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Agroforestry-based Livelihoods and Nutrition Security in Smallholder Households in West Java, Indonesia

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"Agroforestry-based Livelihoods and Nutrition Security in Smallholder Households in West Java, Indonesia"

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Acronyms

B/C	Benefit/Cost
BPS	Indonesian Bureau of Statistics
DD	Dietary Diversity
DDS	Dietary Diversity Score
ES	Ecosystem Service(s)
etc.	*et cetera* (and so forth)
et al.	*et alii* (and others)
FKDC	Forum Komunikasi DAS Cidanau (Communication Forum Cidanau Watershed)
ha	hectare
HDDS	Household Dietary Diversity Score
IDR	Indonesian Rupiah
kg	kilogram
NGO	Non-Governmental Organization
PES	Payment for Ecosystem Services
US$	United States Dollars
yr	year

Abstract

Payment for Ecosystem Services (PES) schemes are established economic instruments that promote environmental conservation while also improving peoples' livelihoods. Both are crucial in developing countries, where environmental degradation poses a threat and smallholder farmers often face poverty, food- and nutrition insecurity. Hence, PES schemes are considered suitable to reduce poverty, with varying success and impact. This research focusses on the influence of a PES scheme on farming profitability as well as food and nutrition security in smallholder households with agroforestry systems in Cidanau watershed, Banten, Indonesia. Results indicate that the PES has not increased farmers' profitability and received payments represent a minimal share of farmers' incomes from agriculture. Nonetheless, depending on the tree-crop composition, agroforestry systems can be economically viable in comparison to rice mono-cropping. Across all farming systems, there is a big potential to increase productivity and consequent profitability. At the same time, food and nutrition security in Cidanau is moderate, yet comparable across farming systems and independent of PES participation. Considering all sampled households however, significant positive correlations were identified for food expenditures and (i) dietary diversity as well as (ii) food security in the access dimension. This indicates that food- and nutrition security in Cidanau is influenced by households' purchase power. The extreme market-orientation and -dependency of smallholders leaves them vulnerable to market failures and fluctuating prices. Policies must help to increase smallholders' productivity and facilitate their market-integration for higher incomes, while at the same time strengthen food self-sufficiency of smallholders.

Key Words: Payment for ecosystem services, agroforestry, land-use profitability, food and nutrition security

1. Introduction

Improving peoples' livelihoods and environmental conservation are often considered conflict-loaded opposites, especially in view of an increasing global population as well as economic progress in developing countries. Finding ways to combine both is a major goal of our time. Novel approaches to integrate both are being developed constantly, as former ones seem to have failed. One example is the ecosystem services (ES) approach, which focusses on the goods and services humans receive – mostly at no cost – from nature (TEEB, 2015). The ES approach has become quite popular and with it a number of mechanisms to incentivize sustainable land-management and ensure the consistent provision of ES (Wunder, 2005). One example are Payment for Ecosystem Services (PES) schemes, which use financial incentives to compensate possible production disadvantages a sustainable land-use entails (Pagiola et al., 2005). The excitement for this new approach has led to widespread implementation of PES mechanisms worldwide, which however often left out important considerations like benefiting the poor and distributing benefits fairly. Therefore, PES now strive to be fair and pro-poor environmental management approaches that also improve livelihoods in developing countries. (Wunder, 2005)

Agricultural intensification worldwide has generally led to increased productivity and improved food security on a global scale. Big discrepancies however still exist between developed- and developing countries and in the latter, undernutrition and malnutrition remain huge issues. (IFPRI, 2014) Increasing homogeneity in food supply and the simplification of agricultural systems represent the general global trend, leading to decreasing agrobiodiversity[1] within farming systems and therefore less diverse diets of farming households (Khoury et al., 2014; Heywood, 2013; Kumar, 2006). Agriculture and nutrition are tightly linked, indicating that developing food- and nutrition security strategies must include the adoption of more sustainable farming practices. And this is where diverse tree-based production systems like agroforestry (AF) come in.

[1] The biodiversity in agriculture and food production

Tree-based farming systems are increasingly recognized as a possible solution for two problems, which especially target the rural poor in developing countries: improving people's nutrition statuses and increasing households' incomes (Pingali, 2015; Ickowitz et al., 2014; Duguma et al., 2001). Socio-economic benefits of mixed tree- and crop systems are studied much less than their bio-physical aspects until now. Nevertheless, increasing evidence suggests that these systems are highly productive, have the potential to provide regular and secure income for farming households, improve households' ability to cope with shocks and improve farming households' nutrition as well as health. (Dawson et al., 2013; Duguma et al., 2001; FAO, 2016; Powell et al., 2013) In short, AF have been related to improvements of numerous environmental problems, bringing social and economic benefits to (especially poor) people and creating positive interactions between those three dimensions, which is the very essence of sustainability (Torquebiau, 1992).

1.1 Case study - Cidanau river watershed

Environmental degradation in Indonesia is a great threat not only for the environment, but also for economic activities. Hence, new management measures are being implemented across the country. Among different projects and approaches, Cidanau river watershed in Banten province has become something like a showcase for conservation efforts. Due to a well-functioning PES scheme (more on Payment for Ecosystem Services in Chapter 2.2), AF farmers in the watershed are increasingly aware of their responsibility for the provision of clean water in sufficient quantities for downstream industries as well as for the Rawa Danau wetland, an important habitat for critical biodiversity. Farmers have adopted farming practices to reduce erosion, facilitate water infiltration into the soil and increase tree cover on their plots – and they receive compensation payments from the PES for this. Since 2004, smallholder AF farmers that adopt sustainable farming practices receive annual cash payments. Participating farmers in Cidanau currently practice diverse AF and chose crop diversification over intensification as a risk aversion strategy towards: fluctuating

market prices; low productivity and harvest failures due to a lack of farming know-how; and an increasing shortage of workforce due to the young generation's migration to the cities (EI-01; EI-03; EI-04). Nevertheless, poverty and low nutrition status of the population are two issues that are repeatedly reported from Banten province (Dewan Ketahanan Pangan et al., 2015). This holds true even in rural areas, where diets are thought to be quite monotonous and dependent on farm produce (EI-01).

The present master thesis was planned and designed in order to get a better understanding of the influence of the cash payments for sustainable agricultural practices on smallholders' wellbeing in Cidanau river watershed.

1.2 Objectives and Scope

Within the limited scope of this thesis, it tries to contribute to the understanding of benefits of payments for sustainable agriculture as well as tree-based production systems for smallholder farmers. Focus lies on two main aspects: farming system profitability as well as nutrition security of smallholder households. **¡Error! No se encuentra el origen de la referencia.** graphically demonstrates the research framework with existing interlinks and influences.

Financial analysis and comparisons of the profitability of different land-uses has gotten little attention in Indonesia. Therefore this thesis analyses AF systems and demonstrates realistic estimates for farmers of what their land is able to produce and weather it is beneficial and profitable for them. Furthermore, the influence of the payment scheme on farming system profitability is analyzed. This thesis hypothesizes that due to an increased social capital of PES participants (organization of farmers in farmer groups, increased governmental support, improved knowledge, etc.) those farmers practicing AF within the PES scheme have a higher financial return from their plots. The assessed farming systems are chosen based on their dominance in the

watershed as well as participation and non-participation in the PES. They include the following:

- Farmers with agroforestry plots that mainly cultivate *melinjo*[2]
    - Participants of the PES scheme
    - Non-participants of the scheme
- Farmers with agroforestry plots that mainly cultivate clove
    - Participants of the PES scheme
    - Non-participants of the scheme
- Farmers with crop-based plots that mainly cultivate rice and horticulture

Food and nutrition security of a population is highly context specific and influenced by different factors. This work therefore focusses on the influence of the practiced farming system as well as the participation in the payment scheme on dietary diversity and access to diverse foods in smallholder households in the case study area. AF systems generally are associated with higher agrobiodiversity than agricultural systems with short-cycle crops and research suggests that high agrobiodiversity results in high dietary diversity. Therefore the second hypothesis of this thesis is that households practicing tree-based systems have a higher dietary diversity than those producing mainly rice in monoculture. Furthermore, the PES scheme is believed to positively correlate with dietary diversity.

For both analyses, two local farming systems are being analyzed and compared: tree-based and crop-based systems. A further division is made within the tree-based group between participants and non-participants of the PES scheme in order to assess its possible influence on both assessed aspects.

[2] *Melinjo* (*Gnetum gnemon*) is an up to 15m tall tree native in Southeast Asia and the Pacific. Fruits, seeds, young leaves and flowers are used for human consumption. ((Orwa et al, 2009)

Specific objectives of this thesis are:

- The profitability of three major farming systems in Cidanau is assessed in a Land-use Profitability Analysis
- Dietary diversity and food security in smallholder households practicing these major production systems is analyzed and serves as a basis to draw conclusions about nutrition security
- If possible, the influence of the PES scheme on households' food consumption patterns and nutrition security as well as the profitability is studied

Corresponding research questions are:

- How does a profitability analysis of these farming systems look like?
    - Does the PES scheme influence farmers' management decisions?
    - Which local farming system is most viable for smallholder farmers?
- What are the food consumption patterns of households with tree-based and crop-based production systems?
    - How important is home produce in the food consumption patterns of these households?
    - Are these households food-secure?
    - Does the farming system influence dietary diversity and nutrition security?
    - Can land-use be directly linked to nutrition security?
- Has the PES scheme diversified households' diets, improved nutrition security or had an effect on farming system profitability?

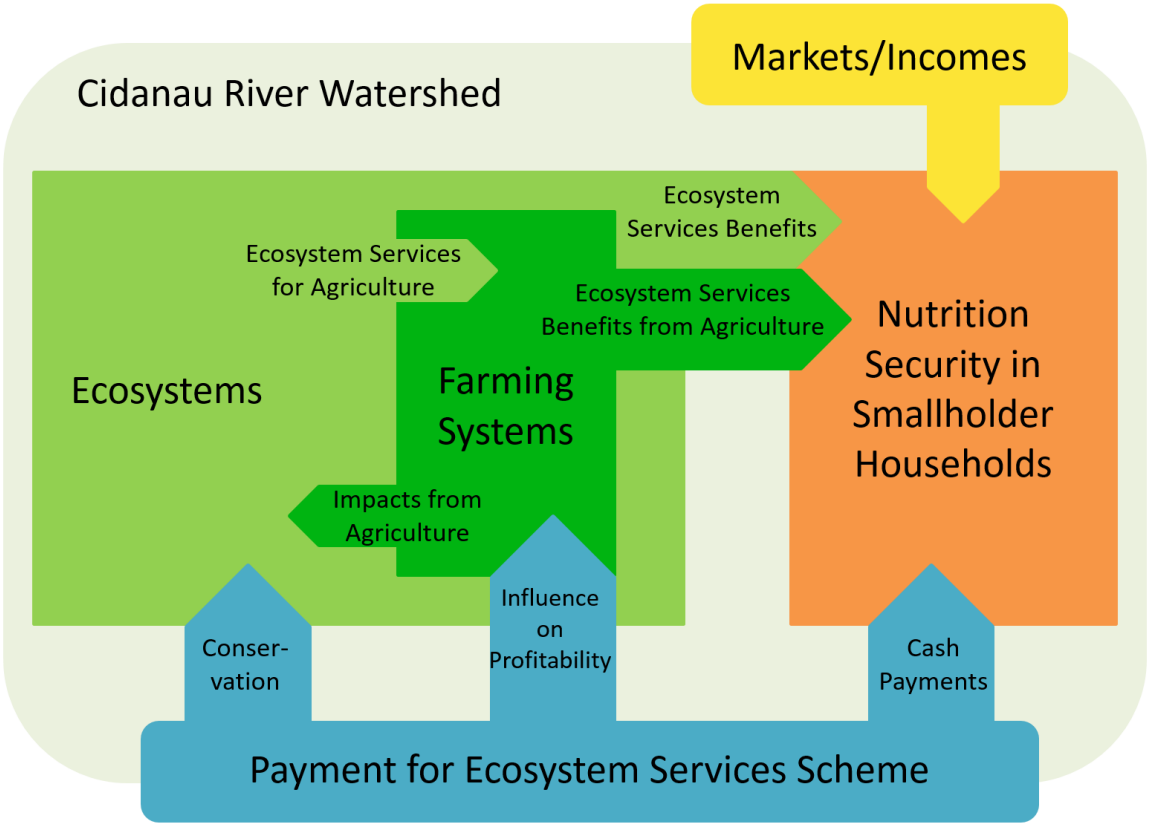

Figure 1: Research Framework of this thesis. (Source: Own graph adapted from CGIAR 2014)

The results of this master thesis add to the knowledge-base about the links and influences of PES schemes on tree-based agricultural systems, land-use profitability as also food and nutrition security, and will add new aspects to the discussion. To do so, this document is organized as follows: First, it will introduce the main key-concepts of this research in Chapter 2. Chapters 3 gives and introduction to related issues in Indonesia and presents the case study site. An overview of the chosed research methodology and sampling approach is provided in Chapter 4. The results of this investigation are presented in Chapters 5 and 6, and thereafter analyzed and discussed in Chapter 7. As a final aspect, a conclusion and key recommendations for policy planning and future research are given in Chapters 8 and 9.

2. Background

This section will give a more detailed introduction into the relevant concepts of this research, namely the land-use system ‘agroforestry’, Payment for Ecosystem Services schemes as economic incentives for conservation, the role of profitability in farming systems as well as nutrition security and its links to agriculture.

2.1 Agroforestry

Defined as “a dynamic, ecologically based, natural resources management system that, through the integration of trees in farms and in the landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels” (Leakey, 1996), AF systems are a common land-use, practiced by more than 1.2 billion households worldwide in traditional or modern systems (Dawson et al., 2013; FAO, 2016). The diverse forms of AF, like mixed tree-gardens, shifting cultivation and intercropping systems, were a dominant form of land-use globally at some point in time. Some examples for the tropics include the selected slashing of forest vegetation, leaving certain trees and adding short-cycle crops for few production cycles before moving on; or the cultivation of a high diversity of crops in various strata of the same plot to make use of limited space and enjoy multiple benefits. (King, 1987) While AF prevails as a major farming system in many areas worldwide, most agricultural areas were and still are converted into more input-intensive systems as they are thought to be more productive and easy to manage (Kumar, 2006). Those ‘stigmas’ however have been corrected and there has been a growing political interest in and recognition of the benefits of AF as governments increasingly commit to support this land-use through their political agendas. Examples include India, where a National Agroforestry Policy was adopted in 2014; the United States of America that in 2011 adopted a Strategic Framework for Agroforestry to promote knowledge and implementation; or Europe, where tree-based

intercropping systems were eligible for funding support from the Common Agricultural Policy since 2004 to improve rural development and biodiversity. (FAO, 2016)

Agroforests copy natural patterns in structure and function and therefore provide an array of gains for the environment as well as for humans. These have long been recognized in academic circles and are scientifically proven. Some examples include numerous bio-physical benefits like improved soil fertility and water conservation, as well as the provision of other ES like carbon sequestration, erosion control and biodiversity conservation (Young, 1997; Kumar, 2006; Duguma et al., 2001). These benefits are particularly important, as many farmland areas, especially in developing countries, are suffering from nutrient depletion and degradation, often due to unsustainable farming practices. (FAO, 2011) AF may also increase the resilience of landscapes by increasing the capacity to cope with and recover from natural hazards and disasters. These natural disasters include for example landslides and desertification, which trees and their roots might help mitigate by strengthening the soil structure and increasing water conservation. (FAO, 2016) Further positive traits associated with AF systems include the provision of a high diversity of crops, promoting food- and nutrition security (Kumar, 2006). Apart from the direct food-production, farm-trees provide secondary benefits for the production of other food crops, like shade and nutrients (Maliki et al., 2012).

Especially smallholder farmers highly benefit from AF systems, as they may provide food, fuel and fodder in addition to cash incomes from sold produce. They are therefore regarded suitable production systems in areas where markets are non-existent or with unstable provision of products. In other, more monotonous farming systems, the mentioned benefits (food, fuel, fodder) might not be freely available for farmers, increasing their expenditures. Diverse production systems with consequent diversified incomes are also thought to be a suitable risk reduction strategy for smallholder farmers. In case of for example meteorological extremes or market variability, households have more than one pillar to stand on. (Garrity, 2004; Dawson et al., 2013) By occupying diverse niches and creating positive interactions between crops, diverse AF systems have great potential for enhancing farming productivity and profitability. (Kumar, 2006; Steffan-Dewenter et al., 2007)

In summary, AF systems are dynamic and multi-functional land-use systems based on ecological principles. If managed properly, they can be highly productive and provide social, economic and environmental benefits. These are qualities that especially in developing countries are crucial in times of global change, the need to improve peoples' livelihoods and increase food- and nutrition security.

2.2 Payment for Ecosystem Services

Ecosystems play an important role for humans by providing an array of benefits upon which life and all economic activity is based. They provide products with direct value to people, like food, fuel and water, as well as numerous indirect benefits that provide and maintain the natural resource base for all economic activities. These include climate regulation, filtration of water, soil formation and photosynthesis as well as spiritual and educational experiences, to name a few. All those benefits from nature for humans are generally called ecosystem services (ES). (TEEB, 2015; MEA, 2005) Since the Millennium Ecosystem Assessment in 2005, the magnitude of those benefits, human dependency on them as well as the degradation of ecosystems and their services has become much clearer (Figure 2). A constant provision of ES from healthy ecosystems is especially important for poor rural communities in developing countries, as they often live in close connection and strongly depend on their natural surroundings, leaving them vulnerable to deterioration of those ecosystems. Nonetheless, and despite increasing recognition from the scientific world as well as politics, ecosystems and the goods and services they provide are still deteriorating rapidly. (Swallow et al., 2007)

As conventional markets rarely include negative effects of economic activities on the environment, a number of policy responses to stop environmental degradation have been developed. By 'commodifying' ES and giving them a monetary value, at least part of their real values is supposed to be captured. (Gómez-Baggethun et al., 2010) An example for these environmental policy approaches and market-based

instruments are Payment for Ecosystem Services (PES) schemes, which use some form of compensation to efficiently encourage environmental protection. (Pagiola et al., 2005) The increasing scarcity of ES worldwide makes them potential subject to being traded like in a traditional market with one central idea: ES beneficiaries 'buy' ES from land stewards in return for adopting practices that secure ES provision. PES schemes therefore try to bridge conflicts of interests for land-uses and compensate land-users' trade-offs (see **¡Error! No se encuentra el origen de la referencia.**). (Wunder, 2005; Farley & Constanza, 2010) Given the widespread perception that 'traditional' conservation approaches failed to deliver, market-based mechanisms have recently increased in popularity (Ferraro & Simpson, 2002*).*

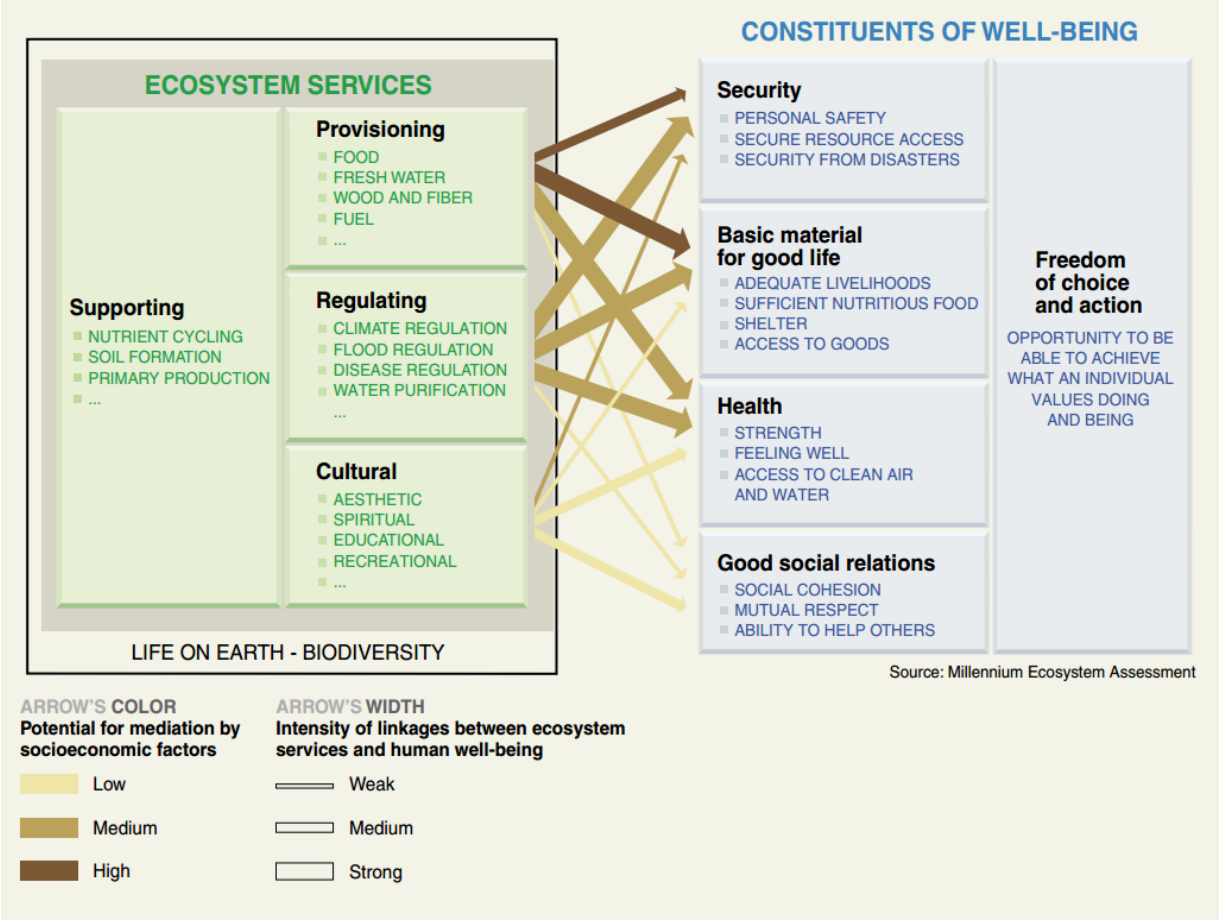

Figure 2: Links between ecosystem services and human well-being (Source: MEA, 2005).

