Yom River. This area is generally flooded for 3-4 months annually. The main employment of interviewees (all female), about 53% of the total 45 participants were not involved in fishery and aquaculture.   42% were farmers, who mainly produce rice or paddy farming. Approximately 47% were fishermen and/or fish farmers. However, a total of 87% of the total of those interviewed participated in the fishery industry during flooding period (August-November).

Tambon Nakhon Pa Mak is located along the Wang-thong River. This area is generally flooded for 3-4 months annually. The majority of the participants, approximately 65% of total 51 interviewees were involved in fisheries and aquaculture.   20% were farmers who mainly produce rice. Approximately 82% of the interviewees were involved in fisheries during the flooding period. The locations for catching fish were in natural water resources, especially in canals, wetlands and flooding areas during September-November. The farmers used several methods to catch fish including gill nets, lift nets, seine nets, cast nets, traps, and hand lines.

Tambon Kao Kaeo is located in the Chaopraya River plain region and generally flooded for a short period in each year.   Approximately 55% of total 42 interviewees were farmers who mainly produced rice, 31% were fishermen and/or fish farmers. However, about 83% of the interviewees were involved in fisheries during flooding period.

Tambon Gop Chao is located in the Chaopraya River plain region and generally flooded for a short period every year. More than 90% of total 24 interviewees were not involved in fishery and aquaculture. 75% were housewives, laborers and others. A total of 30% were involved in fish processing business, 16% were rice farmers and less than 10% were fishermen and/or fish farmers. Approximately 75% of the interviewees were involved in fisheries during flooding period.

Table 1. Career of Interviewees of Four Tambons

	Chum SaengSongkram (N=45)	Nakhon Pa Mak	KahoKaeo	Gop Chao	Total
Career	**No. (%)**	**No. (%)**	**No. (%)**	**No. (%)**	**No. (%)**
Involved in Fishery	**21 (46.7)**	**33 (64.7)**	**13 (31.0)**	**2 (8.3)**	**69 (42.6)**
1.Fishery	8 (17.8)	2 (3.9)	12 (28.6)	1(4.2)	
2.Aquaculture	1 (2.2)	16 (31.4)	1 (2.4)	1(4.2)	
1&2	1 (2.2)	5 (9.8)	-	-	
1 and others	2 (4.4)	4 (7.8)	-	-	
2 and others	8 (17.8)	5 (9.8)	-	-	
1&2 and others	1 (2.2)	1 (2.0)	-	-	
Others	**24 (53.3)**	**18 (35.3)**	**29 (69.0)**	**22 (91.7)**	**93 (57.4)**
Paddy farming	19 (42.2)	10 (19.6)	23 (54.8)	4 (16.7)	
Others	5 (11.1)	8 (15.7)	6 (14.3)	18 (75.0)	
Fish Processing Activity	**10 (22.2)**	**8 (15.7)**	**5 (11.9)**	**7 (29.2)**	**30 (18.5)**
Fish Capturing and	**39 (86.7)**	**42 (82.4)**	**35 (83.3)**	**18 (75.0)**	**134 (82.7)**

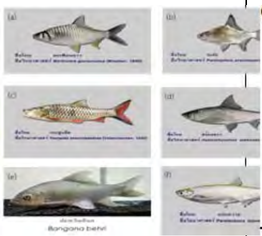
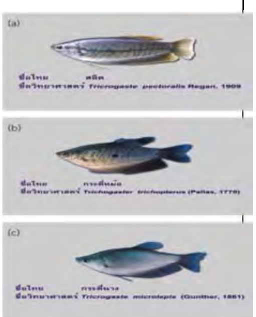
Source: Interview

2) Predominant Fish Varieties in Four Tambons

A summary of predominant species of fish caught and their utilization is shown in Table 2. The people in the four Tambons caught fish in natural water resources including rivers, canals, wetlands and flooding areas using several varieties of fishing gear including gill nets, lift nets, seine nets, cast nets, traps, and hand lines.

Table 2. Predominant fish species in 4 Tambons and Value in Fresh and Processed Products

Fish variety		Tambon	Utilization	Value of fresh fish	Value of Processed
Family	**Species**				
(1) Cyprinidae (Common name: Barb) ตะเพียนกะมังกระสูบขีด	a) Silver barb (*Barbonymusgonionotus*),	CSS NPM KK GC	Fermentation	Low value if fresh and too many in flooding season : 30 ฿/kg(CSS) 10 ฿/kg(NPM) 10-15฿/kg(GC)	More value after processing: 100-120 ฿/kg (CSS) 50 ฿/kg(NPM) Home consumption
	b) Smith's barb (*Puntioplitesproctozysron*),	CSS NPM KK GC			

Fish variety		Tambon	Utilization	Value of fresh fish	Value of Processed
Family	**Species**				
	c) Tranverse-bar barb (*Hampalamacrolepidota*),	CSS NPM KK GC			Only (KK) 40-50฿/kg(GC)
	d) Siamese mud carp (*Henicorhynchussiamensis*),	CSS NPM KK GC			
	e) *Paralaubuca spp. Cyclocheilichthysspp.and Banganabehri*	CSS NPM KK GC			
(2) Family Bagridae (Naked catfish, Bagrid catfish) แขยงกด 	*Mystus spp.* and *Hemibagrus spp.*	CSS NPM KK	Large size: sold fresh Small size: sundry, grill/roast	Large size: 50-60 ฿/kg (CSS) Small size: 20-30 ฿/kg(CSS) 30-50 ฿/kg(NPM)	Dried 100฿/kg Roasted 120 ฿/kg 150 ฿/kg(NPM, KK)
(3) Family Osphronemidae(Labyrinth fish, Gourami) ปลากระดี่ 	*Trichogaster spp.*	CSS NPM KK GC	Sundry, ferment	Low value 10-15฿/kg (CSS, GC)	Dried fish 100฿/kg (CSS) Dried fish 150฿/kg Pla-ra 50 ฿/kg (NPM) Pla-yang 30-40฿/kgPla-ra 30-40฿/kg (GC)

Fish variety		Tambon	Utilization	Value of fresh fish	Value of Processed
Family	**Species**				
(4) Family Siluridae (Sheatfish) ปลาแดงชะโอน  	*Phalacronotusbleekeri*	CSS NPM	Large size: Sold fresh Small size: Grill	Large size: 190฿/kg Small size 100 ฿/kg (CSS)	Grilled fish 150 ฿/kg (NPM)
(5) Family Notopteridae (Featherback fish, Knife fish) ปลาสลาด  	*Chitala spp.* and *Notopterusnotopterus*	CSS NPM	Large size: Sold fresh Small size: Grill	High value if large size Low value if small size	Grilled fish 150 ฿/kg (CSS)
(6) Family Anabantidae (Climbing gourami) หมอ 	*Anabas testudineus*	CSS NPM KK GC	Large size: Sold fresh Small size: Ferment	Large size 50-60 ฿/kg Small size 20-30 ฿/kg (CSS,NPM, KK, GC)	Pla-ra 50 ฿/kg (KK) 50-60฿/kg (GC)

Fish variety		Tambon	Utilization	Value of fresh fish	Value of Processed
Family	**Species**				
(7) Family Channidae (Snake head fish) ปลาช่อน 	*Channa spp.*	CSS NPM KK GC	Large size: sold fresh Small size: Sundry, grill	Large size 100-200 ฿/kg (CSS) 120 ฿/kg(GC) Small size 100 ฿/kg (GC)	200-250 ฿/kg (CSS) Pla-yang 250฿/kg (NPM) 250฿/kg (GC) Pla-ra 50฿/kg (NPM)
(8) Family Clariidae (Walking catfish) ปลาดุก  	*Clarias spp.*	CSS NPM KK GC	Large size: Sold fresh Small size: Sundry, grill	large size: 80 ฿/kg (CSS) 60 ฿/kg (KK) 80 ฿/kg (GC) small size: Low value	250฿/kg (CSS) Dry, pla-yang 250฿/kg (NPM) 150฿/kg (KK) 150-200฿/kg (GC)

Source: Interview and Department of Fisheries, Thailand

3) Utilization of Fish Resources

The utilization of fish resources in the four Tambons is summarized in Table 3. The usual methods of selling and processing of fish in all four tambons were mainly sold fresh, sun-dry process and fermentation, after adequate use for household consumption. Smoked/Roasted fish was a processing method only used in Tambon Chum SaengSongkram and Tambon KhaoKaeo. Because there are less fish is available during a normal season, the people around these areas feel that they can add more value to the fish by roasting the fish and selling their roasted product for a higher price.

The utilization of fish depends on the variety of the fish. Most of the large fish and higher value fish, such as, snakehead fish, bagrid catfish, feather back fish, sheatfish, climbing gourami and walking catfish, were sold to the middlemen and/or local markets. Only a small amount was kept for household consumption. The smaller sized and lower value fish such as, Cyprinidae (barb) and Osphronemidae (gourami), were fermented and sun- dried for household consumption and/or sold to the local markets.

Table 3.Utilization of Fish Resources of Four Tambons

	Major Fish Variety identified	**Household consumption**	**Sold fresh**	**Sun- dry process**	**Fermented fish Pla-ra, nam-pla**	**Smoked/ Roasted fish**
1. T. Chum SaengSognkram,	**8**	**X**	**X**	**X**	**X**	**X**
2. T.Nakhon Pa Mak,	**8**	**X**	**X**	**X**	**X**	
3. T.KhaoKaeo,	**6**	**X**	**X**	**X**	**X**	**X**
4. T.Gop Chao,	**5**	**X**	**X**	**X**	**X**	

Source: Interview

2.2 Fish Processing and Value Addition Activities

Chum SaengSongkram

Only about 20% of interviewees were involved in the fish processing business. The three main processing methods were fermentation, sun-drying and charcoal grill. Harvested, caught and locally purchased fish were separated into three main groups.

1/ (i) barbs, (ii) gourami and (ii) snake head, bagrid catfish and walking catfish. The barbs (Cyprinids) were fermented as fermented fish and fish sauce. Gourami fishes were sun-dried and also were fermented as fermented fish and fish sauce.

2/Snake head, bagrid catfish and walking catfish were processed before being sun-dried as dried salted fish and grilled as charcoal grilled fish. Their fish processing products were sold to middlemen who came to collect the products from farmer’s homes.

Nakhon Pa Mak

Only about 18% of interviewees were involved in the fish processing business. The three main processing methods were fermentation and sun-drying. Harvested, caught and locally purchased fish were separated into two main groups.

1/ (i) barbs and gourami and (ii) snake head, bagrid catfish, sheatfish and walking catfish. Then barbs and gourami were fermented as fermented fish and fish sauce.

2/ Snake head fish, bagrid catfish, sheatfish and walking catfish were sun-dried as dried salted fish and grilled as charcoal grilled fish. These fish processing products were sold to local markets and some excess products were used for household consumption.

KhaoKaeo

Only about 10% of interviewees were involved in the fish processing business. The three main processing methods included fermentation, sun-drying and charcoal grill. Harvested and caught fish were separated into two main groups.

1/ (i) barbs and gourami and (ii) snake head and walking catfish. Fishes within barbs and gourami group were fermented as fermented fish.

2/ Snakehead and walking catfish were sun-dried as dried salted fish and grilled as charcoal grilled fish. These fish products were sold to local markets.

Gop Chao

About 30% of interviewees were involved in the fish processing business. Two main processing methods used are fermented and sun dried. Locally purchased fish were separated into two main groups.

1/ (i) barbs and gourami and (ii) snake head. The barbs and gourami were fermented as fermented fish,
2/ Snake head were sun-dried as dried salted fish. Their fish products were sold at home.

Table 4. Fish Processing Activities in Four Tambons

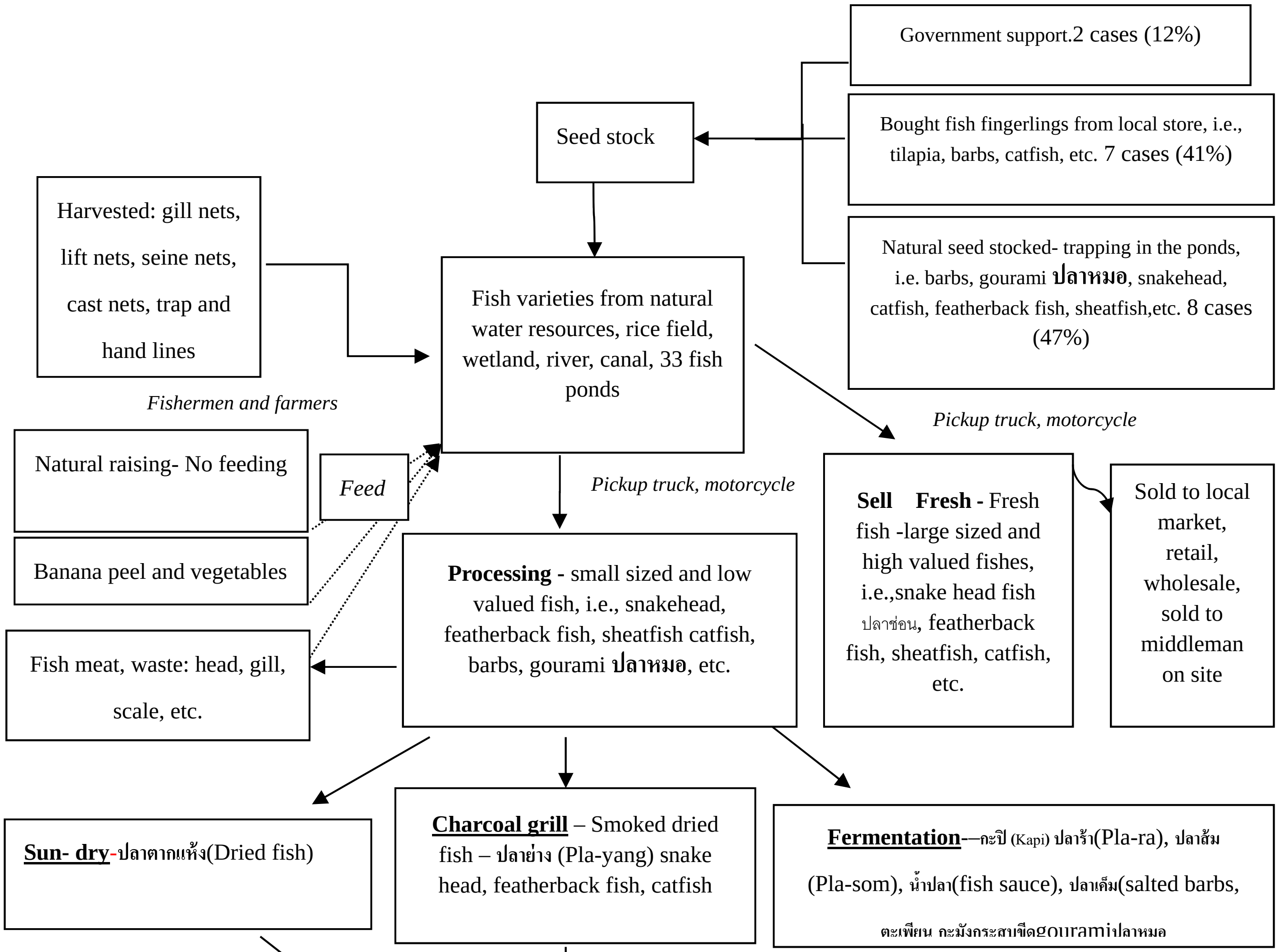
		Chum SaengSongkram	Nakhon Pa Mak	KahoKaeo	Gop Chao
		N=45	N=51	N=42	N=24
% of Involved in Processing Activities		27%	18%	36%	88%
% of Involved in Processing Business		20%	18%	10%	20%

Dried Fish		34 (38%)	10 (17%)	7(17%)	4(17%)
	Consumption /Sell	30/70	10/90	20/80	100/-
Pla-ra		39 (43%)	39 (67%)	23 (55%)	12 (50%)
	Consumption /Sell	20/80	20/80	100/-	10/90
Pla-som		3 (3%)	1 (2%)	-	-
	Consumption /Sell	30/70	100/-	-	
Nam-pla		11 (12%)	4 (7%)	2 (5%)	1 (4%)
	Consumption /Sell	40/60	90/10	100/-	100/-
Kapi		2 (2%)	4 (7%)	-	14 (58%)
	Consumption /Sell	20/80	90/10	-	50/50
Smoked/ Roasted Fish		1 (1%)	-	6 (14%)	-
	Consumption /Sell	90/10	-	90/10	
Salted Fish				4 (10%)	
	Consumption /Sell			100%	
Fried Fish					2 (8%)
	Consumption /Sell				20/80

Source: Interview

2.3 Value Chain of Fishing Activities

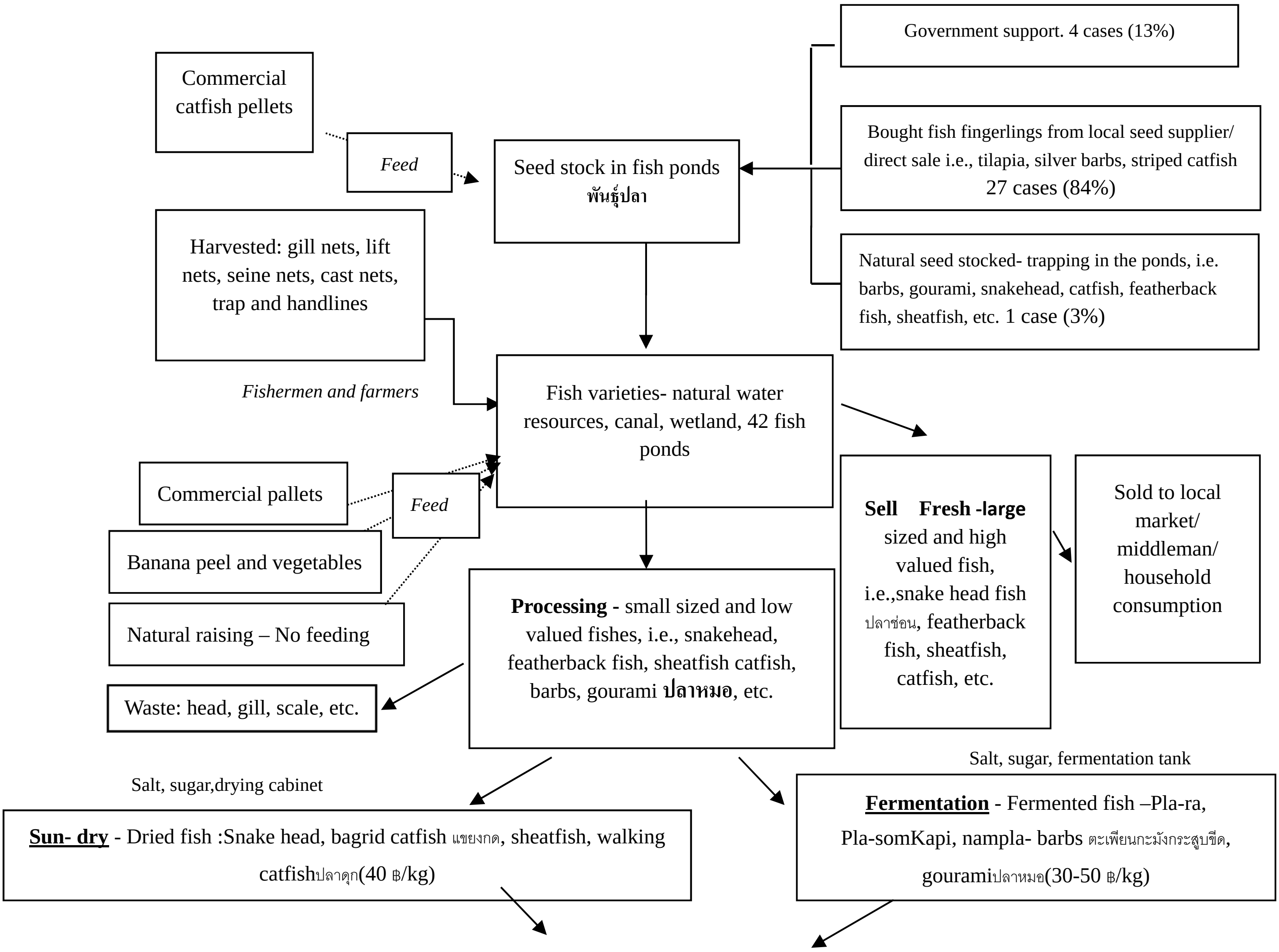
Based on the interview survey of fishing activities including processing, the value chain of fishing activities is prepared for the four tambons. The results for each tambon are shown on the next page.



