Determinants of Income Generating Activities of Rural Households

A Quantitative Study in the Vicinity of the Lore-Lindu National Park in Central Sulawesi/Indonesia

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Abstract

This study aims to identify and analyse the determinants of income generating activities of rural households in the vicinity of the Lore-Lindu National Park in Central Sulawesi, Indonesia. It helps to identify factors which are essential for the design of policies promoting alternative income strategies. Data was collected through a standardised, formal questionnaire from 301 randomly selected households. In the analysis, the following income generating activities are differentiated: agricultural self-employment, agricultural wage labour, non-agricultural self-employment, and non-agricultural wage labour. Because of its importance the agricultural self-employment category is further divided into annual and perennial crop production, livestock production, and the sale of forest products. Various econometric models are used to analyse the influence of socio-economic factors on income generating activities. A linear model is applied in the case of total household income. Probit models are used to investigate factors influencing activity choice. In the analysis of activity incomes, a simultaneous equation model with correction for the endogeneity of activity choice is applied. Finally, the determinants of income diversification are analysed using Tobit models.

Agricultural activities are the most important source of income for rural households in the region and make up 70% of total household income. Within this category the most important source of income is crop production, with the most important crops being irrigated rice and cocoa. The remaining 30% of the total household income originates from non-agricultural activities. However, only around 18% of the households gain income from the latter activities. In contrast, 96% participate in agricultural activities. Differentiation between different wealth groups shows that activities outside the agricultural sector are particularly important for the less-poor households. Although rural households are engaged in many different activities, there exists a specialisation among households. Applying a Lorenz curve shows a rather uneven distribution of income among households.

The econometric analysis shows that access to physical and human capital has a significant influence on total household income. The area owned, the value of other assets possessed, as well as the number of livestock and family labourers positively influence household income. The possession of land also has a strong positive influence on the participation in crop production, whereas the possession of irrigated land reduces the likelihood of participation in agricultural wage labour activities and in the sale of forest products. Richer and non-indigenous households are more likely to participate in non-agricultural self-employment. In contrast, non-indigenous households are less likely to participate in the sale of forest products and in agricultural wage labour activities. Participation in formal credit markets discourages participation in annual crop production, but encourages participation in the production of perennial crops and non-agricultural wage labour activities. The access to roads has a strong influence on participation in almost all activities. The analysis of activity incomes shows again that the possession of land has a strong positive influence on the income gained from crop production, while the possession of irrigated land reduces the income gained from agricultural wage labour and the sale of forest products. Similar to its effect on participation, the value of other assets owned has a positive influence on the income from non-agricultural self-employment. The analysis also shows the importance of education in non-agricultural wage labour activities and in annual crop production. Ethnicity has a strong influence on perennial crop produc-

tion as well as on income from non-agricultural self-employment. The access to tarmac roads has a positive effect on the income from agricultural wage labour and the sale of forest products. Diversification out of the agricultural sector is positively influenced by the wealth of the household, education, and participation in formal credit markets. The number of livestock owned and the access to social capital have a positive effect on the overall degree of diversification.

The results of the analysis are used to draw policy conclusions with respect to poverty alleviation, deforestation and rural development.

Zusammenfassung

Die vorliegende Dissertation untersucht den Einfluss sozioökonomischer Faktoren auf die Einkommensaktivitäten ländlicher Haushalte in der Umgebung des Lore-Lindu-Nationalparks in Zentralsulawesi, Indonesien. Die Kenntnis dieser Faktoren ist Voraussetzung für die Formulierung von Politikmaßnahmen und Entwicklungsprojekten, die der Schaffung alternativer Einkommensmöglichkeiten dienen. Die Datengrundlage bildet eine Befragung von 301 zufällig ausgewählten Haushalten mittels Fragebögen. In der Analyse wird selbständige Tätigkeit sowie Lohnarbeit im beziehungsweise außerhalb des landwirtschaftlichen Sektors unterschieden. Aufgrund ihrer Bedeutung wird die selbständige Tätigkeit im Agrarsektor untergliedert in die Produktion ein- und mehrjähriger Kulturen, die Tierproduktion, und in den Verkauf von Produkten, die im Wald gesammelt wurden. In der ökonometrischen Modellierung kommen lineare, Probit sowie Tobit Modelle zur Anwendung. Außerdem wird in der Analyse des Einkommens aus den einzelnen Aktivitäten ein simultanes Gleichungsmodel mit Korrektur der Endogenität der Aktivitätenwahl angewendet.

Tätigkeiten im landwirtschaftlichen Sektor tragen 70% zum gesamten Haushaltseinkommen bei. Innerhalb dieses Sektors stammen 60% des Einkommens aus der Pflanzenproduktion, wobei Nassreis und Kakao die bedeutendsten Kulturen sind. Aktivitäten außerhalb des landwirtschaftlichen Sektors tragen 30% zum Haushaltseinkommen bei und sind besonders bedeutsam für die bessergestellten Haushalte. Allerdings erzielen nur 18% aller Haushalte überhaupt Einkommen aus diesen Aktivitäten, wohingegen 96% der Haushalte Einkommen aus Tätigkeiten im landwirtschaftlichen Sektor haben. Obwohl Haushalte in vielen verschiedenen Aktivitäten involviert sind, gibt es doch eine Spezialisierung hinsichtlich einer Einkommensaktivität.

Die ökonometrische Analyse zeigt, dass insbesondere die Ausstattung an physischem Kapital sowie an Humankapital das Gesamthaushaltseinkommen positiv beeinflusst. Die Analyse der Einkommensaktivitäten ist untergliedert in die Untersuchung der Entscheidung zur Teilnahme an Aktivitäten und der Höhe des daraus erzielten Einkommens. Der Besitz an Bewässerungsland wirkt negativ auf die Teilnahme an landwirtschaftlicher Lohnarbeit und den Verkauf von Waldprodukten. Reichere Haushalte nehmen mit einer höheren Wahrscheinlichkeit an selbständiger Tätigkeit außerhalb des landwirtschaftlichen Sektors teil. Das gleiche trifft auf nicht-indigene im Vergleich zu indigenen Haushalten zu. Jedoch nehmen nicht-indigene Haushalte mit geringerer Wahrscheinlichkeit am Verkauf von Waldprodukten und an landwirtschaftlicher Lohnarbeit teil. Die Aufnahme von Krediten von formellen Institutionen erhöht die Wahrscheinlichkeit der Produktion mehrjähriger Kulturen und der Teilnahme an Lohnarbeit außerhalb des landwirtschaftlichen Sektors. Im Gegensatz dazu reduziert der Zugang zu Krediten die Teilnahme an der Produktion einjähriger Kulturen. Die Analyse des erzielten Einkommens aus den einzelnen Aktivitäten zeigt den starken positiven Einfluss von Landbesitz auf das erzielte Einkommen aus der Pflanzenproduktion. Darüber hinaus hat der Besitz von Bewässerungsland einen negativen Einfluss auf das Einkommen aus landwirtschaftlicher Lohnarbeit sowie dem Verkauf von Waldprodukten. Reichere Haushalte nehmen nicht nur mit höherer Wahrscheinlichkeit an selbständiger Tätigkeit außerhalb des landwirtschaftlichen Sektors teil, sie erzielen dort auch ein höheres Einkommen. Weiterhin zeigt die ökonometrische Analyse die Bedeutung von Schulbildung auf das Einkommen

aus nicht-landwirtschaftlicher Lohnarbeit sowie der Produktion einjähriger Kulturen. Nicht-indigene Haushalte erzielen höhere Einkommen aus der Produktion mehrjähriger Kulturen und aus selbständiger Tätigkeit außerhalb des landwirtschaftlichen Sektors. Die Entfernung zu Asphaltstraßen hat einen negativen Einfluss auf das Einkommen aus landwirtschaftlicher Lohnarbeit sowie dem Verkauf von Waldprodukten.