After a first ‘boom’ of implementation, PES schemes have received harsh criticism. On the one hand side, the ES approach and PES mechanism *per se* created ideological resistance, as the ‘economization’ of the environment erodes culturally rooted, intrinsic, non-profit conservation and alienates people from nature. (Wunder & Vargas, 2005; Reyers et al., 2012; Robertson, 2012) At the same time, the focus of the initial PES concept, primarily efficiency, received numerous objections. This criticism was mainly due to a lack of equity in the benefit-distribution within society (Pascual et al., 2014) as well as missing emphasis on pro-poor aspects and the inclusion of marginalized stakeholders (Wunder, 2005). Considering the situation in developing countries, where many important ES are provided by low-income families in rural areas that own and/or manage forests, agroforests and farmland, these aspects further gain in importance. (Molnar et al., 2004) By creating markets for ES, low-income land-users have already or still could benefit from the ‘new’ value placed on the ES their lands provide both at the community as well as at household level. (Milder et al., 2010) The mentioned benefits do not only include cash or in-kind payments, but also better knowledge of profitable and sustainable land-use systems, more secure land tenure due to the ‘legalization’ of many people on their land, improved local organizations and institutions etc. (Pagiola et al., 2005; Rosa et al., 2003) Thus, the concept of PES schemes was broadened to additionally embrace poverty-alleviation, rural empowerment as well as social justice (Swallow et al., 2007). PES schemes therefore added to the discussion and increasing awareness that smallholder farmers and rural development are the key to reducing rural poverty, feeding the population and consequently increasing food security, both in the rural and urban sector. (FAO, 2011)

Payment mechanisms for environmental services now try to fill the gap of lacking funding for conservation while being a pro-poor approach. The new concept therefore now tries to create integral approaches that reach the dual goal of environmental conservation and poverty alleviation through the creation of win-win solutions for all involved stakeholders in environmental, social and economic aspects. The discussion however on the reasonability and effectiveness of PES systems continues and different perspectives remain.

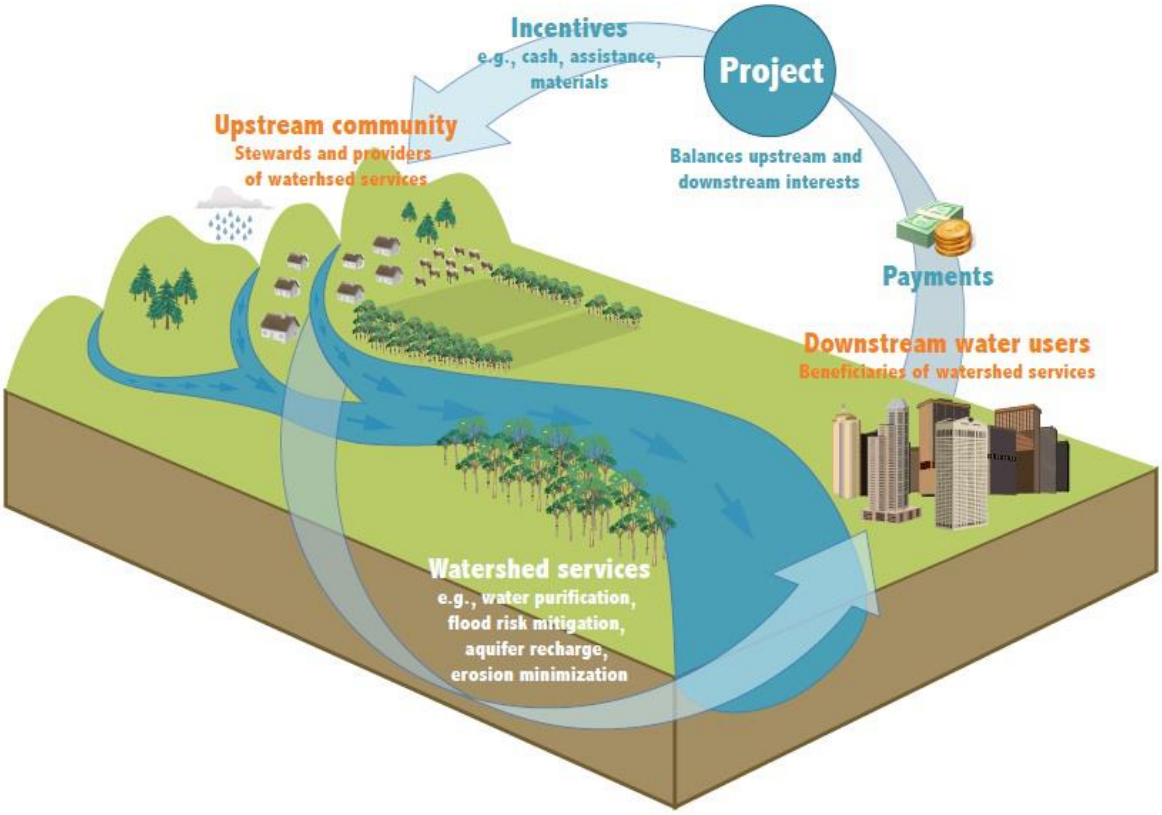

Figure 3: Example of a payment scheme for ecosystem services targeting watershed services. (Source: http://s3.amazonaws.com/mongabay-images/13/0128.foresttrends_watershed_large.jpg)

2.3 Profitability

After having compiled numerous environmental and sustainability benefits as well as some social benefits of AF systems, socio-economic aspects of this farming system are now discussed.

While a 'profit' describes the "money that is earned […] after paying the costs of producing and selling […]" (Cambridge University Press, 2016), the profitability of any business is calculated by measuring the incomes minus the expenses (Payne, 2009). In a farming context, the inputs might include labor needs, tools and irrigation infrastructure as well as costs for seeds or agricultural chemicals. The income is the revenue from selling agricultural products. (Payne, 2009). The economic performance

or profitability of agricultural systems significantly depends on the investments allocated and decisions made by the farmer or land owner. (Rahmanulloh et al., 2013) Profitability of land-use systems from the perspective of the land owner is typically called ‘private profitability’ or financial profitability. It often differs from society’s perspective, ‘social profitability’ or economic profitability, which includes the society’s benefits and costs as well as non-marketed values or externalities that may arise with a certain land-use. (Gittinger, 1984; Alavalapati et al., 2004)

Extensive and detailed research on the profitability of AF systems in developing countries is still relatively scarce. Nonetheless, based on the results of some studies, AF systems can be established highly profitable land-use systems. This is especially the case when comparing them to other, less sustainable farming systems found in the same landscape. Examples include the comparison of AF systems to slash-and-burn systems or mono-cropping. (Mohan et al., 2006; Duguma et al., 2001; Rasul & Thapa, 2006; Duguma, 2013; Khasanah et al., 2015). A number of factors however are important determinants for the profitability of AF systems:

First of all, the type of AF system is an important factor. Especially those systems that combine woody tree-crops and short cycle crops were found to be profitable, while those that introduce animals into the system lose profitability, as they require high inputs. Animals are often introduced despite this fact, as farmers keep them as a risk reduction strategy for cash income in emergency situations. (Molua, 2005) Secondly, the woody tree-crop species composition, or associated trees, is essential for farm profitability. Especially mixing (woody) cash crops with fruit trees is found to highly increase farm profitability, if markets are present (Duguma et al., 2001; Sereke et al., 2015). Furthermore, the age of an AF system plays a crucial role in its profitability. As these systems often have quite long transition periods until returns from tree-crops are provided, profitability mostly increases with age (Mohan et al., 2006; Duguma, 2013).

Crop diversification in socio-economic aspects is regarded a valid strategy to increase farmers’ income sources, generate employment opportunities, as also decrease household vulnerability. Efficiently increasing crop diversity is only possible though up

to a certain point: when incomes from diversification are lower than the benefits of specialization. (Joshi et al., 2004)

The general perception is that AF systems are more labor intensive than other, less complex systems. There are however a number of studies that did not find this trend (Ajayi et al., 2009; Bertomeu, 2003). While a higher need of labor during the establishment of the systems as well as at times of pruning is possible, overall, those systems do not require more labor input than conventional systems. Considering labor and farmers' opportunity costs is different when comparing developed - and developing countries. Off-farm labor might be scarce and farming activities the only income option for household members in many developing countries, reason for which opportunity costs are often low or non-existent. (Lanjouw & Lanjouw, 2001).

When discussing economic aspects of agricultural production, resilience of the system is also highly important. By increasing the number and diversity of crops and with it income sources, the effects of natural disasters and socio-economic problems are reduced and economic failure might be prevented. (FAO, 2016)

Profitability is stated a major determinant for the adoption of a certain farming system like AF, reason for which Franzel et al. (2001) recommend including this aspect more in AF research. On the other hand side, profitability is an abstract concept unknown to many smallholder farmers, especially if education is low and income and expenditures are not recorded in detail. In many cases plots are therefore managed based on the farmers' needs of food, fodder and cash income (Arnold & Dewees, 1999). But as farming is the major income source for many households, especially in rural areas of developing countries, it is important to understand land-use systems and their profitability in order to improve people's livelihoods. (Rahmanulloh et al., 2013)

2.4 Food and Nutrition Security

The concept of ‘food security’ is quite common and describes the provision of “sufficient save and nutritious food” at all times (FAO, 2008) and is given when the goals of four dimensions are reached:

(1) Physical availability of food: Addresses food production, trade and stocks in order to supply sufficient food on a national and international level.

(2) Physical and economic access to food: Addresses the household’s ability to access these national and international stocks through income levels, functioning markets and adequate prices.

(3) Utilization of food: Addresses the physical ability of people to metabolize and physically “use” consumed foods, but also includes safe food preparation, dietary diversity and nutrition as well as the distribution of food in one household.

(4) Stability: The prior three dimensions have to be secured over time, even with political or economic instability or extreme meteorological events. (FAO, 2008)

While this definition is already quite comprehensive and features some nutrition aspects, the much less known concept of ‘nutrition security’ tries to deal with an even broader array of issues. It includes health aspects (itself requiring a set of other parameters like an adequate nutritional basis), mother and child care as well as water and sanitation. (Frankenberger & McCaston, 1998) With this in mind, it becomes apparent that ‘food security’ and ‘nutrition security’ are not identical but rather closely interrelated and simultaneous prerequisites for each other (see Figure 4). (FAO, 2009) Two important terms often associated with nutrition security are ‘malnutrition’ (“deficiencies of specific nutrients or […] diets based on inappropriate combinations or proportions of foods” (Shetty, 2003)) and ‘undernutrition’ (“caused primarily by an inadequate intake of dietary energy, regardless of whether any other specific nutrient is a limiting factor” (Shetty, 2003)).

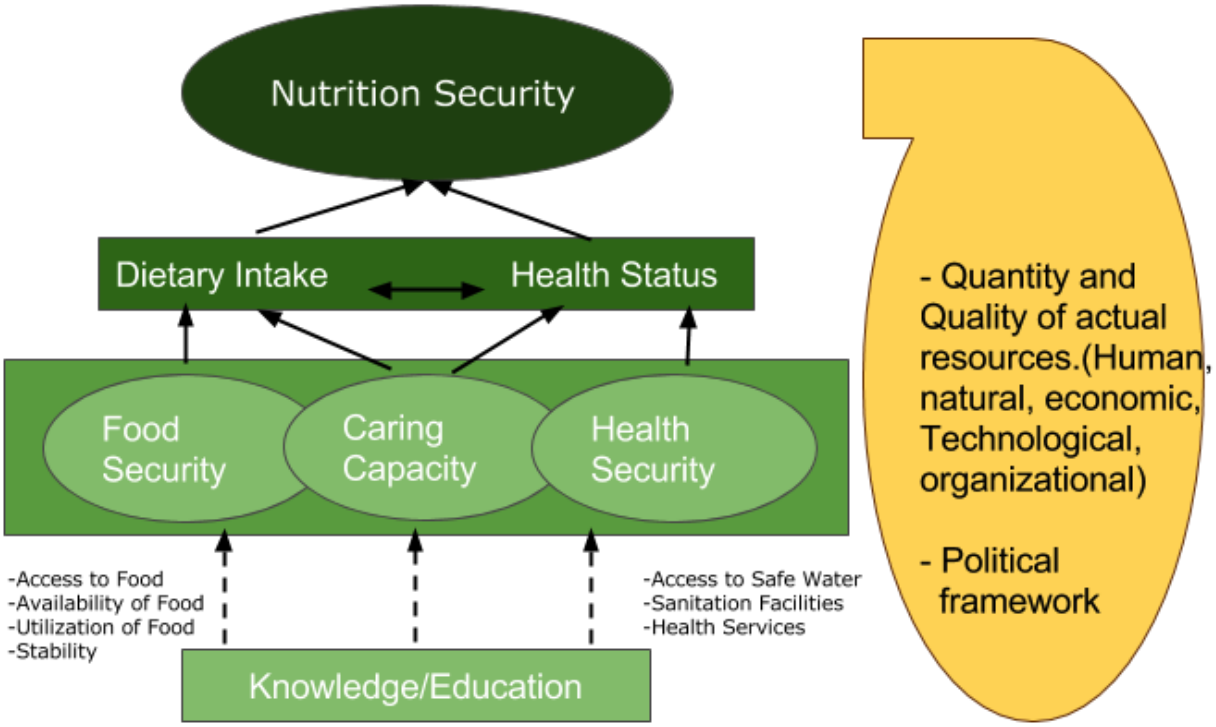

Figure 4: Factors influencing nutrition security and the links to food security. (Source: Own graph, adapted from Roetten & Krawinkel, 2000)

The general trend of agricultural production and modernization over the last few decades has narrowed down global production patterns, focusing on a limited number of major crops (Khoury et al., 2014). This has highly increased the productivity of many cereals and consequently improved food security worldwide. Despite this fact, nutrition security, mal- and undernutrition remain important issues and pose challenges for public health and development. (Gómez et al., 2013). As nutrition security requires an adequate nutritional basis, it is important to understand the concept behind. An adequate and balanced diet satisfies the physical dietary needs and, combined with regular physical activity, is regarded a basis for health (WHO, 2016). “Poor nutrition [that does not satisfy the body’s needs] can lead to reduced immunity, increased susceptibility to disease, impaired physical and mental development, and reduced productivity.” (WHO, 2016) In theory, a highly diverse diet increases the likelihood of being adequate; meaning that all food components essential for health and physical wellbeing are consumed (Ruel, 2003). The links between diverse diets and energy sufficiency, micronutrient adequacy as well as

normal child growth have been demonstrated in several studies (Ruel, 2003; Arimond & Ruel, 2004; Arimond et al., 2010; Kennedy et al., 2007). Recognized strategies to improve nutrition status and health therefore include increasing dietary diversity (Pingali, 2015).

Most undernourished people in Asia live in rural areas, and many of them are smallholder farmers. (Pinstrup-Andersen, 2007). This is not only the result of too little food quantities consumed, but rather poor dietary diversity and quality. Until recently however, there has been little evidence of how agriculture and nutrition are linked (IFPRI, 2014). Nevertheless, the links of sustainable diets, food systems and biodiversity are now rapidly being recognized throughout the scientific world (Sunderland, 2011; Macdiarmid, 2013). The positive correlations between crop diversification and dietary diversity in smallholder systems (Herforth, 2010; Powell, 2012; Jones et al., 2014), between crop diversification and nutrition adequacy (Powell, 2012) as well as between crop diversity and intake of nutritious foods (Herforth, 2010; Jones et al., 2014) have been demonstrated numerous times. Increasing crop diversity is therefore increasingly recognized as a reasonable approach to improve nutrition status in these often marginalized groups of society (The World Bank, 2007; Jones et al., 2014; Remans et al., 2011; Powell et al., 2015).

Furthermore, increasing evidence suggests that there is a positive relationship between tree-cover and diverse diets (Ickowitz et al., 2014; Powell et al., 2013). While it is not yet possible to determine the exact reason for the increased dietary diversity through the presence of trees, there are several assumptions. First of all, fruit-trees might provide nutritious foods and fill seasonal gaps during scarcity periods (Dawson et al., 2013; Garrit, 2004; Kumar & Nair, 2004; Cerda et al., 2014), as about 50% of global fruits are supplied by trees (Powell et al., 2013). In addition to these direct benefits, it is also possible that a higher tree-cover positively influences the diversity of diets through indirect benefits: through the provision of ecosystem services that themselves are beneficial for the production of other foods (Sunderland et al, 2013; Maliki et al., 2012). Examples include the provision of a favorable microclimate for fruit and vegetable production and pollination services (Powell et al., 2013) as well as biodiversity and agrobiodiversity conservation.

Sibhatu et al. (2015) however found that while there is a positive association of dietary diversity and crop diversity, this does not apply at all times, and the effect is not linear. Increasing an already high crop diversity does not have significant further positive effects on dietary diversity, or may even turn into the contrary, as farms operate beyond optimal levels. In some cases, access to and participation in markets is found to have a higher effect on dietary diversity than crop diversity. Some studies found that especially farming households with a market-oriented production have much higher food diversity than subsistence farmers, as they are able to purchase more diverse foods, which cannot be fully substituted by own production. (Sibhatu et al., 2015; Olney et al., 2009; Herforth, 2010; Keding et al., 2012) Jones et al. (2014) furthermore found that higher portions of land used for cash crop production increased dietary diversity. These findings suggest that rather diverse income sources through farm diversification have effects on smallholders' nutrition status, especially if the produce is sold and nutritionally important foods are bought. Off-farm income sources, which are quite common in smallholder households, as well as gender aspects furthermore contribute to this complexity of household food- and nutrition security (Haggblade et al., 2007; Sraboni et al., 2014; Herforth, 2010).

The presented arguments are evidence for the high context-specificity of the production-consumption diversity relationship. Agrobiodiversity, nutrition, markets and wealth have to be assessed for each individual site to understand the given situation.

3. Case Study

3.1 Agriculture in Indonesia

Not only is Indonesia the fourth populous country in the world, it is also one of the largest agricultural producers, exporters and importers. It is the largest palm oil

producer, second-largest natural rubber and third-largest rice producer globally, despite its relative scarcity of arable land. (OECD, 2012) In 2015, the agricultural sector contributed 13.5% to the GDP (The World Bank, 2016), yet still employs almost 35% of the population (OECD, 2012). Smallholder farmers produce most consumed food crops, while most large agricultural companies specialize on perennial crops like oil palm, which are mainly exported. (OECD, 2012) Agricultural imports mainly include grains, horticulture products and animal products. (Quincieu, 2015) Considering this, it becomes obvious that smallholders contribute substantially to food security in Indonesia. Large agricultural enterprises however are known for unsustainable land-management, enormous negative environmental impacts and profit maximization. But also smallholders contribute to environmental degradation in Indonesia as awareness of the roll of agriculture in conservation is just starting. Therefore efforts for sustainable agricultural production in Indonesia should increase in importance.

After the economic crisis in 1997, Indonesia initiated a reformation process, '*Reformasi*', which also targeted the agricultural sector and four main objectives were defined: (1) self-sufficiency of food production (especially for rice, sugar, soybean, maize and beef) to assure food security; (2) diversification of production and consumption towards a higher share of fruits, vegetables and animal products; (3) increase competitiveness of the agricultural sector and value-adding procedures; (4) increase farmers' incomes and livelihoods. In order to achieve this, the government has subsidized agricultural inputs (agro-chemicals, seeds, etc.) and outputs. (OECD, 2012) Since 2007, Indonesia has reached self-sufficiency in rice production and the government plans to expand production in order to meet the country's future demand and to maintain independence from imports (Dewan Ketahanan Pangan et al., 2015). However, poverty and food insecurity prevail, especially in rural areas where most people work in agriculture. Farmers are net buyers of staple foods, reason for which they were hit particularly hard by the 2007/08 food price crisis. (OECD, 2012; Quincieu, 2015) In addition, climate change is expected to decrease farm level net revenues by 9 to 25%. For these reasons, the government selected agriculture as one of the key strategic sectors in the 2015-2019 National Medium-Term

Development Plan. It includes a further increase of rice production for food security as well as augment high-value crops to improve farmers' livelihoods. The strategy to reach this involves the rehabilitation of irrigated lands and establishment of more irrigation infrastructure, promote sustainable farming approaches and build infrastructure. Estimates calculate a US$ 50 billion increase in agricultural revenues by 2030 if smallholder productivity nationwide augmented by 7%. Recommended reformation of the agricultural sector in Indonesia include increasing commercialization, facilitating access to land in order to gain economies of scale in farm size, enable re-investment and generally increase the attractiveness for investments in agriculture. However, the lack of adequate infrastructure in many parts of the country, the difficulty to access credits, as well as the lack of extension services and input from modern research constrain the progress and therefore productivity of small-scale farmers. (Quincieu, 2015; OECD, 2012)

In general, Indonesian farming systems are strongly heterogeneous due to the vast expansion as also cultural and geographic diversity of the country. Hence, agricultural strategies should allow specific adaptations of agricultural policies to each context. Despite expressed interest in agriculture from governmental side and the understanding that poverty-reduction, food security and the food production systems are closely linked, there is still a long way to go in order to establish a national food system that feeds and benefits everyone.

