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# Linking Food Security, Climate Adaptation and Carbon Management: A Case Study from Indonesia

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# Contents

# Linking Food Security, Climate Adaptation and Carbon Management: A Case Study from Indonesia

**Yulius P. K. Suni and Jonatan A. Lassa**

## Abstract

The increase of anthropogenic CO2 concentration in the atmosphere has unequivocally altered global climate change. Food production and consumption elements of food security directly emit CO2. Without significant efforts in stabilizing global carbon in all sectors, the atmosphere can be increasingly insecure to human and biological nature. Reduction of carbon has been the global climate mitigation imperative. While at the sometime negative impacts of climate change on food production will likely continue. It will be a serious challenge for the 9 billion people in 2050. To ensure that climate adaptation, food security and climate mitigation objectives are mutually achieved, local level intervention is necessary. This paper shows local level action where efforts achieving food security through mutual adoption of climate adaptation (e.g. drought and soil erosion management through land and water conservation measures) and carbon mitigation. The research question how food security, adaptation (through drought, water and soil erosion management) and carbon management objectives are achieved at local level? Constraints and opportunities are discussed from a local context in Indonesia.

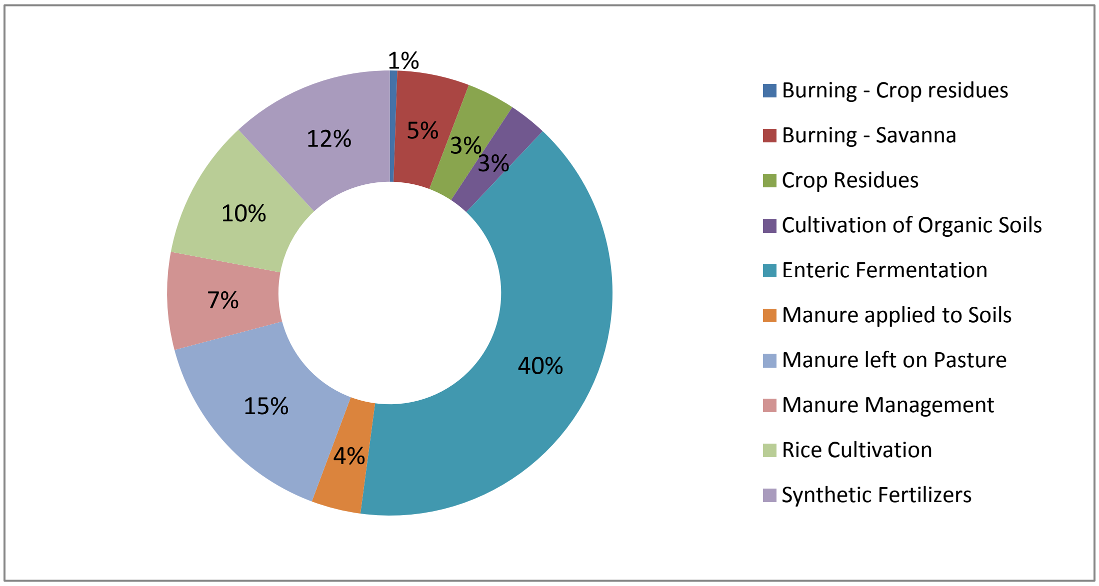
## Introduction

Climate change mitigation in agriculture is a challenge as there is tension between how to meet global food demand with lower CO2 emission amid global demographic change and food price volatility. A sustainable food production system involves environmental objectives (Wilde 2013). In addition, climate change adaptation has been a necessary intervention if countries are to secure future sustainability of food security.

Production elements of food security directly emits CO2 through the processes such as burning (crop residues and savannah), crop residues/ harvest wastes, enteric fermentation, manure, rice cultivation, crop residues decay, and so on. However the total emission related can include deforestation that is required for new agricultural land (Teng, Lassa and Morales et. al. Forthcoming) FAO has recently released its own global estimates of greenhouse gas (GHG) emissions from agriculture, forestry and other land use which contributing to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

The CO2 emissions from agriculture (crop and livestock production) increased from 4.7 billion tonnes in 2001 to more than 5.3 billion tonnes in 2011 (CO2 equivalent). The increase occurred mainly in developing countries, due to an expansion of total agricultural outputs. The expansion of the outputs has been associated with the land use change and deforestation which during 2001-2010 period registered a nearly 10% decrease. This is equivalent to at least 3 billion tonnes CO2 eq/yr. (Tubiello 2014). Of the total CO2 equivalent in 2011, enteric fermentation (from livestock digestive systems) contribute 40% to the emission composition. Burning of crop residues and savannah combined 5%. Manure from livestock (managed and left on pasture) combined to contribute to 19% of the total emission. Rice cultivation and synthetic fertilizers subsequently contribute 10% and 12% from the total agricultural emission (See Figure 1). In addition, FAO reports emission from energy use in the agriculture sector, including electricity and fossil fuels burned to power agricultural machinery, irrigation pumps and fishing vessels have increased by 75 percent since 1990 (and have exceeded 785 million tonnes of CO2 eq. in 2010).