Diese Ergebnisse dienen zur Formulierung potentieller Politikmaßnahmen im Hinblick auf Armutsreduzierung, Verringerung der Umwandlung von Wald in landwirtschaftliche Flächen sowie auf die Entwicklung des ländlichen Raumes.

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Abbreviations

3SLS	Three-Stage Least Squares
ANOVA	Analysis of Variance
BLUE	Best Linear Unbiased Estimator
bn	billion
BRI	Bank Rakyat Indonesia
CI	Condition Index
IMR	Inverse Mills Ratio
LLNP	Lore-Lindu National Park
mill	million
MLE	Maximum Likelihood Estimation
OLS	Ordinary Least Squares
SPSS	Statistical Programme for the Social Sciences
STORMA	Stability of Rainforest Margins
VIF	Variance Inflation Factor

Chapter 1

1 Introduction

1.1 Background

The World Bank (1999) estimates that more than 70% of the world's 1.8 billion (bn) poor live in rural areas, most of them in developing countries. Therefore, reducing rural poverty has been on the agenda of international development agencies as well as governmental and non-governmental organisations for a long time. Since the 1980s a common approach was through integrated rural development focused on the agricultural sector. The core instrument was the promotion of Green Revolution technologies aiming to increase productivity. Due to market failures for smallholders the state had to distribute and often subsidise the delivery of new technologies, for example chemical fertiliser and pesticides. The integrated rural development approach had only limited success and often turned out to be not sustainable (de Janvry et al., 2002).

Succeeding rural development approaches share the distinct feature of taking a more holistic view on rural households. Among rural households there is a great degree of heterogeneity in asset position and in income generating activities. Rural households are engaged in a wide variety of activities: they cultivate crops on their fields, work as wage labourers on other farms, or operate a small shop. A literature review on studies concerning the rural non-farm economy by Reardon et al. (1998) reports a non-farm income share of 42% for Africa, 40% for Latin America and 32% for Asia. For Indonesia they state that about 35% of rural incomes stem from non-agricultural activities indicating their importance. However, the figure is not based on nation-wide data. It is derived from three different studies based on data from 1977, 1983, and 1987 from different regions in Indonesia.

Since the review many studies dealt with the rural non-agricultural sector but their focus was mainly on Africa and Latin America. Despite its importance indicated by the review there is still little known about non-agricultural activities and on the role they play in the income generating strategies of rural households in Indonesia.

1.2 The research area

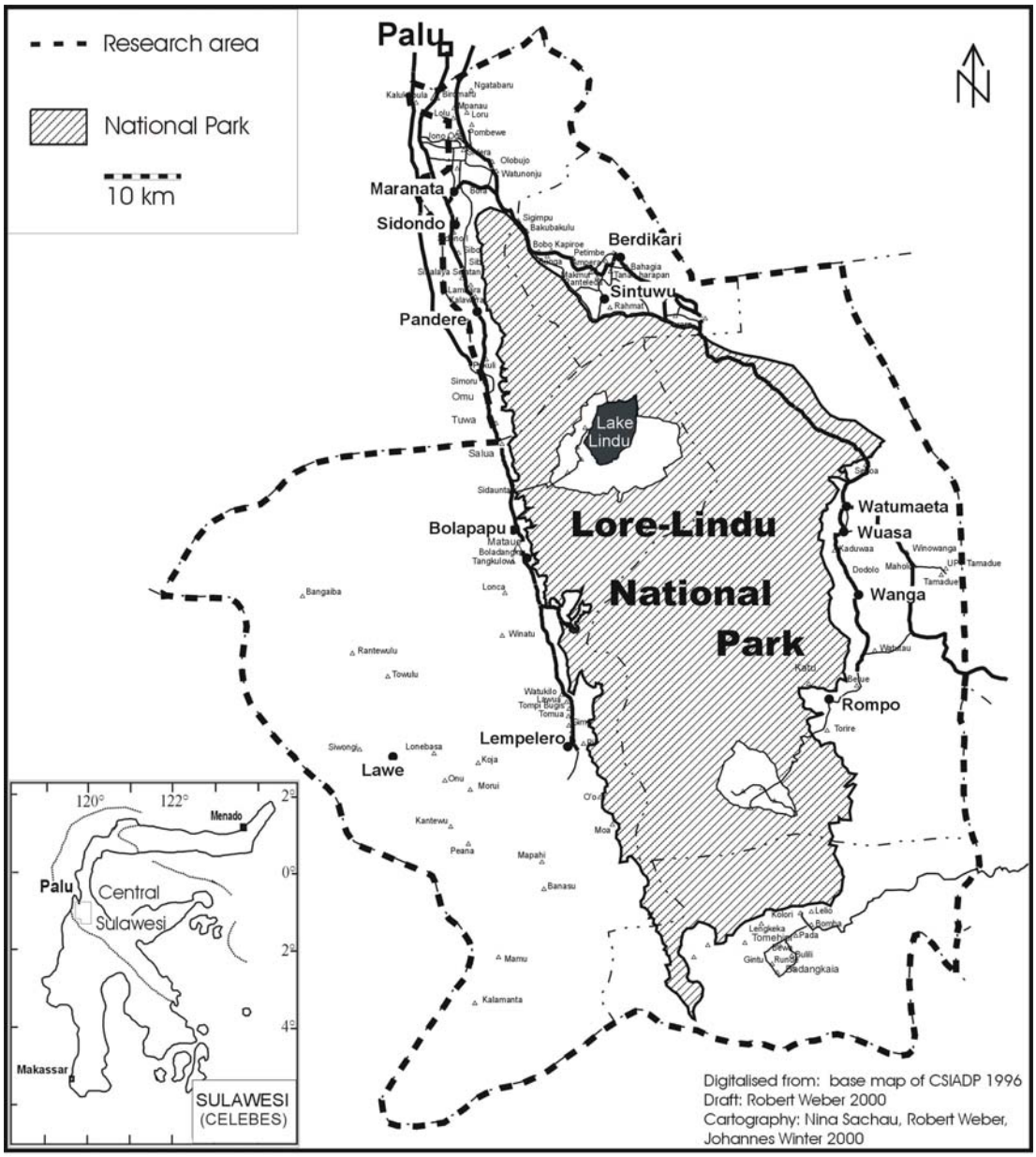
The research took place in the vicinity of the Lore-Lindu National Park (LLNP) in the province of Central Sulawesi, Indonesia, about 50 kilometres south of its capital Palu (Figure 1). The mountainous region covers an area of 722,000 hectares including 220,000 hectares inside the LLNP. It is located in the humid tropics around one degree south of the equator. The research region is characterised by huge differences in environmental conditions. The altitude ranges from just above sea level to up to 2500 metres and rainfall varies from 500 – 2500 mm per year (Maertens, 2004).

The research area is administratively divided into five sub districts[1] ("Kecamatan"). The sub district of Sigi Biromaru is located south of the province capital

[1] During our research the southern part of Lore Utara became the sub district of Lore Tengah. Since January 2002 the region of Pipiorke in Kulawi also became a sub district of its own (Kreisel et al., 2004).

Palu and borders the national park in the south. The sub districts of Palolo and Lore Utara stretch along the eastern side of the LLNP and the sub district of Kulawi on the western side. The sub district of Lore Selatan is located south of the national park (Figure 1).

Figure 1: The research area



1.3 Problem analysis

The province of Central Sulawesi is one of the poorest provinces in Indonesia (Suryahadi and Sumarto, 2001). Based on household survey data, 28% of the households were classified as poor and more than 42% of the households as vulnerable. Only six provinces had a higher share of vulnerable households than Central Sulawesi. There was a strong increase of 23% in that group compared to figures from 1996. This is the second highest increase of all provinces of Indonesia. Estimates based on household data are not available for the region surrounding the Lore-Lindu National Park, but a study based on Rapid Rural Appraisals at the village level reported a mean income of IDR 597,300 in 1997, which is more than 50% below the official poverty line of IDR 1,165,750 per household. Based on the same figures, 97% of the villages were classified as below the official poverty line (ANZDEC, 1997).