3.2 Nutrition Issues in Indonesia

As already mentioned above, nutrition and food security remain issues in Indonesia, despite the increasing production of important staple foods (Dewan Ketahanan Pangan et al., 2015). About 28% of children under five are malnourished or severely undernourished in Indonesia, and up to 68% are moderately nourished (Government of Indonesia, 2005). Around 12 million Indonesian adults consume less than the minimum daily requirement of protein and energy of 2,100 kcal. Also other indicators

for malnutrition remain high, like the occurrence of anemia among children and micronutrient deficiency in women. These data indicate that nutrition security in addition to food security is an aspect that requires attention from diverse sides. (Ministry of People's Welfare, 2006) In general, more children under five are underweight or stunted in rural areas (underweight 20.7%) compared to urban areas (15.2%) (UNICEF, 2013). To tackle problems of food- and nutrition security, the government has mainly focused on increasing staple food production (OECD, 2012), without putting much attention to nutrition and distribution aspects. In a country as disaster-prone as Indonesia, policies targeting food- and nutrition security must include the increasing risk of climate change and natural disasters.

Little knowledge exists on why Indonesians do not eat more fruits, vegetables and animal products, which would ameliorate part of the problem (Ickowitz et al., 2016). One explanation could be the higher price in comparison to staple foods, another the non-existing infrastructure in rural areas that inhibit the access to certain foods. (Herforth & Ahmed, 2015; Ickowitz et al., 2016) Also culturally rooted consumption patterns might play a role.

In addition to these 'traditional' nutrition-related issues, Indonesia is now facing the so called 'double burden' of malnutrition. Changing socio-economic realities and consumption patterns have increased obesity in the population, including related diseases like diabetes and coronary heart diseases. (Rachmi et al., 2016) This is highly linked with an increase in women's' participation in the labor market and a consequent increasing habit to purchase food, rather than preparing home-cooked meals (Nurbani, 2015). Both however must be targeted by national policies and education efforts in order to create a well-nourished, healthy, food secure and productive population.

3.3 Cidanau River Watershed

Cidanau river watershed is located in Banten province, in the western part of the Indonesian island of Java and counts around 1,800 households (Yoshino et al., 2003). Its area of 22,036 ha is covered by diverse habitats, including forests, paddy fields, swamps and swamp forests (see Figure 5). Cidanau lies within the tropical monsoon region with well-distinguishable rainy- and dry season. Average annual rainfall is about 2,500 mm and average temperature is 26-27^{o}C. (JICA, 1992) The watershed is of great local importance as it supplies water for domestic and industrial use for the whole province and especially for the industrial area of Cilegon city (Leimona et al., 2010). The strategic location of the province in close vicinity to Jakarta has brought an increment of local industries. Agriculture nonetheless is and remains a highly important income source for households, especially in the province's rural areas. The most important short-cycle crop cultivated is rice, but a number of permanent crops, including clove, cocoa and *melinjo* are also common. Small plot sizes however inhibit households to entirely live off their land. Thus, most of them depend on additional off-farm income and many young people leave the area to work in nearby cities. Cidanau watershed also includes the Rawa Danau Reserve, a 4,200 ha swamp forest with high ecologic value. (Budhi et al., 2008; Leimona et al., 2010)

Migration to the area occurred especially after 1997, mainly due to the economic crisis in Indonesia. The movement of people into the area and the encroachment of agriculture into conserved upland forest, which is important for water catchment in the watershed, as well as into the Rawa Danau wetland has negatively affected the natural environment. (Yoshino et al., 2003) In addition, decreasing water quality due to unsustainable agricultural practices like overuse of agricultural chemicals, erosion leading to sedimentation and contamination of water sources by ashes from burned rice husks has been an issue in the watershed. Furthermore, extreme variations in water flow, especially water shortage during the dry season, have been harming industries as well as farmers. Finally this has also led to eutrophication in the Rawa Danau wetland. (Yoshino & Ishioka, 2005; Adi, 2003, Budhi et al., 2008).

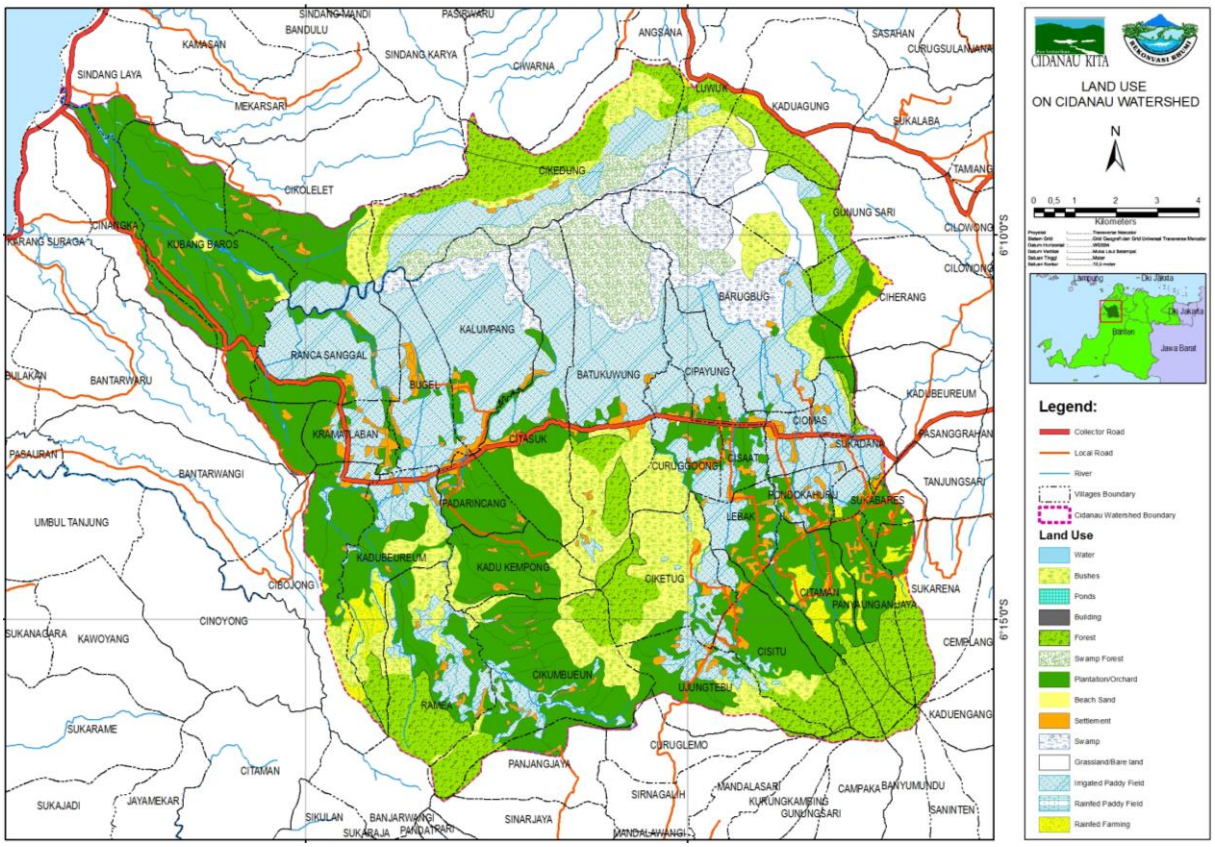

Figure 5: Land-use in Cidanau river watershed. (Source: *Rekonvasi Bhumi*)

Given these preconditions, a number of efforts were undertaken to improve the environmental conditions of the watershed, including the resettlement of local communities and reforestation efforts. These however were not able to reach the expected outcomes and in 2005, a novel approach to watershed conservation, namely a PES scheme, was implemented in order to preserve remaining forest cover and rehabilitate 'critical lands'. This project was part of a broader research and action plan, including the initiation of several payment schemes for environmental services across Indonesia. The PES mechanism in Cidanau was planned and initiated by a multi-stakeholder watershed forum (*Forum Komunikasi DAS Cidanau* (FKDC)) and facilitated by the NGO *Rekonvasi Bhumi*. The state-owned water company (PT Krakatau Tirta Industry) 'buys' the ES and provides water to several industrial areas in the province. (Leimona et al., 2015) It is a small-scale, community-level PES scheme for watershed services, as typical for the Asian context (Leimona et al.,

2010). The initial contracts were supposed to include plots on 'critical lands', declared after an analysis of the area and based on their soil type, vegetation cover and steepness of the slope (Budhi et al., 2008). In praxis however, farmer groups were chosen based on previous good collaboration with the intermediary organization (Lapeyre et al., 2015). Participating farmer groups have to comply with a number of regulations, which include the planting and maintenance of a minimum of 500 trees per hectare as well as organize themselves in farmer groups. Groups that do not comply with those regulations get their contract terminated. (Leimona et al., 2010) Farmers in the first years of the PES scheme (2005- 2010) received annual compensations of US$ 120 per hectare (Leimona et al., 2010). These numbers now are IDR 1.75 million ha^{-1} yr^{-1} for the 'older' members and IDR 1.35 million ha^{-1} yr^{-1} for newer member groups.

Based on results from former research projects in the area, the PES mechanism has brought a number of benefits to participating farmers as well as to the region. The annual compensation payments represent around 3% of participating households' incomes, and the benefits are therefore mainly non-financial and rather include social and natural capital aspects: The expansion of social networks with outside stakeholders (governmental agencies, industries, etc.) brought capacity building initiatives to increase environmental knowledge as well as motivation of entrepreneurship and business development in the villages; Villagers established fruit-tree nurseries and animal breeding programs with the financial benefits from the scheme as well as small infrastructure projects like a water pipeline for clean water. There have however also been some disadvantages for participating farmers: as they lost the ability to harvest firewood from their plots, some households now have to compensate this loss by purchasing firewood. It is not clear if those losses are covered by the payments from the scheme. (Leimona et al., 2010)

A recent study (Lapeyre et al., 2015) also found that economic incentives were not as important in the process of deciding to join the PES scheme, much rather social and cognitive motivation. In addition to altruistic motivation, social pressure from village leaders and the need to maintain a good reputation also contributed to farmers' decision making. The study also states the consciousness of the participants of their

dependency on forest ecosystems for their incomes and livelihoods. Lapeyre et al. (2015) however also found out that participating farmers often are not entirely aware of the content of the PES contract, mainly due to low education levels as well as a lack of capacity of the group leaders to convey the overall message.

Former research furthermore finds that the government has a rather negative reputation in Cidanau (Leimona et al., 2010). Since 1998, Indonesia has been going through strong reformation processes, '*Reformasi'*, after the former president Suharto was forced to leave office. This process has increased decentralization and autonomy to village level governments, nevertheless many rural communities in Indonesia felt more secure during the Suharto period, who strongly considered and integrated rural areas into national development programs and granted them greater government spending (Antlov, 2003). This feeling of being left behind has decreased the villagers trust in the Indonesian government (Leimona et al., 2010), reason for which it is crucial for the success of the PES scheme that local stakeholders earn farmers' trust.

Regarding further scientific research on the watershed, a number of studies have been carried out already. However, it is rather surprising that a comprehensive study on the watershed services, which are subject to the compensation payments and the entire PES scheme, is still missing.

4. Approach and Research Methods

This chapter starts with a presentation and justification of the methods elected to analyze land-use profitability as well as for the assessment of dietary diversity and food security. It continues with the description of an additional research method, namely expert interviews, which further contributed to the present thesis. In the end, an overview of the sampling frame and size as also a description of utilized data analysis methods is displayed.

4.1 Land-Use Profitability Analysis

The first objective of this research is the profitability analysis of dominant land-uses in Cidanau watershed. In order to meet this objective, the three most common farming systems were chosen, in order to demonstrate the financial returns and benefits that can be accrued from these systems and then make a comparison:

(1) *Melinjo*-based agroforestry systems

(2) Clove-based agroforestry systems

(3) Rice mono-cultivation intercropped with vegetables

Furthermore, the two tree-based production systems were then subdivided into participants and non-participants of the PES mechanism.

Key Informant Interviews

In order to gather detailed information on the economic performance of farming systems in Cidanau, key informants were interviewed regarding management practices of their plots. Key informant interviews (KII) were carried out by members of *Rekonvasi Bhumi*, who have known targeted farmers for a long time and have gained their trust. For this, ICRAF provided semi-structured questionnaires (see Annex). The questionnaires are designed to obtain detailed information about farming inputs and outputs. Interviewees were chosen based on the practiced land-use system, the participation or non-participation in the PES mechanism as well as past positive collaboration with the NGO.

Profitability Analysis

The three most common farming systems in Cidanau are established systems that require no or little conversion efforts. Paddy rice systems have been established in the case study area a long time ago; the same counts for AF systems, for which plots of natural forests were slightly slashed and high-value trees were added. The

intention of local stakeholders in Cidanau is not that farmers convert from one farming system to another, but rather demonstrate that AF systems can be economically viable. This way, AF farmers should be kept from converting to other (short-cycle crop) systems, which might seem to be a more economic option in the short-term, but are less beneficial for the environment and ecosystem services provision. Current AF farmers that are interested in joining the PES scheme mostly have to increase the tree-density on their plots to meet the PES requirements. These efforts do require some investments from the farmers' side, but are covered by the PES payments of the first year (Leimona et al., 2010).

Therefore the focus of this research is the comparison of cash incomes from farming in established systems. Common economic valuations, like the Net-Present Value (NPV), which gives information on the best investment option for financial resources, will not be calculated in this research as it is not considered relevant. To study the economic performance of the three farming systems, this thesis calculates the annual net returns from farming as well as the benefit-cost ratio based on the inputs and outputs information collected in the KII.

Net Incomes

Net incomes from farming practices represent the cash returns for farmers after all operational costs are deducted. In Cidanau, the production inputs consist of pesticides, fertilizers, tools (including farm animals), labor and seeds. The farmers' profits are calculated by subtracting those production costs from the farmers' revenues. In this analysis, the revenues are calculated based on 'last-month prices' for each produce mentioned by each farmer. As many farmers sell their produce to middle men at the farm gate and receive highly diverse prices, this option was thought to represent the reality in the field better than using standardized market prices.

All calculations in this master thesis are presented in Indonesian Rupiah (IDR). This was considered appropriate as the research was conducted in collaboration with

ICRAF Indonesia, which might be the most important beneficiaries of the results. A table of exchange rates at the time of research are presented in the Annex.

Benefit-Cost Ratio

Another measure of return calculated in this research is the benefit-cost (B/C) ratio, which describes the ratio of the present benefits from one land-use type to the current value of expenditures. (Gittinger, 1984) It is calculated as follows:

$$B/C = \frac{\sum_{t=1}^{t=n} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{t=n} \frac{C_t}{(1+i)^t}}$$

Here, B_t = benefit at year t; C_t = cost at year t; t = time denoting year; n = number of years from the present study year; i = discount rate). A discount rate of 8% was chosen (Rahmanulloh et al., 2013). B/C ratios >1 demonstrate a return larger than the investment, while ratios <1 demonstrate higher inputs than returns.

4.2 Dietary Assessments

Data acquisition

This master thesis used structured questionnaires in order to obtain information from which conclusions about food and nutrition security in Cidanau could be drawn. The questionnaires used can be found in the Annex of this document. They include a set of socio-economic questions including household composition, employment, land tenure, practiced farming systems as well as homegardens and their uses. Furthermore, they contain a 24-hour recall (described below), a set of questions to assess food insecurity in the access dimension (further information provided below), and information on households' weekly expenditures for food. For this last information, households were asked to detail expenditures in different food groups

adopted from previous research by ICRAF and the Indonesian Central Bureau of Statistics (BPS).

Targeted respondents of the household survey were women from a random sample of households in different villages across the watershed. Villages were chosen based on good relationships with *Rekonvasi Bhumi*. Households were purposively selected based on their farming system as also their participation in the PES scheme. The questionnaires were pretested before the actual data acquisition. Oral consent was sought from each participant at the beginning of each interview.

Diversity Measures

Dietary diversity (DD) is a good proxy for nutrition adequacy of a diet. Nutritional studies that assess DD frequently use count measures, which record the sum of consumed food and drink items or food groups. (Ruel, 2003) However, a great variety can be found within the 'dietary diversity' group of methods: some include qualitative, others quantitative data; some focus on short reference periods (24 hours), others on long-term evaluations. Each assessment method has specific strengths and weaknesses but until now, none of the developed methods can perfectly assess dietary intake. (Biro et al., 2002) As a high quality and precise dietary assessment is time consuming and expensive, a rapid and less costly, but scientifically robust method to analyze the nutrient adequacy of diets was required and dietary diversity measures satisfy this need. Verifications of these DD scores have shown a positive correlation between the quantity and diversity of consumed foods, the nutrient availability in blood samples and the nutrient adequacy of diets. (Arimond et al., 2010) The lack of uniformity of dietary assessments and consensus however makes comparisons of studies difficult and has developed a great variety of always new methods that would like to fill this gap of being *the one* DD method.

One of these DD approaches is the Household Dietary Diversity Score (HDDS), developed by FAO (Kennedy et al., 2011). This method uses food and drink items consumed by the *entire household inside the home* in the 24 hours of the previous day, a method called '24-hour recall' (further details below). FAO in its guidelines

suggests categorization food and drink items into 12 groups. The HDDS is then calculated by adding all consumed groups (maximum score = 12, if at least one item from each group is consumed by any member of the household). As this score includes more than one person and the exact consumption of each person cannot be assessed using this method, it is rather used to assess the household's ability to *access* food than the exact nutritional value of a diet. The HDDS therefore, triangulated with other indicators, serves to give a better overall understanding of a household's food and nutrition security.

As the 12 suggested food groups are quite general, Ruel (2003) suggests adapting the HDDS to local conditions. For this research, the food groups from the BPS were used in order to have comparable results and the same grouping was used for the expenditures analysis: (1) Rice, (2) Other cereals, (3) Roots and Tubers, (4) Fresh fish, (5) Preserved fish, (6) Meats, (7) Eggs, (8) Milk and Milk products, (9) Vegetables, (10) Nuts and Beans, (11) Fruits, (12) Fats and Oils, (13) Drink ingredients[3], (14) Spices, (15) Other carbohydrates, (16) Fried chips, (17) Stall foods and Snacks, (18) Sugary drinks. In a second step, the items were regrouped into a globally used categorization of 5 groups: (1) Staples, (2) Animal Products, (3) Fruits and Vegetables, (4) Legumes, (5) Processed Foods and Drinks.

24-Hour Recall

Data for the HDDS indicator were sampled using a qualitative 24-hour recall. DD measures generally use diverse recall periods, ranging from one day to one month. The benefit of having short recall periods includes a higher level of accuracy in the responses, however only short times are sampled, which might decrease DD values. For this thesis however, a 24 hour recall period was chosen due to its simplicity. Respondents were asked to qualitatively recall and describe all foods and beverages their household consumed the previous day. This methodology also allows follow-up questions and information about the origin of consumed foods was acquired additionally. Published literature suggests applying this method with a minimum of

[3] This food group includes coffee, tea and sugar.

four repetitions (Holmes et al., 2008). Monotonous diets in rural Indonesian settings however permit a single recall to assess the *status quo* of consumption patterns (EI-01). Nevertheless, limitations of this method like seasonality of foods are acknowledged in order to reduce the risk of underestimating household diets.

Food Insecurity

Food and nutrition security are hardly separable. A selected focus of this research is the food security in the *access* dimension, as this is highly linked with households' cash incomes and purchase power. The first methodology to assess this is the HDDS (described above), which looks at DD in households. To gather further information about this issue and broaden the understanding of this issue in Cidanau, it was decided to include a food insecurity measure. Measuring food insecurity is difficult, given the fact that food security is a complex and multidimensional. Commonly, food security is assessed with one of the following measurements: National per capita caloric availability; Household incomes and expenditures; Dietary intake; Anthropometry; or Experience-based food insecurity measures. While the first four methodologies include proxies for food insecurity, the last one actually includes perception and experiences of respondents. (Perez-Escamilla & Segall-Correa, 2008) Furthermore, data collection is easy to implement and inexpensive, while claiming to be methodologically rigorous. One of these indicators that measures the access component of food insecurity is the Household Food Insecurity Access Scale (HFIAS) (Coates et al., 2007). It comprises a set of nine occurrence questions followed by an assessment of their frequency. The score measures the degree of household food insecurity in the access dimension within a timeframe of four weeks and is calculated by summing the scores for the frequency of occurrence of each question. The nine initial questions were adapted to seven questions for the setting of this research and each question has three options of occurrence (rarely = 1 point, sometimes = 2 points, often = 3 points). The maximum HFIAS in this research therefore is 21 (7 questions *x* 3 points). The higher the score, the more food insecure in regards to

access is the household. The classification of food security (access) then takes place based on the following description:

Table 1: Overview of the classification of food insecurity (*access*) categories. (Source: own table adapted from Coates et al. (2007))

Question	Frequency		
	Rarely = 1	Sometimes = 2	Often = 3
1	Food secure		
2			
3	Mildly food insecure		
4	Moderately food insecure		
5			
6			
7	Severely food insecure		

Data Analysis

Statistical analysis was carried out for the dietary objectives only, as the profitability sample size is rather small. All analysis in this thesis is carried out using Microsoft Excel as well as IBM's SPSS Statistics 23. One-Way ANOVA was the method of choice when analyzing means of more than two sample groups, and probed with Fisher's Least Significant Difference (LSD) post-hoc in case of significance. For correlations, Pearson's analysis was chosen.