**Figure 1 Emissions by agricultural sectors sector - Average 1990 - 2011**




**Source: Teng, Lassa, Morales et. Al. 2014 based on data from FAO Statistics 2014**

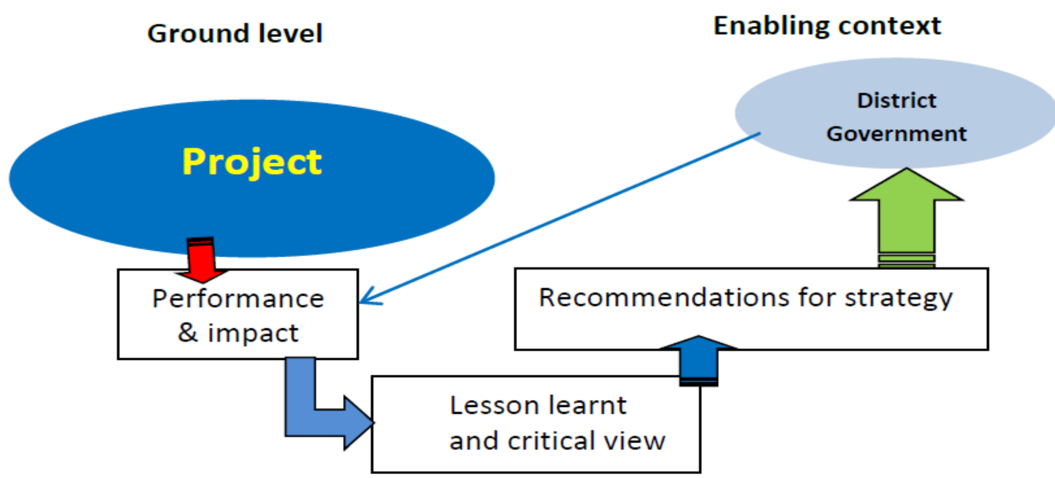
## Research Objectives and Methods

In 2008, the United Nation World Food Programme (WFP) in collaboration with Carbon Free Consulting Corporation (CFC) Japan, a local NGO namely Yayasan Bina Swadaya (YBS) and the local government initiated a pilot project of Food for Carbon Free (carbon management) in Oinbit village, Insana sub district, Timor Tengah Utara district, West Timor, Indonesia. Community is the target group which has the responsibility to execute and maintain the project in the village for 20 years. Model explored in this report represents a combination of WFP's goal of improving food security, CFC Japan's carbon trade target, and local perspectives on what the farmers need. The model includes physical, agronomic and social measures. Physical measures include terracing, mulching and simple bamboo drip irrigation. Agronomic measures are tree planting (cashew nut and jatropha), intercroping (food crops and cash crops), and forage tree along the terrace lines. Social approach covers working group and project management at local level.

The **Purpose of the carbon management project** are to improve community's food security and to strengthen community's capacity on soil and water conservation measures (Inoue 2009). The objectives of this study is to understand the impact of **carbon management model** that recently being exercised in North Central Timor District (Northern West Timor, NTT), Indonesia. This includes stages of adoption of the management model. The key question includes how the Food for Carbon Free is considered by the district government (in terms of policies and regulation) for scaling up the project? What are the impacts of the project? The lessons learnt are provided. Despite the fact that the project title has been focused on climate change mitigation, in fact the project also dealt with climate adaptation through water management (and drought) as well as soil erosion mitigation.

This research also provides recommendations for the district government who has the power in terms of financial support and authority (Resosudarmo, 2004) for scaling up the project. However, the recommendations will be limited on identification of physical appraisal which influences the farmers to adopt, manage and sustain the measures introduced by the project. An analysis of project performance or physical appraisal can be considered as the lessons learnt and critical views. The lessons learnt and critical views help in formulating the recommendations for the actors involved in soil and water conservation projects.

**Figure 2. Research Framework**




This research limits its focus to purpose and outputs adapted from Inoue (2009). Analysis covers also adoption of soil and water conservation measures applied in the project. This paper measures the impact based on performance rate of the project (Figure 2) where food security and carbon management objectives are examined. Implementation and analysis of this assessment refer to objective hierarchy namely goal, purpose and output (Krimmel, et al., 1990).