Products (price, Baht/kg)	Count (%)	Household consumption (%)	Sale (%)
Dried fish (70)	34(38)	30	70
Smoked/roasted fish (60-250)	1(1)	90	10
Pla-ra (50)	39(43)	20	80
Pla-som (50)	3(3)	30	70
Nam-pla (13-20)	11(12)	40	60
Kapi (50)	2(2)	20	80
Total	90(100)		

Selling places	Count(%)
At home	5 (16)
middleman	3(10)
Local market/ community	15(48)
Household consumption	8(26)
Total	31(100)

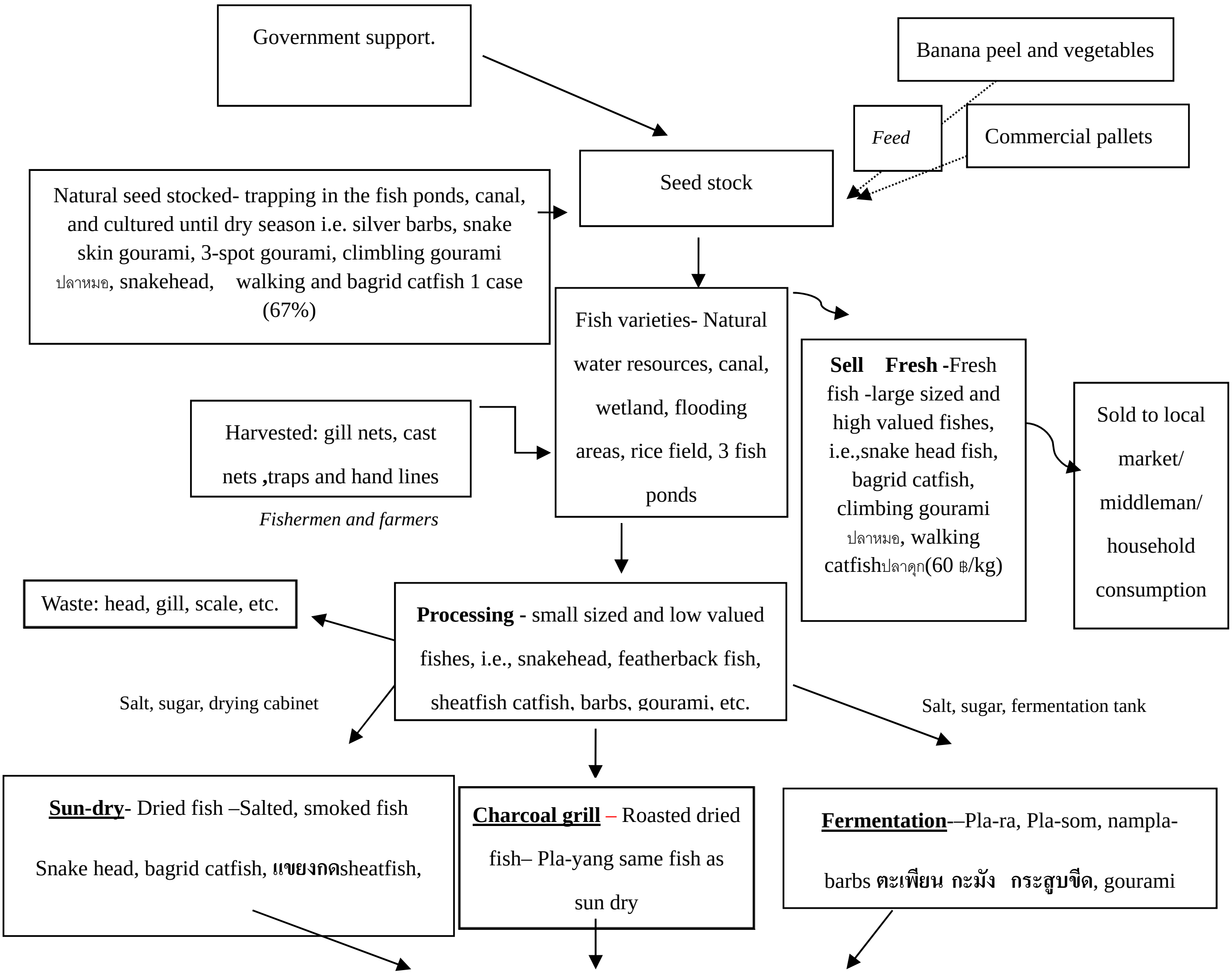
Figure 1.Value chain of fishing activities in Tambon Chum SaengSongkram



Products (price, Baht/kg)	Count (%)	Household consumption	Sale
Dried fish (80)	10(17)	10%	90%
Pla-ra (50)	39(67)	20%	80%
Pla-som (50)	1(2)	100%	-
Nam-pla (20)	4(7)	90%	10%
Kapi (50)	4(7)	90%	10%
	58(100)		

Selling places	Count(%)
Middleman	6(14)
Local market/ community	31(70)
Household consumption	7(16)
Total	44(100)

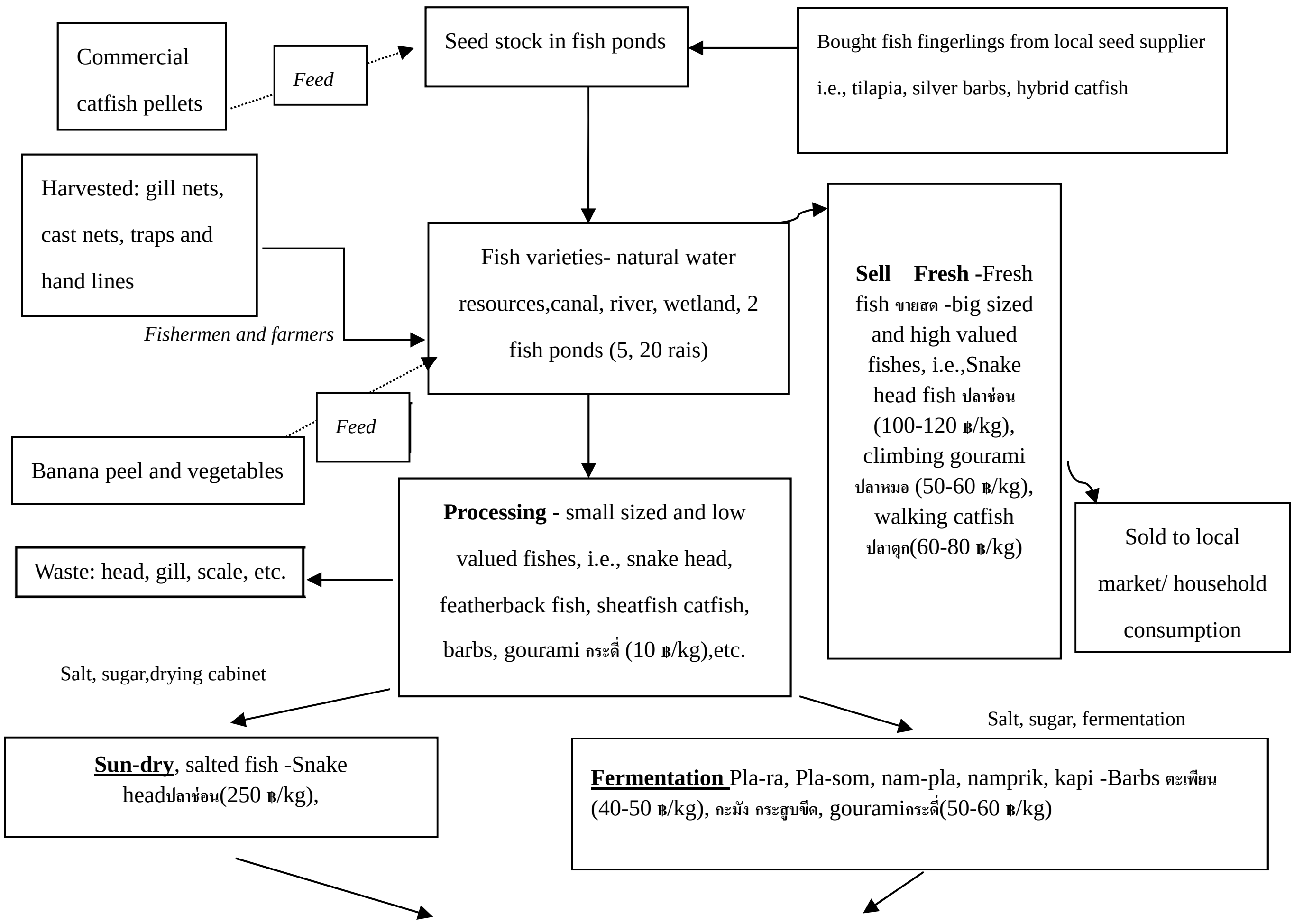
Figure 2.Value Chain of Fishing Activities in Tambon Nakhon Pa Mak



Products (price, Baht/kg)	count (%)	Household consumption	Sell
Dried fish (150)	7(17)	20%	80%
Smoked/roasted fish (150)	6(14)	90%	10%
Pla-ra	23(55)	100%	-
Nam-pla	2(5)	100%	
Salted fish	4(10)	100%	
Total	42(100)		

Selling places	count(%)
Middleman	1(14)
Local market/ community	4(57)
Household consumption	2(29)
Total	7 (100)

Figure 3.Value Chain of Fishing Activities in Tambon KhaoKaeo



Products	Count (%)	Household consumption	Sell
Dried fish	4(17)	100%	
Pla-ra	12(50)	10%	90%
Nam-pla (not available)	1(4)	100%	-
Kapi	14(58)	50%	50%
Fried fish	2(8)	20%	80%
	33(138)		

Selling places	Count (%)
At home	24(100)

Figure 4.Value Chain of Fishing Activities in Tambon Gop Chao

3. Discussion and findings on flood countermeasures

1) Effect on the local economy by fish capturing and processing during flood periods:

According to the interview, people not only suffer from flooding but get benefits from flooding through fishing activities. They understand flooding has some opportunities for them in earning more income and having more fish resources as raw materials to produce their products for household consumption, sale or to be stored during the flood season.

Because of the low price of processed fish during a flood, they kept the product e.g. pla-ra and sold it later in a normal season at a higher price and therefore gained a higher profit. The community people also have local knowledge and skills to produce several fish processing products. The people in the four tambons usually grow vegetables and fruits on their own animal and rice farms during the normal period. Fish processing is considered as an additional activity. They stated that they usually make simply pla-ra for household consumption, but during a flood crisis, the fish population greatly increases in the area and they were able to catch more fish and therefore make pla-ra, dried fish, which they sold to the local market to earn more income.

2) Comparison between flood and non-flood periods:

The Non-flood period is 8-9 months annually. From the interview, the participants' main careers and income is only from selling rice, animals, fruits and vegetables and other agro-products. Some of them are merchants and employees. The flood period usually take place over 3-4 months in each of the 4 tambons. Some regular farming activities have to be stopped, resulting in less income e.g., growing rice, and farming, animal raising or unemployment. However, a good opportunity for some people to earn more income by producing more fish, then storing for sale or even processed fish caught during the flood period and therefore compensating their annual income. The fish price, during a normal situation/ non-flood season, is higher for both the fish and fish related products than those during the flood period. However the ability of raising fish is also limited due to drying up and less water in some natural water resources such as canals and rivers during a normal season.

Abnormal flooding in 2011 seriously damaged the agricultural sector in the rural community including crop loss and other industries e.g., rice and field crop, livestock died, aqua-cultural sector suffered from the loss of fish and aquatic animals. However, less equipment, the only way of sun-drying was applied in several flooding areas. Thus, flood damage causing loss of major harvests or deprived income opportunities would be important to consider to understand the possibility of the utilization of fish as an available local resource during the flood period. When compared to a non-flood season, lots of fish during the flood period were less than half-price for fish in both fresh form and after processing. One way to add more value to the product is the selection and value of the fish based on varieties, fish size and processing methods. Moreover, building more fish ponds is also possible to keep the seed stock and raising the high-value fish rather than relying on obtaining fish from natural water resources.

3) Findings for improvement of fish processing activities from value chain analysis:

A limited number of product lines/varieties (P1: Product), and only a few processing methods (fermented, salted, grill) were employed. More value-added product are required (P2: Price), so they can earn more income. There are many ways this can be done e.g., selection of high value and low value fish as raw materials for further processing, generate new ideas for product and package development, learn new processing techniques or use a combination of existing processes in their communities. One advantage is that there seems to be a lack of competitors in their market area. A lack of not having real marketing people or sale representatives for each group, requires them to be more involved with more people such as sales personal, the distributor, middleman to be able to sell their products at other locations besides selling in local areas only (P3: Place). Community members know their strengths and weaknesses and need to learn more on how to produce good quality products, how to conduct marketing on a larger and more professional scale. A suitable person might have the skills to be a manager, marketing, processing or designer for either the product or package design. Promotion (P4), advertising, sales promotion, cooking demonstration, cooking contest for new recipes, buy 3 get 1, and buy 6 bottles get free cooked book may also be considered as incentives.

4. Conclusion

Based on the discussion above, we conclude that

1) Local community people are utilizing the flood period as an opportunity to earn extra cash income,
2) Fish capturing and fish culture is an important economical activity in the local community. Processing of fish and its related products is an alternative for earning a higher income in the local community, and
3) Local community people use their skills and experiences gained during household processing of fish and are able to also use conventional methods such as sun-dry, salted and fermentation.