All statistical analysis is carried out with an alpha value of 0.05. The presented data represent mean values, unless indicated otherwise, ± standard deviation.

4.3 Expert Interviews

Three semi-structured expert interviews were carried out for this investigation. Experts were chosen and approached based on interest for this research. Conducting expert interviews was chosen as an additional method to gather further background

information in addition to the literature review, questionnaires and KII. Interviewees included:

EI-01 Prof. Dr. Ir. Ali Khomsan, Faculty of Human Ecology, Bogor Agricultural University, Bogor, Indonesia

EI-02 N.P. Rahadian, Director of *Rekonvasi Bhumi*, Serang, Indonesia

EI-03 Anang Suryana, *Rekonvasi Bhumi*, Serang, Indonesia

EI-04 Andi Sukman, Department of Agriculture, Banten province, Indonesia

Two interviews (EI-02, EI-03) were recorded and their main findings were summarized, while the information from interviews EI-01 and EI-04 were documented in a protocol and then summed up. All summaries can be found in the Annex of this document.

4.4 Sampling Frame and Size

Given the fact that there are two distinct research objectives in this thesis (profitability- as well as food and nutrition security objectives), two different sampling frames were required.

KII for the profitability objective were identified based on a two-step sample division, where the first criterion for farmer selection was the farming system and the second the participation or non-participation in the PES scheme. Therefore the following characterization was made:

- Farmers with agroforestry plots that mainly cultivate *melinjo*
    - Participants of the PES scheme (hereinafter referred to as Mel-PES)
    - Non-participants of the scheme (hereinafter referred to as Mel-Non)
- Farmers with agroforestry plots that mainly cultivate clove
    - Participants of the PES scheme (hereinafter referred to as Clo-PES)
    - Non-participants of the scheme (hereinafter referred to as Clo-Non)

- Farmers with crop-based plots that mainly cultivate rice and horticulture (hereinafter referred to as Rice)

Based on this characterization, key informants were selected by *Rekonvasi Bhumi.* The final sample size is presented in Table 2.

Table 2: Sample frame and size for 'profitability' objectives.

Farming System	PES Participants	Non-Participants
Melinjo-based Agroforestry	9	9
Clove-based Agroforestry	6	7
Rice/Horticulture	-	10
Sub-total	15	26
Total		41

Data for the food and nutrition security objective were collected with questionnaires targeting women of farming households. These were randomly selected in villages, in which good working relations and trust was established with *Rekonvasi Bhumi*. Households were selected following a different two-stage process:

- Households with tree-based plots that are part of the PES scheme (hereinafter referred to as PES-TB)
- Households with tree-based plots that are not part of the PES scheme (hereinafter referred to as TB)
- Households with crop-based plots (hereinafter referred to as CB)

Table 3: Sample frame and size for 'nutrition' objectives.

Farming system	PES Participants	Non-Participants
Crop-based	-	36
Tree-based	34	35
Sub-total	34	71
Total		105

The sample size is based on the feasibility and scope of this research, yet is rather small due to limited time resources. This limitation however is compensated by obtaining information with a higher level of accuracy and depth however compensates this. Data collection for both objectives took place in April 2016.

5. Results – Profitability objectives

The results of the KIIs conducted with farmers of the three land-use systems under evaluation in Cidanau (*melinjo*-based AF, clove-based AF and rice-horticulture systems) are presented in this section. Initially, a detailed description of each farming system is given based on the questionnaires, observations in the field as well as findings from expert interviews. This is followed by the presentation of the profitability analysis, which was carried out based on information from KII.

5.1 Description of Farming Systems

5.1.1 Agroforestry System

AF in Cidanau has a long tradition. During the Dutch colonial times, many farmers were forced to plant rubber trees. Only afterwards people changed to rice and vegetable cultivation. Yet many AF areas remain. When part of the AF farmers joined the PES in Cidanau, they had to start actively managing their land, which most of them did not do before, or not to this extent. (EI-02)

Today, AF plots highly resemble natural forests (see Figure 6). They are systems with mixtures of diverse tree-crops using different strata and the ground is covered with shrubs and bushes. Tree-crops are mostly fruit trees intercropped with some timber-trees. AF farmers here have diverse crops on their land as a risk aversion strategy (EI-03). Highly fluctuating prices for their produce is one reason for this trend, which is amplified by the presence and influence of middlemen, to whom farmers sell their produce at the farm gate. The received prices for the same commodity at the same time in the same village might be very different between two farmers, because the middlemen estimate how much each farmer will ask for. Farmers' however often depend on these middlemen as they lend money or grant cash advances. (EI-03)

These price fluctuations make it difficult for farmers to plan ahead, as they are highly market-oriented and produce mainly for sale. Farmers chose the tree-crops they plant based on current prices and market demand. This however often means that there is a ‘hype’ of planting a certain high-value crop, resulting in over-supply and dropping prices when all farmers start producing. (EI-03)

In the eyes of local agricultural authorities, having a high diversity of plants is not beneficial, as farmers’ decrease their productivity. If tree-based farmers had one main product, like a plantation, this could increase their livelihoods. (EI-04)

Figure 6: *Melinjo*-based agroforestry plot with terraces of a PES-member in Citaman village. (Source: Own photo)

An important observation from the field is that most interviewed farmers were of higher age. Many young people in the visited villages go to the city to find employment. Being a farmer has a low reputation and therefore parents prefer that their children leave for ‘something better’. The village community works as an

important actor that ‘controls’ family reputation. (EI-03) Most AF farmers in Cidanau are the owners of their land, which they either inherited or bought.

Concerning pest management, several observations were made during the field survey in Cidanau. While walking through a number of AF plots, the researchers observed fowling crops on trees like moldy cocoa pods that were not removed despite being a source of infection for the rest of the pods or other plants. Additionally, none of the sampled farmers used the understory of their plots. Reported reasons are a lack of willingness and motivation, time as well as knowledge (EI-03).

AF farmers in Cidanau are increasingly rejuvenating their plots with timber-trees, which they plant as an additional ‘insurance’. When the family is in need of a fast cash income, timber trees are harvested and sold. Main species are *albasia* and *mahogany*. Some species like *albasia* are not permitted in the PES, as they are fast growing species requiring large amounts of water, which is a scarce resource, especially in the dry season. (EI-02) It is however possible also for PES participants to have timber-trees on their land as the contracts have a duration of five years (with possibility of renewal), which allows them to harvest the timber after the termination of the contract.

The PES scheme has been targeting AF farmers in Cidanau, and all interviewed farmers are happy with the contract. The experienced success of the PES scheme in Cidanau is mainly a success of *Rekonvasi Bhumi*, as their proximity to the villages and the farmers has created a relationship of trust. When members of *Rekonvasi Bhumi* visit the villages, they are welcomed like family by farming households. The socio-economic benefits of the PES were explained by Pak Nana (EI-02): participating households benefit from increasing financial resources and some farmer groups have initiated small entrepreneurial projects like a small goat breeding project and therefore diversified their income sources.

Melinjo-based agroforestry

The main crop in this AF system is *melinjo*, a tree that produces small fruits of which the skin is peeled off and then used for cooking like a vegetable; the seeds as well as

the leaves are also consumed. Part of the harvest is used for household consumption, while most is sold. Harvest of the *melinjo* fruit occurs twice a year in a 'large' and a 'small' harvest, while leaves are harvested year around. Farmers report a period of seven years until the first fruit bearing and a peak harvest at the age of 20 to 25 years. Reported annual harvests vary widely: 1 to 9 kg per tree in the first years for the PES participants and 3 to 10 kg per tree in the non-PES sample, 3 to 45 kg as well as 6 to 30 kg per tree respectively in the peak harvest years, and 3 to 6 kg as well as 6 to 20 kg per tree respectively after that. Stated tree-density of *melinjo* trees is 100 to 1,250 trees per hectare for PES participants and 67 to 600 trees per hectare for non-participants. Prices per kilo in the month prior to sampling are IDR 6,000 to IDR 13,000 in the PES group and IDR 5,000 to IDR 16,000 in the non-PES group. The average plot size of PES participant *melinjo* farmers is 0.49 ha, while non-participants on average have 0.69 ha.

In differing combinations and densities, the sampled farms also cultivate clove (*Syzygium aromaticum*), durian (*Durio zibethinus*), jengkol (*Archidendron pauciflorum*), stink bean (*Parkia speciosa*), coffee (*Coffea arabica*), coconut (*Cocos nucifera*), banana (*Musa acuminata*) and cocoa (*Theobroma cacao*) trees on their plots, both, the PES participants as well as the non-participants. M*elinjo*-based AF farmers would like to shift to a rather clove-dominated production system, as they expect higher returns. The total tree density per hectare is 216 to 1,890 for PES participants and 140 to 1,660 for those that are not.

Farmers here carry out most of the work by themselves, occasionally receive help from other family members, and at times also hire laborers. This applies especially for the harvest season. Pesticides are used in moderation in both groups (PES and Non-PES). The same applies for fertilizer like urea or NPK. All tools used by the farmers are hand-held, muscle-powered tools like hoes and chopping knives. Only one farmer of each sample group had purchased used seedlings, most however have their own nurseries.

Clove-based agroforestry

Clove farmers in Cidanau are highly market-oriented, as they sell the entire harvest of their main crop. The blossoms of the clove tree are harvested just before opening and then dried before being sold. Harvest occurs twice a year, with a 'major' and a 'minor' harvest, and some years in which trees do not flower at all. Farmers report a period of seven years until the first inflorescence and a continuous increment of harvest quantities from then on. The harvest quantities in initial years reported by Cidanau farmers are 1 to 2 kg per tree for PES participants and 1 to 30 kg per tree for non-participants. These quantities increase to a peak of 2 to 33 kg per tree in the PES group and 4 to 45 kg per tree for the non-PES group. Clove tree density per hectare in the PES participating plots is 188 to 300 and 60 to 400 in the non-participating plots. Stated prices in the month prior to sampling are IDR 105,000 to IDR 150,000 in the PES group and 110,000 to 120,000 in the non-PES group. PES farmers have an average plot size of 0.75 ha, and non-PES farmers of 0.68 ha.

In addition to clove trees, farmers also cultivate *melinjo* (*Gnetum gnemon*), durian (*Durio zibethinus*), jengkol (*Archidendron pauciflorum*), petai (*Parkia speciosa*), cocoa (*Theobroma cacao*), coconut (*Cocos nucifera*), banana (*Musa acuminata*), nangka (*Artocarpus heterophyllus*) and coffee (*Coffea arabica*) trees on their plots, with varying composition and density. The total tree-density on the plots is 547 to 1,144 trees per hectare for farmers that participate in the PES and 400 to 1,520 for non-participants.

Farmers of this system also do most of the work themselves, receiving some help from family members in labor-intensive times and hire some laborers for harvest, which they pay per kg harvested. Pesticides are used moderately, with half of the interviewed farmers using none. Fertilizer is used with a higher frequency, mostly NPK, urea and manure. Similar to the *melinjo*-based system, tools are hand-held and muscle operated like chopper knifes and hoes. Most clove-based AF farmers in Cidanau have their own nurseries and do not purchase seedlings.

5.1.2 Rice mono-cultivation and Horticulture Systems

Rice cultivation in Cidanau watershed is generally rain-fed cultivation; few farmers have installed a simple irrigation system that leads water from a river to water basins close by the rice fields. Average plot size of rice farmers in the sample group is 0.49 ha. Land ownership in this sample is mixed; some own the land while others lease it. Instead of paying the lease in cash, farmers cultivate the land and receive 1/5th of the harvest for their work. The land owners often do not live in the villages and sell their share of produce after the harvest. Many farm workers prefer to work as day laborers on someone else's rice field in order to have a daily income and not having to bear the risk of managing a plot, including when harvests fail. (EI-03) Crop-based farmers are also affected by fluctuating prices and often depend on middlemen to sell their produce.

Rice farmers have experienced a shift in their traditional seed conservation strategy: For some years now, farmers have been buying the seeds for the next cropping season, mainly because bought seeds need less time to harvest (3-4 months) than traditional varieties (harvest after 5-6 months). Nevertheless, farmers report a lower quality of the harvest, increased necessity of pesticides and fertilizers. With the new varieties however, farmers are able to have two to three rice harvests per year, which due to longer maturation time was not possible with the old varieties. A rather new trend is to have crop rotation of two harvests of rice and one of horticulture per year in order to increase soil fertility.

Some farmers also comment on changing climate and precipitation patterns, according to which the dry season is longer and with even less precipitation than before. Due to the fact that much of the rice cultivation in Cidanau is rain-fed, this negatively affects rice production. Some farmers report of other villagers that transformed their rice-plot into *acacia* plantations due to these reasons. This trend has caused that the government protects paddy fields from investors and conversion into other land-uses. (EI-04)

The most common pests in this system include rats (*Rattus argentiventer*), snails *(Pomacea canaliculata L.)* as well as stem borers and tungro. Rice farmers use pesticides against stem borers and tungro, with a 'trial and error' method. New symptoms or pests are treated by farmers using the same method.

Figure 7: Rice and horticulture farmers on their plots in Kadebereum village. (Source: Own photo)

Interviewed farmers report average harvests of 2,400 to 8,000 kg of rice per hectare and prices of IDR 3,000 to IDR 4,000 per kilo in the month prior to the interviews. Horticulture crops include corn, cucumber, sweet potato, chilly, long beans and eggplant, which are either mono-cropped or mixed (see Figure 7). Most farmers work on their fields, but require additional work force and therefore hire workers, especially for land preparation, seeding, harvest and post-harvest. There is a strong gender-specificity of labor: While men are employed for hard physical work like land preparation, seeding and harvest is mostly carried out by women. Daily wages vary widely between the two and can be IDR 65,000 for men and IDR 20,000 for females per man day. Pesticide use in the rice/horticulture system in Cidanau is very common,

as is the use of fertilizers, which are mostly on a chemical basis. Tools used in this system are also mostly hand-held, muscle powered tools like sickles and hoes. However there are some farmers that use buffalos or tractors for land preparation before seeding, which then are rented. As mentioned earlier, most farmers now also purchase the seeds, this counts for rice as also for all other crops. Only one interviewee saved seeds from the last harvest for the next generation.

5.2 Net Benefits and Benefit/Cost Ratio

After giving a general overview of the three important agricultural production systems in Cidanau, this section focusses on their financial performance.

To allow for a better understanding of farmers cash incomes from farming, this research calculated the net per hectare income for three dominant farming systems in Cidanau. These results, the B/C ratio as well as an overview of major production inputs per hectare are summed up in Table 4. Net incomes are furthermore presented graphically in Figure 8.

Table 4: Overview of the major production inputs, net incomes and B/C ratio within the assessed farming systems. Values represent mean values with minima/maxima as well as mean values with standard deviation in brackets.

	Mel-PES	Mel-Non	Clo-PES	Clo-Non	Rice
Net Income	11,596,934 (±32,635,889)	17,271,349 (±27,397,556)	46,638,803 (±36,647,983)	111,823,532 (±108,417,217)	74,229,762 (±166,546,913)
Percentage PES of net income	(15%)		(3%)		
B/C Ratio	2.49 (±2.26)	3.39 (±3.88)	5.08 (±5.91)	6.81(±3.89)	4.06 (±7.45)
Labor	20,828,072 (1,040,000/ 38,760,000)	10,973,393 (3,000,000/ 19,257,143)	18,538,390 (6,125,000/ 50,050,000)	14,228,571 (3,090,000/ 28,370,000)	20,858,375 (6,680,000/ 43,225,000)
Pesticides	294,378 (0/ 2,500,000)	145,748 (0/ 900,000)	106,893 (0/ 400,000)	64,286 (0/ 324,000)	782,700 (0/ 6,600,000)
Fertilizer	110,733 (0/ 500,000)	76,444 (0/ 298,000)	547,564 (0/ 2,500,000)	127,143 (0/ 400,000)	3,282,500 (210,000/ 17,600,000)
Tools	403,870 (52,500/ 1,220,000)	245,934 (15,333/ 642,500)	135,789 (9,167/ 362,500)	160,306 (0/ 560,000)	669,413 (30,000/ 1,660,000)
Seeds	0	0	0	0	729,750 (0/ 2,030,000)

After having provided the AF data separated by dominant crop, AF samples are now combined to show the overall financial performance of AF and compare it to rice mono-cultivation. The data is presented in Figure 9, which shows a mean annual net income per hectare of IDR 41,148,869 (± IDR 65,963,533) for AF systems and IDR 74,228,762 (± IDR 166,546,914) for rice and horticulture systems. An independent-samples t-test was calculated to compare the two groups, yet showed no significant difference ($t(37)= -0.9$, $p = 0.374$).

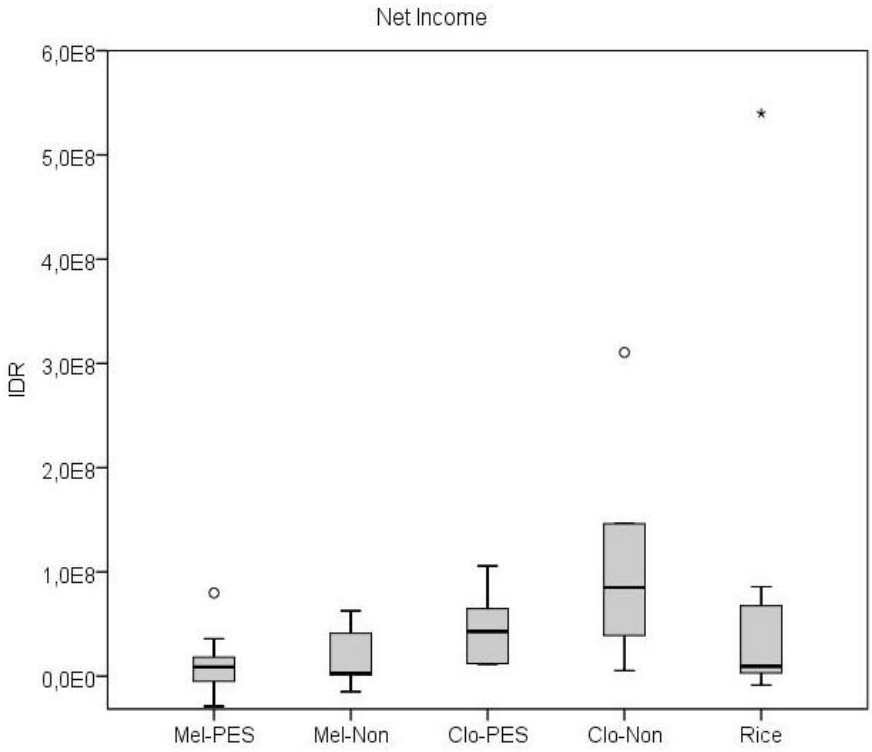

Figure 8: Net income from farming in the sampled groups: Mel-PES (n=9); Mel-Non (n=9); Clo-PES (n=6); Clo-Non (n=7); Rice (n=10).

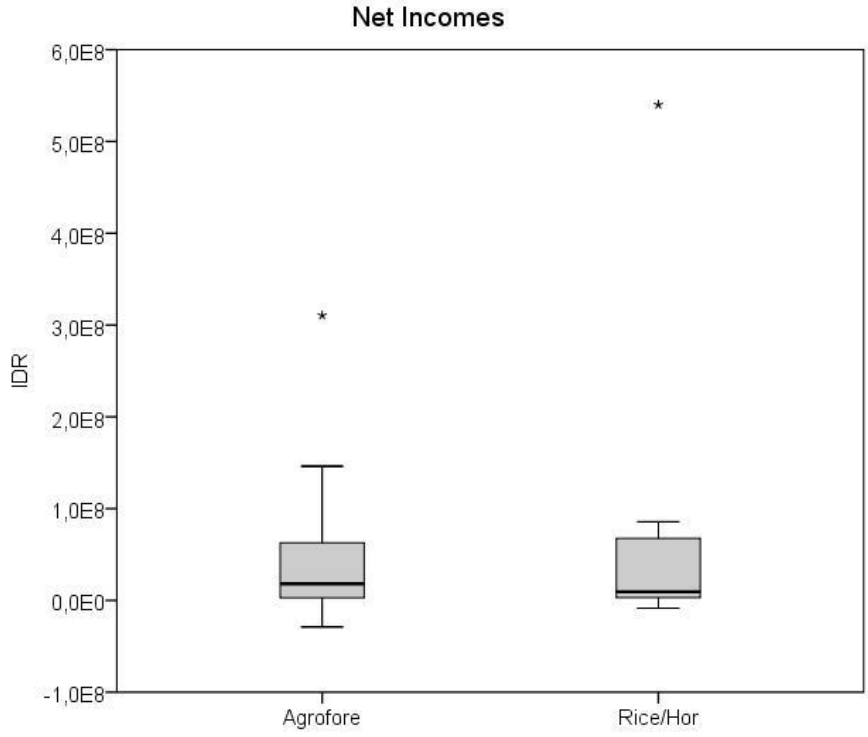

Figure 9: Net income from farming in two sampled groups: Agroforestry (n=29) and Rice/Horticulture (n=10). The independent-samples t-test showed no significant difference ($p > 0.05$).

6. Results – Nutrition Objectives

After having presented the results of the first objective of this master thesis, the following section presents the results for the second on. Starting with a socio-economic overview of sampled households, this chapter provides information on HDDS results, sources of and expenditures for consumed foods, as well as the HFIAS results. A final overview is provided before in the end.