The area is also characterised by an increase in population by 2.4% per year over the last twenty years, of which 21% is due to immigration (Maertens, 2003). These people were and are attracted by the income opportunities in coffee and particularly in cocoa cultivation. During the past two decades the area planted with cocoa increased from almost zero to 18,000 hectares being a major source of deforestation often located inside the LLNP (Maertens, 2003). This ongoing encroachment threatens the integrity of the park, which hosts some of the world's most unique plant and animal species. It is home to important populations of endemic bird species, like the Maleo-bird, and mammals like the Dian's tarsier, the Anoa or the Babirussa (Waltert et al., 2003).

Therefore, alternative income sources for rural households are needed which are able to reduce poverty and the pressure on the national park. A good understanding of the determinants of activity participation as well of the income derived from these activities is essential for the design of policies promoting alternative income strategies.

1.4 Objectives and research topics

The study aims to identify and analyse the determinants of income generating activities of rural households in the vicinity of the Lore-Lindu National Park. It helps to identify factors, which are essentially for the design of policies and programmes aiming to promote rural development. It is part of project A4 “Economic analysis of land use systems of rural households” of the Collaborative Research Centre “Stability of Rainforest Margins” (STORMA).

The analysis of income generating activities is divided into a descriptive analysis and into a causal analysis. The descriptive analysis addresses the question “what” (research questions 1 and 2), whereas the causal analysis seeks to answers the question “why” (research question 3 until 6). Specifically the following research questions will be addressed:

1. In which income activities are rural households engaged?
2. Do poor differ from less-poor households in their activities?
3. Which factors influence total household income?
4. Which factors influence the participation in different activities?
5. Which factors influence the income gained from different activities?
6. Which factors influence income diversification?
7. Which policy conclusions can be drawn from the results with respect to poverty alleviation, deforestation and rural development?

1.5 Outline

Chapter 2 reviews the theoretical and empirical literature on determinants of income generating activities of rural households. It establishes the conceptual framework, which is the foundation of the empirical analysis. It begins with a description of two conceptual approaches, the livelihood and the assets-activities-

income approach, which link assets with activity choice and incomes. Then, the conceptual framework is described guiding the further analysis. It stylises the influence of various socio-economic factors on the activity choice of rural households. The chapter continuous with a definition of the key terms of this study: assets, activities, and incomes. The third section reviews the empirical evidence of factors influencing income generating activities and hypothesises their outcome for our analysis. The chapter ends with the introduction of a mathematical model of activity choice and incomes yielding the total income and activity income equations on which the econometric models are based.

Chapter 3 describes the methodology used for the analysis throughout this work. We present the sampling frame and describe the selection of households. As empirical studies crucially depend on the data quality, the data collection process as well as the entering and cleaning of the data are described in detail. We continue with a description of the measurement of the dependent as well as the independent variables used in the analysis. Then, the use of sampling weights and the methods applied to measure statistical inferences are introduced. Chapter 3 ends with the presentation of the methodology used in the causal analysis. It describes the different econometric models applied to analyse the influencing factors on total households income, participation, activity incomes, and income diversity.

Chapter 4 presents the results of the descriptive analysis of income and activities rural households are engaged in. The analysis follows the differentiation of activities introduced in the previous chapter according to sectors and functions. After illustrating the composition of the total household income over all households it is shown how this mixture changes according to different socio-economic groups. Then, the different activities are explored in detail with special emphasis on regional differences. After evaluating income shares and the degree of income specialisation the final section looks at the distribution of income. We derive a Lorenz curve to show graphically the income distribution and calculate the Gini coefficient.

The socio-economic factors influencing activity choice and incomes introduced in the conceptual framework are described in Chapter 5. Emphasis is placed

on the variables, which are included in the econometric models in the next chapter. In the first section the possession of physical capital and its differences between regions is analysed. Then, the demographic structure of rural households and the educational background of its members are described. The third section shows the access to social capital, the pattern of migration and the ethnic composition. After evaluating the participation in financial markets the last section, Chapter 5 briefly describes the access to road infrastructure.

Chapter 6 presents the results of the econometric models used in this thesis. The influence of internal and external factors as described in the conceptual framework on total household income, on participation in income activities as well as on activity incomes is analysed. In the later analysis we consider endogeneity as well as simultaneity of activity choice. The chapter ends with an evaluation of the influence of internal and external factors on income diversification.

Chapter 7 summarise the major results of the descriptive as well as the econometric analysis in relation to the research questions presented in Chapter 1.

Chapter 2

2 Conceptual framework

This chapter reviews the theoretical and empirical literature on determinants of income generating activities of rural households. It establishes the conceptual framework, which is the foundation of the empirical analysis.

The chapter starts with the discussion of two conceptual approaches linking assets with activity choice and incomes. Then, the conceptual framework is described, which guides the further analysis. Furthermore, this section explores different definitions and classifications of assets. The definition of income and its classification is presented in the second section. The third section reviews the empirical evidence of determinants of income generating activities and hypothesises their influence concerning our analysis. The chapter ends with the introduction of a mathematical model of activity choice and incomes in the last section. It yields the total income and activity income equations on which the econometric models are based.

2.1 Conceptual approaches linking assets with activity choice and incomes

In recent years two approaches emerged in the literature linking income and activities: the livelihood approach and the assets-activities-incomes approach.

There exists some variation in the definition of a livelihood in the literature. An early definition is in Chambers and Conway (1992, p.7). To their understanding livelihood "comprises the capabilities, assets (stores, resources, claims, and access) and activities required for a means of living". More recently, Ellis (2000, p.10) defines a livelihood as consisting of "[…] the assets (natural, physical, human, financial and social capital), the activities, and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household". As livelihood and income are not synonymous, they are nevertheless inseparably connected, because income "at a given point in time is the most direct and measurable outcome of the livelihood process" (Ellis, 2000, p.10). The livelihood approach emphasises the role of the household's resources as determinants of activities and highlights the link between assets, activities and incomes. Moreover, it stresses the multiplicity of activities rural households are engaged in. A review of empirical studies concerning rural non-farm incomes by Reardon et al. (1998) shows their importance for rural households. On average, non-farm incomes contribute 29% of the total income of rural households in South Asia indicating that a rural household is not necessarily equivalent to a farm household.

Barrett and Reardon (2000) developed another approach linking assets, activities and incomes. Having a production function in mind, assets correspond to the factors of production and incomes to the outputs of production. Activities are the ex ante production flows of asset services. In contrast to the livelihood approach they highlight the role of prices in the income generating process. They point out that "[…] it is crucial to note that the goods and services produced by activities need to be valued by prices, formed by markets at meso and macro levels, in order to be the measured outcomes called incomes" (Barrett and Reardon, 2000, p.27).

The conceptual framework used in this work builds on the features of these two approaches linking assets, activities, and incomes. However, more emphasis is given to factors mediating the use of assets. A similar framework has been used by Zeller and Minten (2000) to evaluate the consequences of market liberalisation on the income of rural households.

The household is assumed to maximise its utility which is a function of the consumption of goods and leisure. It is subject to various constraints, such as a cash constraint. According to its objective, the household allocates its resources to activities subject to factors which are external to the household (see Figure 2). These activities generate outcomes which will meet the objectives. The activities as well as the income generated have an effect on the stock of resources available to the household in the future[2]. The total household income is the aggregate measure of the outcome of all the activities the household is engaged in. Determinants of the production decision which are external to the household, are illustrated on the left hand side of the conceptual framework. They condition, or as Ellis (2000) calls it, mediate the use of the household's resources. The household's assets are shown on the right hand side, which also stylises the decision making process of the household.