Annex

Local Fish Varieties Pictures
Scientific names and common names

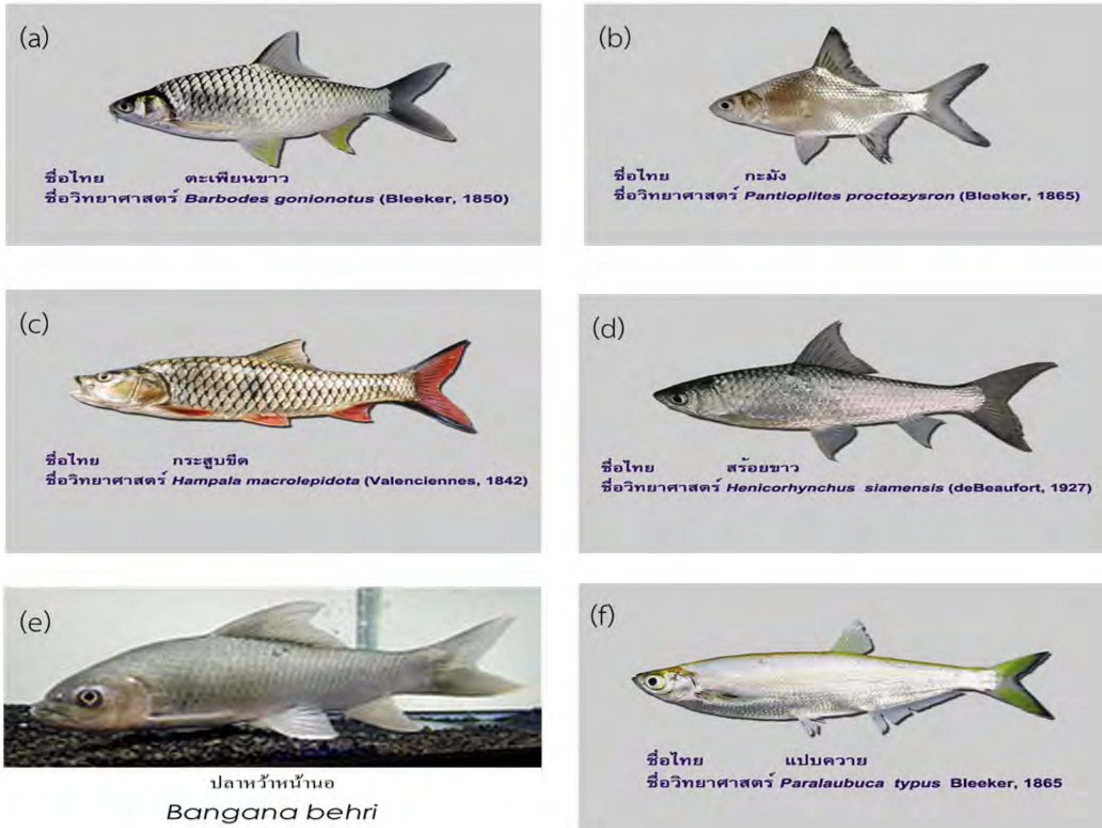


Figure A1. Family Cyprinidae: (a) Silver barb (b) Smith's barb (c) Transverse-bar barb (d) Siamese mud carp (e) *Bangana sp*. (f) *Paralaubuca spp*.
Source: http://www.fisheries.go.th/sf-sukothai

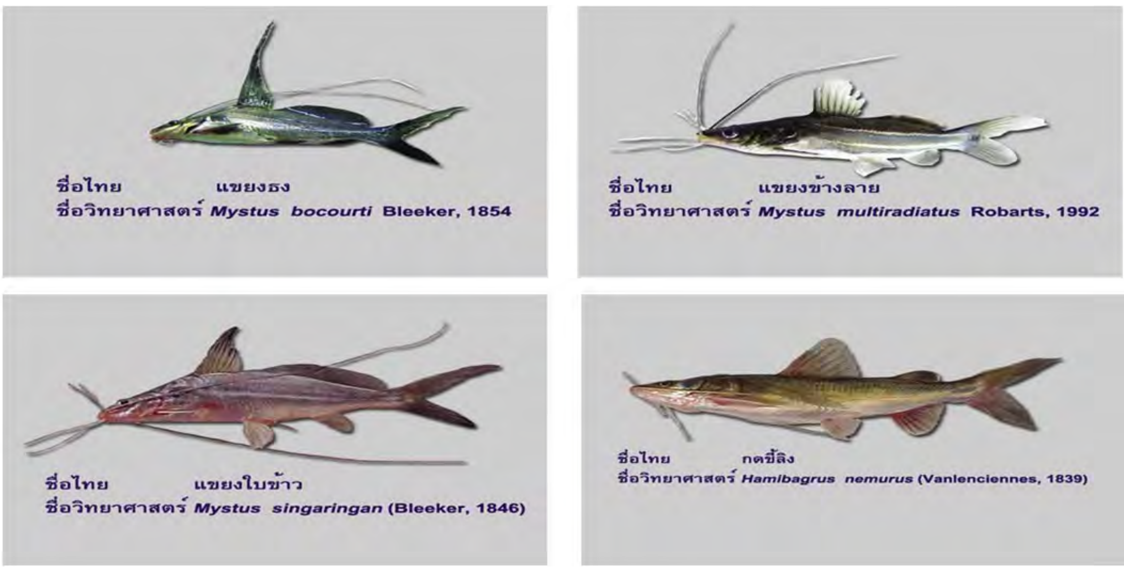


Figure A2.Family Bagridae (Bagrid catfish)
Source: http://www.fisheries.go.th/sf-sukothai

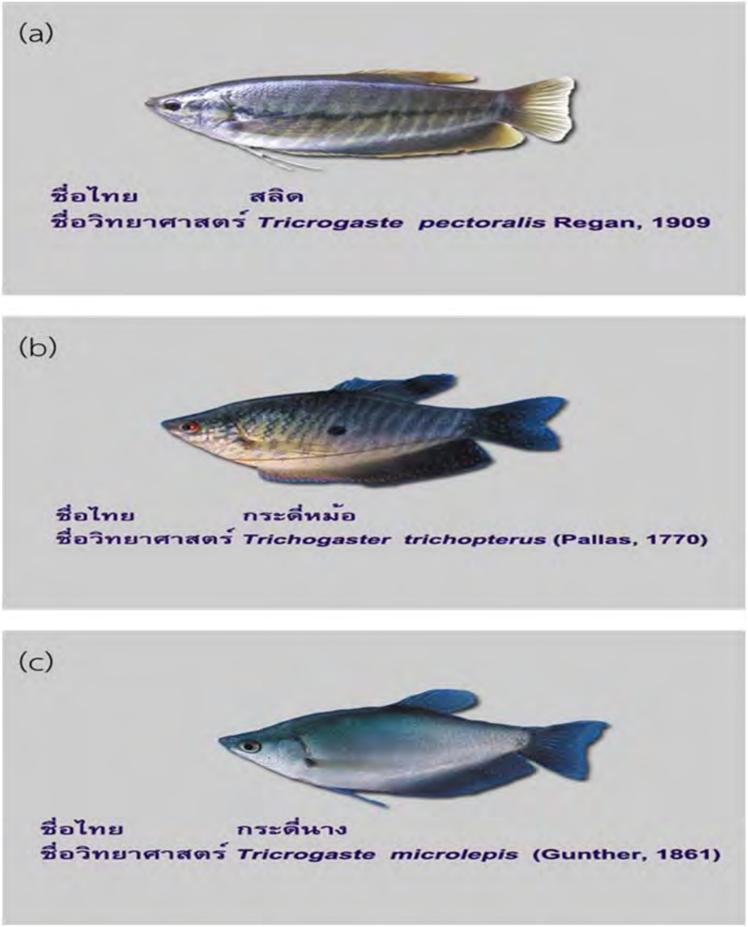


Figure A3. Family Osphronemidae: (a) Snake skin gourami (b) Three-spot gourami

(c) Moonlight gourami
Source: http://www.fisheries.go.th/sf-sukothai

Figure A4. Family Siluridae (Sheatfish)
Source: http://www.fisheries.go.th/sf-sukothai

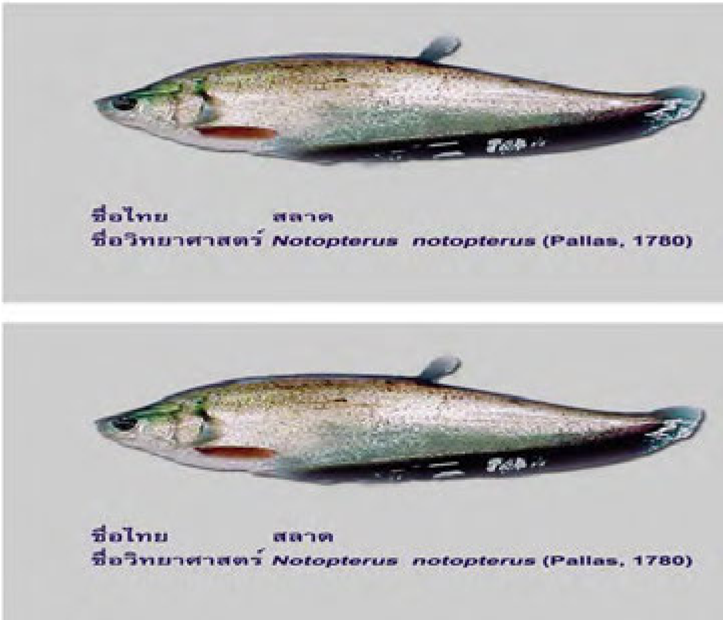


Figure A5. Family Notopteridae (Featherback fish)
Source: http://www.fisheries.go.th/sf-sukothai

Figure A6. Family Anabantidae (Climbing gourami)
Source: http://www.fisheries.go.th/sf-sukothai

Figure A7. Family Channidae (Snake head)
Source: http://www.fisheries.go.th/sf-sukothai

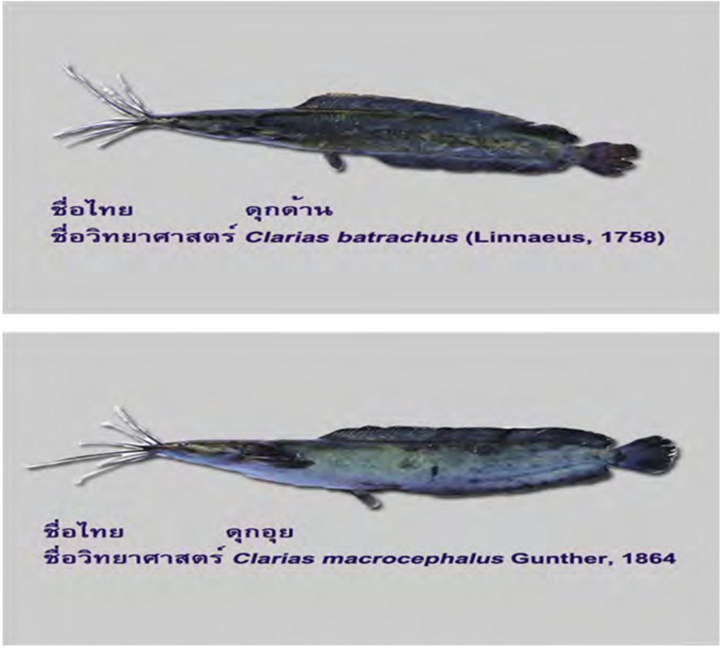


Figure A8. Family Clariidae (Walking catfish)
Source: http://www.fisheries.go.th/sf-sukothai

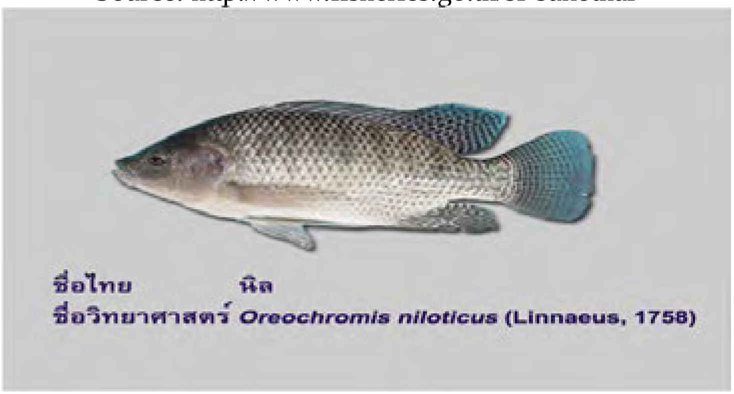


Figure A9. Nile Tilapia (Oreochromisniloticus)
Source: http://www.fisheries.go.th/sf-sukothai

Figure A10. Striped catfish (Pangasianodonhypophthalmus)
Source: http://www.fisheries.go.th/sf-sukothai

The Project for Flood Countermeasures for Thailand Agricultural Sector

‘Guideline for Disaster Resilient Agriculture and Agricultural Community’

Technical Paper Series No. 21

Income Generation Activities during Flood and Post-flood

Prepared by JICA Project Team and

Faculty of Agriculture, Natural Resources and Environment,

Naresuan University

Income Generation Activities during Flood and Post-flood

1. Introduction

The flood that occurred in 2011 caused serious direct damage to crops and facilities in the agriculture sector. In addition to this, the long flood period in the rural area raised problems by reducing the opportunity to gain cash income especially for the elderly and females. This technical paper describes a process and points for implementation of income generation activities, especially food processing and handy craft processing as a flood countermeasure based on experiences of pilot activities by the Project and information of cases collected by JICA Project Team.

2. Contents of Technical Information

1) Summary of Technical Information

During and after disasters, especially flood, losses of opportunity to gain cash income cause serious problems for the rural area. In order to take an opportunity of cash income in rural areas, income generation activities to add to income such as the processing of food and making handy crafts might be effective. This concept of income generation activities is shown below:

- Utilization of local resources in flood prone area
- Income during flood supplement loss/ damage caused by a big flood
- Income diversification can reduce vulnerability
- Group formation can contribute mutual help and support of members facing difficulties

2) Income generation activities in model Tambon

The JICA Project Team carried out processing activities based on ideas of the community though PRA workshops in several model areas. A summary of income generation activities are shown in the following table.

Table 1. Summary of income generation activity in model area

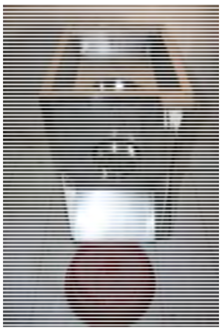
	Tambon	District	Province	Title
a)	Chum Saeng Songkhram (CSS)	Bang Rakam	Phisanulok	Support for Improvement of Fish Processing
b)	Nakhon Pa Mak (NPM)	Bang Kratum	Phisanulok	Support for Improvement of Fish Processing
c)	Gop Chao (GC)	Bang Ban	Ayutthaya	Support for expansion of fermented fish and shrimp paste processing
d)				Support for introduction of water hyacinth processing activity

Source: JICA Project Team

a) Fish Processing Chum Saeng Sonkhram (CSS-iGEN-IGLR-1)

Summary of Fish Processing Activity in Chum Saeng Sonkhram

Objective of activities	To utilize local fish resources available in the flood period for income generation by local residents.
Group members	Fish processing group in Chung Saeng Sonkhram 10-15 members combine with nam-prik producer Moo7, final product will be nam-prik pla-ra or nam-prik pla-yang.
Related agencies	JICA Project Team, Naresuan University, local FDA, Industrial Standard Office, Provincial Community Development office
Background/concept	In order to improve community resilience for natural disaster such as flood, it might be effective to diversify sources of cash income in communities. Through the PRA workshops in the model area, based on that concept, it was proposed to utilize community available resources for income generation, especially increased numbers of fish available during a flood. Through the activity, JICA team and Naresuan University supported the community food processing group to utilize local fish resources and improve their product quality. Currently, the group or individual participants mostly have some technical skills as they routinely work in drying and fermentation. They can also provide the fish raw material or/and being fish processors or that of related products, They may have their own or related products currently available for sale in the market or sale at home or having potential to launch their products to the market such as nam-prik. Sa-gueam nam-prik's producer is one of successful producers in the local area. The project provides support to improve the quality of the produce and obtain FDA and/or OTOP certification for selling outside the community by training and giving advice on packaging and marketing.
Process of activities	1. Fish resource survey in local area (Nov. 2012) 2. Survey of community food processing activity (Nov. 2012) 3. Confirmation meeting of activity, commence improvement of product (Feb. 2013) 4. Workshop on new product (Mar. 2013) 5. Workshop on production development and improvement (Mar. 2013) 6. Final workshop to present products (Apr. 2013)
Support for activity	- To identify interested people in local resource utilization (food processing) activities including existing groups according to the survey result in the community. - To discuss with the community for confirmation of members, product and components of the activity. - To prepare material for trainings for the community food processing group as follows: 1) product development in general: guideline how to generate new product ideas and screen the ideas to meet the needs of consumers, 2) general guidance on food product processing mainly fermented food, including safety and quality concern, and 3) packaging, labeling and marketing strategy - To demonstrate food processing utilizing local resources from a selected producer - To provide technical training for select participants

Photo of activities	 Cooking activity at CSS	 Ingredients
	 Mixing equipment	 Minced and Mixed
	  Phitsanulok FDA staff and Industrial officer observe the activity and are guided how to obtain อย. or FDA certificate and มผช. or TISI certification	
	   Packing in glass bottles:Namprik pla-yang and hand-made label. Namprik pla-yang sampling and analysis was conducted at FDA laboratory and NU laboratory	

	 Improved products and packages presented in the workshop

b) Fish Processing in Nakorn Pa Mak (NPM-iGEN-IGLR-1)

Summary of Fish Processing Activity in Nakorn Pa Mak

Objective of activities	To utilize local fish resources available in a flood period for income generation in community people
Group members	Fish processing group in Nakhon Pa Mak; Before visiting CSS workshop, it was not decided , however, after observing the namprik processing at CSS, they decided to cook the same thing as CSS; namprik pla-yang on 13th March 2013.
Related Agencies	JICA Project Team, Naresuan University, local FDA, Industrial standard office, community development office
Background/concept	In order to improve community resilience for natural disaster such as flood, it might be effective to diversify resources of cash income in communities. Through the PRA workshops in the model area, based on that concept, it was proposed to utilize community available resources for income generation, especially the larger numbers of fish available during a flood. Through the activity, JICA team and Naresuan University supported the community food processing group to utilize local fish resources and improve their product quality. Currently the group or individual participants mostly have some technical skills in drying and fermentation, providing the fish raw material and or being fish processor or related products. They may also have their own products currently available for sale in the market or sale at home or have potential to launch their products to the market.
Process of activities	1. Fish resource survey in local area (Dec. 2012) 2. Survey of community food processing activity (Dec. 2013) 3. Confirmation meeting of activity, commence the improvement of product (Feb. 2013) 4. Lesson learned workshop (Mar. 2013) 5. Final workshop (Apr. 2013)
Support for activity	- To identify interested people in local resource utilization (food processing) activities including existing groups according to the survey result in the community. - To discuss with the community for confirmation of members, product and components of the activity.

<table>
<tr><td></td><td colspan="2">- To prepare materials for training the community food processing group as follows: 1) product development in general: guideline how to generate new product ideas and screen the ideas to meet the needs of consumers, 2) general guidance on food product processing mainly fermented food, including safety and quality concerns, and 3) packaging, labeling and marketing strategy
- To demonstrate food processing utilizing local resources from a selected producer
- To provide to technical training for the selected participants</td></tr>
<tr><td rowspan="3">Photo of activities at NPM

13 March 2013</td><td>
Learning Center for Sufficiency Economy</td><td>
Cooking area</td></tr>
<tr><td colspan="2">
Participation from CSS and officer from CDD tambon joined the workshop</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td colspan="2">Cooking activity</td></tr>
</table>

	 Mixing equipment	 Ingredients
	   NPM products in plastic bags and glass container with lids and sticker	

c) Fish and Shrimp Processing in Gop Chao (GC-iGEN-IGLR-1)

Summary of Fish and Shrimp Processing Activity in Gop Chao

Objective of activities	To improve on existing processing activities of fish (fermented fish, Pla Ra) and shrimp (shrimp paste, Kapi) for income generation and storing preserved food for use during flood period.
Group members	20 members from 4 villages, especially elders and females based on an existing unofficial group in the community. This group also carries out other activities such as artificial flower making and handy crafts.
Related agencies	JICA Project Team, Community Development Department (CDD)
Background/concept	The group produces fish (fermented fish, Pla Ra) and shrimp (shrimp paste, Kapi) processing foods at house industry level. These food processing activities have been continued traditionally so the technical skills have accumulated in the community. Due to a lack of equipment for processing, their amount of product produced has been low. With the linkage of the Project, they are aiming to expand produced amount and sales. Raw materials (fish and shrimps) are caught in the local area by fishermen. The group purchases fish and shrimps from local fishermen. Therefore, there are good effects on the local economy.by this activity. The groups sells the products through existing marketing routes such as in the local community, and at the local market etc.