6.1 Socio-economic household data

To evaluate food and nutrition security aspects in Cidanau, household questionnaires with women of farming households were carried out. In order to give a first general impression of the sampled households, this section presents the socio-economic background information from the three samples. Table 5 holds information on household size and composition, information about the education levels of different household members as also information on employment within the three sample groups. Data in the table present mean values and percentages with standard deviations in parenthesis. One-way ANOVAs were calculated for each aspect, and results are included in the table.

Table 5: Information on household composition obtained in the 'nutrition' questionnaires targeting women of the three study groups (TB-PES, n=34; TB, n=35; CB, n=35). Data shows mean number of household members and percentage of household members as well as standard deviations in parenthesis.

	PES-TB	TB	CB
Household size	4.6 (±1.6)	4.3 (±1.7)	4.4 (±1.6)
Adult men *	1.6 (±0.8)	1.3 (±0.5)	1.3 (±0.6)
Adult women	1.3 (±0.5)	1.3 (±0.5)	1.4 (±0.7)
Children (<18)	1.7 (±1.3)	1.5 (±1.1)	1.6 (±1.1)
Educated adult men	89% (±27%)	88% (±30%)	90% (±29%)

Primary School	53% (±45%)	58% (±46%)	58% (±46%)
Middle School	13% (±30%)	21% (±37%)	15% (±29%)
High School	19% (±33%)	8% (±25%)	17% (±36%)
Educated adult women	81% (±39%)	92% (±22%)	88% (±29%)
Primary School	60% (±46%)	70% (±44%)	63% (±44%)
Middle School	7% (±25%)	14% (±31%)	24% (±37%)
High School	9% (±23%)	5% (±19%)	1% (±8%)
Boys (6-17 y) enrolled/graduated	81% (±40%)	75% (±41%)	67% (±47%)
Primary School	63% (±47%)	74% (±44%)	51% (±50%)
Middle School	9% (±27%)	2% (±8%)	11% (±32%)
High School	9% (±20%)	0% (±0%)	0% (±0%)
Girls (6-17 y) enrolled/graduated	80% (±38%)	56% (±51%)*	88% (±33%)*
Primary School	63% (±46%)	39% (±50%)	66% (±46%)
Middle School	18% (±37%)	17% (±38%)	17% (±34%)
High School	0% (±0%)	0% (±0%)	6% (±24%)
Respondent's work information - Primary occupation			
Housewife	85%	89%	72%
Farmer	9%	3%	14%
Business owner	3%	6%	6%
Respondent's work information - Secondary occupation			
None	65%	60%	53%
Farmer	12%	11%	11%
Business owner	18%	20%	22%
Working household members†	83% (±19%)	88% (±21%)	83% (±16%)
Household members with off-farm employment† **	26% (±19%)	48% (±19%)	46% (±20%)
Household members that work as farm workers† **	1% (±9%)	14% (±25%)	22% (±33%)

†Refers to adult household members only, minors are not considered.

* Significant at p-value <0.05; ** Significant at p-value <0.01; *** Significant at p-value <0.001

As household incomes are difficult and time-consuming to assess, asset ownership was assessed instead. Table 6 shows the percentage of households that own the respective asset in the three study groups as well as the mean number of items and the standard deviation in brackets. The results were analyzed statistically (ANOVA), showing no significant differences of asset ownership between the three study groups.

Table 6: Information on household asset ownership obtained in the 'nutrition' questionnaires targeting women of the three study groups (TB-PES, n=34; TB, n=35; CB, n=35). Numbers represent the percentages of households owning the specific asset; the mean quantity owned and standard deviations are shown in parenthesis. Statistical analysis (ANOVA) showed no significant difference between the groups (p>0.05).

	PES-TB	TB	CB
Bicycle	13% (0.2 ±0.6)	33% (0.4 ±0.6)	35% (0.5 ±0.7)
Motorbike	40% (0.5 ±0.7)	81% (1.0 ±0.7)	68% (1.0 ±0.9)
Car	7% (0.1 ±0.3)	5% (0.0 ±0.2)	0% (0.0 ±0.0)
Television	87% (0.9 ±0.4)	90% (1.0 ±0.5)	90% (0.9 ±0.4)
Mobile phone	73% (1.3 ±1.0)	86% (1.9 ±1.6)	90% (1.7 ±1.0)
Bank account	13% (0.2 ±0.6)	10% (0.1 ±0.3)	19% (0.2 ±0.5)
Gas stove	80% (0.8 ±0.4)	71% (0.7 ±0.5)	84% (0.8 ±0.4)
Fridge	33% (0.3 ±0.5)	33% (0.4 ±0.6)	48% (0.5 ±0.5)
Laptop	7% (0.1 ±0.3)	10% (0.1 ±0.5)	3% (0.1 ±0.4)
Chicken	73% (5.0 ±5.9)	76% (5.8 ±7.0)	52% (3.8 ±5.4)
Sheep/Goat	27% (1.0 ±2.6)	14% (0.2 ±0.7)	6% (0.9 ±4.5)
Cattle	7% (0.1 ±0.5)	0% (0.0 ±0.0)	6% (0.1 ±0.4)

6.2 Dietary Diversity

One main objective of this research was the assessment of dietary diversity in three groups of smallholder households and according to the practiced farming system. For this, the HDDS for each assessed household was calculated (for further details see Chapter 4.2). The results are presented in this section.

A total of 127 food and drink items are mentioned to be eaten or drunk at least once throughout the three sample groups the day prior to sampling. On average, tree-based PES households consume 17.3 (±4.5) items, while tree-based households consume 16.6 (±6.7) and crop-based households 18.8 (±6.1) items. A one-way analysis of variance (ANOVA) shows no significance between the datasets ($F(2,102) = 0.824$; $p = 0.442$). From this information and based on the 18 food groups described above the HDDS was calculated. The results are demonstrated in Figure 10. PES-TB households has a mean HDDS of 9.09 (± 2.27), TB households of 9.06 (± 2.2), and CB households of 9.39 (± 2.03). The One-Way ANOVA shows no significant results in the statistical analysis ($F(2,102) = 0.254$; $p = 0.776$).

In order to get a better overview of local food consumption patterns, food consumption data were further assessed. The share of households within each sample that consumed the specific food group is presented in Figure 11. Most households consume spices, drink ingredients, oils and fats as well as vegetables and rice. Very few households consume fried chips, noodles, milk, eggs, meat, fresh fish as well as roots and tubers.

One expert interview stated that households that participate in the PES scheme have changed their consumption patterns due to higher purchase power and are now able to eat meat more regularly. (EI-02)

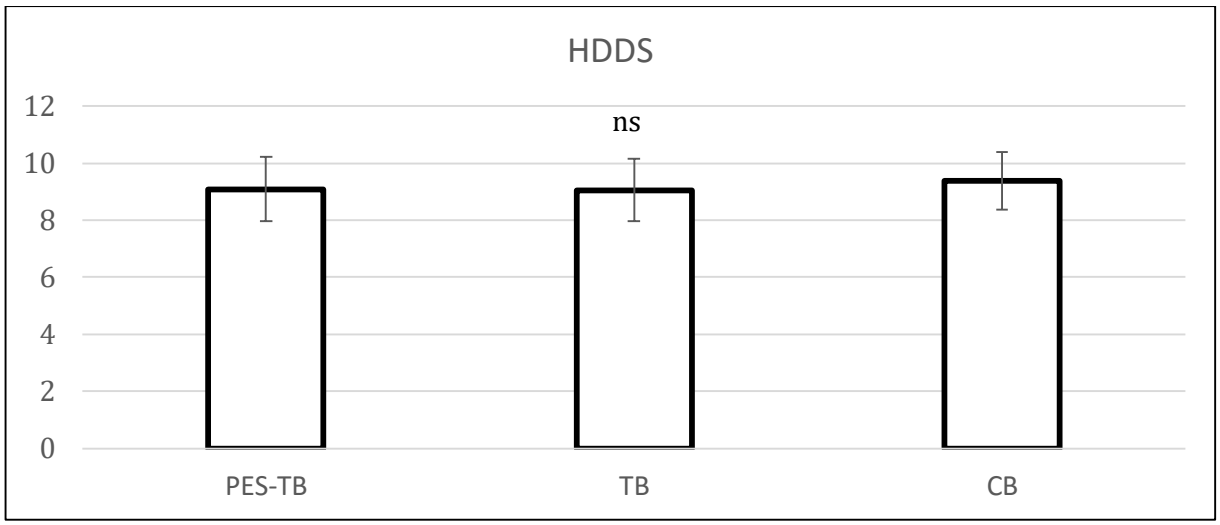

Figure 10: Mean HDDS based on 18 food groups in the three study groups: TB-PES, n=34; TB, n=35; CB, n=35. Statistical analysis (ANOVA) showed no significant differences between the three groups (*p*>0.05).

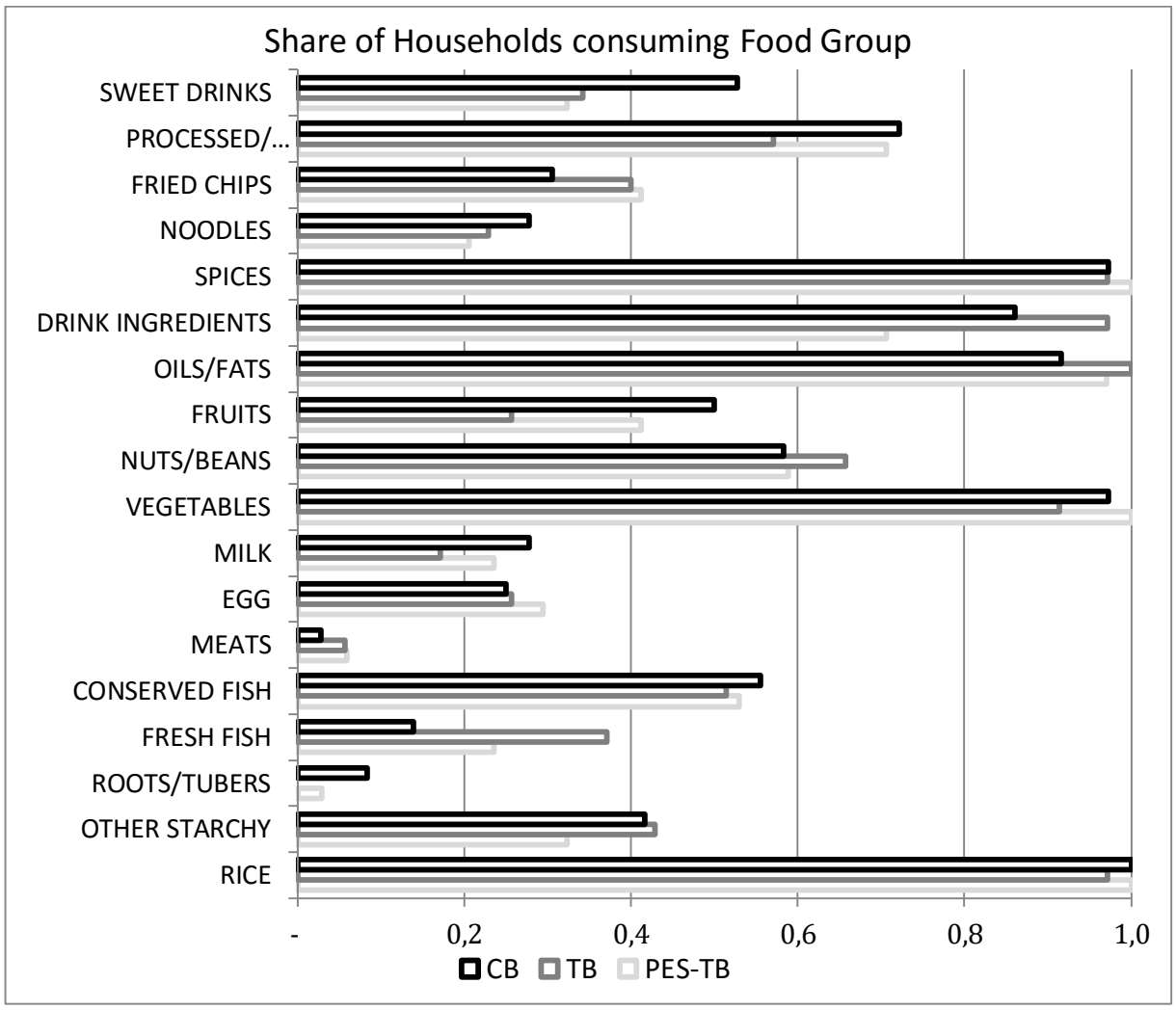

Figure 11: Share of households within each study group that consumed respective food groups.

6.3 Source of Consumed Items

Within the 24-hour recall, households were asked to specify the source of their consumed items, whereby the focus was placed on items from own production, items that were purchased by the households as well as items that were exchanged for labor or gifts from friends or neighbors. Figure 12 demonstrates the results.

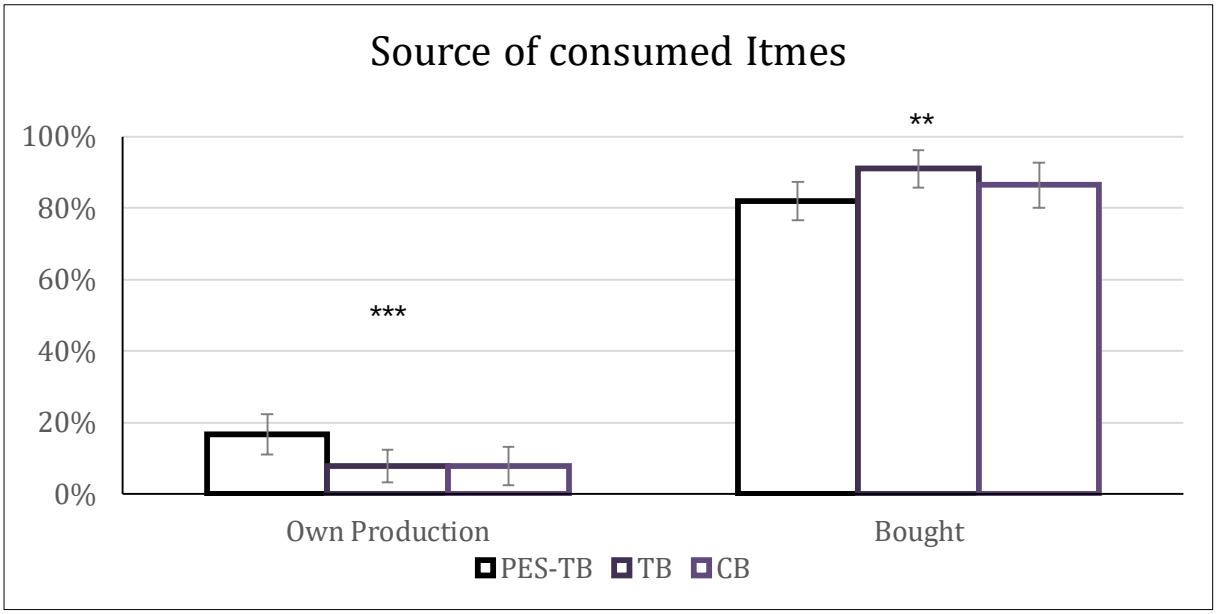

Figure 12: Mean percentage of food and drink items from own production and bought in the three study groups: TB-PES, n=34; TB, n=35; CB, n=35. Statistical analysis (ANOVA) showed a highly significant difference of the mean values of own production (p<0.001), as well a significant difference between the mean values of bought items (p=0.005).

Mean percentages of items that are produced by the households themselves are 17% (±11%) in the PES-TB group, 8% (±9%) in the TB group and 8% (±11%) in the CB group. The statistical analysis of these results shows a highly significant difference (ANOVA $F(2,102)=8.821$; $p<0.000$), more specifically between PES-TB and TB ($p<0.000$) and PES-TB and CB ($p<0.000$) using Fisher's least significant difference (LSD) test. Mean percentages of items that are purchased by the households are 82% (±11%) in the PES-TB group, 91% (±10%) in the TB group and 86% (±13%) in the CB group. The statistical analysis of these results using a One-Way ANOVA

shows a significant difference ($F(2,102)=5.653$; $p=0.05$), more specifically, a high significance between PES-TB and TB ($p=0.001$) probing with Fisher's LSD test. The mean share of items that were exchanged for labor or gifts from friends and families is negligible in the three study groups and was therefore excluded from the analysis.

6.3.1 Forest Products

In addition to asking participants to specify the source of consumed items, the general use of forest products was assessed. Participants were asked if and how often they gather non-timber forest products in the natural forest (not AF plots) and then were asked to specify. 9% of PES-TB as well as TB households harvest forest products, all mentioning firewood. In the CB group, this number is 3% (see Table 7).

Table 7: Information on harvesting of forest products obtained in the 'nutrition' questionnaires targeting women of the three study groups (TB-PES, n=34; TB, n=35; CB, n=35). Data shows shares of households that harvest forest products.

	PES-TB	TB	CB
Share of HH that harvest forest products	0.09	0.09	0.03
Harvested products	Firewood	Firewood	Firewood, Fruit

6.4 Household Food Expenditures

The household questionnaires furthermore included question about weekly household expenditures for consumer goods like foods and cigarettes. Also here, all information is presented for above mentioned reason, that main beneficiaries are research partners in Indonesia. The results are demonstrated in Figure 13. Tree-based PES households spend on average IDR 507,386 (± IDR 419,871) per week for food and drinks, while tree-based households spend IDR 370,036 (± IDR 155,047) and crop-

based households IDR 414,682 (± IDR 229,911) per week. A one-way ANOVA was calculated for these values. The analysis was not significant ($F(2,102)=2.03$; $p=0.136$).

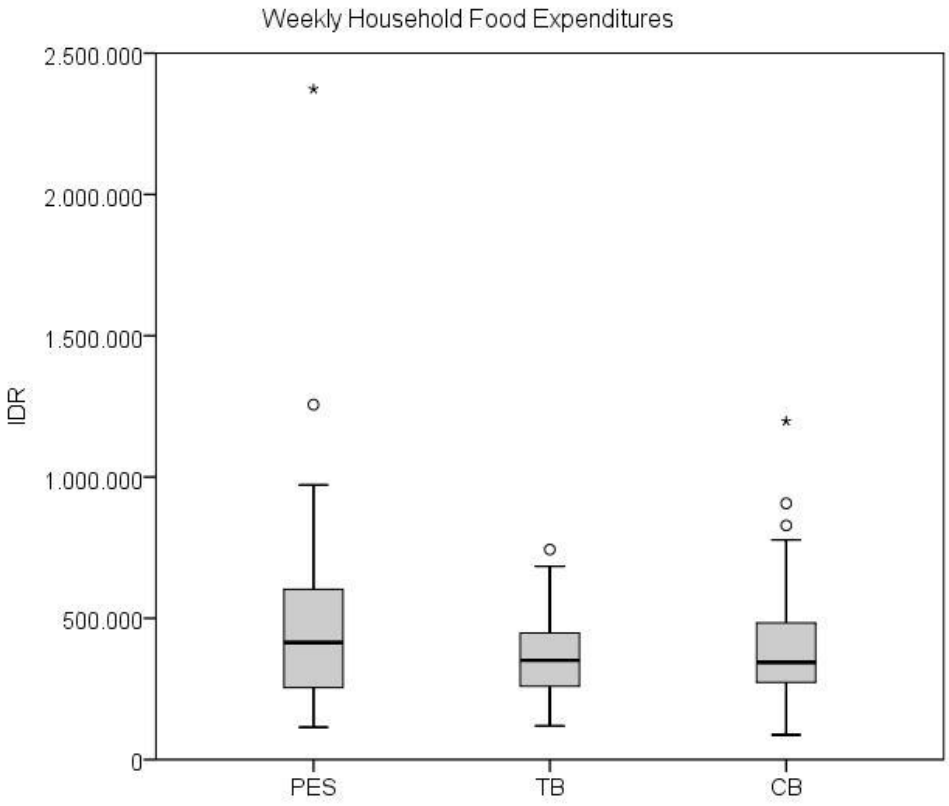

Figure 13: Mean weekly household expenditure for foods in the three study groups: TB-PES, n=34; TB, n=35; CB, n=35. Statistical analysis (One-Way ANOVA) showed no significant differences between the groups (*p>0.05*).

After dividing household weekly expenditures for five major food groups, the results are represented in Figure 14. PES tree-based households on average spend more than the TB group and the CB group on staple foods (IDR 144,901 (±IDR 113,575); IDR 113,063 (±IDR 62,403); IDR 109,139 (±IDR 92,351) respectively), animal products (IDR 89,824 (±IDR 82,127); IDR 52,105 (±IDR 35,366); IDR 58,951 (±IDR 39,335) respectively), fruits and vegetables (IDR 43,749 (±IDR 33,133); IDR 37,036 (±IDR 28,062); IDR 43,271 (±IDR 29,861) respectively) as well as processed foods and drinks (IDR 212,582 (±IDR 281,040); IDR 150,246 (±IDR 85,930); IDR 184,147

(±IDR 171,975) respectively), however a statistical significance only exists with animal products (ANOVA, $F(2,102) = 4.44$, $p = 0.014$). For the food group 'legumes', the data for the three groups is as follows: IDR 16,331 (±IDR 12,887) in the PES-TB group, IDR 17,586 (±IDR 14,781) in the TB group, and IDR 19,174 (±IDR 14,547) in the CB group, with no statistically significant difference (ANOVA, $F(2,102) = 0.357$, $p = 0.7$).