A combination of field observation and semi-structured interview was conducted (by Suni) on 29 farming plots and farmers of the project. The observation was used to assess achievement of project outputs and their current performance such as plot size, survival of cashew nut trees, availability of jatropha along plot borders, and soil and water conservation (SWC) measures and their maintenance. A semi-structured interview was prepared but during execution farmers hesitated to speak openly when they are seeing me wrote what they told. On the next day onward, informal interviews were applied. However, points of discussion with farmers still relied on questions on semi-structured questionnaire. This was done during field observation to gain farmers' perception and experience about the project.

## Conceptual Framework

Carbon mitigation, poverty reduction and food insecurty eradication can be made through different routes. One of the routes is through soil and water conservation projects. Most of soil and water conservation programs worldwide apply a top down approach within a short period (Noordwijk & Verbist, 2004) and use direct insentives such as food (and/or cash) to support the implementation process. Intention of the projects and food stimulant is to minimize land degradation as well as to address poverty and food security. Facilitating agencies in general are the government and non governmental organisations (NGOs). This approach is often known as new instititutional economics (NIE) theory. NIE suggests that institutions provide incentives that may drive actors' decisions and preferences to implement certain conservation activities in order to achieve certain environmental goal (Lassa 2011). Incentive is understood as referring to more than monetary incentives including food and the existence of facilitating agencies.

Incentive based soil and water conservation projects are not free from problems. Cases from Bolivia suggest that in the absence of facilitating agency and incentive often led to the failure of the project (Middleton et al., 2003, cited by Graaff & Kessler, 2010). This describes that target of beneficiaries is food incentives only and not the importance of introduced soil and water conservation techniques. Another problem is program approach of NGOs and the governments that inherently have different approach. NGOs which usually execute small scale projects and apply bottom up approach get some success stories but they are isolated within the community and project site. There is no replication mechanism provided by NGO to enhance the benefits of the projects to more people and more coverage areas (Lovell, et al., 2003). Furthermore, most often, the project is not linked to the government strategic plan. The government has large scale projects and applies top down approach but the government's projects cannot be easily implemented in ground level.

However, NIE will not be used to frame this research. We pragmatically use Graaff and Kessler (2010) view on group incentives namely: direct and indirect incentives. Direct incentives can be in cash such as subsidies, cost sharing, credits and wages; or in kind such as food aid, provision of inputs, tools and allocation of farming plots (Graaff & Kessler, 2010). While indirect incentives cover fiscal in the forms of fiscal facilities, market prices and land tenure security; services such as technical assistance, improvement of road, accessibility to water supply and use of machinery; and education in terms of training, extension and social services (Graaff & Kessler, 2010).

**Soil and water conservation**

Soil and water conservation measures are the management strategies a farmer applies to control or prevent soil erosion and to maintain soil fertility (Stocking, et al., 1989) and in turn can improve agricultural land productivity, conserve natural resourses and enhance the quality of agro-ecosystem (Mausbach & Dedrick, 2004). These include physical or mechanical measures such as terracing; biological or agronomic measures such as tree planting; and soil management practices for example minimum tillage. We use influencing factors of soil and water conservation measures adoption or adaptation namely personal, physical, socioeconomic, institutional and technological factors (Bewket, 2007).

**Stages of Adoption**

Adoption is crucial because the introduced soil and water conservation measures can improve farmers' livelihood (Demeke 2003). "Adoption is not an action (yes/no), it is a process in which decision making is crucial from acceptance to continued use" (Kessler, 2010, p. 28). In terms of soil and water conservation measures adoption, Graaff and Kessler (2010) group eight steps of acceptance phases:

Step 1: Are erosion symptoms recognised?

Step 2: Are erosion effect recognised?

Step 3: Is problem taken serious?

Step 4: Is the farmer aware of adequate measures?

Step 5: Is farmer able to undertake measures?

Step 6: Is farmer willing to undertake measures?

Step 7: Is farmer ready to undertake measures?

Step 8: (Final) acceptance of measures.