Process of activities	1. Planning through PRA workshop (Jun. 2012, supported by JICA project) 2. Business planning by the processing group (Nov. 2012, Supported by JICA and CDD) 3. Study tour of OTOP fair (Dec. 2012, supported by JICA) 4. Procurement of processing equipment (Dec 2012, supported by JICA) 5. Production of Pla Ra and Kapi (Dec. 2012) 6. Commence sales of product (Pla Ra Feb. 2013 and Kapi Apr. 2013)	
Support for activity	JICA team supported the preparation of activities and the purchasing of equipment (only for high cost equipment, ordinary equipment was procured by themselves).	
Photo of activities	 Discussion of group activities through PRA meeting	 Sun drying shrimp paste (Kapi)

Microbial analysis of products e.g., Kapi and pla-ra at NU lab *(As Appendix B)*

d) Water hyacinth processing in Gop Chao (GC-iGEN-IGLR-2)

Summary of Water hyacinth Processing Activity in Gop Chao

Objective of activities	To carry out community processing activity utilizing “water hyacinth” growing naturally in ponds or canals in the local area for income generation to assist revival from flood damages.
Group members	18 female members from 5 Villages formed a group after the PRA workshop by the Project based on discussion among the community.
Related agencies	JICA Project Team, Community Development Department (CDD)
Background/concept	From the problem analysis session which JICA Project Team conducted for Gop Chao, one problem concerning loss of income during a flooding season had been identified. As water hyacinth baskets and bags are becoming more famous in the Thai and overseas market, a Gob Chao women’s’ group was formed to process water hyacinth as an income generation activity during the flood. Water hyacinth is suitable in this situation because not only is there a lot of the resource of water hyacinth locally found in their pond, but in the flooding period excessive water hyacinth can cause blockage problems in the water ways, so its removal gives added incentive. The group produces bags processed from water hyacinth growing in ponds or canals in the local area. They sell the basic processed product without any decoration, handle etc., to producers group who provided training to the Gop Chao group. After secondary processing, the final product with decorations and a handle can be sold to the Ayutthaya floating market, Prathumthani flea market etc. They are planning to expand their sales channel after trail processing and sales with improvement of

<table>
<tr><td></td><td colspan="2">technical skills. Raw materials of water hyacinth can be collected in local area. The group started to collect water hyacinth from local ponds and canals once a week as a group activity.

The products can be retailed as well as wholesaled in many variations. Nevertheless, this market has other competitors and the group needs to develop their own original product with identities and improve their skills as much as possible.</td></tr>
<tr><td>Process of setting up activities</td><td colspan="2">1. Proposal of conducting the activity from community at a PRA workshop (Jun. 2012, supported by JICA)
2. Formation of the group from community (Nov. 2012, supported by JICA and CDD)
3. Planning and carrying out of a study tour to an advanced area, Khlong Nok Kratum, Kakorn oratum (Dec. 2012, supported by JICA)
4. Group discussion of the activity (Dec. 2012, supported by JICA)
5. Study tour to OTOP fair (Dec. 2012, supported by JICA)
6. Carry out a second study tour by group, organized by themselves (Jan. 2013)
7. Start production of the water hyacinth bag (Jan. 2013)</td></tr>
<tr><td>Support from related agencies</td><td colspan="2">JICA Project Team supported planning of the activity through PRA workshop and carrying out the study tour. The processing group of water hyacinth in an advanced area supported with technical knowledge. Community Development Department (CDD) supported the group formation and management.</td></tr>
<tr><td>Photo of activities</td><td>
Group member of water hyacinth processing group</td><td>
Final product of water hyacinth bag</td></tr>
</table>

3. Impact and Adaptability as Flood Countermeasure

Income generation activities are considered to have both direct and indirect impact as a flood countermeasure for community people through the experience of pilot activities in the model area. The direct impact is the ability to increase the cash income of a household. This has two functions, firstly, to reduce the negative impact to a household economy during a flood and secondly, to reduce the risk of disaster in the future by diversification of cash income sources. In order to reduce the risk it is important to combine this activity with other activities such as vegetable growing promotion etc. Meanwhile indirect impacts include the relief of their depression during a flood and to strengthen community relationship. The impact as a flood countermeasure by income generation activities is summarized in the following figure.

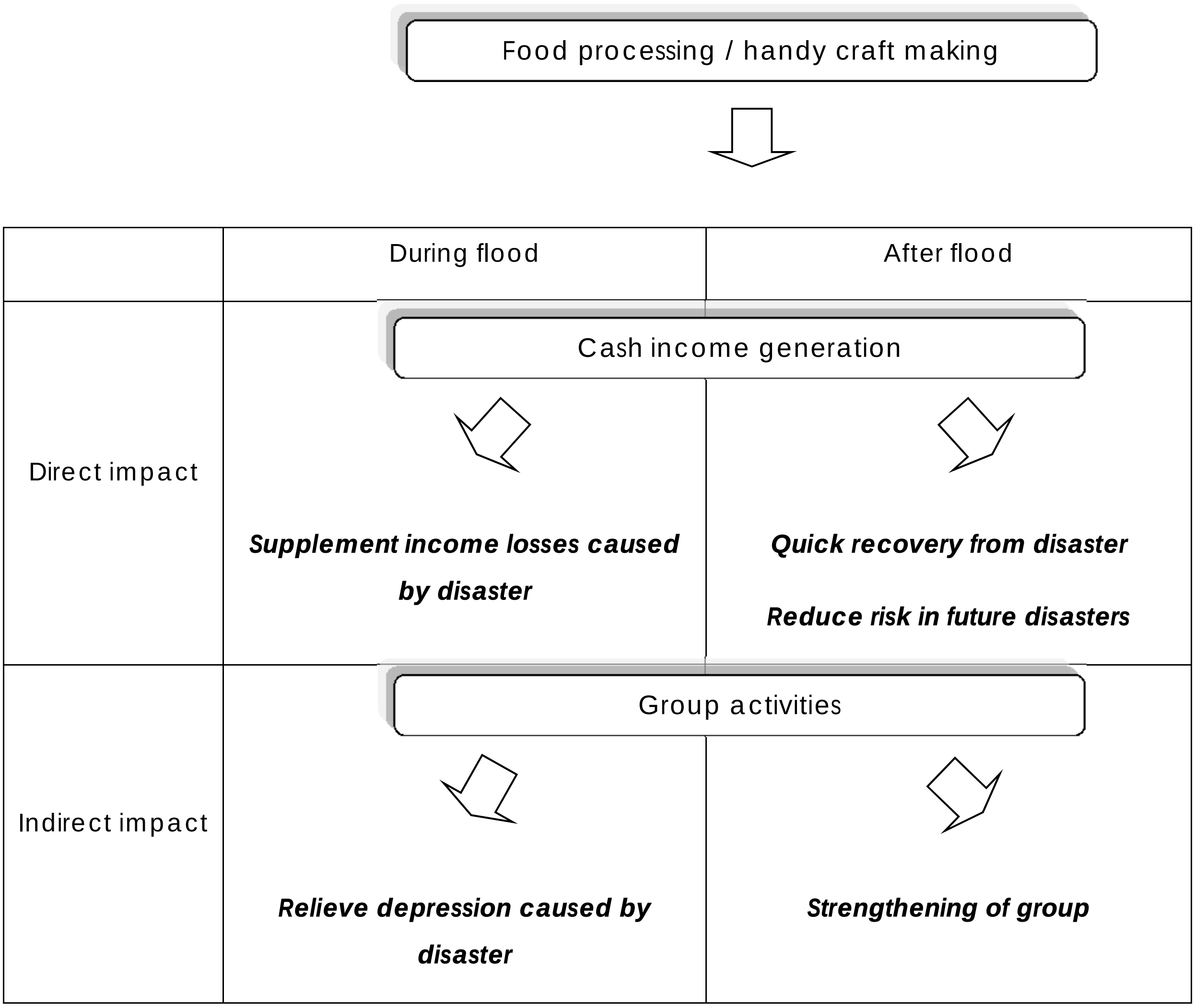


Figure 1. Impact as Flood Countermeasure

A limitation of income generation activities also exists. When the community introduce an income generation activity as flood countermeasures, it is necessary to keep in mind the following points.

- It is impossible to develop all groups of income generation to independent business level by support from the Tambon or other governmental organization since there are many factors that decide whether the business is a success or not. When a community introduces an income generation activity, it is important to compare both direct and indirect impact by the activity.
- In the case of food processing activities, in order to sell the product outside the local area/market, they need to have their product certified by Food and Drug Administration (FDA), Thailand. For certification, improvement/investment in facilities and equipment might be necessary. To introduce a food processing activity, it is better to target Pre-GMP level production and local markets.
- From the experience in the Project area, there was a case where a food processing facility was damaged and contaminated by flood, it was necessary to obtain the FDA certification again. It will be necessary for a damaged facility to get support from outside for reinvestment of

facilities and increase capacity development of hygiene controls at Pre-GMP level. However, in minor cases of damage, it is not necessary to obtain the full FDA certification, but the products need to be sampled for analysis. This analysis process is more costly and the business cannot operate until the certification is gained.

- To reduce the repeated renovation of the production house and facilitate the basic equipment to be recertified by the Thai FDA, the production areas and storage room should be located on the upper floors of the house where it is not going to be flooded. Portable equipment and the preparation areas may be located in a downstairs area as they can easily be moved before the flood arrives.

4. Role of Government Agencies and Other Stakeholders

Income generation activities in the community could be linked with the following governmental and non-governmental agencies/stakeholders when they carry out income generation activities.

Table 2. Related Agencies/stakeholders for Income Generation Activities

	Name of agencies/stakeholders	Possible support/cooperation
1	Department of Agricultural Extension (DOAE), Ministry of Agriculture and Cooperatives	・ Registering a group as a 'Community Enterprise' ・ Providing a loan to a Community Enterprise
2	Community Development Department (CDD), Ministry of Interior	・ Institutional support (formation of group) ・ Preparation of business plan ・ Linkage with other OTOP project
3	Food and Drug Administration (FDA)	・ Certification of food processing product
4	Department of Industrial Promotion (DIP), Ministry of Industry	・ Support for community product development
5	Universities (Faculty of Agriculture etc.)	・ Technical support for quality improvement and the development of product/technology
6	Non-Governmental Organization	・ Linkage with agencies connected to community

Source: JICA Project Team

Technical support for quality improvement and the development of products was separated into the following five steps.

Step1: The guideline for development of food product, process, package, safety and marketing was prepared briefly as follows.

1.1 Principles of Food Product Development – Why we need to develop the product in general, product life cycle, product development process; idea generation, idea screening/ SWOT analysis (qualitative and quantitative screening), product information (technical and market information) and product brief

1.2 Processing and Development of Aquatic Animal Products- types of products (frozen, dried, salted, fermented, smoked), e.g., pla-ra: fish types as raw materials for pla-ra, types of pla-ra, and pla-ra processing and changing of fish product during fermentation

1.3 Food Packaging and Labeling – definition and the uses of containers or materials including labels and lids to contain or hold the product in a unit and maintain product quality before the product reaches consumers, function of package (containment, preservation and protection, identification of contents, utility, convenience and machinability), the requirement by law to disclose certain information about the products through standardized Nutrition Facts panels

1.4 Value Chain (VC) Management and Marketing. Level of importance, example of smoked fish, idea generated by VC management, e.g., small size pla-ra producer, the marketing mix strategy, marketing factors 4P's, cases of (1) pla-ra (SWOT analysis and recommendation for small producer), (2) nam-pla (product quality and safety factors, and marketing factors such 4P's), (3) nam-prik, factors influencing nam-prik consumption (consumer focusing on the safety of nam-prik, labeling, expiry dated) and consumer behavior (price vs. quantity, buying location in modern trade), OTOP product

1.5 The safety of food in practical situations. The causes the sources and the effects of unsafe foods, introduction of Good Manufacturing Practice (General and specific GMP) 6 categories; plant location, processing equipment, process control, hygienic process, maintenance and personnel, Sanitation Standard Operation Procedure (SSOP), Hazard Analysis and Critical Control Point (HACCP); hazard in foods (physical, chemical and biological hazards), microbes (non-toxic and toxic microbes) and control measures and ISO22000, respectively.

1.6 Thai FDA for food production –Food law and regulation B.C.1979 (พระราชบัญญัติอาหาร พ.ศ.2522, กระทรวงสาธารณสุข) Ministry of Public Health, document preparation of food production, GMP, Pre-GMP, food labeling required by law.

1.7 Community Development Department for the development of one tambon one product (OTOP). The definition, basic principles and production of OTOP, qualification and registration of OTOP producers (food and non-food production), characteristic and uniqueness of OTOP products, product development from local knowledge - based OTOP (KBO), market channel opportunities.

Step 2: Demonstration of canned fish processing and practice on nam-prik na-rok pla-yang processing was set up during a 2 day workshop on the 23rd and 24th of March in 2013 at the Department of Agro-Industry, Faculty of Agriculture, Natural Resources and Environment, Naresuan University, Phitsanulok. The lecture included information on the basic principles of the canning process with a demonstration of canned fish processing and practice on nam-prik na-rok pla-yang processing. (*The program and materials are shown in Appendix a*)

Step 3: Nam-prik samples were also analyzed at NU laboratory. (*The analytical results are shown in Appendix b)* and the recommendation for 2 local areas processing are also summarized *(Appendix c*)

Step 4: Stickers of fishery products were provided for CSS, NPM and Gop Chao producers. (*The stickers are shown in Appendix d*)

Step 5: Posters about program introducing, guidelines for production of food required by law and advertising the communities' products were provided (*The poster design is shown in appendix e*)

5. Lessons Learned from Pilot Activities

1) Lessons Learned from the income generation activity by the community

Lessons learned through the income generation activities by JICA Flood Project and other related agencies are summarized below:

- Support for existing groups and existing activities is easily adopted and started by a group. Therefore, rapid support can get good results especially for income generation and group strengthening**. *(Utilization of existing group and activity)***
- Utilization of locally caught fish and shrimp has a good effect on the local economy for the fishermen's group. The linkage of local economy through an income generation activity is effective. ***(Utilization of locally available recourses)***
- It was observed through the income generation activities that the activity motivated group communication inside a group and stimulated people outside the group in the activity. ***(Motivating group communication)***
- The group members have always preferred to stay at home for working/processing activities rather than working outside. It enables members to take care of their family members. It showed that the activity for income generation which can be done in the house in their spare time is effective for females. Meanwhile, to obtain FDA certification it is necessary to process their food products at home with well-organized system in place as required by law at either Pre-GMP or GMP. ***(Activity at home)***
- For technical improvement of food processing, it is effective to cooperate with universities or

other agencies which have technical knowledge. These technical agencies from outside in some cases might not be familiar with how to communicate with local communities and have difficulties to obtain needs from the community. For such cases, it is recommended to utilize a well-trained organization which has the skills and knowledgeable in related areas for communication with local communities at workshops and training sessions. ***(Communication with local community)***

2) Points for supporting of income generation activity by community

For implementation of income generation activities as flood countermeasures, the followings points should be kept in mind based on experiences from the pilot activities by the Project.

- Utilization of existing group, activities, marketing channel, skills etc.
- Development of linkage with advanced groups in technical and marketing knowledge
- Selection of raw materials which are available and their amount increases during a flood
- Selection of house industry level activities without large initial investments
- Selection of product with a short processing period (short time from purchasing raw materials to selling the final products)
- Selection of products that can be kept for a long period (preserved food, handy crafts etc.)

3) Flow of income generation activity by community

The flow of income generation activities by a community and points for supporting the activity are shown below.

Step	Check Point
1. Workshop(s) in community to confirm current situation	• To check existing group/skill/local recourses • To involve more stakeholders related to activity including NGO, govt. agencies
↓	
2. Planning workshop of activities	• To utilize local resources, existing group/skills as much as possible
↓	
3. Preparation of business plan	• To involve government agencies such as CDD etc.
↓	
4. Improvement of technical knowledge and skill	• To link with local advanced group • To link with universities for technical support
↓	
5. Procurement of equipment and improvement of facilities	• Procurement must be done based on the business plan.
↓	
6. Marketing	• To link with existing marketing group • To utilize local fair, market, etc.