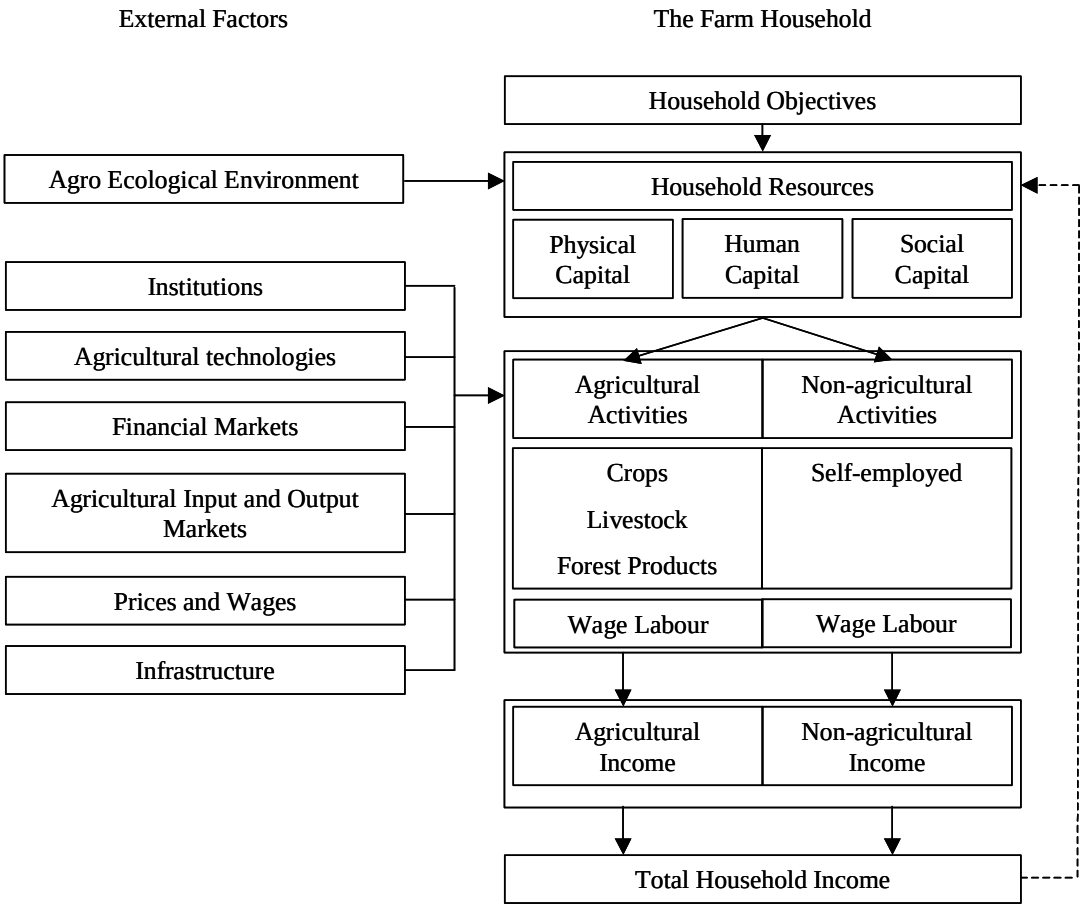
The household is taken as a single decision-making body. Processes by which resources are allocated among household members, the so-called intra household resource allocation, are not taken into account due to limitations in time and budget for data collection. This implies that consequences of policies can only be modelled for the household as a whole and not for its individual members[3].

[2] Such inter-temporal resource allocations are not the subject of this study and hence a broken line illustrates this relationship. Inter-temporal linkages are investigated in project A3 of STORMA.

[3] For a more detailed discussion of the problem of intra household resource allocation see Haddad et al. (1997).

Factors external to the household influencing decision-making are the agro-ecological and socio-economic environment. Main components of the latter are the access to institutions (such as for agricultural extension and credit), agricultural technologies, infrastructure and the access to agricultural input and output markets. These components determine together with agricultural and rural development policies the transaction costs and farm-gate prices of rural producers and consumers. An important role in this regard plays the wage rate, but also the price for land.

Figure 2: Conceptual Framework



Source: Adapted from Zeller and Minten (2000, p. 25)

Barrett and Reardon (2000) define assets as stocks that produce cash or in-kind returns. These assets are the bases for the households' ability to participate in activities to generate income. In the literature various classifications of assets can be

found. For example, Reardon and Vosti (1995) differentiate natural, human, on-farm physical capital, off-farm physical capital, and community owned resources. Barrett and Reardon (2000) propose to distinguish productive and non-productive assets. Productive assets are inputs used in the production process and therefore generate income indirectly via the activities. In contrast, non-productive assets generate income directly through transfers or capital gains. Furthermore, they propose a distinction based on ownership. Ellis (2000) distinguishes natural, physical, human, social, and financial capital. He claims that his categorisation can solve the anomalies between the different researchers, but without giving clear definitions to differentiate them.

In our analysis we follow the asset classification proposed by Vosti and Reardon (1995) but without a spatial differentiation of physical capital. Additionally we differentiate explicitly the household member's access to social networks and institutions. Recent empirical studies highlight the important influence of social capital on household welfare and poverty (Narayan and Pritchett, 1997, Grootaert, 1999, Collier, 1998). Thus, the household's resources are classified as physical capital (land, livestock, and other assets owned), human capital (labour, education, gender and age), and social capital (access to social networks and institutions).

2.2 Definition of income and its classification

As income is defined as the output of activities it measures both cash and in-kind contributions. All the goods and services produced in activities are valued at market producer prices regardless of their use. So, all own-farm products are valued at the same price as if they were sold (Ellis, 2000).

In the literature there has been a wide range of different systems in classifying sources of income. Terms like off-farm and non-farm income are used in an at first glance synonymous way, but with slightly different definitions. Ellis (2000) for example defines off-farm income as income originating from wage labour on other farms whereas Barrett et al. (2001) refer to off-farm income as all activities away from the farmer's own property. We follow the classification proposed by Barrett et

al. (2001) according to sectors (agriculture and non-agriculture) and functions (wage and self-employment). The third criteria used, spatial classification, is not distinguished here because there is not a single household in the sample where income from migrated household members is relevant. All income derived is therefore classified as local. Figure 3 illustrates the concept and the classification of the different income sources.

Figure 3: Classification of activities according to functions and sectors

	Sector	
Function	Agriculture	Non-agriculture
Self-employment	Annual crops	Enterprises
	Perennial crops	Rents
	Livestock	
	Forest products/Fishing	
Wage employment	Agricultural wage labour	Non-agricultural wage labour

Source: Adapted from Barrett et al. (2001)

In the analysis we distinguish the income activities mentioned in Figure 3, but aggregate income from enterprises and rents to non-agricultural self-employed income. This differentiation also allows a detailed analysis of the non-agricultural sector, because it might represent an income opportunity for rural poor without leading to further encroachments. We further differentiate agricultural self-employment into four different activities, because the analysis of perennial crop production is particularly important as the encroachment into the national park is mainly driven by cocoa (Maertens, 2003). Moreover, the collection of forest products in the LLNP also deserves special attention.

2.3 Review of empirical evidence on determinants influencing income generating activities

As depicted in Figure 2 the approach applied focuses on the access to the different types of assets which is conditioned by external factors, like institutions and

infrastructure. In this section we review the empirical evidence on determinants influencing activity choice and activity income.

Why do households diversify their activities and increase for example their income from activities outside agriculture? They change because returns to their assets endowed in agricultural production decrease in relation to the returns from using them in activities outside agriculture. This implies that the choice of activities highly depends on access to the different types of assets (Winters et al., 2002 and Barrett et al., 2001) and also explains why not all households have the same opportunities to participate in non-agricultural activities. Poorer households tend to have less access to non-farm activities than households that are better off. Moreover, there is a strong link between non-farm income share and total household income (Reardon et al., 1998). In the econometric model we will explore this relationship by including the value of other assets owned as a welfare indicator. These other physical assets are mainly unrelated to agricultural production. The area of land and the livestock units owned are also included as explanatory variables in the regression models to account for the influence of physical capital related to agriculture on activity choice. In the activity choice and income models we distinguish the possession of rainfed and irrigated land to investigate the influence of paddy rice production on the production of perennial crops and furthermore on the encroachment into the LLNP.