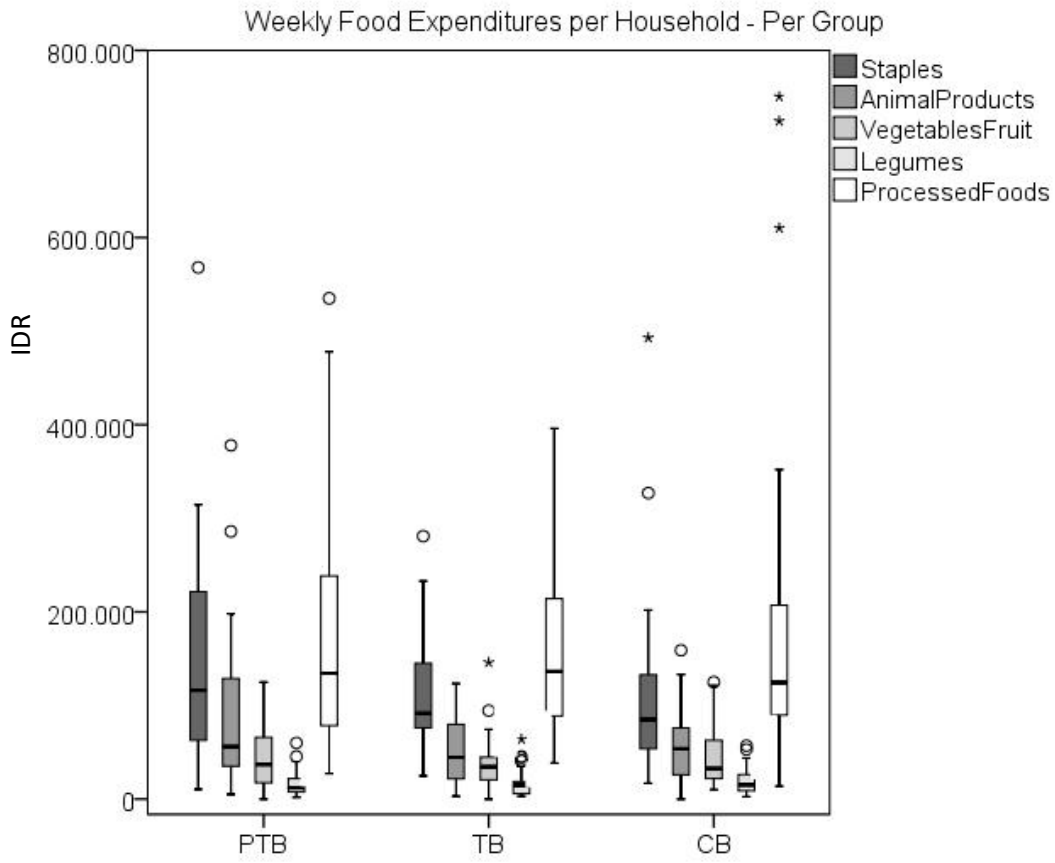

Figure 14: Mean of weekly household expenditures for different food groups in the three study groups: TB-PES, n=34; TB, n=35; CB, n=35. Statistical analysis (ANOVA) showed a significant difference between the expenditures for animal products (p=0.014), yet no significant results for the other food groups (p>0.05).

6.4.1 Expenditures for cigarettes

At this point, the results of a spontaneous addition to the questionnaire are presented as a short discourse about household expenditures for cigarettes. Table 8 gives an overview of the number of smoking household members, their share within the household as well as the gender distribution of smoking household members.

The mean number of smoking household members as well as the mean weekly household expenditures for cigarettes are not significantly different between the three sampled groups. One-way analyses of variance show the following results: $F(2,102) = 2.009$, $p > 0.05$ and $F(2,102) = 0.413$, $p = 0.663$ respectively. Expenditures for cigarettes and tobaccos in tree-based PES households represent 27% of the expenditures for food and drinks, 30% in tree-based households and 29% in crop-based households.

Table 8: Information on smoking behavior obtained in the 'nutrition' questionnaires targeting women of the three study groups (TB-PES, n=34; TB, n=35; CB, n=35). Data shows mean number and standard deviation in parenthesis.

	PES-TB	TB	CB
Mean number of smoking HH members	1.32 (±0.88)	1.11 (±0.76)	1.00 (±0.63)
Share of smoking HH members	0.31	0.26	0.23
Share of HH with only male smokers	0.85	0.71	0.78
Share of HH with only female smokers	0.0	0.6	0.3
Share of HH with both genders smoking	0.3	0.6	0.3
Weekly household expenditures for cigarettes	IDR 137,353 (±IDR 121,864)	IDR 110,914 (±IDR 94,679)	IDR 119,528 (±IDR 146,561)

6.5 Food Insecurity

Finally, the household questionnaire also included a part about food insecurity, with special focus on the '*access*' dimension (for details refer to Chapter 4.2). The results for these questions are demonstrated in Table 9, which shows the percentage of households within each study group that affirm the respective question for a time-frame of four weeks prior to survey.

Table 9: Results of 7 food insecurity questions based on Coates et al. (2007) for the three study groups: TB-PES, n=34; TB, n=35; CB, n=35. The percentage with which households responded affirmatively to a question is represented. ANOVA showed no significance (p>0.05).

In the past four weeks…	PES-TB	TB	CB
1. … did you or any member of your household worry that you would not have enough food?			
YES	50%	69%	69%
2. … were you or any member of your household not able to eat the kinds of foods you preferred?			
YES	56%	57%	58%
3. … did you or any member of your household eat some foods that you really did not want to eat because of lack of resources to obtain others?			
YES	15%	23%	14%
4. … did you or any member of your household have to eat fewer meals in a day because there was not enough food?			
YES	3%	11%	14%
5. … was there ever no food to eat of any kind because of lack of financial resources to get food?			
YES	12%	3%	6%
6. … did you or any member of your household go to sleep at night hungry because there was not enough food?			
YES	15%	17%	14%
7. … did you or any member of your household go a whole day and night without eating because there was no food?			
YES	3%	-	-

At this point, the author would like to highlight that for some questions the respondents were asked for further aspects: in addition to the frequency with which the household experiences the given event, contestants were asked about which household member felt the event most and which type of resources were missing (financial, market availability etc.). In general, respondents across all three groups named their children as those household members that want to eat different foods (especially chicken, meat and snacks).

Based on the results above, the Household Food Insecurity Access Scale (HFIAS) for each household was calculated and the results categorized into four food insecurity levels. The findings are summarized in Table 10. A one-way analysis of variance (ANOVA) showed no significant differences ($F(2,102) = 0.79$; $p = 0.46$).

Table 10: Results of the Household Food Insecurity Access Scale and Food Insecurity levels for the three study groups: TB-PES, n=34; TB, n=35; CB, n=35. Numbers represent mean values as well as percentages with standard deviation in brackets. ANOVA showed no significant difference between the study groups (p>0.05).

	PES-TB	TB	CB
HFIAS	3.2 (±3.8)	3.9 (±3.4)	4.3 (±3.7)
Food Secure	38%	26%	31%
Mildly Food Insecure	32%	37%	36%
Moderately Food Insecure	21%	17%	11%
Severely Food Insecure	9%	20%	22%

6.6 Overall Nutrition Results

While until now all indicators were assessed according to the farming system and households' participation or non-participation in the PES, this last part of this chapter looks at general influences and trends. With the information gathered from all

households across the three study groups, some correlations regarding food insecurity can be identified (Table 11).

Table 11: Pearson correlations between HFIAS and selected socio-economic and DD indicators (n = 105)

	R	*p*
HDDS	- 0.214	0.028
Food Expenditures	- 0.264	0.007
Paternal Education	- 0.268	0.006
Maternal Education	- 0.203	0.038

7. Analysis and Discussion

This thesis studies the profitability of the three most dominant farming systems in Cidanau under their current management in order to analyze if AF farming is a viable option for smallholder farmers. In addition, dietary diversity and food security (access) are assessed in local households in order to draw conclusions on the influence of the farming system as well as cash income on food and nutrition security. Finally, the influence of the PES scheme on both profitability as well as food and nutrition security are evaluated. The upcoming chapter takes up the results presented above, sets them into perspective, combines findings and discusses them. First, findings respecting the profitability objectives are discussed, followed by the analysis of the food and nutrition security objectives. Finally, this paper tries to combine the findings from both objectives under the aspects of influences of the PES scheme on the assessed socio-economic factors.

7.1 Analysis of Profitability Results

As mentioned above, this thesis assessed profitability in different farming systems in Cidanau to obtain information about farmers' management decisions and cash income for households from farming. Before going in further detail, the author would like to point out the extreme variability of the gathered information. It appears that farms and management practices in Cidanau are highly heterogeneous and farmers do not follow a 'farming blueprint', but much more rely on experience as well as trial and error.

Net Income and B/C Ratio

Net incomes were calculated in this thesis to gain knowledge about smallholders' incomes from farming. The results demonstrate great differences between farmers

within the same farming system. While some farmers manage their land with relatively high profit per ha, others have negative net incomes. Additionally, results show that AF systems in general can be profitable land-use options if managed well. Furthermore, results display that households that participate in the PES scheme do not manage their plots with higher profitability than non-participants, despite greater social capital and interaction with diverse stakeholders, including from governmental side.

In absolute terms, clove-based AF systems perform better than rice/horticulture systems as well as *melinjo*-based AF. Within both AF system, those farmers that are not part of the PES scheme perform better than those that are. Especially the substantial difference within the clove-based system is striking, as the management is quite similar in terms of prices received for produce as well as most inputs. Merely labor costs are higher in the PES group, resulting in this divergence. Rice/horticulture cultivation has comparatively high returns as well, nonetheless is also quite input intensive. It requires high financial inputs for labor, agro-chemicals, tools as well as seeds. Additionally, the rice prices are comparatively low. Those paddy farmers with the best performance receive their high returns from the cultivation of vegetables, hence income from different produce. The one rice farmer with exceptionally high profitability is the only sampled farmer that included chilly into his production system, which has very high returns. Returns for other vegetables like cucumber and sweet potato are not as high, however do contribute to the overall profitability of the system. Net incomes are lowest in the PES participant *melinjo*-based AF group, where profitability for some farmers is even negative. This indicates that farmers have no cash returns from farming with their current management.

In relative terms, this trend is repeated. The B/C ratio for clove-based systems is highest as they were able to yield the highest returns per investment unit. In accordance with decreasing net benefits, also the B/C ratio decreases in rice/horticulture as well as *melinjo*-based AF.

When combining all AF systems in order to jointly compare their economic performance to rice mono-cropping systems, the mean results shift slightly in favor of

rice cultivation. The variability of net incomes from AF however is very high, while the range of returns for rice cultivation much more narrow. However, AF farmers mostly produce non-food cash-crops of which most is sold, while rice farmers keep most of their harvest for household consumption. Therefore rice farmers do not actually have cash incomes from their plots, rather 'rice incomes'. Those 'rice incomes' mostly do not include the whole harvest, as many rice farmers lease their plots and receive only a share of the produce. Therefore despite being slightly more profitable than AF systems, the benefits from rice system do not all go to smallholder farmers managing the land.

The net benefits calculations for both PES AF systems already include the compensation payments from the PES mechanism. The share of these payments of the entire cash income for farmers however are very low (15% in Mel-PES and 3% in Clo-PES). This, in addition to the fact that many recipients spend much of the PES income for social or religious purposes suggest that economic benefits from participating in the PES cannot be the sole reason for joining. This conclusion goes hand in hand with the findings of Lapeyre et al. (2015).

The findings of the profitability analysis however stand in contrast to comments in EI-02, where it was mentioned that AF farmers that joined the PES first started to actively manage their lands, while management was rather random before. Farmers would 'wildly' plant trees without considering distances, light or other factors and leave them to nature, before eventually having some benefits from them. The results of the KIIs do not support this comment and even contradict it, as non-PES AF farmers appear to have a more profitable management.

As indicated above, the results from some KII indicate that the net benefits for some farmers reach below zero. This holds true with highest frequency for Mel-PES farmers (six out of nine KII). Net incomes were negative for those farmers when valuing family labor at the same cost of hired labor, not however when this labor is not valued. Considering that unemployment in Banten province is relatively high (10% in 2013 and the highest nationwide; Dewan Ketahanan Pangan et al., 2015) and that off-farm employment opportunities in the area are limited, it can be argued whether family

labor should be included into the analysis, as farmers' opportunity costs are low or equal to zero. Bearing this in mind, net incomes for all smallholders in Cidanau would result in higher values if family labor was not accounted equally to hired labor.

The results from this analysis might furthermore be an underrepresentation of the AF performance, as the benefits these systems receive from timber trees are not included. The profitability analysis in this work focusses only on regular cash incomes. Revenues from timber are punctual, non-regular and serve as a source of fast cash when it is needed, and is therefore not included here. Also non-timber forest products like medicinal plants or wild meats, which some households harvest on AF plots, are not included in this calculation.

Finally, profitability results of all systems strongly depend on market prices for their respective produce. Rice farmers benefit from relatively stable and even increasing rice prices since 2008 (BPS b) and also have relatively high returns for horticulture products. As Indonesia plans to keep up their rice self-sufficiency, rice farmers have can expect a continuation of this trend in prices. *Melinjo* farmers perform low also due to relatively low prices for *melinjo* fruits. Clove farmers on the other hand side also benefit from high prices for this spice. Historically nonetheless, there have been strong fluctuations of clove prices. Clove prices are probably tightly linked to tobacco prices and smoking habits in Indonesia, as most clove is used for *kretek*[4] production and therefore sold on domestic markets. Efforts to reduce smoking in Indonesia would therefore highly impact clove revenues and farmers' livelihoods. Compared to international markets, Indonesian clove farmers are not competitive, which further demonstrates their strong dependency on local consumption. (Keyser & Juita, 2005) If the Indonesian government lowered trade restrictions for clove and prices dropped, the current profitability of clove AF systems would decrease with it. A risk assessment including these scenarios could highlight the vulnerability of clove AF systems in terms of profitability.

In addition to market fluctuations, farmers also face the 'arbitrariness' of the middlemen, which appear to take advantage of farmers' remoteness. With farmers'

[4] *Kretek* is a scented cigarette, containing high amounts of clove in addition to tobacco.

dependency on cash advances however, it might be difficult to change their power. While this middlemen connect farmers to the markets, which might be far away and difficult to reach for farmers, the question arises if smallholders would not be better off if they sold directly at the markets or to wholesalers. This dilemma is no rarity in developing countries (Abebe et al., 2016), however farmers could increase their profits if they found ways to either empower their position in price negotiations with middlemen or organize as farmer groups and skip the intermediary.

Nonetheless, this research was able to demonstrate that AF, provided certain conditions are met, can be a viable farming opportunity for smallholders in Cidanau. This finding adds to the literature of cases, where diverse and environmentally sustainable production systems are financially competitive to less diverse and more harmful systems. Furthermore, in AF systems as well as in rice/horticulture systems, some farmers manage their plots with high returns. This gives reason to believe that there is still high potential within both types to increase farming profitability. Farmers need to be introduced to high-value crops that might currently be out of their focus or they simply lack the knowledge of how to cultivate them. However the question arises if high-value crops, which often require more labor input, are suitable for Cidanau. This is due to the fact that the area is facing an outflow of young people. Therefore farmers have to find their own ways to introduce high-value crops into their systems that are manageable within their available time and workforce.

Based on the results of this research it can be concluded that AF systems are definitely competitive land-use systems in Cidanau compared to rice-monocropping and horticulture systems. This however highly depends on numerous factors like crop composition and (fluctuating) prices for farmers' produce.

Productivity

In addition to profitability and with the intention of providing a more complete impression of agriculture in Cidanau, this thesis furthermore discusses farming system productivity.

Official numbers report a rice productivity in Banten province of around 2,800 kg ha^{-1} (2015) (BPS d). Average productivity of sampled farmers in Cidanau is around 2,100 kg ha^{-1}. This demonstrates that local harvests are well below provincial average, despite the fact that that farmers use input intensive new rice varieties with higher yields. Farmers however have little experience with these varieties and in order to fight pests and provide nutrients, they invest in expensive chemicals and often use them without respecting the guidelines. Therefore improved irrigation infrastructure, knowledge of pest management as well as crop management might be able to close that gap. *Tungro*-resistant rice varieties are available in Indonesia (IRRI) and as most rice farmers already buy their seeds, purchasing these varieties might be an easy option to decrease losses from this virus, which is typical in Cidanau. Furthermore, when looking at rice cultivation across the landscape, plots in every stage of the cropping cycle can be found at the same time. If farmers synchronized their cropping cycles they might be able to prevent the continuous infection of pests and diseases throughout the landscape. Rice intensification techniques might furthermore help rice farmers to increase their harvests and decrease production expenditures. Furthermore, Indonesia is prone to natural disasters, which often result in harvest losses. In 2013 for example, Banten province was among the provinces with the highest damages to paddy fields due to floods, droughts as well as pest infestations (Dewan Ketahanan Pangan et al, 2015). This demonstrates that in order to increase productivity, those meteorological risks as well as pests should be taken seriously and targeted in order to ensure a stable production and therefore incomes for farmers.

The comparison of AF productivity per hectare is not an easy task, as little research has been carried out in Indonesia as also it is difficult to generalize from such highly diverse systems. Nonetheless there is some information about the per tree productivity. Mean annual productions of up to 10.3 kg $tree^{-1}$ are mentioned by Verheij & Snijders (1999). These numbers are higher in Cidanau, where based on data from clove-based AF farmers per tree production in peak years is 14.3 kg. The mentioned source is already quite old, which might contribute to this difference.

However, Verheij & Snijders also highlight the high yield variability between trees as well as between years.

Regarding *melinjo* yields, reported productivity per tree reaches up to 80 to 100 kg fruit tree^{-1} (Orwa et al., 2009). Sampled *melinjo*-based AF farmers however have average maximum yields of merely 13.5 kg tree^{-1}. Reasons for this gap might be the relatively low production inputs as well as the mentioned lack of pest management.

Farmers of AF systems in Cidanau obviously face the dilemma of maintaining their high diversity to avoid risks or specializing on less crops to increase productivity. The latter is recommended from local agricultural entities (EI-04), however knowledge and assistance for this transition is not being provided as extension officers are rare.

Increasing farm productivity would not only be beneficial for farmers' livelihoods. It would furthermore increase the production of foods and therefore contribute to local food security. In addition, this would furthermore decrease pressure on the natural forest areas in Cidanau, as farmers were able to live off their lands without having to expand the agricultural frontier to increase their incomes. This in turn would highly benefit conservation efforts in the area.

In general, AF systems including tree crops (except for oil palm) are not a governmental priority. Priority crops are those that sustain national food sovereignty and/or have high economic importance. Crops like *melinjo*, stink bean and cocoa do not fall into that category and therefore little is invested in research to improve those crops as also increase management knowledge aiming at higher yields. This consequently also results in limited extension services from local governments for AF farmers, which visit and consult rice farmers with much higher frequency. This perspective, coupled with the non-appreciation of more than a handful of crops, which might highly impact farmers' livelihoods, is currently holding back countless farmers in their progress.

Further findings

A striking observation in Cidanau was the great number of young people that have no official occupation and often live with their families and are maintained by them, an observation which matches the comment in EI-01. Given the relatively low incomes families have through farming, it is striking that their children seldom join in farming activities to make better use of the land they own or lease and this way contribute to households' incomes. This however might also be due to the fact that farming as an occupation is regarded a 'low' job with no recognition. Farmers prefer that their children leave the villages to work in the cities even though it is a low-paying, low-quality job, and often they do not even know what their children do. As in a setting like the Indonesian village, where social cohesion, but also social control, is so important, the family's reputation is at stake. (EI-03)

7.2 Analysis of Food and Nutrition Security Results

In order to analyze whether the second objective of this research can be confirmed, dietary diversity as well as food security in the access dimension was assessed. For this, questionnaires were carried out which targeted women of farming households as described in Chapter 4.2. The results are now used to draw conclusions on household food and nutrition security.

The first part of the questionnaire obtained extensive background information about the household. Comparing these, the three sample groups look quite homogeneous. This applies for the household size and composition, the education levels of adults, as well as occupation of the responding women, who in all three groups mostly work as housewives, with no secondary occupation. The education levels of girls however vary significantly, with comparatively low percentages in the TB group. The share of adult household members with off-farm income is significantly higher in the TB group as well as in the CB group. The PES-TB group has a significantly lower share of family members that work as farm workers on other plots. Asset ownership is also

similar in the three study groups, suggesting a similar distribution of wealth among the three sample groups.

Dietary Diversity

The number of food groups consumed per household offers a quantifiable measure of this households' access to food. Generally, higher DD reveals an increasing adequacy of a household's diet. Until now, numerous studies have assessed the influence of farming systems on household food and nutrition security, none however has assessed the influence of PES schemes on smallholders DD.

The HDDS in the three study groups is similar: 9.1 (PES-TB), 9.1 (TB) and 9.4 (CB) with no significant difference. This means that from 18 food groups, households across the sample on average eat 9, suggesting a moderate DD. 'Spices', 'drink ingredients', 'fats', 'vegetables' and 'rice' are food groups that dominate households' diets in all study groups. It is important to note that the used classification includes chilly, onion and garlic in the 'vegetable' group, which are important ingredients for *sambal*, a spicy sauce eaten on a daily basis. Those three ingredients are often the only vegetables consumed by households. Other classifications assign those foods to 'spices' rather than to 'vegetables', or even leave them out entirely as the consumed quantities are low. Considering this classification in the present research would shift the graph (Figure 11) towards less vegetable consumption. 'Roots and tubers' as well as 'meat' are the food groups consumed by the least amount of households in all three groups. The first is most likely due to culturally rooted consumption patterns, as people from Java eat rice with every meal and very little other starchy foods to satisfy their energy demand. The low meat consumption is probably due to the higher prices (1kg chicken = IDR 34,534.5; 1 kg beef = IDR 93,043.8 (2014 prices; BPS a) compared to 1kg rice = IDR 9,278 (2014 prices, BPS b). Following this logic, it is astonishing that 'processed/prepared foods' have comparatively high shares of consumption, despite also being relatively expensive. Considering the distribution of foods consumed by households within the three sample groups it becomes clear that there are similar food consumption patterns. Nonetheless, the observations of the

director of *Rekonvasi Bhumi*, who states that PES participants now eat more meat than before, can be verified in this research.