Figure 2. Flow of Income Generation Activity

References

- Food Processing Training Materials prepared by Naresuan University

Appendix A

Analytical results of products

Samples	Details	Analytical methods	Results*
น้ำพริกปลาย่างบรรจุถุง13 มีนาคม2556 Nam-prik pla-yang in plastic bag (NPM)	1. Total Plate Count	FDA BAM (2001),Ch.3	4.50 x 10^4 cfu/g
	2. Yeast and Mold Count	FDA BAM (2001),Ch.18	< 100 cfu/g
	4. *E.coli*	FDA BAM (2002),Ch.4	< 3 MPN/g
น้ำพริกปลาย่างบรรจุขวด 13 มีนาคม2556 Nam-prik pla-yang in glass container (CSS)	1. Total Plate Count	FDA BAM (2001),Ch.3	5.40x10^5 cfu/g
	2. Yeast and Mold Count	FDA BAM (2001),Ch.18	< 100 cfu/g
	3. *E.coli*	FDA BAM (2002),Ch.4	< 3 MPN/g
น้ำพริกปลาย่างบรรจุขวด 1 พฤษภาคม 2556 Nam-prik pla-yang in glass container with 500mg/kg Sodium benzoate (CSS)	1. Total Plate Count	FDA BAM (2001),Ch.3	25 cfu/g
	2. Yeast and Mold Count	FDA BAM (2001),Ch.18	< 100 cfu/g
	3. *E.coli*	FDA BAM (2002),Ch.4	< 3 MPN/g
	4. *Staphylococcus aureus*	FDA BAM (2002),Ch.12	ไม่พบ

* มาตรฐานผลิตภัณฑ์น้ำพริกผัด มผช.321/2547 (Nam-prik Standard): Total Plate Count < 1x 10^4 cfu/g; Yeast and Mold Count < 100 cfu/g; *E.coli* (*Escherichia coli*) < 3 MPN/g

Recommendations for Good Manufacturing Practice (GMP) of 2 processing areas

<u>CSS</u>

The production house should be separated from the lodging area, good process control, cleaning of equipment before and after production; however (1) need to separate the specific zones inside the plant e.g., preparation, cooking, packing, storage of raw materials/ kitchen utensils (2) need more preventive measures against pest and insect and (3) personnel hygiene. In order to save the time and be more cost effective, all this should be done under local FDA and academic/university consultation.

<u>NPM</u>

Good personal hygiene must be maintained. Where the member does not have a specific production house, but may use a hall for general purpose the following needs consideration. NPM members need to discuss and search for a proper production house/location and procure suitable process equipment. To save time and be more cost effective, all this should be done under local FDA and academic/university consultation.

Appendix B

Products Quality from Gop Chao – microbial analytical results

Samples	**Details**	Analytical methods	Results*
ปลาร้า/ 25 มีนาคม2556 (Pla-ra) Gop Chao	1. Yeast and Mold Count	FDA BAM (2001),Ch.18	2.80×10^{5} cfu/g
	2. *Staphylococcus aureus*	FDA BAM (2002),Ch.12	1.00×10^{3} cfu/g
	3. *E.coli*	FDA BAM (2002),Ch.4	5.70×10^{2} cfu/g
กะปิ/ 25 มีนาคม2556 (Kapi) Gop Chao	1. Yeast and Mold Count	FDA BAM (2001),Ch.18	1.55×10^{2} cfu/g
	2. *Staphylococcus aureus*	FDA BAM (2002),Ch.12	4.70×10^{2} cfu/g
	3. *E.coli*	FDA BAM (2002),Ch.4	8.70×10^{3} cfu/g

* มาตรฐานผลิตภัณฑ์ปลาร้า มผช.37/2546 (Pla-ra Standard); มาตรฐานผลิตภัณฑ์กะปิ มผช.61/2546 (Kapi Standard) and DMSC (2535): Yeast and Mold not detected; *Staphylococcus aureus* < 100 cfu/g; *E.coli* < 3 MPN/g; *C. prefringens* < 1000 cfu/g; *B.* cereus < 1000 cfu/g; *Salmonella* not detected in 25g

The Project for Flood Countermeasures for Thailand Agricultural Sector

<u>'Guideline for Disaster Resilient Agriculture and Agricultural Community'</u>

Technical Paper Series No. 22

Land Use Database for Faster and Accurate Compensation Payment

Prepared by

JICA Project Team

and

Office of Agricultural Economics (OAE)

Land Use Database for Faster and Accurate Compensation Payment

1. Introduction

Damage caused to the agriculturesector by the 2011 Flood was estimated to be as much as 72 million baht (OAE), and compensation for farmers consisted of 17,847 million baht for crops. Out of this total, 58% (10,560 millionbaht)was paid to one (1) million rice farmers. However, it was reported that payment of compensation was delayed due to a lengthy and time consuming process required to confirm the damage and actual identity of the cultivators and land owners. Some farmers received compensation without damage of paddy after harvest. Therefore, it is important for the government to be equipped with a tool which can facilitate faster and a more accurate evaluation of crop damage and complete the payment of compensation to the farmers.

To calculate the amount of compensation for farmers who are hit by a disaster such as the flood in the target area, we use the GIS application. For this application to work correctly, the most important factor is to have sufficient and up to date data, both in spatial and attribute data. The OAE (Office of Agricultural Economics) has implemented pilot projects for creating a land parcel database based on ortho-photo (adjustment or correction using images) in seven model areas to establish a database link with the Department of Agricultural Extension (DOAE)'s farmer registration data and to gain information on the planning of production or marketing for crops.This conceptshall be appliedforthis project, and uses data on land parcel with information stored in a land use database, which can be used for calculating amounts correctly forcompensation payments.

The objective of this guideline is to prepare standard procedures to construct a land parcel GIS database at a Tambon level in order to facilitate an accurate and faster compensation payment system.This guideline requires the following actions;

- To identify necessary data sources and agency of data sources.
- To define the processfor establishing a land use database.
- To define data structure and portrayal of a land use database.

It should be noted that this land parcel GIS database can also be used as a form of tax map for Tambon Administration Organizations in addition to the objective above.

2. Guideline of Establishment of aGIS Land Parcel Database

This guideline was developed by focusing on 3 components; Input, Process and Ouput.

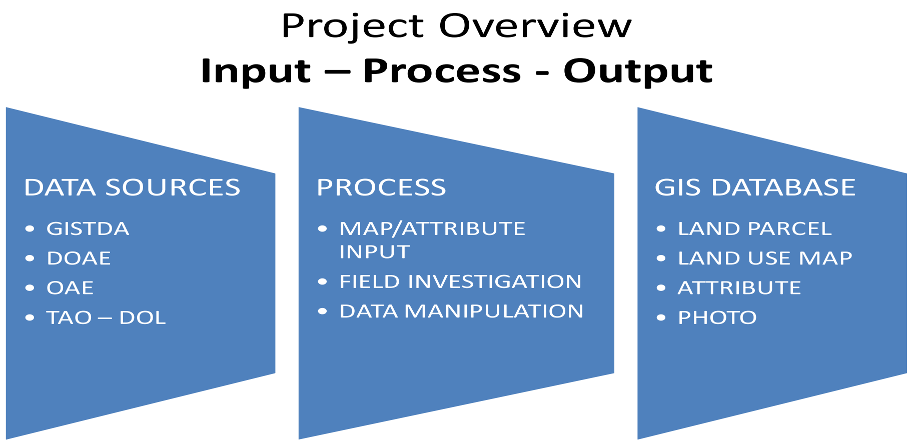


Figure-1: Input – Process - Output

The input is the data obtained from government agencies that shall be used in the process for creating a GIS Database as the output of the project.

The procedure for generating a GIS Land Parcel Database has been developed and consists of;

- Data preparation
- Land parcel input
- Field investigation
- Land Use Database creation
- Final maps and documents

The overview of all processes is shown in the following figure.

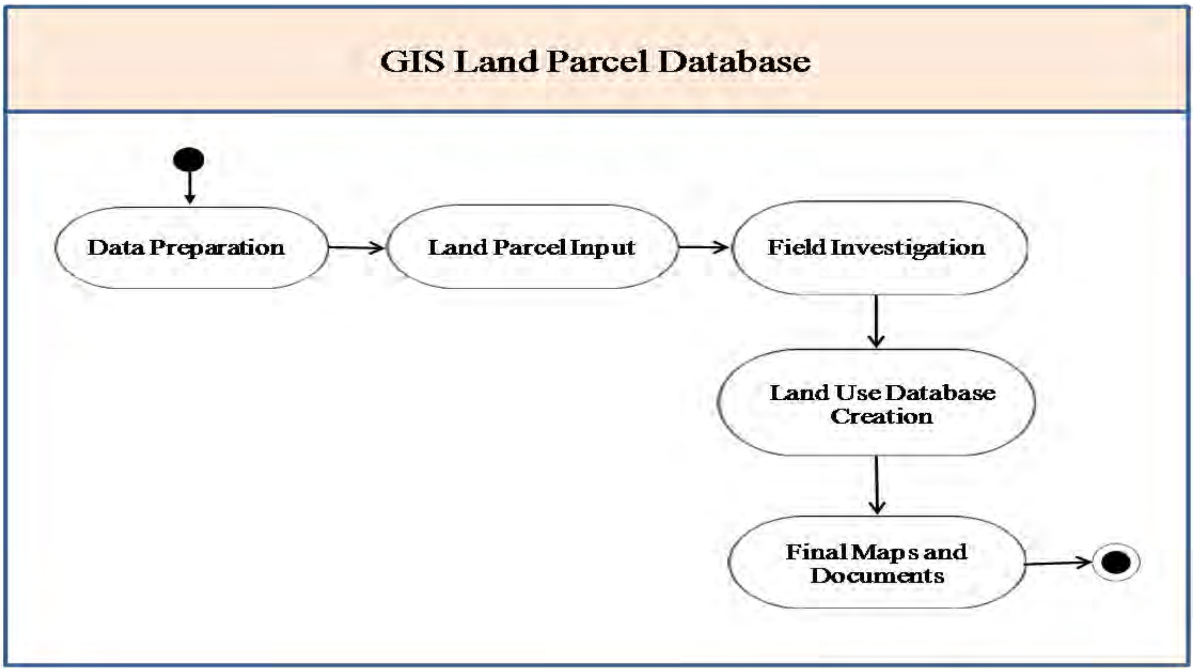


Figure-2:Overview of Land Parcel Database process

The details of each process are described as follows;

1) Data Preparation
   a. Data Collection
      Data is collected from several sources including the following;
      - Satellite images; WorldView-2, with panchromatic resolution 0.5 meters GSD (Ground Sampling Distance), from Geo-Informaticsand Space Technology Development Agency (Public Organization) (GISTDA).
      - Cadastral map (official register of land value/ownership),Land Owner registrationfromtheTambon Administration Organization (TAO) and Department of Lands (DOL)Provincial Land Office and Agricultural Land Reform Office (ALRO) Provincial Office.An example of the letter requesting informationis shown below as attachment No.1.
      - Farmer registration from Department of Agricultural Extension (DOAE)District Office. Example shown as attachment No.2.
      - Land use classification from Office of Agricultural Economics (OAE).

      The data preparation process is shown in the following figure.

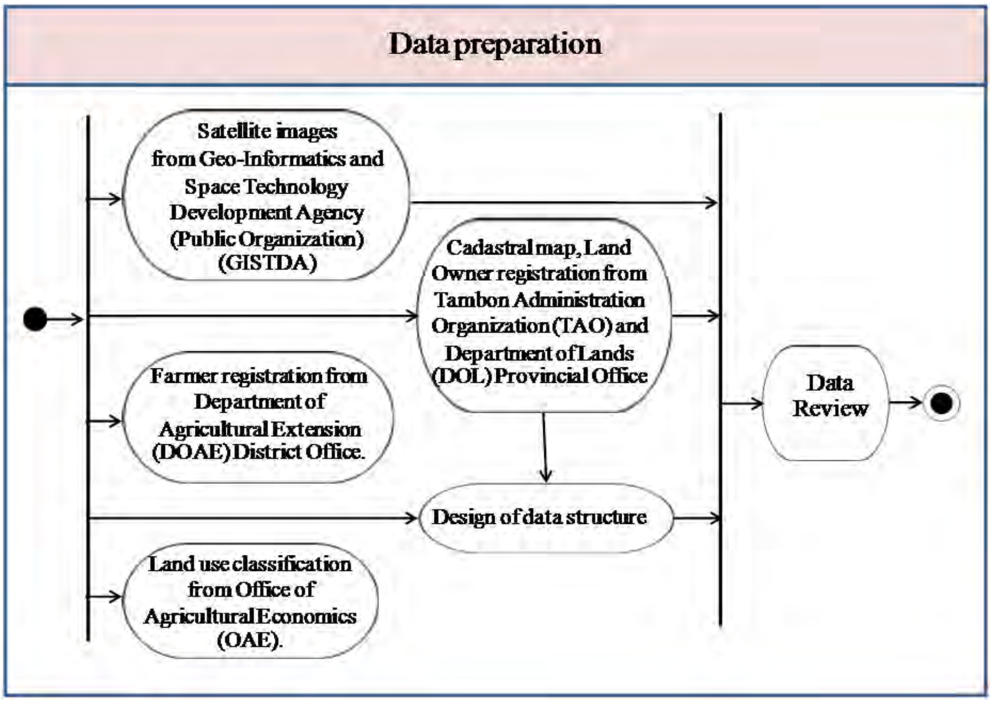


Figure-3: Data preparation process

   b. Design of Data Structure
      According to the requirements of the project and the raw data obtained from several data sources,described above, the style and necessary attributes such as; field name,

field type and field width are defined, and then can be used for the land use database as shown in the Table below.

Table-1:Data structure for land use database

DATA STRUCTURE
LAYER : LAND USE
FEATURE : POLYGON

Column Name	Description	Data Type	Width
OBJECTID	OBJECTID		
AD_CODE	Land parcel code(user defined)	Long Integer	16
R_UTM50K	Map sheet1:50,000	Text	8
UTM50K_NO	Sub Map sheet1:50,000	Short Integer	10
R_UTM4K	Map sheet1:4,000	Text	8
UTM4K_NO	Sub Map sheet1:4,000	Text	2
LAND_NO	UTM Land No.	Short Integer	10
SUR_PAGE	Survey No.	Short Integer	10
TITLE_NAME	Title of farmer	Text	10
FIRST_NAME	Name	Text	50
LAST_NAME	Surname	Text	50
ID_CARD	Farmer ID Card	Text	18
HOUSE_NO	Address	Text	10
MOO	Moo	Text	5
TAMBON	Tambon	Text	30
AMPHOE	Amphoe	Text	30
PROVINCE	Province	Text	30
DEED_NO	Deed No.	Text	15
T_TENURE	Type of Tenure	Text	20
DOC_TITLE	Document of title	Text	20
DEED_AREA	Deed area (rai-ngan-wa)	Text	15
USE_AREA	Used area (rai-ngan-wa)	Text	15
LU_CODE_E	Land use code	Text	8

More detail is shown in attachment No.4.

2) Land Parcel Input

a. Cadastral Map Digitizing

The procedure for digitizing shall be done as follows;

- The cadastral map scale 1:4000 (DOL map sheet) covering 2 km. x 2 km. per map sheet that can be obtained from TAO, shall be scanned and rectified as UTM Zone 47 Indian Datum coordinate system (DOL's Coordinate System). To correctly create the cadastral map, at least 4 points at the corner of each map must be used.

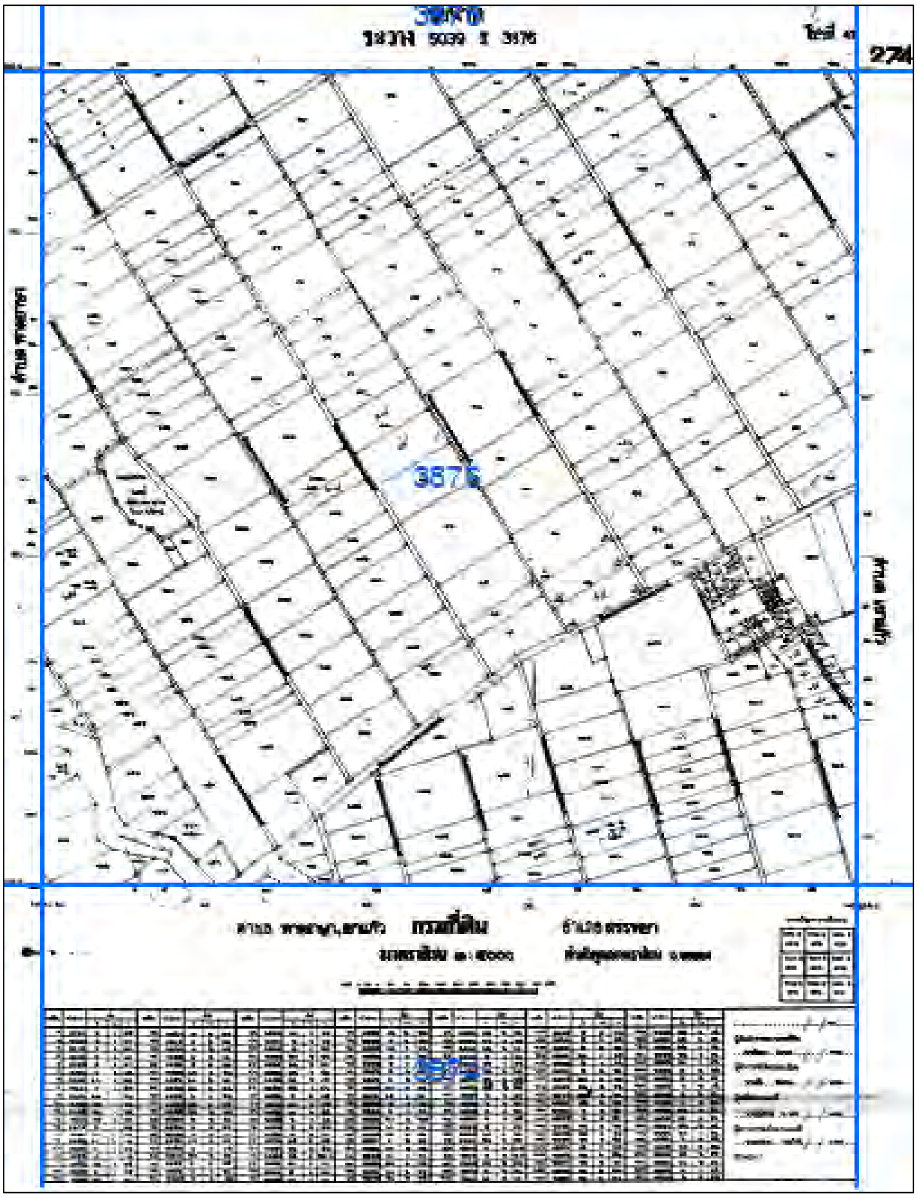


Figure-4: Cadastral map sheet from DOL

- Land Parcel boundariesaccording to the cadastral mapare digitized.