**Food Security**

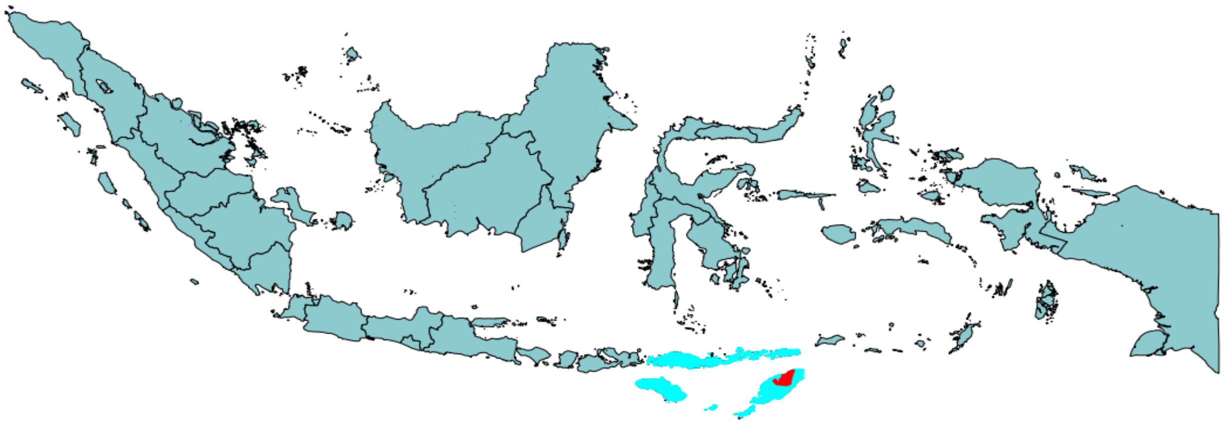
This paper adopts FAO's definition of food security a condition "when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996). Based on this definition, six elements are embedded in this definition namely: availability (through production and trade), accessibility (physical), utilization, affordability (economic access), stability and quality (that qualify as healthy).

## Research area climate and agriculture context

TTU district (Figure 3) with total area 2,669.7 $km_2$ (BPS-TTU, 2008) consists of 24 sub districts (BPS-TTU, 2009). One of sub districts is Insana. Total area of Insana sub district, covers 13 villages (BPS-TTU, 2009), is 333.08 $km_2$ (BPS-TTU, 2008). Most of the people in TTU mainly rely on agriculture sector for their livelihoods. This sector absorbs 67.7 % of labour force (BPS-TTU, 2009). Primarily farmers depend on rain-fed agriculture. Farmers generally apply slash and burning practices in cultivating their farmlands. Cutting off trees and bushes then burning them are common practices in this area. Slash and burning practice in combination with steep topography, fragile and mobile soil and abuse of fire intensively accelerates land degradation and deforestation (McWilliam, 2000).

The research was focused on Food for Carbon Free project in Oinbit village, Insana sub district, Timor Tengah Utara district, West Timor. Total area of this village is 81 $km^2$ (BPS-TTU, 2008). It is located about 257 km from Kupang, province capital of Nusa Tenggara Timur (Indonesia) and about 40 km from Kefamenanu, the capital city of Timor Tengah Utara district. This village is home to 340 households who totally depend on rain-fed agriculture and poor agriculture practices. WFP Indonesia only has one Food for Carbon Free project which is implemented in Oinbit village.

**Figure 3. Map of TTU (North Central Timor) District, NTT, Indonesia**



Climate in TTU is similar to Timor climate in general which categorised as dry and wet season. In general dry season lasts for between eight to nine months of the year. Wet season period is three to four months but currently rainfall patterns during wet season become erratic in terms of volume and frequency (Lassa et. al. 2014, Inoue 2009, Ormelling 1957). These conditions make this area is known to be a drought prone area. This worsen by absense of upgraded traditional knowledge to determine the right time for planting (Muslimatun & Fanggidae, 2009). This area indicates mountainous topography. Slope range below 40 % covers 77 % of the area while the rest has the slope more than 40 % (BPS-TTU, 2008). Farmlands, generally slope area, are cultivated for a variety of subsistence crops such as maize, cassava, vegetables and some rice (Russell-Smith, et al., 2007).

Climatic condition, land degradation and agriculture practices lead to food crop failure every year in this region. Food crops contribution to local revenue has decreased from 53.7 % in the late 1960s to 21 % in 2006 (Lassa, 2009). And this region contains the poorest in Indonesia. These conditions attracted the government and international donors for developing programs on how to deal with land degradation and its associated problems such as food insecurity and malnutrition.

## Early Findings

**Food security.** The following figure is a comparison of food and cash crops harvested from the project in the period of 2009 and 2011.There is no baseline data on the harvest in 2009, however, farmers were asked concerning their perception on whether food and cash crops harvest increase or not (Figure 4). Since the project started in 2009, the analysis considers 2009 as the first harvesting year while 2010 and 2011 are second and third harvesting year respectively.

It is obvious that food crops harvested from the project decrease currently due to extreme rainfall (due to La-NiNa n 2010) and fallowing application. Over-rain leads to waterlogging worsening crops 'roots and in turn crops fail to grow. Farmers were not sure about the plots' fertility. This uncertainty leads farmers to leave the plot fallowed. Fallowing is leaving the plot without seasonal crops such as maize, peanuts and green bean to maintain soil fertility. Since farmers planted cash crops they still have access to food by selling cash crops, planted in the project, to the market. It means the main purpose of the project to improve communities' food security to some extend is achieved.