In a literature review, Barrett et al. (2001) find a strong positive relation between education and non-farm incomes in almost all of the papers reviewed. Nevertheless, when also considering the agricultural sector than the results are mixed. Jolliffe (1998) reports for Ghana that schooling has a negative influence on income from agricultural self-employment, whereas it has a positive impact on total and off-farm income[4]. In Mexico, Taylor and Yunez-Naude (2000) find high returns from schooling in wage labour, whereas the returns in the production of staples are low and not significant. These results reveal the importance of activity differentiation. Moreover, they show the need for a clear definition of the income activities to make

[4] Jolliffe (1998) refers to off-farm income as the aggregate of wage income and income from self-employment outside agriculture.

the results more easily comparable. In this study we include the years in school of the head of the household as a proxy for education. Besides education, we also control for the influence of ethnicity on activity choice and income.

Other than human capital, access to social capital can also play an important role. Narayan and Pritchett (1997) demonstrate with an econometric model for Tanzania, that social capital has a higher influence on household income than human or physical capital. Grootaert (1999) highlights the important influence of social capital on welfare and poverty in Indonesia. In terms of activity choice social capital can foster the ability to participate in many different income activities. To test whether the density of a social network has any influence on activity choice and incomes we include a social capital index, measuring the access and the influence of household members in formal institutions. Moreover, we also include a variable measuring the ethnicity of the head of the household since this can influence the access to informal social networks.

Less-poor households do not only own more productive assets, but also have better access to markets, especially to financial markets. Limited access to credit can either "push" poor households into wage labour activities to earn cash (Reardon et al., 1998) or it further restricts their ability to invest in non-agricultural activities. Poor households are not able to adjust their capital stock to the different needs in activities outside agriculture. Households which have access to credit are able to participate in credit markets, but they may choose not to do so or may borrow less than they could (Diagne et al., 2000). Due to difficulties in measuring access to credit, we measured the participation in formal credit markets by using a dummy variable which is "one" when the household received a formal credit in the last five years and "zero" otherwise.

Studies by Canagarajah et al. (2001) in Tanzania and Smith et al. (2001) in Uganda show that better physical access to markets increases non-farm earnings. Thus, we include the distance from the homestead to the next tarmac road in our econometric models. Nevertheless, it is difficult to distinguish the effect of the distance to roads from other spatially fixed effects. To control for these effects we in-

clude location dummies, which are equivalent to the four sub districts in our research area.

In the context of income diversification various studies highlight the importance of risk. Studies by de Janvry et al. (1991) and Kinsey et al. (1998) indicate that income diversification is positively correlated with an increased ability to cope with shocks. Diversification is a way rural households insure themselves against the occurrence of such shocks. Therefore we included a variable in the model on income diversification measuring the number of harvests failed in the last 10 years.

2.4 Mathematical model of activity choice and income

The following model of activity choice is a simplified mathematical description of the conceptual framework presented in the previous sections. It is based on a mathematical model developed by Taylor and Yunez-Naude (2000).

The household is assumed to maximise total income subject to an investment constraint. For simplicity reasons we further assume:

- Two activities: food crop (a) and cash crop (c) production.
- Among the household characteristics we distinguish schooling and other household characteristics.

Net income (y) of an activity (i) is a function of the investment (L), of the level of schooling (S), other household characteristics (Z), and of prices (P).

$$(1) \quad y^i = y^i\left(L^i; S; Z^i; P^i\right) \quad i = a, c\,.$$

The functional characteristics of Equation 1 are also influenced by the socio-economic and agro-ecological environment. Total household income (Y) is given by

$$(2) \quad Y = y^a + y^c\,.$$

Subject to an investment constraint

(3) $L^a + L^c \leq \bar{L}$.

Given the investment constraint, the optimal allocation of resources between the two activities is given by the first order condition

(4) $$\frac{dY}{dL^a} = y_L^a\left(L^a; S; Z^a; P^a\right) - y_L^c\left(L^c; S; Z^c; P^c\right) = 0 .$$

In order to ensure a maximum the second order condition must also hold (y^a_{LL}; y^c_{LL}). After totally differentiating the previous equation with respect to S the marginal effect of schooling on investment in food crop production is

(5) $$\frac{dL^a}{dS} = \frac{y_{LS}^c - y_{LS}^a}{y_{LL}^c + y_{LL}^a} .$$

Using the investment constraint, the marginal effect of schooling on investment in cash crop production is

(6) $$\frac{dL^c}{dS} = -\frac{y_{LS}^c - y_{LS}^a}{y_{LL}^c + y_{LL}^a} .$$

If the marginal effect of schooling on the net income productivity in investment in food crop production (y^a_{LS}) is greater than in cash crop production (y^c_{LS}) the numerator becomes negative. As the denominator is also negative, an increase in schooling increases investment in crop production. The reverse is obtained if the marginal income effect is higher in cash crop production than in food crop production. The effects of schooling on net incomes are given by

(7a) $$\frac{dy^a}{dS} = y_L^a \cdot \frac{dL^a}{dS} + y_S^a$$ (7b) $$\frac{dy^c}{dS} = y_L^c \cdot \frac{dL^c}{dS} + y_S^c .$$

When the direct effect of schooling on the production is positive, the marginal productivity of investment also increases in both activities. However, in the activity that loses investment, the schooling effect on production is ambiguous because of the reallocation effect. Solving the first-order condition and by using the optimal invest-

ment in the activity income equation obtains the reduced form activity income equations

$$(8) \qquad y^i = y^i\left(S; Z^i; P^i\right); \quad i = a, c$$

The activity income equations are linked by the reallocation effect. Thus, income from one activity depends on the variables affecting both activities. Total income is given by

$$(9) \qquad Y = \sum_i y^i\left(S; Z^i; P^i\right); \quad i = a, c$$

The econometric modelling of activity choice and incomes in the following chapter is based on the last two equations.

The mathematical model presented is a simplification of the conceptual framework, as it explicitly shows one form of capital, human capital, only. Other forms of capital are modelled implicitly through the investment constraint L. An extension of the model to explicitly take into account all four types of capital mentioned in the conceptual framework is possible. It is not shown here because the mathematical formulation becomes very complex. Furthermore, the basic arguments stay the same only that the marginal rates of return to different types of capital have to be equal in the optimal solution. Another possible extension concerns the objective function which can be extended to assume utility maximisation under a consumption and a leisure constraint. Moreover, the inclusion of a food subsistence constraint reflects a situation where the access to food markets is limited. Households are forced to cultivate more food crops for home consumption compared to households with better access to markets for basic staples.

2.5 Summary

This chapter reviewed the theoretical and empirical literature on determinants of income generating activities of rural households. The conceptual framework, which is the foundation of the empirical analysis was established. The livelihood

approach and the assets-activities-income approach were discussed as they link assets with activity choice and incomes. The conceptual framework was then described guiding the further analysis. It stylises the influence of various socio-economic factors on the activity choice of rural households. In the literature various definitions of assets, activities, and incomes exist. We reviewed the literature concerning these key terms and thoroughly defined them for the purposes of our study. Assets are distinguished into physical, human and social capital. Activities and incomes are classified according to functions and sectors. In the following analysis we will distinguish agricultural self-employment, agricultural wage labour, non-agricultural self-employment, and non-agricultural wage labour. Because of its importance the category agricultural self-employment is further differentiated into annual and perennial crop production, livestock production and the sale of forest products. Based on a literature review the influence of various factors on income generating activities was hypothesised. Finally, a mathematical model of activity choice and incomes was introduced which yields the total income and activity income equations for the econometric models.

The review of the theoretical and empirical literature leads to the formulation of hypotheses and to the design of a conceptual framework, which was then described in a mathematical model. The whole conceptual framework was the foundation for the data collection process. The next chapter describes how the necessary data was collected, processed, and analysed.