But how to interpret the HDDS and classify DD as low or high when each is highly context-specific and has no well-defined scoring systems and cutoff-points? For this, a literature review was conducted in search of other studies that used the HDDS in Southeast Asian context and verified the cutoff-points with nutrition statuses of respondents. Baliwati et al. (2015) is one example of found researchers applying exactly this approach. Hence, the study used a total of 12 food groups and classified the consumption of <5 food groups (42%) as low DD, of 6 to 8 food groups (67%) as moderate DD, and of more than 9 food groups (75%) as high DD. Using these percentage values, the food groups for each category were calculated for this thesis with a total of 18 food groups. HDDS of the three study groups were then grouped accordingly. The results are presented in the following table.

Table 12: HDDS cutoff points for low, moderate and high dietary diversity and share of households in each sample in the respective classification. ANOVA showed no significant results (p>0.05).

	Food Groups	PES-TB	TB	CB
Low	0 to 7	26%	26%	14%
Moderate	8 to 12	68%	71%	83%
High	13 to 28	6%	3%	3%

As established above, a household's DD and nutrition status correlate. By classifying the HDDS values into three DD levels it is possible to draw conclusions about the nutrition status of the households. The results presented in the table above indicate that nutrition statuses of very few households are high (adequate), of most households moderate, and of still a large share of households low. From this, it can be concluded that nutrition security in Cidanau still represents a respectable problem.

In addition to the HDDS values, the conversion into DD levels also shows no significant difference between the samples. All in all and in contrast to the hypothesis

of this research, it can be said that there is no obvious and direct correlation between the farming system and the DD of farming households.

Another striking finding is the relatively high consumption of processed and prepared products, especially compared to food groups like fruits. Processed, starchy foods are comparatively cheap and filling. Therefore households with limited financial resources rather chose to purchase those instead of more expensive, but healthier food choices like fruit, vegetables and animal products. Furthermore, knowledge about healthy food and eating habits might be limited, which might represent another reason for such food preference. As mentioned before, Indonesia is experiencing a rising trend to purchase prepared meals in food stalls (Nurbani, 2015), which often also include fried foods (like *gorengan*). Obtained data however also show relatively high consumptions of snacks like cakes, cookies and ice cream. These findings have been described before (Sekiyama et al., 2012) and further demonstrate the shift in Indonesian food consumption patterns, on the one hand side towards a more 'westernized' diet which might include processed and fast foods. Markets and small shops in Cidanau watershed offer a great variety of fruits and vegetables as well as chicken, so the reason for the low consumption cannot be explained by a lack of availability. Additionally, all markets and small shops also offer a great variety of snacks. And although there are no big fast-food chains present in the watershed, advertisements for snacks were found even in the furthest village. The high percentage of children that would like to eat more snacks are evidence of these trends. Soft drinks on the other hand are not common in Cidanau, as sugary tea is served traditionally. On the other hand side, Indonesians are also increasingly becoming concerned with healthy diets, for example shifting towards a diet with red or whole grain rice instead of white rice, a phenomenon, which, for financial reasons, is a privilege of few. In terms of access to foods, the general trends as well as the results of this research suggest that Indonesians are able to access a great variety of foods, including snacks and processed foods, and even in highly remote areas. It is arguable though if this increased availability and accessibility of rather 'unhealthy' foods represents a progress. Nevertheless, if only a small change in eating habits, like eating the easily available and cheap whole grain rice instead of white rice,

occurred in Indonesia, some micronutrient deficiencies might be easier to tackle than thought.

Source of Foods

In order to assess the influence of the farming system on food and nutrition security, respondents were asked to give information on the source of food items named in the 24-hour recall. While no clear connection between the land-use and the DD was found, there is however some interesting difference in the source of consumed foods. Of all the stated foods consumed the day prior to sampling, PES-TB households consume highly significantly higher amounts of foods from own production, nevertheless still a very low share. When zooming in, this includes especially the groups ‘staples’ and ‘fruits and vegetables’. The source of other food groups is similar among the three samples. Food gathered from the natural forest areas is not important for the diet of any sample group.

Other than expected prior to this research, there is very little difference between food sources in tree-based and crop-based households. This study assumes that AF systems have higher agrobiodiversity than rice/horticulture systems, and theoretically (see Chapter 2.4) high agrobiodiversity increases food and nutrition security within smallholder households. But, as demonstrated above, the more diverse AF systems do not directly contribute to higher DD, and it now becomes clear why this is: All three sample groups highly rely on markets for their access to (diverse) foods, instead of consuming produce from their land. This finding goes along with the comment that AF systems produce with high market-orientation (EX-04).

One explanation for this finding might be the seasonality of certain fruit trees. Therefore it is possible that AF systems have much higher shares of consumed foods from own production in times when certain fruits are ripe.

Nonetheless, and sustainability of the given situation in Cidanau, where some villages have highly remote settings and connecting infrastructure is in desolate conditions, this high dependency on markets both for selling their produce as well as purchasing foods is questionable. Farmers could decrease their food expenditures, decrease

dependency on markets, increase DD and therefore nutrition statuses, if they increased the amount and share of foods from own production. This increased self-sufficiency would furthermore decrease households' vulnerability to market failures and price fluctuations. With some training and increased knowledge, farmers could increasingly incorporate foods that have high prices and are therefore rarely consumed, like chicken or goats. Possibilities to incorporate these food crops in existing management include the understory of the agroforestry plots, between rice plots as well as through a better use of homegardens. Until now, most families do not or to a very limited extent use the area around their houses to cultivate spices, fruits and vegetables. An increasing use of homegardens would also include women in the responsibility of providing food for the family, however in order to reach this point, awareness of nutrition issues as well as knowledge of how to manage a homegarden must be disseminated.

Expenditures for Food

Household expenditures for food are strongly linked to food security in the access dimension. Findings from the household survey indicate that PES-TB households have higher mean food expenditures per week (IDR 507,386) than TB (IDR 370,036), and CB households (IDR 414,682). In order to compare them to national averages, this research converted these values in monthly per capita expenditures, which are available for rural Indonesia and amount IDR 336,738 (2014 data; BPS c). Considering inflations rates in Indonesia, the monthly per capita expenditures in Cidanau are higher than national averages in the PES-TB sample, but similar in the other two.

The highest share of food expenditures in all samples is spent on processed foods (42%, 41%, 44% in PES-TB, TB and CB households respectively), followed by staples (29%, 31%, 26% respectively). Expenditures for animal products (18%, 14%, 14% respectively) are much lower, as are those for fruits and vegetables (9%, 10%, 10% respectively) and legumes (3%, 5%, 5% respectively). These numbers explain the low shares of consumption of the last three food groups. As mentioned above,

processed foods as well as staples are filling and therefore a higher priority for households that have rather low incomes.

Mean per capita expenditures in rural Indonesia for meat have been reported at IDR 10,583. (2014 data; BPS c) These numbers are lower than in the PES-TB group in Cidanau (IDR 32,723) even when considering inflation, and comparable in the other two groups (IDR 7,045 (TB) and IDR 8,825 (CB)). The higher expenditures for meat in the PES-TB sample, which theoretically signals higher purchase power that should also include other food groups with rather high income elasticity, does not see itself reflected in the HDDS.

In this context, the astonishing results of this research in terms of expenditures for cigarettes should be mentioned. Households spend up to 30% of the food expenditures on tobacco products. Monthly national mean per capita expenditures for cigarettes in rural Indonesia were IDR 48,125 in 2014 (BPS c). In Cidanau, these numbers are IDR 129,038 (PES-TB), IDR 101,189 (TB) and IDR 105,728 (CB), therefore substantially higher than the national average. Higher results in the PES-TB group could lead to the assumption that farmers spend parts of the PES payments on tobacco. Introducing conditions for recipients, like the elaboration and presentation of an investment plan, could decrease these numbers and increase cash availability for other purposes. Finally, a higher participation of women in the PES scheme and the administration of the payments should be achieved, as it is common knowledge that female members of the household spend incomes in a way that rather benefits the entire household. A final and more general point regards the high share of smoking males in Indonesia, and based on observations especially in Cidanau. Governmental policies should target smoking to a much higher extent, as it has a great impact on national health. Increasing addiction counceling might be very costly and therefore not feasible, but imposing higher taxes on cigarettes and elevating market prices might be a good strategy to reduce smoking rates. At the same time, the government could even benefit from the tax revenues.

The fact that households that are PES participants spend more on certain foods as well as on tobacco however does not necessarily demonstrate their increased

purchase power. The first indicator for this is that these higher expenditures are not reflected in the HDDS, which is assumed to positively correlate with household purchase power (and consequently food expenditures). A possible explanation could be that PES participants were chosen based on the location of their plots and therefore often live in villages further uphill. The increased distance to markets and bad conditions of infrastructure might be the reason for higher prices of certain foods.

TB and CB farmers have significantly higher household members with off-farm employment. One would assume that this elevates households' cash income and availability. Following the same line of thought and as found in other research projects (like Sibhatu et al., 2015), higher household incomes should see itself reflected in higher food expenditures and consequently HDDS for those two samples, however this is not the case.

As described before, higher household expenditures for food positively correlate with dietary diversity (Thorne-Lyman et al., 2012). This study however was not able to provide prove of this when considering the three sample groups based on agricultural production system independently. When considering the entire sample of smallholder households in Cidanau however, a highly significant positive correlation between household food expenditures and HDDS (which is used as a proxy for nutrition security) can be found.

Food Insecurity

An indicator to measure food insecurity in the access dimension was introduced into this thesis in addition to the HDDS in order to be able to link farming systems with food and nutrition security aspects. The method of choice is the HFIAS, a set of generic questions to assess food insecurity (access) by strongly including respondents' feelings in terms of uncertainty of food supply, insufficient food quality as well as insufficient food intake. Higher HFIAS scores stand for higher food insecurity.

As reported in the results part, the CB group has the highest mean HFIAS (4.3), indicating the highest mean food insecurity levels of the three sample groups. The

PES-TB group meanwhile shows the lowest HFIAS (3.2). In terms of levels of food insecurity, the PES-TB group also scores best, as it has the highest share of food secure households (39%) and by far the lowest share of severely food insecure households (6%). The difference of these results to the other two study groups are not statistically significant (26% and 20% in the TB sample as well as 31% and 22% in the CB group), but do provide a strong indication. Crop based smallholders have quite a high share of food secure households as well, but also the highest share of severely food insecure households.

The relatively high share of households that are considered food insecure correlates with a report from Dewan Ketahanan Pangan et al. (2015) where it is indicated that Banten province is still among the governmental priority provinces to improve food and nutrition security.

An interesting finding in this context refers to coping mechanisms of households in times of financial shortcomings. Most households either borrow money or food from friends or neighbors, or have 'buy now – pay later' agreements with local shops. These results again provide prove for a well-functioning social structure and bonds in the villages. Furthermore also religious reasons bring households to help out other families in need.

A significant association between the HFIAS and the farming system could not be demonstrated in this research. Nonetheless, the HFIAS negatively correlates with the HDDS, when considering the entire sample of households in Cidanau. This indicates that households with higher HDDS scores, which are able to access a higher diversity of foods, are significantly less likely to be food insecure in terms of access. This supports the findings of Baliwati et al. (2015), who validated the use of HDDS to identify food insecure households. Furthermore, the HFIAS negatively correlates with paternal as well as maternal education levels, indicating that increasing education levels in households significantly decreases food insecurity. At last, when considering the entire sample of smallholder households in Cidanau, significant negative correlations were found for HFIAS and food expenditures. This indicates another important aspect for a secure access to food.

7.3 Final Points of Analysis

Previous research in Cidanau has demonstrated that PES does not highly benefit households in financial terms, and this research has provided further indications for that. Until now, the increase of natural capital through the scheme is unknown, despite the fact that it targets the provision of watershed services. One natural capital benefit however can be established: PES-AF plots on average have a higher tree-density then non-PES plots, which provides some environmental benefits (carbon sequestration, wildlife habitat, etc.). Demonstrated benefits do however include social capital, which increases in villages and farmer groups that participate in the scheme. This social capital includes better relationships of stakeholders, like farmer groups and governmental officials and institutions. Nonetheless, these relations until now have not been able to benefit farmers in terms of improving land-management and increase productivity and profitability. Therefore this research fails to prove the first hypothesis, stating that participating in the PES scheme improves farmers' profitability.

Additionally, the results of this research do not provide prove for a direct influence of the farming system on DD, food expenditures as well as food insecurity in terms of access to food. The same accounts for the participation or non-participation in the PES scheme. This research expected to find a situation in the field, where PES participants, due to the compensation payments for sustainable land-use as well as the production of diverse agricultural products, had higher incomes and produced large parts of their consumed foods on their plots, and therefore were able to have a different lifestyle (including diverse diets) than non-PES participants. The results however contradict this and therefore the second hypothesis of this research. If the PES was able to provide higher financial benefits for participating farmers, this situation however might present itself differently. Food and nutrition security in Cidanau consequently must be influenced by other factors than the farming system or the participation in the PES scheme, and the above mentioned results strongly indicate that food expenditures as well as education levels strongly influence DD and

food security. It is important to bear in mind however, that this research focusses solely on the access dimension of food security and does not target all four dimensions (food availability, access, utilization and stability (FAO, 2008)). Furthermore, as purchase power and cash incomes are highly important to buy diverse foods, these findings do not come as a surprise. Nonetheless an important finding of this research is that food and nutrition security are distributed relatively equally within the watershed, independently of the farming system.

Despite the fact that benefits of the PES are rather intangible than direct and based on 'hard' facts, PES participants are very pleased with their contracts. During the field trip, the researcher witnessed many positive comments from diverse local stakeholders about the changes since participating in the scheme. The high number of farming groups that are being established and that want to join the PES is further prove of its good reputation. Research findings like this nonetheless should always be used as a basis to discuss the further development of the PES scheme in order to maximize benefits. The PES scheme as it is currently managed targets a wide spectrum of beneficiaries that receive quite low compensation payments and therefore have relatively low impact. Finding solutions where payments are bound to the development of one or two precise projects in the watershed (infrastructure, capacity building, etc.) might improve the situation for the entire watershed, while making better use of the available financial capital. This however would decrease farmers' power to decide what to use the payments for, which might be a highly important factor for the high acceptance of the scheme.

The funds for the PES still come from companies' corporate social responsibility funds (Leimona et al., 2010). This implies that the scheme as such is not maintaining itself yet, meaning that the savings companies achieve from improved water provision do not yet overweigh the expenditures for the PES. The positive attitude and experiences of *Rekonvasi Bhumi*, which is the most important actor for further success of the PES, give reason to believe that the scheme has had a high impact on peoples' livelihoods in the watershed. The PES has not been able to bring 'hard' benefits to Cidanau. The 'soft' benefits however, the willingness of all stakeholders to keep up the participation in addition to the AF farmers' awareness of their role in

conservation appear reasons enough to maintain the PES scheme in Cidanau. Nevertheless, its further development should also include some effectiveness aspects. And at last, it now appears to be the government's responsibility to join efforts in improving peoples' lives in the watershed.

7.4 Limitations and weaknesses

In order to provide truthful and complete information to the reader, the limitations and weaknesses of this study are presented and discussed at this point. Despite the effort of carrying out a comprehensively designed and scientifically robust research, the fact that this is a master thesis with a limited scope represents the first limitation. The sample size, while chosen strategically, is not representative for the entire farming community in Cidanau watershed.

Farmers participating in the KII were chosen based on their relative 'cleverness', education as well as former positive collaboration with *Rekonvasi Bhumi,* which includes some bias in the sample, especially in the PES participant group. Furthermore, and given the low education levels in Cidanau, it is unlikely to have obtained exact data on farming inputs and outputs, as no written documentation of this information is kept. Data sampling therefore relied on farmers' memory. In addition, even though farmers knew the members of *Rekonvasi Bhumi* conducting the interviews and trusted them, some farmers at the beginning of interviews were reluctant to disclose all information, which might lead to a slight misrepresentation of the reality. This was probably due to the fear that interviewees would pass on their information to governmental agencies.

In rather poor rural Indonesia with relatively monotonous eating habits, the 24-hour recall method captures households' diets quite well. Nevertheless, due to the seasonality of some foods (like fruits) and the time of survey within the cropping cycle, household DD might be underestimated. While the recall period of 24 hours was chosen purposefully to make it easier for participating women to recall all

consumed foods and drinks, given the education level as also conscience level towards food and diets, it is likely that some items might have been forgotten. The enumerators always tried to create a private and secure environment while carrying out the questionnaires. Given to the embarrassment of not being able to provide diverse foods for their families however increases the possibility that respondents exaggerated their consumption. The same also counts for the HFIAS questions of food insecurity, where respondents might have concealed certain information due to embarrassment.

Lastly, in Indonesian the term ‘yesterday’ and ‘in the past’ are equal. Enumerators tried to avoid this misunderstanding by naming the day of the week prior to sampling, nevertheless the possibility exists that respondents named consumed items that might not have been consumed ‘yesterday’, but on another day in the past.

In addition to these weaknesses regarding the research design, some methodological limitations exist. In general, DD indicators are a relatively fast and easy to implement method to assess nutritional adequacy of a diet as well as households’ ability to purchase foods. Despite being good proxies, these simple count measures are never able to fully reflect contestants’ diets and nutrition status.

8. Conclusion and Policy Implications

The present master thesis provides answers to two specific research hypotheses: that agroforestry smallholders in Cidanau, and especially those that are part of the PES scheme, (i) manage their land more profitably than crop-based farmers, and (ii) in comparison to crop-based farmers, have higher dietary diversity and food security in the access dimension due to higher agrobiodiversity and incomes from compensation payments.

Regarding the first research hypothesis, this thesis has been able to show that: (1) agroforestry systems can be a viable option for smallholder farmers in Cidanau, nonetheless this highly depends on the crop composition as well as current prices for their produce; (2) PES-participants do not manage their agroforestry plots with higher profitability than non-PES agroforestry farmers, despite being more connected to diverse stakeholders, including local governments. The given findings therefore contradict the first hypothesis.

With respect to the second hypothesis of this thesis, results of this research indicate that: (1) dietary diversity and food insecurity in the access dimension in Cidanau are moderate; (2) the prior point is not a direct result of smallholders' farming system, but rather a result of their high market-orientation and –dependency; (3) PES participating households do not have higher dietary diversity than households that do not receive payments; (4) in Cidanau, household expenditures for food as well as the level of education have major impacts on dietary diversity and consequently food and nutrition security.

Both, rice cultivation and agroforestry systems have their *raison d'être* in Cidanau as they serve different purposes. Rice producers support local food production, local food sovereignty and contribute to food security, while agroforestry farmers with their environmentally friendly production contribute to the provision of ES while producing a number of high-value crops. However until now, attention from official side and investment in research only focusses on the first of the two systems.

One the one hand side, having a high diversity of crops and therefore crop incomes is regarded an insurance policy in Cidanau. On the other hand side, the low specialization might reduce farmers' economic performance due to decreased competitiveness. High-value cash-crops like clove currently yield higher financial returns than food crops and therefore AF systems are able to perform quite well economically. However, it is questionable if the complete dependence on markets, for both incomes from agriculture as well as for obtaining food, is the best option. Having high agrobiodiversity might be more reasonable if the subsistence-level of food production was higher. Given the concentration of poverty and malnutrition in Indonesia's rural areas and consequent high vulnerability to shocks, changing climatic conditions as well as highly fluctuating market prices, smallholders in Cidanau should reconsider (re)vitalizing their self-sufficiency in food production. Combining both, higher productivity and profitability as well as decreasing dependencies from markets, might be a two-pronged approach and therefore the way to go in smallholders' risk reduction.

The policy lesson which can be drawn from these findings are the following: Farming profitability and households' incomes are tightly linked to food and nutrition security. For this reason, agricultural- and food security policy should strongly collaborate. Furthermore, the government has to overcome its obsession with rice self-sufficiency and pay attention to more diverse farming systems, which also have promising potential in improving farmers' livelihoods. These systems require urgent assistance in increasing productivity and, in face of a changing climate, adaptation capacity. Additionally, more attention should be paid to the development of local infrastructure, schools and medical assistance, facilitate access to markets with stable prices as well as provide knowledge about farm management to increase productivity. Only when farmers are able to have appropriate lifestyles and their land can bring some prosperity, the reputation of farming will change, which is crucial for the further development of rural areas and the attraction of young people for rural life.

Finally, the PES is highly popular among the participating farmers despite the fact that until now it has had a minor role in improving peoples' livelihoods and an unknown impact on the provision of watershed services. For these reasons and based on

results of this and other research projects, its future development should constantly be monitored and readjusted in order to meet its goals. The conservation work of the PES initiative will hopefully soon be supported and expanded from governmental side in a new watershed policy.

9. Further Research Demand

This very last section focusses on identified demand for further research.

A major research gap in Cidanau is a study about the provision of watershed services, which could prove the effectiveness of the PES scheme. It is surprising that this research was not carried out prior to establishing the PES, as this means that no baseline of watershed services provision was established. Studying the water provision and proving the positive impact of the scheme could highly motivate further investors to join the 'buyers'. Proving no impact through the PES would allow to redirect funds and conservation efforts and improve the impact of the scheme.