The project realized the importance of **capacity building** by means of training in order to raise farmers' awareness and to improve their sklill on cultivating farm plots. As a complementary to this training, YBS staffs also provided training for CPC members. Farmers mainly attended the trainings because of food incentives were provided and intensive assistance from NGO staff was still offered.

**Farmland area.** Most of the participants have the plot size equal or more than 0.32 ha according to the project requirement while few farmers have less than 0.32 ha depending on labor availability within family. Many villagers haven't received land certificates yet. There are fewer incentives for villagers to issue it. It is often costly to get land certificate; after having the certificate, they will be obliged to pay tax annually. In addition, villagers feels their cultivating land plots will not be taken by anybody even not having the certificate, because it has been already clear that where belongs who among villagers. Application of soil and water conservation measures during availability of food incentive was good but the current maintenance is varied in the absence of food incentive (69% still have all introduced measures but n maintenance – Figure 5).

**Cashew nut.** Minimum survival rate of cashew nut trees is in an advance stage of failure (minimum survival rate is 70 % while the current achievement is 69 %) (Figure 5 and Figure 6). Farmers assume that soil type on the plot is not suitable for cashew nut plantation. It would be better to plant magohany trees since they grow well on cultivating land plots. This condition is worsen by unwillingness of most of the farmers to replant died trees by their own contribution. However, this conclusion does not represent the whole picture of the project because the study involves 29 respondents only.

**Figure 4. Farmers' perception on food and cash crops generated from the project (A comparison of harvest in 2009 and 2011) Source: Compilation from the assessment**

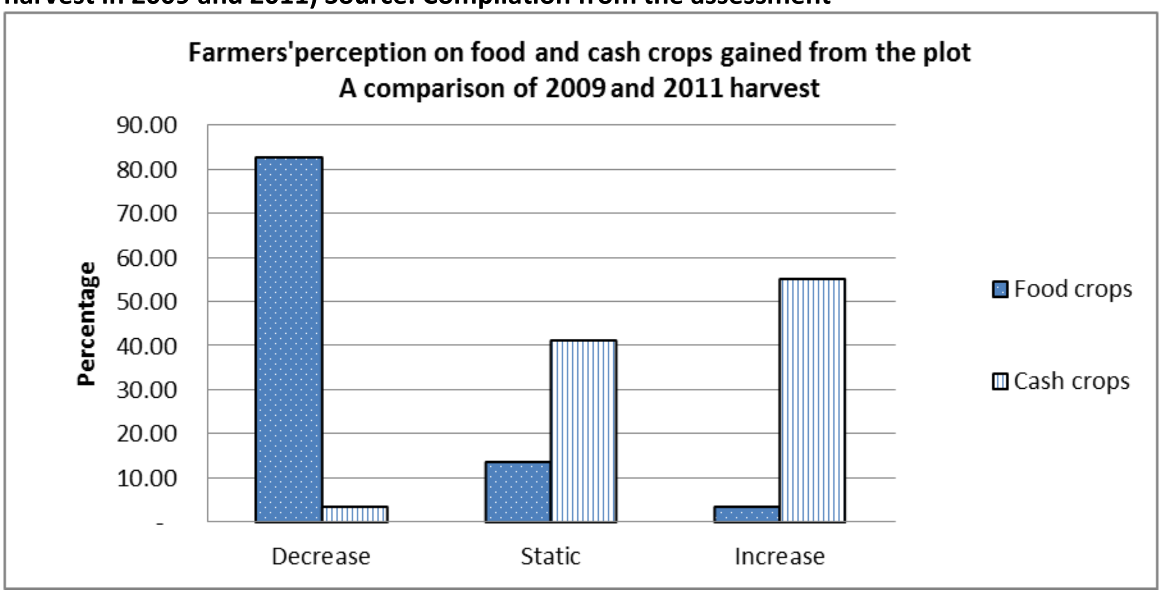



**Figure 5. Outputs indicators and achievement (Source: compilation from the assessment)**

**Farmland area 0.32 ha/HH with certificate and SWC measures**

- 86% ≥ 0.32 ha without certificate
- 31% applied SWC with good maintenance

**≥ 70% cashew nut: survive**

- 69% farmers achieve minimum survival rate
- 79% farmers hesitate for replanting

**Jatropha planted along the border, interval 1 m**

- All farmers planted jatropha but interval > 1m
- Jatropha fruits are not used for nor sold

**Figure 6 Cashew nut and mahogany trees**

Good cashew nut tree | Stunted cashew nut tree | Mahogany tree

**Jatropha trees.** All farmers do have jatropha trees along the farm plots' border but the trees planting density is not 1 meter as stated in the project proposal (see table 3.1). The interval between trees is about 2 – 5 meter. Farmers said that they keep this distance for at least two reasons. First, trees can have more branches and in turn produce more fruits. Second, farmers established wooden fence mixed with leguminous trees to protect the whole project area from animal intrusion. They do not need jatropha fence in every single plot. Function of jatropha trees then is to indicate the border of each plot.