Figure-5: Shows land parcel boundaries digitized from the cadastral map

- Attributes of the land parcel such as land number, map sheet are input. This data shall be used for owner data linkage.
- Overlaying of the land parcels on the satellite images is then done to adjust line map and make any edge matching corrections.

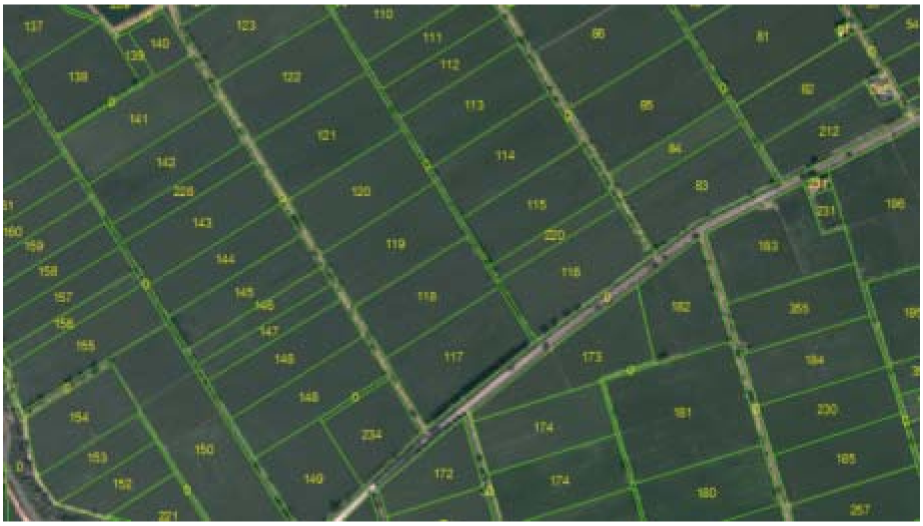


Figure-6: Shows land parcels overlay on satellite images

At this step, the land parcels from a hard copy format are converted into digital format and also corrected to match the satellite images which can then be used for field investigation.

b. Farmer Registration Data Input

Farmer registrationdata from DOAE includes: name of farmer, address, location of land parcel, area of land use, date of planting, date of harvesting, certificate of land, area of land, in/out irrigation and type of crops as shown in the following figure.

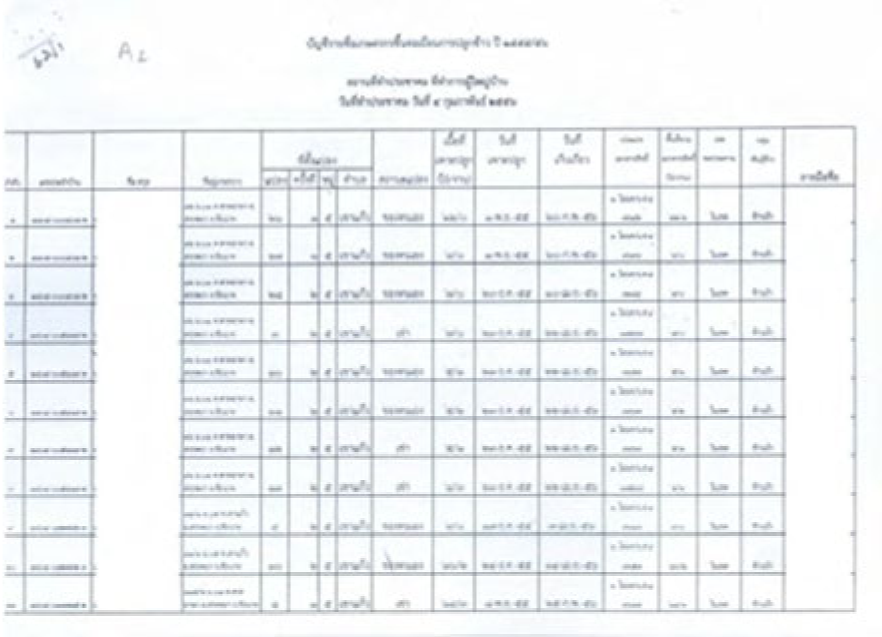
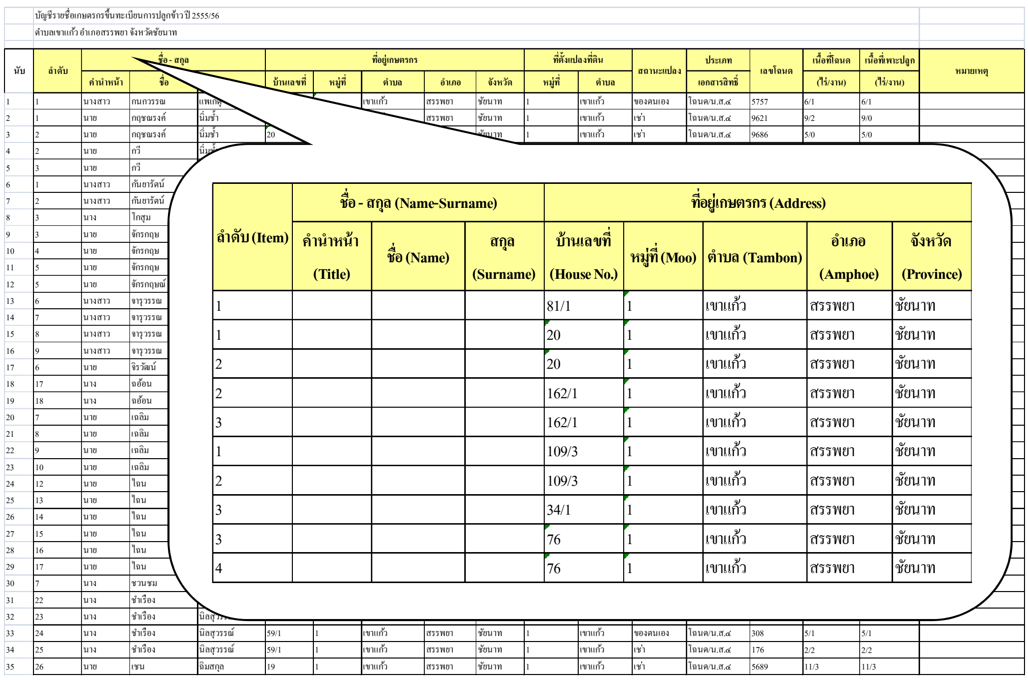


Figure-7: Shows farmer registration data from DOAE

All data is input using MS Office Excel format as shown in the Table below.



ลำดับ (Item)	ชื่อ - สกุล (Name-Surname)			ที่อยู่เกษตรกร (Address)				
	คำนำหน้า (Title)	ชื่อ (Name)	สกุล (Surname)	บ้านเลขที่ (House No.)	หมู่ที่ (Moo)	ตำบล (Tambon)	อำเภอ (Amphoe)	จังหวัด (Province)
1				81/1	1	เขาแก้ว	สรรพยา	ชัยนาท
1				20	1	เขาแก้ว	สรรพยา	ชัยนาท
2				20	1	เขาแก้ว	สรรพยา	ชัยนาท
2				162/1	1	เขาแก้ว	สรรพยา	ชัยนาท
3				162/1	1	เขาแก้ว	สรรพยา	ชัยนาท
1				109/3	1	เขาแก้ว	สรรพยา	ชัยนาท
2				109/3	1	เขาแก้ว	สรรพยา	ชัยนาท
3				34/1	1	เขาแก้ว	สรรพยา	ชัยนาท
3				76	1	เขาแก้ว	สรรพยา	ชัยนาท
4				76	1	เขาแก้ว	สรรพยา	ชัยนาท

Table-2: Farmer registration in Excel format

c. Map and Investigation Form preparation

Land parcel maps on satellite images at appropriate scale such as1:4000 or1:5000 shall be plotted for field investigation as follows;

Figure-8: Shows map for field investigation

The land parcels input process described above is shown in the following figure.

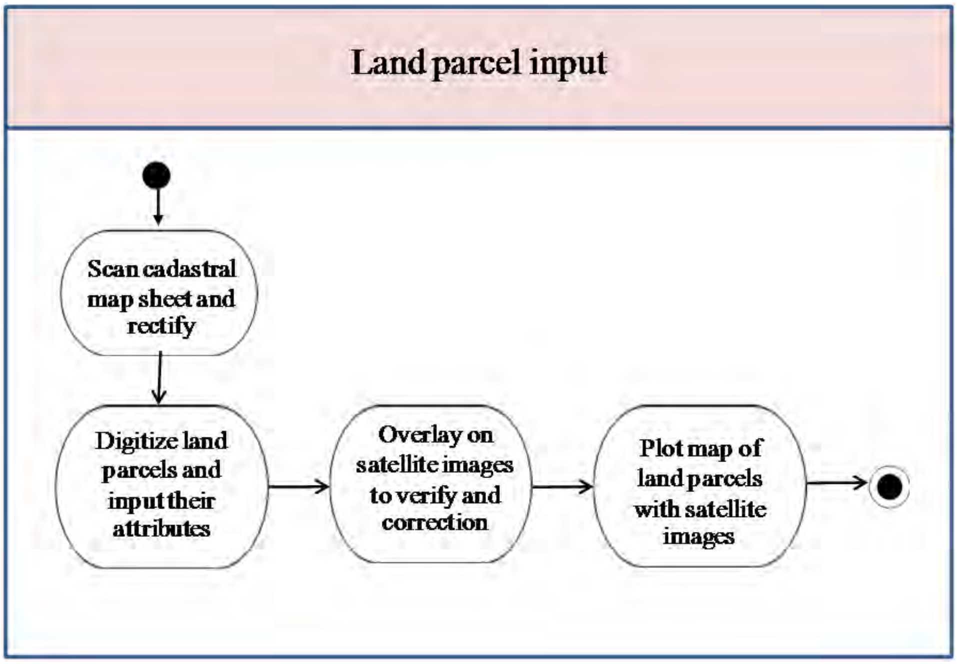


Figure-9: Land parcel input process

The investigation form shall be prepared as follows.

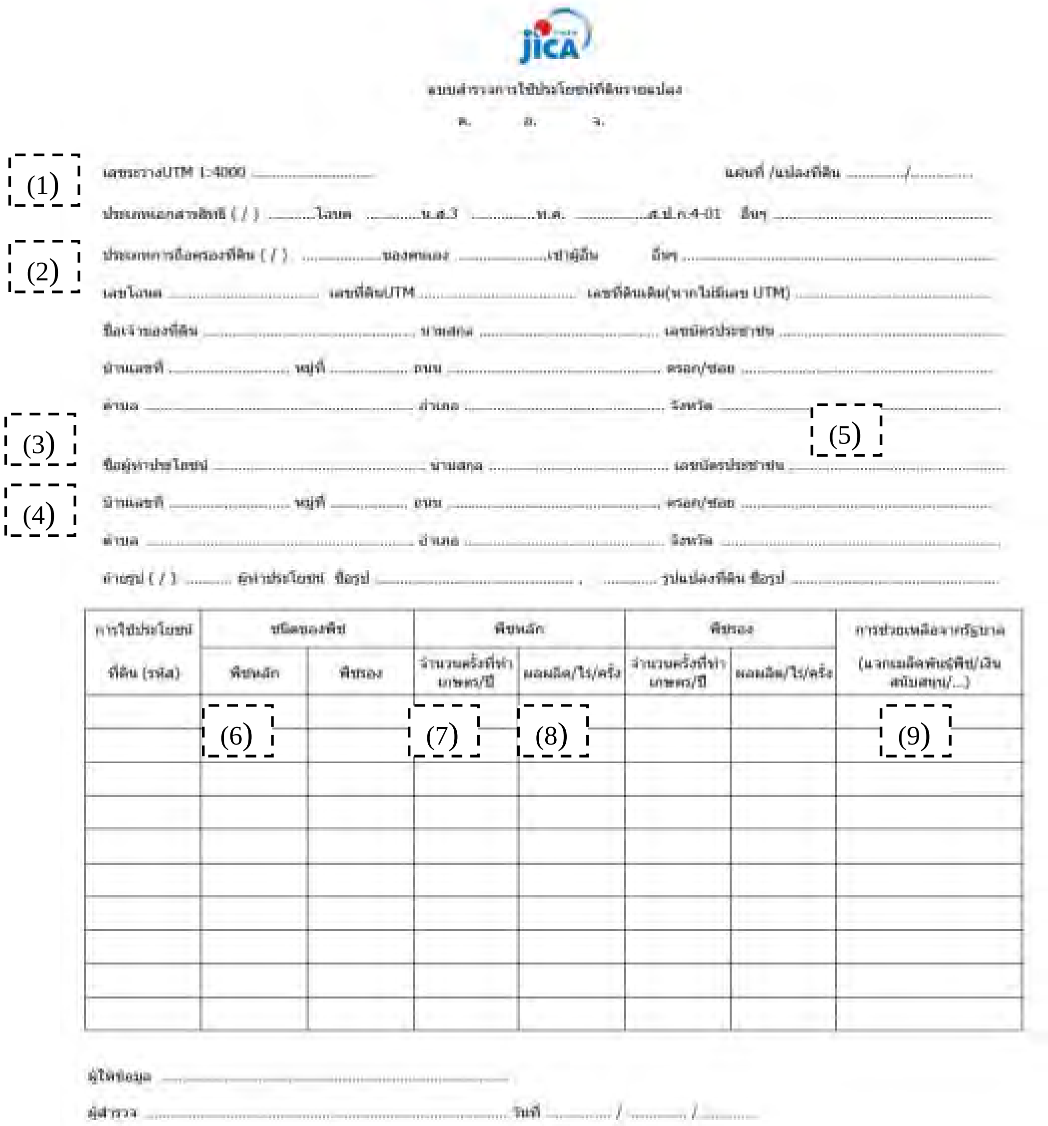


Figure-10: Information to be gathered on the farmer investigation form

Data to be recorded from the interview with the farmers consists of the following details and refer to the numbers on the form above in Figure-10.

(1) Certificate of land / No. of title deed (title deed, co-operative)
(2) Location of land parcel on map
(3) Name of Tenant Farmer (s) (First name, Family name)
(4) Address (Moo, Tambon, Amphoe, Province)
(5) ID Card Number (13 digits)

(6) Type of crops (main crop and secondary crop)
(7) Frequency of harvesting / Year
(8) Yield (Kilogram / Rai)
(9) Government assistance (If the farmer receives seed or any other form of support from government or not)

Maps and the Investigation form shall be used for field investigation.

3) Field Investigation

After inputting the land parcel data,the field investigation shall be conducted in order to collect the additional data regarding the land use.

a. Land Use Classification
   In the field, current land use from satellite images and farmer interview data shall be confirmed by field surveying. The classification of land use shall be defined according to OAE specification. The list of land use types are as follows;
   - Rice (RI)
   - Aquacultute (AQ)
   - Tree (TR)
   - Other Agriculture (OA)
   - Other Non-agriculture (OT)
   - Water (WA)
   - NA

b. Farmer Interview
   By cooperation with the Head of the Village (Phuyai-baan and Phuchuay), the farmers of each village (from listing in farmer registration data) shall be informed of the date set for the interview. When the farmer comes for the interview, the details of land use shall be recorded in the form and farmer’s photo will also be taken.

Figure-11: Photos of the farmer interviews.

An example of a completed farmer interview form is shown below.

Figure-12: Photo of the actual land use and the photo of the individual farmer

c. Data Input

Data from the field investigation shall be input to Excel file format, some records from the interview data as design data structure are shown in the following tables.