Future research in terms of agricultural economics in Cidanau should target various aspects. First of all, very little knowledge exists about the productivity and management of many tree species included in the AF systems. Long-term studies that establish best-practice recommendations would highly benefit farmers, as they currently appear to be using a 'trial and error' management style. In order to complete the knowledge about farming profitability in Cidanau, a risk assessment for all production systems should be carried out. This should include price fluctuations as well as an assessment of adaptation potential in the face of climate change. The results would help policy makers to better target assistance for farmers.

Regarding food- and nutrition security in Cidanau, this thesis focused on the access dimension of food security. A more general assessment could highlight possible influences of the PES scheme on other dimensions of food security and therefore establish social benefits of the mechanism. In addition, a dietary diversity assessment that covers a time frame of an entire year might increase the chance of detecting differences in dietary diversities between farming systems as it is able to capture seasonal products. Another interesting fact is the more direct and detailed assessment of homegardens, their diversity and uses in Cidanau and finally their influence in dietary patterns and diversity.

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11. Annex

Annex 1: Farming System Profitability Interview Guideline

Annex 2: Food and Nutrition Security Questionnaire

Annex 3 Summary Expert Interview 1 (EI-01)

Annex 4 Summary Expert Interview 2 (EI-02)

Annex 5 Summary Expert Interview 3 (EI-03)

Annex 6 Summary Expert Interview 4 (EI-04)

Annex 7 Exchange Rates

ANNEX 1: Farming System Profitability Interview Guideline

ID Respondent .....

Profitability Analysis of Land-Use Systems					
Name interviewer		Name respondent		Notes:	
Date of interview (D/M/Y)		Land-use (Dominant crop on plots)			
Time of interview (HH:MM)					
Name village		Size of all Plots [ha]			
Name farmer group		Planting year			

Production of Main Crop (Please be highly specific about the crop you are referring to. E.g. Melinjo has fruits, leaves and flowers. E.g. Rice can be dried rice grains or paddy)		
First Harvest [years after planting]		Notes:
First Harvest [quantity]		
Average harvest in years 1-5 [quantity/year]		
Average harvest in years 5-10 [quantity/year]		
Average harvest last year [quantity]		

Prices of Main Crop (Please ask the respondents to provide the prices at which they sold each unit of the **main product** mentioned before)		
Price at last harvest [price/unit]		Notes:
Lowest price [price/unit]		
Highest price [price/unit]		
Price last month [price/unit]		

Production and Prices of Other Crops (Please ask the respondents to give details on **all other crops** they harvest from their plots. Again, be very specific. E.g. Melinjo has fruits, leaves and flowers. E.g. Rice can be dried rice grains or paddy)			
Crop/Product	**Number of trees/Area [m^2]**	**Average harvest last year [quantity]**	**Price at last harvest [IDR/unit]**

ID Respondent .....

Labour			
Activity	Hours/day (Generally, how many hours per day does each person need for each activity)	People needed (Please mention all family members, friends, neighbors as well as hired labour)	Days/year (Generally, how many days per year does each person work on each activity)
Land preparation			
Seeding			
Planting			
Crop Care (Weeding, pruning, etc.)			
Fertilizing			
Spraying			
Harvesting			
Post-Harvest (Packaging, transportation, selling, etc.)			
Notes:			

ID Respondent .....

Herbicides/Pest Control			
Type (Product name or composition)	Frequency of use [per year]	Quantity used each time[m3/l]	Price [IDR/unit]

Fertilizer			
Type (Product name or composition)	Frequency of use [per year]	Quantity used each time [m3/l]	Price [IDR/unit]

Tools			
Type (Any tool needed like wires, axes, baskets etc.)	Unit/Quantity needed	Price per each unit [IDR/unit]	Lifetime [yr] (How many years does this tool last?)

Wages	
General wage rate of hired labour [IDR/day]	

Seedlings	
Seedling type (seeds, sprouts, etc.)	
Price [IDR/unit]	

ANNEX 2: Food and Nutrition Security Questionnaires

ID respondent: .....

HOUSEHOLD FOOD CONSUMPTION QUESTIONNAIRE – A

Household dietary diversity and food security

Name of enumerator: _____

Date of survey: I___I___I/I___I___I/I___I___I___I___I

Time start of survey: I___I___I : I___I___I (HH:MM)

Time end of survey: I___I___I : I___I___I (HH:MM)

Village Name: _____

Name of Farmer Group: _____

A. General Information

A.1. Respondent Name: _____

A.2. Respondent's Age: I___I___I

A.3. Respondent's main occupation: _____

A.4. Respondent's Side occupation: _____

A.5. Respondent's education: _____(SD/SMP/SMA/ Sarjana)

A.6. Husband's Name: _____

A.7. PES participant: ☐NO ☐YES Since (year): _____

A.8. Main crop cultivated: _____

ID respondent: .....

A.9. Please provide the following information about your agricultural plots and home gardens

Nr.	Plot type[1]	Size [m2]	Commodities	Walking distance from home [min]	Ownership status[2]
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

[1]**Coding:**
1= Rice fields
2=Melinjo Agroforestry
3=Cengkeh Agroforestry
4=Horticulture
5=Mixed garden
6=Other (specify)

[2]**Coding:**
1=Own land and self managed
2=Own land and managed by other people
3=Own land - Idled
4=Managing other people's land
5=Managing state forest/conservation area

ID respondent: .....

B. Household Information

No.	Name	Relationship to respondent	Age	Sex 1=female 0=male	Education[1]	Occupation[2]	
						Primary[2]	Secondary[2]
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							
15.							

[1]Coding: 1=SD
2=SMP
3=SMA
4=Sarjana

[2]Coding: 1= IbuRumahTangga
2= Petani
3= Buruhtani
4= Wiraswasta/pedangang
5= Tidak ada pekerjaan
6= Lain (sebutkan)

ID respondent: .....

C. 24-Hour Recall – Household food consumption

C.1. Was yesterday a celebration or feast day where you ate special foods or where you ate more, or less than usual?

☐ No, it was a typical day. ☐ Yes, it was a special day.

C.2. Are you responsible for meal preparation in this home? ☐ YES ☐ NO: Who is instead? _____

C.3. Please name all foods and drinks that **your entire household** consumed yesterday from waking up until bedtime **inside the home, including meals bought outside and consumed inside**. Provide the ingredients for composed foods and drinks as well as the source of each item.

	Food/ Drink Item	**Ingredients** (Specify for all composed foods prepared at home)	**Method of preparation**[1]	**Source of this item**[1]	**If bought, price [IDR]**	***List Number*** ***[do not fill]***
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						

31.						
32.						
33.						
34.						
35.						
36.						
37.						
38.						
39.						
40.						

[1]Coding:

1=Dikukus (steamed)
2=Direbus (boiled)
3=tumis (saute))
4=Digoreng (deep fried)
5=Dibakar (grilled)
6=Dipanggang (roasted/baked
7=Other (specify)

[2]Coding:

1= Own production on field
2= Gathering, hunting, fishing
3= Purchased
4= Borrowed, bartered, exchanged for labour
5= Gift from friends or relatives
6= Other (specify)

ID respondent: .....

D. Use of home garden

D.1. Do you have a home garden for your household? ☐ YES ☐ NO *(skip this question)*

D.2. Are you responsible for managing the home garden? ☐ YES ☐ NO. If so, who isinstead? .....

D.3. Please name all plants you grow in your home gardens, their uses and frequency of use.

	Local name of plant	Uses[1]	Frequency of use				Comments
			Monthly	Weekly	Daily	Other	
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							

14.							
15.							
16.							
17.							
18.							
19.							
20.							
21.							
22.							
23.							
24.							
25.							

[1]Coding:

1= Food
2= Spice for food preparation
3= Drink ingredient
4= Medicinal use
5= Ornamental
6= Market/Selling
7= Other (specify)

ID respondent: .....

E. Food Security Information

E.1.	In the **past four weeks**, did you **worry** that your household would not have enough food?	a) ☐ NO ☐ YES	☐ 1-2 times ☐ 3-10 times ☐> 10 times
E.2.	In the **past four weeks**, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	a) ☐ NO ☐ YES	☐ 1-2 times ☐ 3-10 times ☐> 10 times
		b) Which resources?	☐ Financial resources ☐ Not available in the market ☐ Social ☐ Others: .....
E.3.	In the **past four weeks**, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	a) ☐ NO ☐ YES	☐ 1-2 times ☐ 3-10 times ☐> 10 times
		b) Which resources?	☐ Financial resources ☐ Not available in the market ☐ Social ☐ Others: .....
E.4.	In the **past four weeks**, did you or any household member have to eat fewer meals in a day because there was not enough food?	a) ☐ NO ☐ YES	☐ 1-2 times ☐ 3-10 times ☐> 10 times
		b) Which household member?	☐ Husband ☐ Children ☐ Wife ☐ Elders

E.5.	In the **past four weeks**, was there ever no food to eat of any kind in your household because of lack of financial resources to get food?	a) ☐ NO ☐ YES	☐ 1-2 times ☐ 3-10 times ☐> 10 times
E.6.	In the **past four weeks**, did you or any household member go to sleep at night hungry because there was not enough food?	a) ☐ NO ☐ YES	☐ 1-2 times ☐ 3-10 times ☐> 10 times
		b) Which household member?	☐ Husband ☐ Children ☐ Wife ☐ Elders
E.7.	In the **past four weeks**, did you or any household member go a whole day and night without eating anything because there was not enough food?	a) ☐ NO ☐ YES	☐ 1-2 times ☐ 3-10 times ☐> 10 times
		b) Which household member?	☐ Husband ☐ Children ☐ Wife ☐ Elders
E.12.	Do you harvest any goods from the forest? [*not home gardens or agricultural plots*]	☐ NO ☐ YES	☐Firewood/Charcoal ☐Wood for: ..... ☐Fruits: ..... ☐Mushrooms: ..... ☐Natural Medicines: ..... ☐Others: .....
E.13.	How long do you have to walk to the next forest?	..... Minutes	

E.14.	How many times per month do you go to the forest?	..... Times
E.15.	Where does your drinking water come from?	☐Well ☐ Tap ☐River ☐ Spring ☐Bottle ☐Other: ..... ☐Simple pipe system
E.16.	If PES participant, has your participation let to any changes for your household?	☐Increased incomes ☐Diversified incomes ☐Diversified foods ☐Reduced amount of produced food ☐Increased amount of bought food ☐Other: .....

ID respondent: .....

F. Household expenditures

F.1.	Please specify how much money your household spends on the following groups of items **per week**.			
	Golongan Pangan	**Jumlah**		**Ket.**
		Banyaknya	**Nilai [IDR]**	
F.1.1	**Padi-padan** – a. Beras			
	b. Lainnya (jagung, terigu, tepung beras, tepung jagung, dll.)			
F.1.2	**Umbi-umbian** (ketela pohon, ketela rambat, kentang, gaplek, talas, sagu, dll.)			
F.1.3	**Ikan/ udang/ cumi/ kerang** – a. Segar/ besah			
	b. Asin/ diawetkan			
F.1.4	**Daging** (daging sapi/ kerbau/ kambing/ domba/ babi/ ayam, jeroan, hati, limpa, abon, dendeng, dll.)			
F.1.5	**Telur dan susu** – a. Telur ayam/ itik/ puyuh			
	b. Susu murni, susu kental, susu bubuk, dll.			
F.1.6	**Sayur-sayuran** (bayam, kangkung, ketimun, wortel, kacang panjang, buncis, bawang, cabe, tomat, dll.)			
F.1.7	**Kacang-kacangan** (kacang tanah/ hijau/ kedele/ merah/ tunggak/ mete, tahu, tempe, tauco, oncom, dll.)			
F.1.8	**Buah-buahan** (jeruk, manga, apel, durian, rambutan, salak, duku, nanas, semangka, pisang, pepaya, dll.)			
F.1.9	**Minyak dan lemak** (minyak kelapa/ gorent, kelapa, mentega, dll.)			
F.1.10	**Bahan minuman** (gula pasir, gula merah, the, kopi, coklat, sirup, dll.)			

F.1.11	**Bumbu-bumbuan** (garam, kemiri, ketumbar, merica, terasi, kecap, vetsin, dll.)			
F.1.12	**Konsumsi lainnya** - a. Mie instant, mie basah, bihun, macaroni, dll.			
	b. Lainnya (kerupuk, emping, dll.)			
F.1.13	**Makanan dan minuman jadi** – a. Makanan jadi (roti, biscuit, kue basah, bubur, bakso, gado-gado, nasi rames, dll.)			
	b. Minuman non alkohol (soft drinks, es sirop, limun, air mineral, dll.)			
	c. Minuman mengandung alkohol (bir, anggur, dll.)			
F.1.14	**Tembakau dan sirih** - a. Rokok (rokok kretek, rokok putih, cerutu)			
	b. Lainnya (sirih, pinang, tembakau, dan lainnya)			

F.2.	Are there any months during which your household typically suffers from high food prices?											
	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
F.3.	Are there any months during which your household typically benefits from low food prices?											
	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec

F.4.	How many household members smoke? ……	☐All male ☐All female	☐Both
F.5.	How do you cope with situations when your resources are not sufficient to buy food?	☐Sell livestock ☐Take a loan	☐Borrow from friends/family ☐Other: ……

ID respondent: .....

G. Other Information

G.1.	How much is your total household income? *(From primary and secondary occupation of each household member)*					Per month: iDR		
G.2.	How many of the following objects do you own?							
	Bicycle	I___I	Television	I___I	Gas stove	I___I	Chicken	I___I
	Motorbike	I___I	Mobile phone	I___I	Fridge	I___I	Sheep/Goat	I___I
	Car	I___I	Bank Account	I___I	Laptop	I___I	Cattle	I___I
G.3.	Indicate a maximum of 3 environmental issues / disasters that exist in your community / village or on your plots in the past 10 years?				☐No problem ☐Garbage ☐Water shortage ☐Decreasing water quality ☐Floods ☐Less soil fertility		☐Erosion ☐Wild animals ☐Deforestation ☐Other:	
G.4.	What are the causes of these problems?				☐Agriculture/logging ☐Firewood extraction ☐Commercial timber harvest ☐Financial issues ☐Lifestock ☐Deforestation		☐Overpopulation ☐Lack of knowledge ☐Governmental policies ☐Polution/ Litter ☐Other:	

ANNEX 3: Summary Expert Interview 1 (EI-01)

Interviewee: Prof. Dr. Ir. Ali Khomsan, Faculty of Human Ecology, Bogor Agricultural University, Bogor, Indonesia

Date and Place: 08.03.2016, Dr. Khomsan's office at Bogor Agricultural University, Bogor, Indonesia

Summary of interview content:

- Two or even one 24-hour recall sufficient in Indonesia (especially in rural areas) as diets do not differ much. This is also true for weekday/weekend differences.
- Agriculture in Indonesia faces the problem of having old farmers and children do not want to work in agriculture.
- Rice has much higher cultural value and is much more common than vegetable farming.
- Women, who are at home and are responsible for cooking are good informants, also because men leave the house and it is difficult to get hold of them.
- Animal protein consumption low, most households then eat salted fish.

ANNEX 4: Summary Expert Interview 2 (EI-02)

Interviewee: N.P. Rahadian, Director of *Rekonvasi Bhumi*, Serang, Indonesia

Date and Place: 27.04.2016, Office of *Rekonvasi Bhumi*, Serang, Indonesia

Summary of Interview content:

- Ten years of PES, what is your conclusion and which are positive and negative aspects?
    - Groundbreaking environmental initiative for the government which could help establish a new watershed policy. Also for the farmers it is new, they now have to actively manage their land, which they did not do before. PES provides additional income for participants, but is not their main income source, which is farming. Water users (industries) are also highly important, receptive and show interest in maintaining the scheme. Now it is important to coordinate them in an equilibrium.
    - Physical characteristics of water, their changes or improvements in watershed service provision have not been studied yet. And it is difficult to compare as no baseline study exists. Also the payments of PES are not based on 'value' of water, but based on negotiations between stakeholders. Other research in Cidanau support *Rekonvasi'*s policies and the PES.
- Have you experienced changes in farmers' lives since initiating the scheme?
    - During Dutch colonial times, main commodity cultivated was rubber. This then changed to dry paddy production, then to a mix of paddy with forestry, now agroforestry in big parts. While there was only rice production, farmers produced no vegetables or fish. Now, with agroforestry and rice/horticulture systems there is higher vegetable and fish consumption. This has become even better with agroforestry as farmers have higher incomes. Nonetheless, some important issues remain, which include, little concern for education etc. Since the PES however, we saw higher social activities in the villages, especially in

Citaman, due to this income. Farmers give parts of it for charity, spend more on maintenance of the village mosque, fund infrastructure projects (water pipe); also schooling and savings have increased.

- Is there a difference in the commodity composition on PES and non-PES plots?
    - Same commodities in PES/non-PES agroforestry plots. Timber production however is now low on PES plots.
- Do you see any problems with the high share of non-food crop production in Cianau?
    - No because this way, farmers can sell their produce and spend their incomes on purchased foods. This can and already has increased the diversity of consumed foods, as farmers eat more chicken etc. This however also means that they eat much processed foods. But traditional eating habits, lack of knowledge of nutrition makes people susceptible for ads (like on TV) and the difficulty to obtain some foods here are problems in the current nutrition situation.
- In the villages, some farmers commented that paddy is now converted to woody-tree plantations. Is this currently a common trend?
    - Not a common trend. The problem is that *albasia* needs high amounts of water and withdraws much water from the ground. This is why *albasia* is not permitted in the PES.
- What do you see for the future of PES in Cidanau?
    - I hope it will expand. If industries are willing to support the scheme but they are interested. Now we are negotiating the prices in order to get more money. We hope government will support the concept, but not yet, no gov degree not finished after 13 years. But I am hopeful. 2,400 ha now and need money until 6 billion/year and potential buyers for 10 billion per year. We socialize and discuss with farmers, 125 farmr groups is target. Priority 30.

ANNEX 5: Summary Expert Interview 3 (EI-03)

Interviewee: Anang Suryana, *Rekonvasi Bhumi*, Serang, Indonesia

Date and Place:

Summary of Interview content:

- Agroforestry farmers in Cidanau have a high diversity of trees on their plots. This is because they do not plant with a plan, they plant high amounts of trees without paying attention to minimum distances, shade management etc. and hope that some survive. Having many trees decreases the risk of losing incomes when the harvest of one type fails. In crop-based systems, many people prefer working as day laborers and have daily incomes, rather than bearing the risk of an agricultural plot and failing crops.
- Farmers chose their crops based on current market values, which is quite short-sighted. All agroforestry farmers then plant certain crops and when they start producing the prices drop. There is a committees which advises farmers on which crops to plant. Regarding tree-crops, they are currently advising to plant high-value varieties of durian. With respect to short-cycle crops, they currently recommend planting roots for export.
- In general, farmers sell their produce to middlemen, as markets are quite far from many villages and they do not have a mean of transportation. So they are very dependent on the prices paid by the middlemen, which somehow have a good knowledge of how much each farmer will ask for. Therefore received prices in the villages might be very different.
- Farming in general is regarded an occupation with low reputation. This is why many families do not want their children to take over the family plot and prefer that they leave for the cities. Also, youngsters in Cidanau now want many ‘western’ or ‘modern’ things like motorbikes. Farmers have quite low incomes from farming because they have the reputation of being lazy, or they do not have the time to invest more efforts into farming, or they do not have the knowledge.

ANNEX 6: Summary Expert Interview 4 (EI-04)

Interviewee: Andi Sukman, Department of Agriculture, Banten province, Indonesia.

Date and Place: 30.03.2016, Department of Agriculture, Serang, Indonesia

Summary of Interview content:

- The main problem for agroforestry farmers in Cidanau is that they do not have one main product, but are highly diverse. The PES however allows plantations. Timber-trees are also planted, but for middle-term income. And the disadvantage is that when it is harvested, the soil lies bare and we have erosion and sedimentation problems.
- Farming is not the main income source for most households, as some household members are employed in the city.
- Farmers are not subsistence farmers, but highly market-oriented. However there are uncertainties in the market. Clove for example had much higher prices 20 years ago.
- Governmental extension services exists, but they do not have the time to actively visit farmers and merely lend them machines. Also, there is a homegarden policy, which is now starting to be implemented and disseminated. The government also promotes diverse sources of carbohydrates (like yams or manioc) to decrease dependency on rice.
- Conversion of paddy fields to other land-uses is high, as land is flat, drained and of good quality for construction (for example of industrial areas). Therefore the government is now creating regulations to protect paddy fields from investors and conversion. We have to think about out food sovereignty.
- While the government highly focused on rice, it is now also increasingly focusing on durian, manggis, cocoa, coconut, onion and eggplant.
- The land currently cannot give prosperity to the farmers, as plots are too small and farmers face market uncertainties. We have to improve productivity and start utilizing the land under the trees.

ANNEX 7: Exchange Rates

Date	**Indonesian Rupiah (IDR)**	**United States Dollars (US$)**
2016-08-17	13,100	1

Source: http://www.xe.com/

Date	**Indonesian Rupiah (IDR)**	**Euro (EUR)**
2016-08-17	14,767	1

Source: http://www.xe.com/

Declaration in lieu of oath

By:

Lina Manuela Tennhardt

This is to confirm my Master's Thesis was independently composed/authored by me, using solely the referred sources and support.

I additionally assert that this Thesis has not been part of another examination process.

Place and Date Signature