This means jatropha plantation requirement is not accomplished by farmers because of their own reasonable considerations.

**Stages in Adoption**

In order to assess the status of adopting terraces on farming practices, eight stages or steps of acceptance phases by Graaff and Kessler (2010) are used.

**Step 1: Are errosion symptoms recognice?**

Genuinely farmers do not see errosion symptoms. Farmers do not blame erosion as influencing factor on experience of recurrent crops' fail to grow and harvesting failure. These problems are usually linked to either erratic rainfall or too much rainfall.

**Step 2: Are erosion effect recognized?**

They see their land not productive as a given fact instead of a continuous process of erosion. To cope with this unproductive land for planting food crops every year farmers have a copying mechanism, fallowing, practiced for generations. Farmers only noticed the erosion problem when attending training on soil and water conservation techniques which was facilitated by YBS staff (outsiders).

**Step 3: Is erosion taken serious?**

Since the erosion was introduced by YBS staff during the trainings, farmers still do not consider it as the main problem on their plots. Thinking about downstream effect of their adverse practice upstream is not taken into account seriously. They constructed terraces when intensive assistance was available.

**Step 4: Is the farmer aware of adequate measures?**

Farmers noticed the benefit of terraces. The crops such as peanuts, green been, cassava and maize planted close to the terraces are more fertile and productive than the others far from terrace line. But farmers still leave the plots fallow because not the whole areas are fertile currently as the impact of terraces.

**Step 5: Is farmer able to undertake measures?**

Working on terracing requires farmers to invest a high labor input. To build new terraces on other plots farmers have to employ additional labour. 72 % farmers have 1 to 2 available agriculture workers within family while the rest consist of 3 or more people. Construction of terraces needs more workers. This gap was not the problem during building terraces in the project because farmers can rely on other farmers group members. Currently farmer's group is still available but farmers have to pay for group members work days. It was found that 45 % farmers cannot afford the price to hire extra labor either from farmer's group members or others. 55 % farmers said that they still maintain the group practices like working together for soil tillage, weeding and harvesting but not for constructing new terraces in other plots.

**Step 6: Is farmer willing to undertake measures?**

In the first year, farmers' willingness to build terraces were driven by food incentive and technical assistance from YBS. Since there are no farmers want to build new terraces, it means they do not want to invest more on agriculture. If we ask their future expectation about their successor, about 93 % prefer their children to go outside the village and work for other sector. They believe that off-farm sector will easily gain economic benefit rather than agriculture they have currently. Farmers compare agriculture production and traditionally manganese mining practiced in the village. From agriculture, farmers only harvest few times in a year and they have to go to market to sale the product. But from traditional manganese mining, the buyers are available in the village with good price.

The previous barriers and constraints clearly explain that farmers' readiness to undertake measures **(step 7)** and acceptance of measures **(step 8)** is still far from expected. There is no adoption of these techniques to other plots outside the project until the district government launching a Food for Work program in 2011 through *Gerakan Cinta Petani (Loving Farmers Movement)*.

The absence of adoption by farmers' own initiative and lack of regular maintenance of terraces are obviously stated in step 1 and step 2. Farmers' awareness on soil erosion symptoms and effects is lacking. Awareness of farmers to some extent does not mean farmers have willingness to adopt the measures by their own motivation. They execute the same measures on other plot outside of the project when the district government launching another food for work program in the area. It means **adoption** still depend on direct incentives.

## Concluding Remarks

### To what extent does the project improve food security?

Farmers in the area are subsistence farmers, totally depend on food crops harvested from their rain-fed plots for own consumption. This dependency in combination with poor agriculture practices makes farmers vulnerable to food insecurity when food crops fail to grow. Application of intercropping (food crops and cash crops) on the project at least contributes to availability of food resource of family. Is this condition considered as an improvement of household food security? Answering this question will be based on selected food security dimensions namely availability (through production and trade), accessibility (physical), utilization, affordability (economic access), stability and quality (that qualify as healthy) (FAO, 1996).