Chapter 3

3 Methodology

This chapter presents the methodology used to answer the research questions of this study. After presenting the sampling frame and the selection of households, the data collection, the entering and the cleaning of the data is described. The third section in this chapter presents the measurement of the dependent as well as the independent variables used in the econometric analysis. The following section deals with the methodology used in the descriptive analysis. It describes the use of sampling weights and the methods applied to measure statistical inferences. The last section presents the methodology used in the causal analysis. It describes the different econometric models applied to analyse the influencing factors on total households income, participation, activity incomes, and income diversity.

3.1 Sampling frame and selection of households

As this study is part of Project A4 of the Collaborative Research Centre STORMA, we used the common sampling frame agreed upon by all participating projects. The procedures used for the selection of villages and households are described in detail in Zeller et al. (2002a). This section describes the main stages in the selection process and highlights some important methodological aspects.

The population for the study are all households living in the 117 villages of the research area. The observation unit is the rural household. A multi-stage sampling design was used because a sampling frame at the household level did not already exist for the research area and the costs of construction would have been high. As a list of villages and additional information for 115 villages is contained in ANZDEC (1997) villages were used as first stage sampling units. Beyond the selection procedure this arrangement also has the advantage of being more cost-effective for the survey. The enumerators do not have to visit households living widely dispersed from each other. They can work in survey teams travelling together from village to village. Working in teams also has the advantage of strengthening the moral of the enumerators (Deaton, 1997, Poate and Daply, 1993). As the survey becomes more cost-effective, the supervision is also less costly and easier to organise.

Before selecting the villages they were divided into mutually exclusive subpopulations, the so-called strata, which were then sampled independently. The main reason for choosing this procedure was to ensure catching the large differences in agro-ecological and socio-economic conditions affecting land-use. It was hypothesised that the following three criteria have a strong influence on the practices of land cultivation in the research area (Zeller et al., 2002a):

- Proximity of the village to the park (two subgroups)
- Population density (two subgroups)
- Ethnic composition (three subgroups)

The 115 villages were divided into 12 strata according to these three selection criteria. After inspection of the data it turned out that one stratum was empty and another one contained only one village. This village was grouped into another strata and ten strata remained. In three subsequent steps 80, 20 and 12 villages have been selected out of the 10 strata. In the latter sub sample it was assured that at least one village out of each strata was chosen (Zeller et al., 2002a). During a field visit at the beginning of 2001, it was recognised that the village of Wanga was grouped into a wrong strata due to an error in the report of ANZDEC (1997). After regrouping this village, another strata became empty and 9 strata remained.

The precision of the statistical estimates depends on the procedures used in the sampling frame. While stratification usually increases the precision of the sampling estimates, clustering reduces it. Within a cluster households are usually more similar to each other than to households in other clusters, especially when the clusters represent different localities. Due to environmental and climatic effects land-use might be more similar within a village than between villages (Deaton, 1997, Poate and Daply, 1993). The effect of clustering and stratification could not be incorporated into the analysis because of software limitations[5].

In a second stage, 301 households were randomly selected out of the 12 villages. The number of selected households in every village was chosen according to the share in the overall population of the strata, but adjustments have been made according to village size and the proximity to the National Park. In small villages a higher number of households have been selected due to cost and logistic considerations. In villages close to the LLNP more households have been selected, as STORMA is particularly interested in households and their plots close to the national

[5] At the time of writing, Stata 8 is the only software package which is able to take the effects of clustering and stratification into account. Unfortunately, it requires that each stratum contains more than one village, which is not the case in our study.

park. In every village, a list containing all households in the village[6] was compiled. In all villages administrative records exist, but there accuracy varied greatly. Therefore, existing records have been updated with the help of the villagers. To ensure that households from the entire list can be drawn, the step size was calculated by dividing the number of households in the list by the sample size. The first household to be chosen was determined by randomly selecting a number between one and the value of the step size (Zeller et al 2002a).

The number of households chosen in the different strata has not been proportional to the strata's share in total population. In order to extrapolate results from the sample to the population, the descriptive analysis as well as the econometric analysis has to use sampling weights. The sampling weights W are calculated for strata i as

$$(10) \qquad W_i = \left(\frac{n_i}{N}\right) / \left(\frac{s_i}{S}\right),$$

where n_i is the number of households in strata i and s_i is the number of households being sampled out of strata i. N refers to the total number of households in the research area and S to the total number of households being sampled. Table 1 gives an overview of the randomly selected villages for STORMA and their corresponding sampling weights.

[6] In Maranata, a large village in the district of Sigi-Biromaru, a random sub-sample of the districts of the village (dusun) were chosen to reduce survey costs. Only households in dusun number 1, 2, and 5 have been selected.

Table 1: Sample villages of STORMA and their sampling weights

District	Village	Strata	Number of selected households	Sampling weight
Lore Utara	Watumaeta	6	20	0.53
	Wuasa	10	27	0.86
	Wanga	6	17	0.53
	Rompo	6	16	0.53
Palolo	Sintuwu	8	25	0.63
	Berdikari	5	21	2.54
Sigi Biromaru	Maranata	3	32	1.35
	Pandere	10	31	0.86
	Sidondo II	4	33	1.17
Kulawi	Bolapapu	9	32	0.68
	Lempelero	7	30	0.58
	Lawe	2	17	1.99

Source: Zeller et al. (2002) and own calculations

3.2 Data collection, entry, and cleaning

Data was collected through standardised, formal questionnaires[7]. A first draft of the questionnaire was designed in Germany in the summer of 2000. This draft was intensively discussed with our Indonesian counterparts and with the other projects within programme area A of STORMA before it was translated into Indonesian. This draft version was tested in the village of Bora, which is not part of the sample villages of STORMA. This guarantees that the pre-test does not influence the subsequent survey. The experiences of the pre-test helped to further improve the questionnaire.

The interviews were conducted by two local teams, which consisted of five enumerators and a supervisor. They were selected out of more than 200 applicants through a written test and interviews. The written test focused on the agricultural

[7] The questionnaires are available at http://www.gwdg.de/~uare/research/projects/storma_a4/activities.php.

knowledge and the arithmetic skills of the candidate, whereas the interview tried to assess personality and character.

The selected candidates were mixed concerning religion and ethnicity. All of them had completed at least high school and some had even finished BSc.-Study at UNTAD University. Out of the group of candidates we selected two supervisors who were responsible for supervision and organisation of the field work. They also represented the group in the villages.

Prior to the survey the enumerators were extensively trained in the classroom and in the field. In the classroom, the first part of the training, the enumerators were familiarised with the survey. The objectives of the survey were explained as well as the relevance to local and national development. Each question of the questionnaire was discussed in detail regarding its reason, measurement, concepts, coverage, and the reference period. Finally, the interview situation was trained using role-playing. The field training again took place in the village of Bora. During the training the enumerators went in teams of two to the respondents. The interviews were analysed by the senior field staff. The experiences of the enumerators with the respondents and the questionnaire were discussed, which helped to finalise the questionnaire.

The teams were guided by senior field staff consisting of members of the STORMA research project. The first survey took place from December 2000 until March 2001. The data was entered twice by different enumerators at UNTAD University in Palu. The two versions were compared using SPSS Data Entry, which records differences between the versions. In case of inconsistencies, the entry was compared with the information in the questionnaire. This procedure minimises data entry errors. After entering the data was cleaned, which consisted of examining the data for missing values, wild codes, inconsistencies, and extreme values.

Due to the high amount of information needed within Project A4 of STORMA, the households were visited twice. In the first survey the focus was on household composition, land and livestock possession, and the use of inputs and outputs. Additionally, all the questions needed to calculate the poverty index have been

included. A second visit followed, asking questions about changes in the household composition and the possession of land and livestock. Once again, the focus was the use of inputs and outputs on agricultural plots and additional questions on wage labour and business income were included. The same enumerators and supervisors were employed and the same procedures used for the first survey were applied. The second survey took place from August until October 2001.