	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	T_NAME	F_NAME	L_NAME	ID_CARD	HOUSE_NO	MOO	TAMBON	AMPHOE	PROVINCE	Moo_L	Tambon_L	SUR_PAGE	DEED_NO	T_TENURE	DOC_TITLE
20	นาย	พิชิต	ข้องหลิม	3180400291740	47/1	3	เขาแก้ว	สรรพยา	ชัยนาท	3	เขาแก้ว	573	10163	เช่า	โฉนด/น.ส.๔
21	นางสาว	อรุณรัตน์	คงสมบูรณ์	1170600086892	90/1	3	เขาแก้ว	สรรพยา	ชัยนาท	3	เขาแก้ว	643	10146	ของตนเอง	โฉนด/น.ส.๔
22	นาย	น้องลักษณ์	นาคทรัพย์	3180400290492	21	3	เขาแก้ว	สรรพยา	ชัยนาท	3	เขาแก้ว	644	10148	ของตนเอง	โฉนด/น.ส.๔
23	นาย	บุญเรือน	นาดีมาก	3600700517897	237	2	หาดอาษา	สรรพยา	ชัยนาท	1	เขาแก้ว	767	9913	เช่า	โฉนด/น.ส.๔
24	นาย	พัฒนะ	ชุ่มจุ้ย	3180400153045	32/2	7	หาดอาษา	สรรพยา	ชัยนาท	6	เขาแก้ว	1055	4316	เช่า	โฉนด/น.ส.๔
25	นาย	กฤษณะ	บุญธรรม	3180400434834	2	8	หาดอาษา	สรรพยา	ชัยนาท	6	เขาแก้ว	1056	4317	เช่า	โฉนด/น.ส.๔
26	นาง	จำนงค์	ตั้งพิสิฐโยธิน	3180400305279	2	6	เขาแก้ว	สรรพยา	ชัยนาท	6	เขาแก้ว	1340	4524	ของตนเอง	โฉนด/น.ส.๔
27	นาง	จำนงค์	ตั้งพิสิฐโยธิน	3180400305279	2	6	เขาแก้ว	สรรพยา	ชัยนาท	6	เขาแก้ว	1344	4526	ของตนเอง	โฉนด/น.ส.๔
28	นาย	เสมอ	จิ๋วแหยม	3180400031411	75/1	4	โพนางดำออก	สรรพยา	ชัยนาท	1	เขาแก้ว	1464	5747	เช่า	โฉนด/น.ส.๔
29	นางสาว	ศิริวรรณ	แย้มเยื้อน	1180400007191	126	1	เขาแก้ว	สรรพยา	ชัยนาท	1	เขาแก้ว	1566	5438	เช่า	โฉนด/น.ส.๔
30	นางสาว	ศิริวรรณ	แย้มเยื้อน	1180400007191	126	1	เขาแก้ว	สรรพยา	ชัยนาท	1	เขาแก้ว	1572	5442	เช่า	โฉนด/น.ส.๔
31	นาย	สมบูรณ์	ปลั่งดี	3180400051285	13	6	โพนางดำออก	สรรพยา	ชัยนาท	1	เขาแก้ว	1616	5379	เช่า	โฉนด/น.ส.๔
32	นาย	สุนทร	นาคทรัพย์	3180400294081	134	3	เขาแก้ว	สรรพยา	ชัยนาท	3	เขาแก้ว	1680	26433	เช่า	โฉนด/น.ส.๔
33	นาย	ธงชัย	ดอกชะบา	3180400123138	46	1	หาดอาษา	สรรพยา	ชัยนาท	5	เขาแก้ว	1709	7199	ของตนเอง	โฉนด/น.ส.๔
34	นาง	มาลี	เล็กถนอมเกียรติ	3180400434737	1	8	หาดอาษา	สรรพยา	ชัยนาท	5	เขาแก้ว	1742	7232	ของตนเอง	โฉนด/น.ส.๔
35	นาง	ณัฐณิชา	อรุณเมือง	3300300165104	98	2	หาดอาษา	สรรพยา	ชัยนาท	5	เขาแก้ว	1751	7241	เช่า	โฉนด/น.ส.๔
36	นางสาว	พรนภา	ชัยบุรินทร์	3180400437574	54/2	8	หาดอาษา	สรรพยา	ชัยนาท	5	เขาแก้ว	1790	7280	เช่า	โฉนด/น.ส.๔
37	นาย	น้องลักษณ์	นาคทรัพย์	3180400290492	21	3	เขาแก้ว	สรรพยา	ชัยนาท	3	เขาแก้ว	1802	7683	เช่า	โฉนด/น.ส.๔
38	นาย	นัยยวัฒน์	พานจันทร์	3180400291391	39/1	3	เขาแก้ว	สรรพยา	ชัยนาท	3	เขาแก้ว	1808	7773	ของตนเอง	โฉนด/น.ส.๔
39	นาย	นัยยวัฒน์	พานจันทร์	3180400291391	39/1	3	เขาแก้ว	สรรพยา	ชัยนาท	3	เขาแก้ว	1833	8131	เช่า	โฉนด/น.ส.๔

	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	D_Rai	D_Ngan	D_Wa	U_Rai	U_Ngan	U_Wa	LU_CODE	M_CROP_E	M_CROP_T	S_CROP	M_FRE	S_FRE	YIELD_M1	YIELD_M2	YIELD_S1	YIELD_S2	G_ASSIST
20	15	0	17	15	0	17	RI	Rice	ข้าว		2		649	798			ได้พันธุ์ข้าว 10 ถัง/ราย ,ได้เงินชดเชย 2222 บาท/ไร่
21	4	0	92	4	0	92	RI	Rice	ข้าว		2		473	473			ได้พันธุ์ข้าว 10 ถัง/ราย
22	4	2	84	4	2	84	RI	Rice	ข้าว		2		1000	1000			ได้เงินชดเชย 2222 บาท/ไร่
23	7	1	32	7	1	32	RI	Rice	ข้าว		2		823	864			-
24	10	3	42.5	10	3	42.5	RI	Rice	ข้าว		2		800	800			ได้พันธุ์ข้าว 10 ถัง/ราย ,ได้เงินชดเชย 2222 บาท/ไร่
25	11	2	1.7	11	2	1.7	RI	Rice	ข้าว		2		725	739			ได้พันธุ์ข้าว 4 ถัง/ราย ,ได้เงินชดเชย 2222 บาท/ไร่
26	8	3	65.3	8	3	65.3	RI	Rice	ข้าว		2		738	724			-
27	5	0	70.5	5	0	70.5	RI	Rice	ข้าว		2		415	485			-
28	14	2	64.1	14	2	64.1	RI	Rice	ข้าว		2		900	990			-
29	8	0	16.2	8	0	16.2	RI	Rice	ข้าว		2		750	800			ได้พันธุ์ข้าว 10 ถัง/ราย ,ได้เงินชดเชย 2222 บาท/ไร่
30	5	1	12.4	5	1	12.4	RI	Rice	ข้าว		2		750	800			ได้พันธุ์ข้าว 10 ถัง/ราย ,ได้เงินชดเชย 2222 บาท/ไร่
31	9	3	85.2	9	3	85.2	RI	Rice	ข้าว		2		728	1000			ได้พันธุ์ข้าว 10 ถัง/ราย ,ได้เงินชดเชย 2222 บาท/ไร่
32	5	2	85	5	2	85	RI	Rice	ข้าว		2		787	699			ได้เงินชดเชย 2222 บาท/ไร่
33	7	0	28	7	0	28	RI	Rice	ข้าว		2		394	638			ได้เงินชดเชย 2222 บาท/ไร่
34	18	0		18	0	[illegible]	RI	Rice	ข้าว		2		1000	1000			ได้พันธุ์ข้าว 10 ถัง/ราย ,ได้เงินชดเชย 2222 บาท/ไร่
35	12	0	99	12	0	99	RI	Rice	ข้าว		2		694	752			ได้เงินชดเชย 2222 บาท/ไร่
36	11	1	8	11	1	8	RI	Rice	ข้าว		2		1000	1000			ได้พันธุ์ข้าว 10 ถัง/ราย ,ได้เงินชดเชย 2222 บาท/ไร่
37	8	3	14.5	8	3	14.5	RI	Rice	ข้าว		2		1000	1000			ได้เงินชดเชย 2222 บาท/ไร่
38	18	1	66	18	1	66	RI	Rice	ข้าว		2		989	812			ได้เงินชดเชย 2222 บาท/ไร่
39	9	1	20	9	1	20	RI	Rice	ข้าว		2		989	812			ได้เงินชดเชย 2222 บาท/ไร่
40	4	2	0	4	2	0	RI	Rice	ข้าว		2		678	644			-

<u>3: Farmer interview data in Excel format</u>

The process of the field investigation is shown in the following figure.

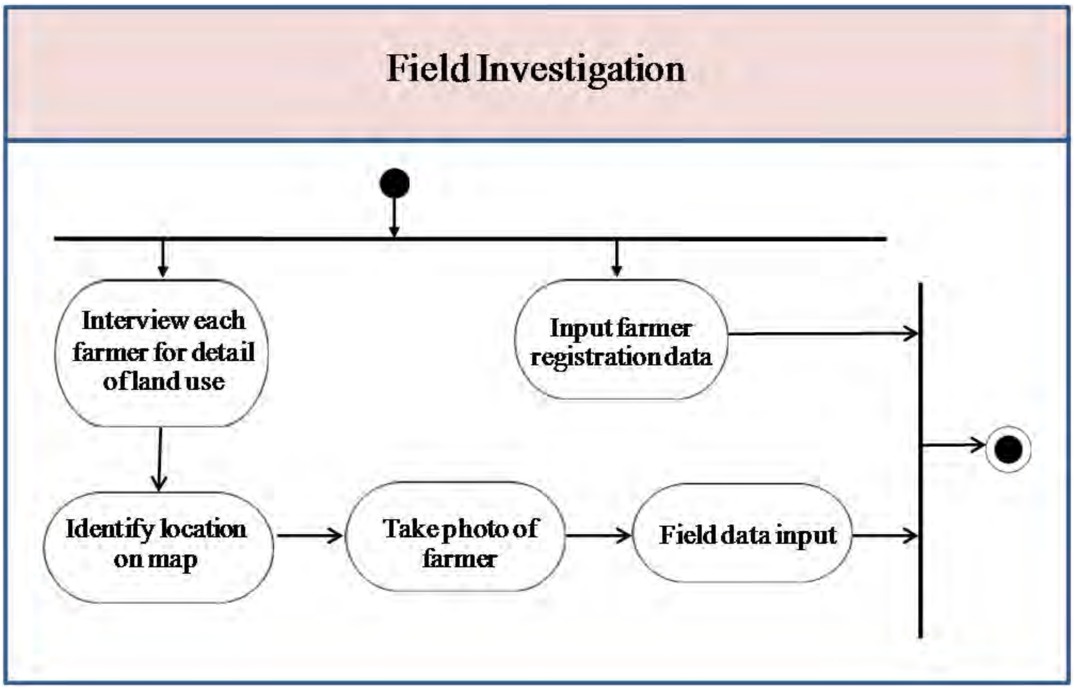


Figure-13:Process of field investigation

4) Land Use Database Creation
   a. Data linkage
      All land use data shall be linked with land parcel data by land No., and map sheet. In the case where some land parcels are used for different proposes, such as the use of both farming and housing, they shall be divided into two parts and so on.
   b. Land Use Map verification and correction
      Land use from the interview data shall be verified with the satellite images. The area and exact shape of land use shall be corrected according to land parcel and satellite images.
      Shape file of the land parcel and land use shall be verified by GIS software as topology checking, the overlap and gap for the spatial data shall be cleaned, these shape files shall then be transformed to WGS 1984 UTM Zone 47 N coordinate system.

The process of creating the land use database is shown in the Figure below.

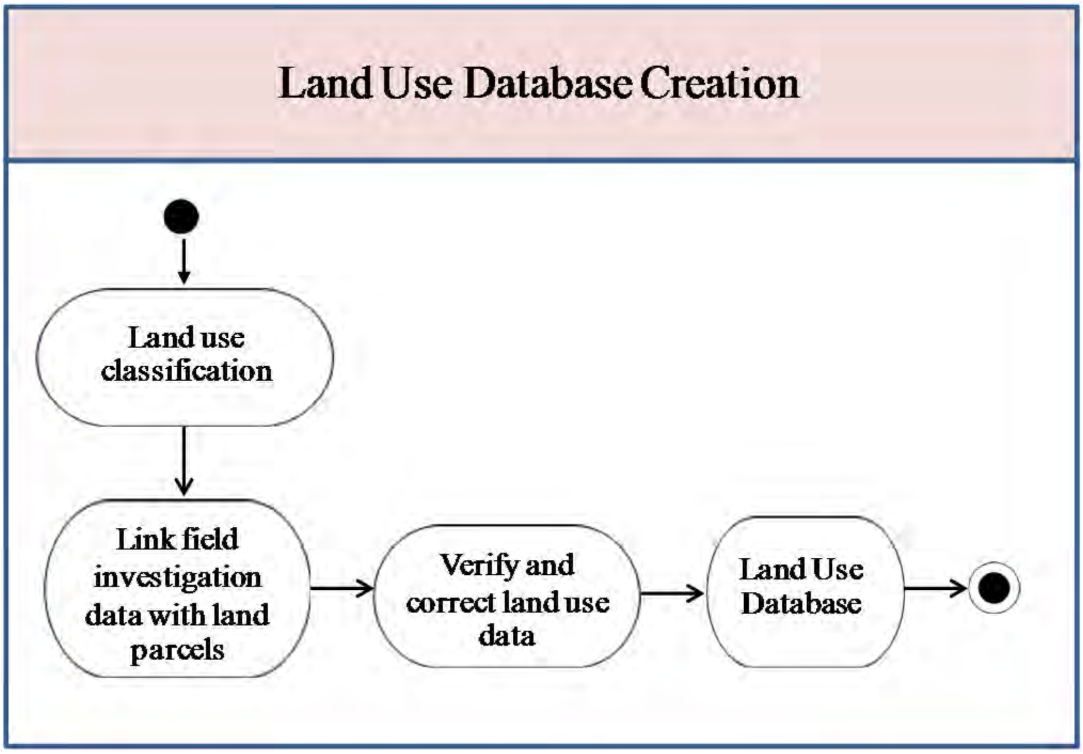


Figure-14: The process of creating the land use database.

5) Final maps and documents

c. Final maps

From the land use database, the template map layout at scale 1:4000 for hard copy plotting shall be developed and consists of;

- Mapping area covering 2 km. x 2 km.
- Title map with logos
- Index map
- Legend
- North Direction Symbol
- Scale bar

Example of final maps contain the following items;

i. Land Parcel map
Land parcel map at scale 1:4000 with land No. overlay on satellite image covering 2 km. x 2 km. shall be conducted.

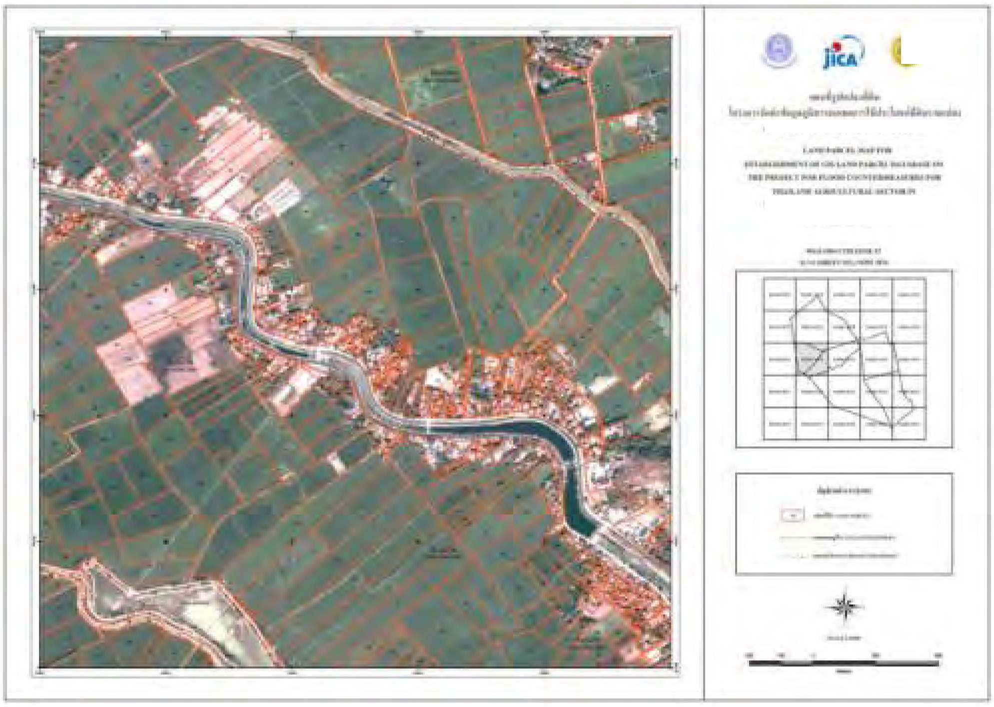


Figure-15: Shows land parcel map

ii. Land Use map

Land use map at scale 1:4000 as the classification type shall be conducted.

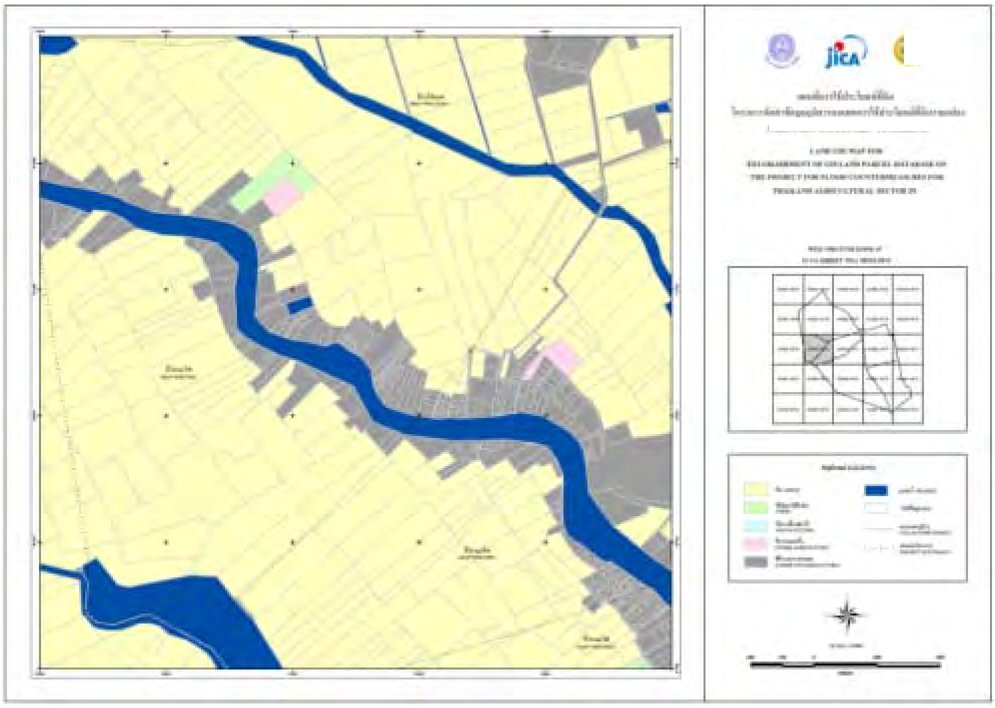


Figure-16: Shows land use map

The Final map creation process is shown in the following figure.