Since most of the farmers failed to grow seasonal food crops on the project due to climatic condition; however, in the short term they still can generate income by selling cash crops such as cassava, peanuts and papaya. The cash gained by farmers is then converted to household needs such as food. This is obvious that in the circumstance of lack of food crops production, in the short term economically farmers still have access to exchange their cash crops to staple food especially rice from the market. Intercropping innovation counters the current believe in the region that harvest failures, lead to food insecurity, are influenced by ecological argumentation such as given poor soil nutrient on the farming plots and erratic rainfall in this semi-arid area.  This innovation supports food availability and accessibility, two pillars of food security (FAO 1996) of the farmers. The question will be on the willingness of farmers to preserve this practice since the assessment was conducted when the project lasted just three (3) years.

Food availability and accessibility alone cannot guarantee food security. Healthy food security is related to utilization of diversified food is crucial. Utilization means families prepare properly the food they access to meet nutritional needs of family members (Barrett, 2010). This issue was not addressed in the study but in order to measure family's food security, utilization need to be taken into account. To come to the answer of project contribution to food security, further research on food utilization which has impact on family's nutritional status is desirable.

Recently issue of food security has been shifted to food sovereignty, "...the right of each nation or region to maintain and develop their capacity to produce basic food crops with the corresponding productive and cultural diversity" (Altieri, 2009, p. 104). This shift is central because the government in national level creates the idea of using rice as the main staple food while in this region farmers basically cultivate maize and cassava for carbohydrate sources (Lassa, 2009). In terms of food production in the region, maize and cassava are higher than rice however farmers prefer to spend most of carbohydrate need on rice (Muslimatun & Fanggidae, 2009).  Furthermore, Muslimatun & Fanggidae (2009) explain that the preference of rice mainly due to prestige. This way of thinking leads farmers in the study area selling cassava to the market then buying rice for their daily dietary. This is clear that effort on improving family's food security cannot rely on a single measure but it requires an interdisciplinary approach. Blaming the project to increase family's ability on food security is a fallacy.

## Incentives

The project was started with heavily incentive-based approach. Incentives are used to encourage farmers to implement the new techniques of soil and water conservation measures. Central to the application of incentives is to enhance the improvement of land productivity through implementation of new soil and water conservation measures.

It is obvious that the project relied on both direct and indirect incentives. Direct incentives to the project are food aid through food for work, provision of cashew nut seedlings and jatropha seeds, and allocation of farming plot to each farmer. Indirect incentives are secure land tenure, technical assistance from YBS staffs, regular monitoring from YBS, WFP, CFC and the government, and trainings. Provision of incentives mobilized farmers to work massively on establishing new techniques of farming on the project. Introduction of the new techniques was delivered by YBS staffs to farmers in the means of trainings and practice on the field. Core questions for discussion: are incentives either direct or indirect really needed in this project? Can incentives effectively facilitate farmers to invest on the project, to innovate and to maintain the introduced measures?

"Essentially, incentives are needed when the adoption of conservation measures are not profitable to the land users" (Graaff & Kessler, 2010, pp. 11-4). Contrary to this statement, this project is totally dedicated to benefit farmers. Farmers get extra farming plots for free and they can consume and sell all food and cash crops available on the plots for their own purposes. Graaff and Kessler (2010) emphasize that when the problem of land degradation is on site and the application of measures are profitable to farmers directly, only extension and suitable information needed. This means direct incentives, in this context food, seedling, seeds and additional farm plots, are not required on this project. However, only relying on educational messages is over optimistic (Napier & Forster, 1982, cited by Graaff & Kessler, 2010). The project will never be executed. Then, what is the intention of direct incentives?

Farmers are not aware of erosion symptoms as previously mentioned. Direct incentives were used to trigger farmers' awareness on land degradation as well as to accelerate the implementation of new conservation techniques. Farmers have been practicing for generations poor agriculture practices such as slash and burning which often led to land degradation. Farmers are required to shift their farming practices from traditionally slash and burning to new ways which are considered sustainable practices. In the long run, CFC Japan also gets benefit from the project by carbon trade. In order to compensate farmers' effort on maintaining the trees (cashew nut and jatropha) CFC Japan provided direct incentives for farmers. Incentives exist due to mutual dependency between farmers and CFC Japan.

Thanks to incentives applied in the project because 108 ha of abandoned land have been changed to considerably productive farmland areas. The farm plots attached with conservation measures are still kept free from destructive farming practices until now in the absence of direct incentives and day to day monitoring from YBS staff. This at least counters the belief that after the withdrawal of direct incentives, the project tends to fail as the case of food for work project in Bolivia (Middleton et al., 2003, cited by Graaff & Kessler, 2010). Despite its contribution to physical measures positively, incentives also contribute to social aspects such as encouraging collective work to strengthen community ties and enhancing development of local leaders (Barrett, et al., 2002). Some farmers mentioned that they can still ask group members to work together on other plots without any payment except providing lunch food. However, this continued collective work is taken as the accelerator of usual farming practice works instead of adopting introduced conservation measures. The project also stimulates local leaders' development by establishing project committee. Currently only committee leader is active but his role in the village is of high importance. Committee leader's influence makes the village government setting the rule of protecting the project from animal intrusion and wild fire. Owner of animal has to pay fine if his/her animal intrude and destroy the crops in the project. The same case is applied to person who abusively put the fire on the project.