In the first survey, all 301 households which were selected were interviewed. During the second round of the survey the number of households dropped to 293 because five households moved and three refused to cooperate any longer with STORMA. We decided not to replace these households, as the sample size was still sufficient.

Additionally, information was drawn from secondary data, interviews with experts, and from the results of other sub-programmes. Of special interest was the work of sub-project A3, which collected data about the regional market and policy environment in the same twelve villages, where the household survey was conducted.

3.3 Measurement of the dependent variables

3.3.1 Measurement of income

The total household income is the sum of the net income from agricultural and non-agricultural self-employment and wage labour activities (see Figure 3 in Chapter 2.2). The net income from an activity is obtained by subtracting the cash expenses incurred in production from the gross income (Taylor and Turner, 1998).

All data needed to calculate the crop income was collected at the plot level. To make the recall process easier for the respondents we asked in the case of annual crops, only for the yield and the input expenditures of the last crop harvested. Data from both rounds covers about one year of activities. Nevertheless, a possible measurement error occurs due to the possibility of almost three harvests per year on some plots in the case of paddy rice, maize, and vegetables. In the case of perennial crops,

it was not possible to ask only for the last harvest because some crops, like for example cacao, are harvested continuously over the year. Therefore, we decided to use a recall period of one year for perennial crops. The gross income from crop production was obtained as the sum of all crops produced during the recall period valued at the market producer price. So all the crops produced were valued at the same price regardless whether they were being sold or consumed at home. If a market producer price for a specific crop was missing at the household level, the corresponding village level price was used. If a village level price was not obtained the next level prices were used and so on up to the highest level, the overall sample price. To reflect the high opportunity costs in marketing their products, the market producer prices in the village of Lawe was reduced by IDR 500 per kg of output. All of the products sold were brought to the village of Gimpu by horse, which is about one day travelling from Lawe. The net income was obtained by subtracting the sum of the cash expenses for land preparation, seeds, fertiliser, irrigation, pesticides, transport, and hired labour from the gross income. The labour component consisted of wages paid in cash and in-kind. We did not consider fixed costs like overhead costs for machinery, as it is not relevant in the region.

The data needed for calculating the income from livestock production was gathered at the livestock level. The gross income from livestock production is the sum of the value sold and the value slaughtered for home consumption between round one and two. The latter was calculated by multiplying the number of animals slaughtered times the mean value of the animals of this type owned. Any other animal products, for example milk, are not relevant in the region. The same applies for by-products, like manure. A third component of the gross income from animal activities are inventory increases (Turner and Taylor, 1998). As the inventory changes from round one to round two turned out to be quite numerous in a fraction of the households interviewed, the income from livestock would have been extraordinary high. As this does not reflect reality we decided to drop this gross income component. From the gross income the variable costs, which is the value of animals purchased and the value of the animals lost due to death or theft, have been subtracted. Finally, these figures have been adjusted for a whole year. In the case of poultry, for

simplicity reasons gross income was assumed as the mean value of poultry owned between the two surveys.

The income from fishing is the value of fishes caught. Due to problems in valuing the forest products gathered for home consumption, forest products income contains only the value of the products sold in the last twelve months. Wage labour incomes are the sum of the earnings of the individual household members. Income from enterprises is the profit of the business minus expenditures for labour and other inputs. In the research area, various rental arrangements exist for example share tenancy. Despite the different arrangements, in all cases the rent received considers cash as well as in-kind payments and the value of inputs provided by the owner is deducted.

In the evaluation of the different income activities three different aspects are analysed: participation, activity incomes, and income shares. Participation measures whether a household is involved in an activity or not. By definition, the household participates if the activity income is different from zero. In the case of zero activity incomes the household does not participate. Activity income refers to the income from a certain activity measured in IDR. The percentage shares in activity incomes are calculated by dividing the mean activity incomes by the mean total income. These shares provide an insight into the importance of certain activities for the region. They should not be mixed-up with income shares, which is the mean of the percentage share of the income from an activity in total household income. Income shares highlight the importance of activities at the household level.

3.3.2 Measuring income diversity

To quantify the degree of diversification out of agriculture we use the share of non-agricultural income in total household income. As a measure of the overall diversity of income we apply the Shannon equitability index. It is derived from the Shannon index (H), which is usually used to assess the diversity of species (Magurran, 1988). Adapting it for our purposes leads to:

$$(11) \qquad H_{income} = -\sum_{i=1}^{S}\left[\left(incshare_i\right)\cdot \ln\left(incshare_i\right)\right] ,$$

where S is the number of income sources and $incshare_i$ the share of income from activity i in total household income. The Shannon index H_{income} takes into account both the number of income sources and their evenness. It is calculated for every household and increases continuously with higher diversity. Based on this index the Shannon equitability index E is calculated by:

$$(12) \qquad E = \left(\frac{D_{income}}{-\sum_{i=1}^{S}\left[\left(\frac{1}{S}\cdot \ln\left(\frac{1}{S}\right)\right)\right]} \right)\cdot 100 \quad ,$$

where the denominator is the maximal possible Shannon index. The Shannon equitability index ranges from zero to 100 and states the percentage share of the actual income diversification in relation to the maximal possible diversity of income.

3.4 Measurement of the independent variables

In the econometric models we use various proxies for the capital endowment as well as for the external factors described in the conceptual framework. The following section describes how we empirically measured these proxies. We follow the differentiation in internal and external factors.

3.4.1 Internal factors

Physical capital is composed of land, livestock, and other physical assets which are owned by the household. The categories land and livestock include productive assets only, whereas the category other physical assets also include non-productive assets, like furniture or televisions. Chapter 5 provides a detailed descriptive analysis of these asset categories. As households own different types of animals it is necessary to use a conversion factor to calculate a single indicator for livestock ownership (see Table 2).

Table 2: Livestock conversion factors

Type of animal	Conversion factor
Buffalloes	1.00
Cattle	0.70
Horses	0.80
Pigs	0.30
Goats	0.10
Poultry	0.02

Source: Taylor and Turner (2000)

In the descriptive analysis we have explored the relationship between socio-economic status and activity incomes by using a poverty index as a medium term welfare indicator. To generate the index a method developed by Zeller et al. (2002b) was used, which employs principal component analysis to select and eventually aggregate various indicators of poverty into a (0,1) normally distributed poverty index. Unlike the commonly used absolute measures of poverty such as a monetary poverty line, this method takes also into account other dimensions of poverty, such as education, food consumption and the condition of the dwelling. Details of this method, including sampling and questionnaire design are reported in Henry et al. (2001). The poverty index was estimated for each of the sample households (Abu Shaban 2001). It is computed from three asset-related indicators, four dwelling indicators, and two consumption indicators[8]. Thus the index can also be seen as a proxy for the endowment with physical capital not related to agricultural activities. The poverty groups are just the terciles of the poverty index. The poverty groups were calculated after the first round of the survey. Due to the households which dropped-out, the groups no longer contain the same number of households.

In the category human capital, we used the dependency ratio and the years in school in the analysis. The dependency ratio is the number of household members

[8] The indicators are total value of electronic appliances, value of transport assets, number of televisions owned, access to electricity, type of wall, type of roof, type of floor, per capita expenditures on clothes and footwear, and the share of income spent on food out of a hypothetical increase in income of IDR 20,000 per week.

below fifteen and above 60 years old divided by the number of the remaining household members. The years in school are calculated based on the level of schooling of the individual household members.

The social capital index of a household was calculated by multiplying the number of memberships in organisations by the so-called decision making index (Grootaert, 1999). The number of memberships measures the density of membership and includes all kinds of groups and the memberships of all household members. Moreover, the head of the household and the spouse were asked to name up to three most important associations they were members of. They were asked to evaluate subjectively whether they were “very active”, “somewhat active” or “not very active” in the decision making process of the group. The response was scaled from 2 (“very active”) to 0 (“not very active”), respectively, and averaged across the number of organisations regarded as important by the head of the household and the spouse. Multiplying by, 50 this figure was re-scaled from 0 to 100 to form the decision making index.