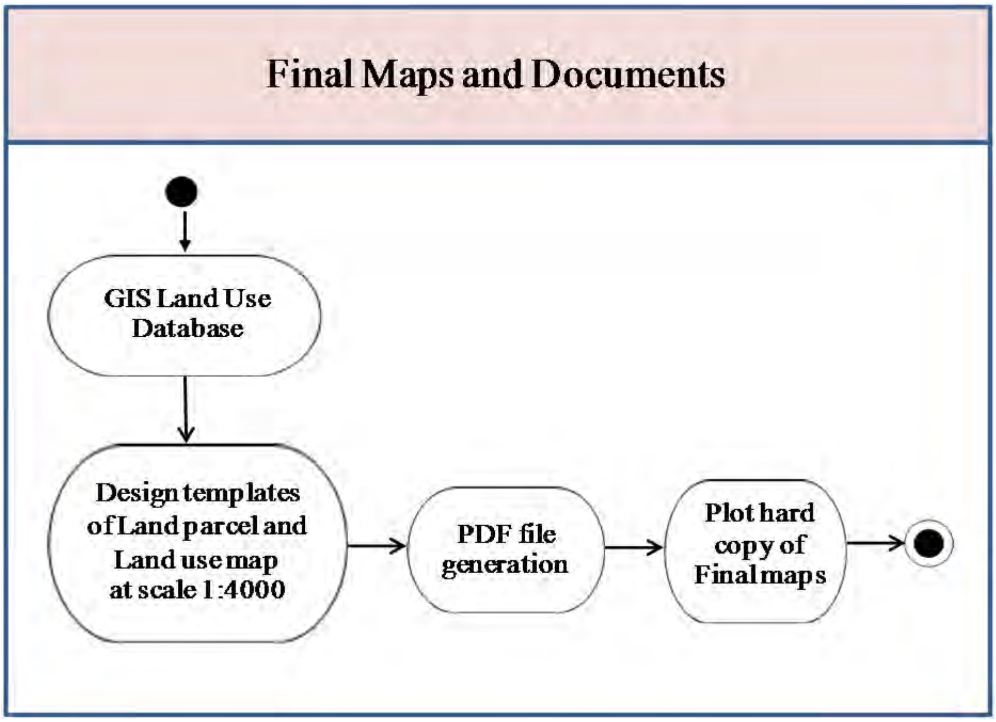


Figure-17: Shows final map and documents process

d. Completion Report

The completion report summarizing the result shall be conducted.

3. Time frame and Cost of Establishment, Maintenance of Database and Further Issues

The project time frame and cost estimation are based on the following factors;

- Size of the project area
- Total number of land parcels, from TAO and DOL
- Total number of agricultural land parcels
- Type of certificate of land such as title deed, certificate utilization (NS. 3K.)
- Cooperation from TAO, Head of village and farmers

An example of an estimation of the time frame and cost of the project based on the project area = 80 sq.km., number of land parcels = 3,000 parcels and number of agricultural parcels = 2,000 each are shown in the following table.

Item	Description	Agency	Unit	Quantity	Unit Rate	Amount	Time Period (Week)	Project period for 4 months 1	2	3	4	Remarks
1	**Data preparation**											
1.1	Data collection											
	Satellite images	GISTDA	Sq.km.		800		4					
	Cadastral map, Land Owner registration	TOA / DOL	Parcel		30		6					
	Farmer registration data	DOAE	Each				4					
	Land use classification type	OAE	LS				2					
1.2	Design of data structure		LS		5,000		2					
2	**Land parcel input**											
2.1	Cadastral map digitizing		Parcel		40		6					
2.2	Farmer registration data input		Each		10		4					
2.3	Map and Investigation form preparation		LS		15,000		4					
3	**Field investigation**											
3.1	Land use classification		Each		30		6					
3.2	Farmer interview		Each		140		6					
3.3	Data input		Each		15		6					
4	**Land Use Database creation**											
4.1	Data linkage		Parcel		40		4					
4.2	Land use map verification and correction		Parcel		50		4					
5	**Final maps and documents**											
5.1	Land parcel map		Sq.km.		300		4					
5.2	Land use map		Sq.km.		300		4					
	Total											

Table-4: Time frame and cost estimation

4. Use of GIS Land Parcel Database for EstimatingFlood Damage and Compensation Payment

The application to calculate the compensation for farmers, who are affected by a disaster such as flood, or even drought, uses satellite images RADARSAT from GISTDA which were captured during the rainy season.

From RADARSAT, the flood area was identified and separated into 5 different periods of flooding (blue color = more than 60 days, pink color = 46-60 days, yellow color = 31-45 days, light blue color = 15-30 days, brown color = less than 15 days), by overlaying flood area and land use data, the affected area for each land parcel was identified and the amount of compensation can be calculated based on the flood situation. The example is shown in the following figure.

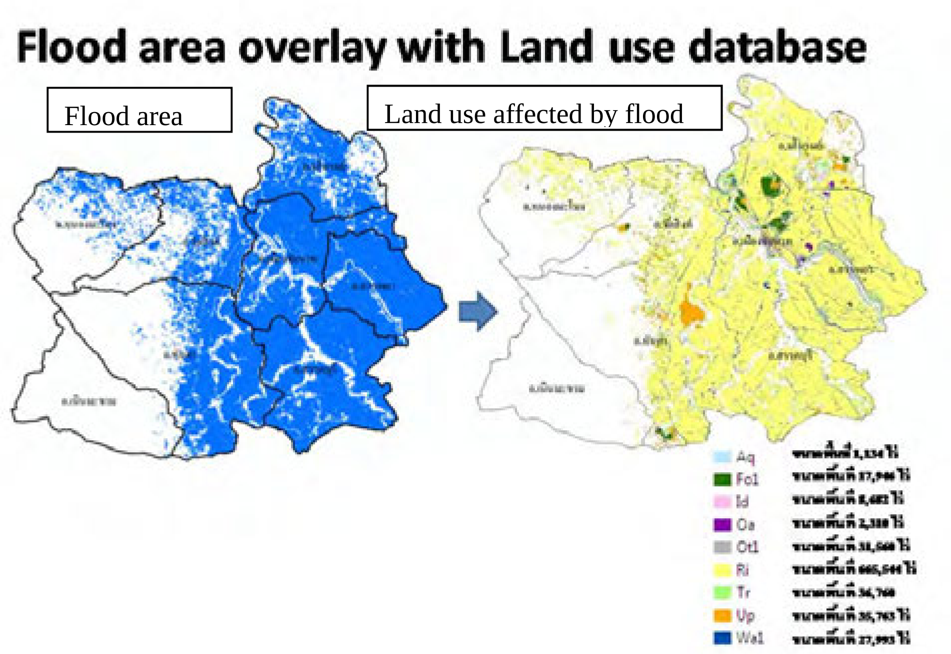


Figure-18: Use of land parcel database

5. Recommendations

The project has to collect data from many government agencies, and some of the data is only in hard copy format and it is difficult to make out the information, such as land numbers and boundary lines in cadastral map sheet, so they need to be verified with data in each title deed.

Apart from the inconsistencies of the project boundaries, the interview data and DOL's data, there are many tasks have been adjusted and modified, which need more time for checking.

In the future, we should try to confirm the boundary of the project at the beginning of the project and as quickly as possible, in order to reduce the tasks that would require redoing due to initial incorrect information.

The key factors to ensure success of this project are to gain the cooperation ofthe related agencies, and especially the farmers to ensure the data is bothcurrent and accurate, which will allow the process to provide fair and speedy compensation to those affected by a disaster.

Attachment 1: Example of the Letter of Request from TAO to DOL

(ตราครุฑ)

ที่ XXX/

ที่ทำการองค์การบริหารส่วนตำบล-------

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7 กุมภาพันธ์ 2556

เรื่อง ขอความอนุเคราะห์สำเนาโฉนดที่ดินและรายชื่อผู้ถือกรรมสิทธิ์ที่ดิน(ใบปริ๊นท์) เพื่อเป็นข้อมูลจัดทำแผนที่ภาษีและทะเบียนทรัพย์สินในเขตองค์การบริหารส่วนตำบล---------

เรียน เจ้าพนักงานที่ดินจังหวัด-------------

ด้วยองค์การบริหารส่วนตำบล------- ได้จัดทำแผนที่ภาษีและทะเบียนทรัพย์สินซึ่งจะช่วยให้การจัดระบบฐานข้อมูลมีความสมบูรณ์ และช่วยให้การจัดเก็บภาษีตลอดจนการวางแผนพัฒนาต่างๆ ขององค์การบริหารส่วนตำบลเขาแก้ว มีประสิทธิภาพยิ่งขึ้น

ฉะนั้นองค์การบริหารส่วนตำบล------ จึงขอความร่วมมือจากท่าน ได้โปรดให้ความสะดวกในการขอสำเนาโฉนดที่ดินและรายชื่อผู้ถือกรรมสิทธิ์ที่ดิน เพื่อจัดทำแผนที่ภาษีและทะเบียนทรัพย์สินขององค์การบริหารส่วนตำบลเขาแก้ว โดยทางองค์การบริหารส่วนตำบล------ ได้มอบหมายให้นาย---------------------- เป็นผู้ประสานงานการดำเนินการดังกล่าว

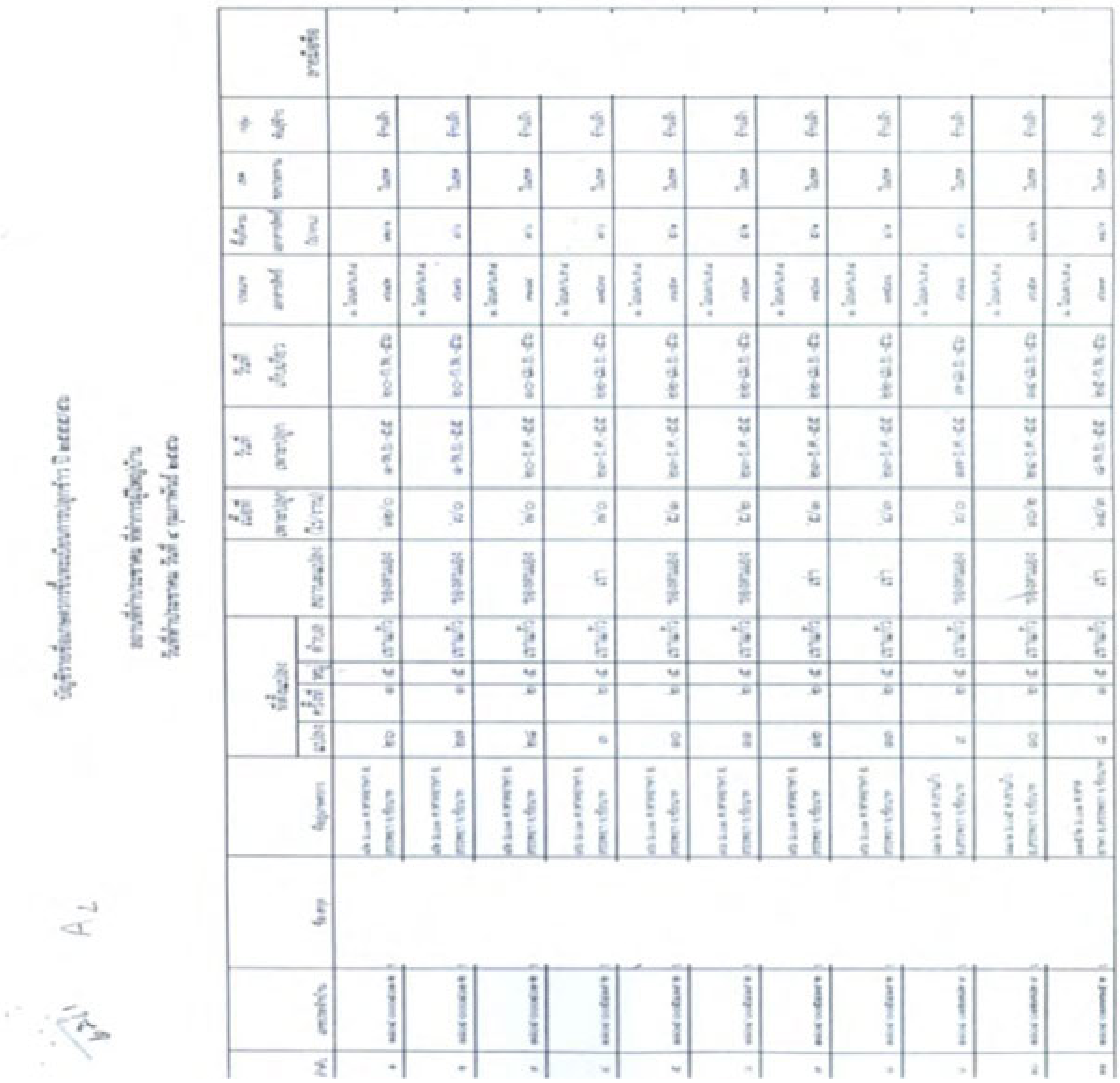
จึงเรียนมาเพื่อโปรดพิจารณาอนุเคราะห์ และขอขอบคุณมา ณ โอกาสนี้

ขอแสดงความนับถือ

(-------------)
นายกองค์การบริหารส่วนตำบล----------

สำนักงานปลัด อบต.
โทรศัพท์
โทรสาร

Attachment 2: Farmer Registration Data



Attachment 3: Investigation Form

แบบสำรวจการใช้ประโยชน์ที่ดินรายแปลง

ต. อ. จ.

เลขระวางUTM 1:4000 .... แผ่นที่ /แปลงที่ดิน ..../.............

ประเภทเอกสารสิทธิ (/) ....โฉนด ....น.ส.3 ....ท.ค. ....ส.ป.ก.4-01 อื่นๆ ....

ประเภทการถือครองที่ดิน (/) ....ของตนเอง ....เช่าผู้อื่น อื่นๆ ....

เลขโฉนด .... เลขที่ดินUTM .... เลขที่ดินเดิม(หากไม่มีเลข UTM) ....

ชื่อเจ้าของที่ดิน .... นามสกุล .... เลขบัตรประชาชน ....

บ้านเลขที่ .... หมู่ที่ .... ถนน ...., ตรอก/ซอย ....

ตำบล .... อำเภอ .... จังหวัด ....

ชื่อผู้ทำประโยชน์ .... นามสกุล .... เลขบัตรประชาชน ....

บ้านเลขที่ .... หมู่ที่ .... ถนน .... ตรอก/ซอย ....

ตำบล .... อำเภอ .... จังหวัด ....

ถ่ายรูป (/) .... ผู้ทำประโยชน์ ชื่อรูป .... , ... รูปแปลงที่ดิน ชื่อรูป ....

การใช้ประโยชน์	ชนิดของพืช		พืชหลัก		พืชรอง		การช่วยเหลือจากรัฐบาล
ที่ดิน (รหัส)	พืชหลัก	พืชรอง	จำนวนครั้งที่ทำเกษตร/ปี	ผลผลิต/ไร่/ครั้ง	จำนวนครั้งที่ทำเกษตร/ปี	ผลผลิต/ไร่/ครั้ง	(แจกเมล็ดพันธุ์พืช/เงินสนับสนุน/...)

ผู้ให้ข้อมูล ....

ผู้สำรวจ .... วันที่ .... / .... /............

Attachment 4: Database Structure

DATA STRUCTURE

LAYER : LAND USE

FEATURE : POLYGON

Column Name	Description	Data Type	Width	Remark
OBJECTID	OBJECTID			
AD_CODE	Land parcel code(user defined)	Long Integer	16	
R_UTM50K	Map sheet1:50,000	Text	8	
UTM50K_NO	Sub Map sheet1:50,000	Short Integer	10	
R_UTM4K	Map sheet1:4,000	Text	8	
UTM4K_NO	Sub Map sheet1:4,000	Text	2	
LAND_NO	UTM Land No.	Short Integer	10	
SUR_PAGE	Survey No.	Short Integer	10	
TITLE_NAME	Title of farmer	Text	10	
FIRST_NAME	Name	Text	50	
LAST_NAME	Surname	Text	50	
ID_CARD	Farmer ID Card	Text	18	
HOUSE_NO	Address	Text	10	
MOO	Moo	Text	5	
TAMBON	Tambon	Text	30	
AMPHOE	Amphoe	Text	30	
PROVINCE	Province	Text	30	
DEED_NO	Deed No.	Text	15	
T_TENURE	Type of Tenure	Text	20	
DOC_TITLE	Document of title	Text	20	
DEED_AREA	Deed area (rai-ngan-wa)	Text	15	
USE_AREA	Used area(rai-ngan-wa)	Text	15	
LU_CODE_E	Land use code	Text	8	
LU_CODE_T	รหัสการใช้ประโยชน์ที่ดิน	Text	30	
M_CROP_E	การใช้ประโยชน์ที่ดินประเภทหลัก	Text	15	ข้อมูลจากภาคส
M_CROP_T	การใช้ประโยชน์ที่ดินประเภทหลัก	Text	20	ข้อมูลจากภาคส
S_CROP_E	การใช้ประโยชน์ที่ดินประเภทรอง	Text	15	
S_CROP_T	การใช้ประโยชน์ที่ดินประเภทรอง	Text	20	
M_FRE	ความถี่ในการใช้ประโยชน์ที่ดินประเภท	Short Integer	5	
S_FRE	ความถี่ในการใช้ประโยชน์ที่ดินประเภท	Short Integer	5	
YIELD_M1	เฉลี่ยผลผลิตประเภทหลักครั้งที่1	Text	10	
YIELD_M2	เฉลี่ยผลผลิต ประเภทหลัก ครั้งที่ 2	Text	10	
YIELD_S1	เฉลี่ยผลผลิตประเภทรองครั้งที่1	Text	10	
YIELD_S2	เฉลี่ยผลผลิตประเภทรองครั้งที่2	Text	10	
GOV_ASSIST	การได้รับความช่วยเหลือจากรัฐบาลได้เ	Text	70	
PIC_BENE	รูปผู้ใช้ประโยชน์ที่ดิน(Picture Benefit)	Text	60	
PIC_LAND1	รูปแปลงที่ดินด้านหน้าแปลง(Picture	Text	60	
PIC_LAND2	รูปแปลงที่ดินด้านข้างตั้งฉากกับแปลง	Text	60	

T_N_OWNER	คำนำหน้าชื่อเจ้าของที่ดิน	Text	10	
F_N_OWNER	ชื่อเจ้าของที่ดิน	Text	30	
L_N_OWNER	นามสกุลเจ้าของที่ดิน	Text	30	
H_NO_OWNER	บ้านเลขที่	Text	10	
MOO_OWNER	หมู่ที่	Text	4	
SOI_OWNER	ซอย	Text	30	
ROAD_OWNER	ถนน	Text	30	
TAM_OWNER	ตำบล	Text	30	
AMP_OWNER	อำเภอ	Text	30	
PRO_OWNER	จังหวัด	Text	30	
CO_OW_SHIP	กรณีมีผู้ถือกรรมสิทธิ์รวม	Text	30	