Incentives solely cannot guarantee farmers to apply the all conservation measures. Farmers have their own decision not to plant jatropha and legume trees even in the time of incentives still exist. There is hardly regular maintenance of terrace structure which some are almost covered by sediment transport except weeding. This can be that "the imposed models look good at first, and then fade away" (Pretty & Shah, 1997, p. 44). No evidence of adaptation on other plots exists currently until the new food for work program funded by the government. This supports the finding of the case in Cusco, Perú that incentives barely have positive influence on farmers' intrinsic motivation for adoption and adaptation of the introduced measures (Vries, 2011).

## Secure land tenure and local value

Secure land tenure is of high importance for conservation. Insecure land tenure leads to farmers' hesitation to invest on sustainable conservation measures such as tree planting and terraces (Pretty & Shah, 1997). For the context of this project, land tenure is secure even though the ownership of most of the plots is not legalized by the district government. This opportunity makes 86 % of farmers cultivating more than 0.32 ha of farming plot. Some long term investments proven in this project are maintaining cashew nut and planting other trees such as mahogany and teakwood along the border. These additional trees are by farmers own initiative planted in order to complement jatropha.

Other key factor to support the success of conservation measures is making use of local knowledge and existing local institution (Pretty & Shah, 1997; Demeke, 2003). Ignorance of knowledge practiced for generation to some extent can increase soil erosion, so there is a need to combine local and introduced conservation measures as the case in Ethiopia (Demeke, 2003). This project takes into account local knowledge such as intercropping and *bata* (terrace in Uab Meto, local language of West Timor). Intercropping application offers short-term on site benefit such as harvesting seasonal food and cash crops. This condition can make farmers aware that the conservation measures are profitable. However, this short-term benefit and adoption of local technology are not enough to stimulate farmers applying the same measures on other plots.

One local value contributing to the success of the project can be seen in Australia. Community groups can manage to handle environmental problem because the groups are linked to the existing institution (Pretty & Shah, 1997). At the initial stage of this project, farmer groups were formed based on geographical inhabitant distribution which represents sub village government boundary. The advantage of this pattern is that project committee can easily manage the group and works. Some working groups still exist until now. Delivering responsibility to local people in the form of project committee helps in monitoring the project closely and sustainably without too much dependency on external parties.

Involvement of the village and sub district government in regular monitoring enhances more parties' participation to maintain the project lastingly.

## Stages of Adoption of Technology

The absence of adoption of introduced conservation measures on other plots is clearly defined previously due to ignorance of erosion symptom and effects. At the first stage, farmers are required to recognize the symptom and effect before introduction of new farming measures of tackling land degradation (Ellis-Jones & Mason, 1999 cited by Kessler, 2006). In order to raise awareness on land degradation, it needs more emphasis on educational programmes in the forms of training, public campaign, media. The trainings provided by YBS staff have increased farmers' awareness on erosion problem and the importance of measures to minimize land degradation process. To achieve acceptance phase of adoption process (Graff, et al., 2008), one or two trainings alone as performed by the project is not enough. It requires a comprehensive and continuous process with various forms of educational programmes.

However, Kessler (2006) argues that farmers' awareness on land degradation problem and its alternative solutions cannot guarantee that adoption will take place. There are various factors influencing farmers to adopt the introduced measures. In addition to effort of delivering educational messages to shake farmers 'awareness, it needs to consider other influencing factors to be integrated in soil conservation plan and execution since the problem of land degradation is a complex interaction process. Those factors can be socio-economic factors (Tenge, et al., 2004; Kessler, 2006). In a broader context, Lal (2001) and Bewket (2007) suggest that soil conservation measures not only refer to socio-economic aspects but also personal, institutional, physical, political, technological aspects. In reference to political aspect, Gisladottir and Stocking (2005) argue that there is a need to synergize soil and water conservation measures with appropriate policy. These factors are not addressed in this study; however, further research is needed. Adoption is important because the introduced measures can improve farmers' livelihood (Demeke, 2003) and in fact execution of conservation measures is disappointing (Kessler, 2006). However, adaptation could be the option in tackling land degradation issues since the farmers can learn from the introduced measures and then can be adjusted based on their ability and local context (Kessler, 2010).

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