3.4.2 External factors

In the questionnaire the households were asked detailed questions about the different types of credit they received. We assumed that the households access smaller informal credits more often than bigger informal credits. Therefore, we differentiated them into informal credit below IDR 30,000, informal credit between IDR 30,000 and IDR 50,000 and informal credit above IDR 50,000. To reduce the costs of data collection we referred the first category to the last 8 weeks, whereas for the other two types of credit the recall period was 8 months. For credit from formal sources we referred the question to the last five years as we assumed that they are accessed much less frequently. Due to the differences in the recall period it is not possible to directly compare formal and informal credits.

The distance to the next tarmac road is used as a proxy for the access to road infrastructure. Each respondent was asked to estimate how many hours he needs to get to the next tarmac road on foot.

3.5 Methodology used in the descriptive analysis

Besides the minimum and maximum values of variables, the descriptive analysis also provides means as a measure of central tendency and the standard deviation as a measure of the variability. Moreover, we used frequency tabulations and cross-tabulations. All the results presented are weighed results by applying the sampling weights presented earlier in this chapter. As a characteristic of the computer package used[9] the number of cases presented are also weighed counts. The 293 households interviewed represent the 290 weighed observations reported in the descriptive tables. In contrast to the point estimates, the standard errors of these estimates have not been corrected for sampling effects.

When observing differences in the mean of variables or among groups of a variable, we do not know whether the difference is a real one or whether it is just by chance. We have to apply statistical tests to ensure that the observed difference is statistically significant. To evaluate differences in the mean between two variables we applied paired t-tests. An example is the difference in the illiteracy rate between male and female household members.

In the case of comparing the mean of three or more groups of the same variable, Analysis of Variance (ANOVA) was applied. An example is the difference in participation in agricultural wage labour activities by poverty group. The ANOVA is based on an F-test which has the following underlying assumptions (Black, 1999):

- Interval or ratio scaled variables
- Each sample observation is randomly drawn from the population
- The sampling distribution of the mean is approximately normal
- The variances of the groups are homogeneous

[9] The Statistical Programme for the Social Sciences (SPSS) version 11.0 was used for the descriptive analysis except for calculating the Gini coefficient.

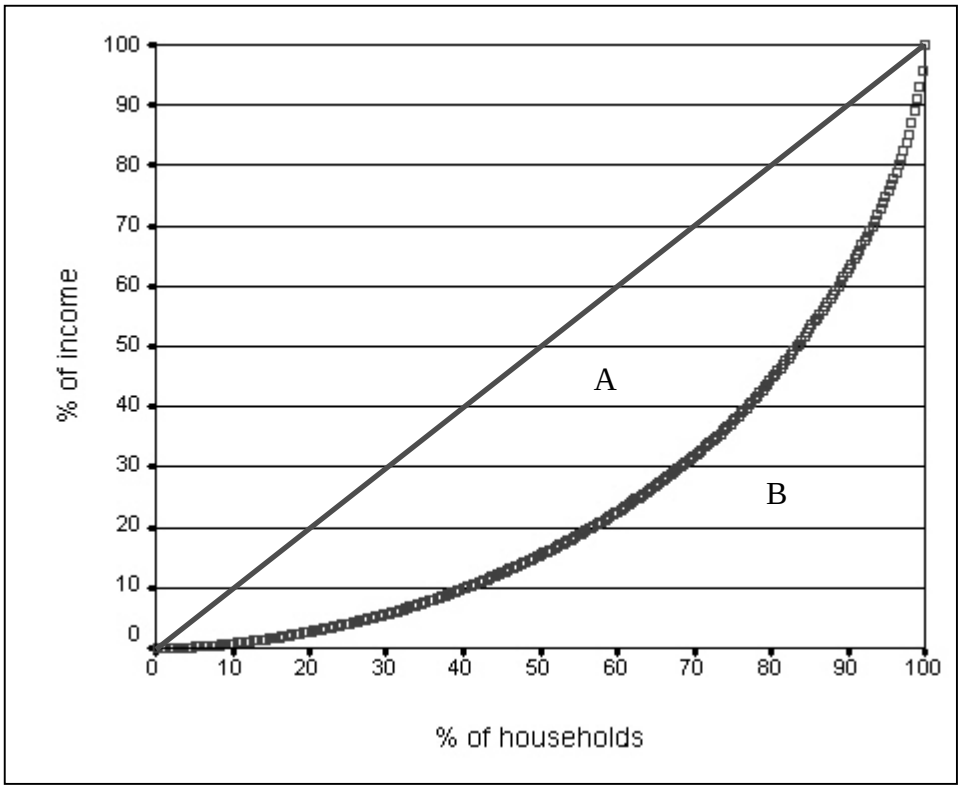
These assumptions can be broken within quite wide limits without invalidating the test. Nevertheless Burns (2000) suggests performing non-parametric tests if more than one of the assumptions is questionable. Therefore, we tested whether the sampling distribution of the mean is approximately normal using the Shapiro-Wilk test and the Lilliefors-Test which is a modified Kolmogorov-Smirnov test. Furthermore, we applied the Levene test to evaluate whether the variances of the groups are homogeneous. If the tests suggest that both assumptions are violated we applied the non-parametric alternative to an ANOVA, the Kruskal-Wallis test which does not assume any type of underlying distribution. It is based on comparing the difference between median ranks (Burns, 2000). Based on the Kruskal-Wallis test we can decide whether there is a difference across the groups, but this does not indicate that all groups are significantly different from each other. For example, if the results indicate that there are differences among poverty groups, we do not know between which poverty groups significant differences exist. If a significant difference among groups exists, pairwise comparisons among the groups have been conducted using the Mann-Whitney test. It is based on comparing the rank order of the variable between the two groups (Burns, 2000).

The test statistics of the ANOVAs and the Kruskal-Wallis tests applied during Chapter 4 and Chapter 5 are shown in the appendix[10]. Throughout these chapters the difference in the mean is called statistically significant if the significant level is greater than 90%.

Common measures for the distribution of income are the Lorenz curve and the Gini coefficient. The Lorenz curve maps the cumulative income share on the vertical axis against the cumulative distribution of the households on the horizontal axis. If each household had the same income, the income distribution curve would be the straight line in the graph (see Figure 4). The further away the Lorenz curve is from the line of total equality, the greater the inequality.

[10] The results of the Mann-Whitney tests are included only once as an example. The remaining test statistics are available on request from the author (stefan.schwarze@gmx.de).

Figure 4: Example of a Lorenz Curve



Source: Own illustration

The Gini coefficient can easily be graphically represented by different areas of the Lorenz curve. It is calculated as the area A divided by the sum of areas A and B (see Figure 4). Therefore, it varies between 0, complete equality, and 1, complete inequality. In the literature, various formulas for calculating the Gini coefficient have been described (see, for example, Nygård and Sandström, 1981). For the computation we used the "ineqdeco" command, which can be implemented into the computer package Stata 8.0. The Gini coefficient (G) is calculated here as (Jenkins, 1999):

$$(13) \qquad G = 1 + \frac{1}{N} - \left(\frac{2}{m \cdot N^2} \right) \cdot \sum_{i=1}^{N} (N - i + 1) \cdot Y_i \,,$$

where N is the number of households, Y_i denotes the total income of household i and m is the mean total household income. The households are ranked in ascending order of Y_i.

3.6 Methodology used in the causal analysis

In the causal analysis, which aims to identify underlying factors influencing the outcomes, various econometric modelling techniques have been applied depending on the nature of the dependent variable[11]. All the results presented are weighed results by applying the sampling weights presented earlier in this chapter. In contrast to the coefficient estimates, the standard errors have not been corrected for sampling effects.

In the descriptive analysis in Chapter 4 and Chapter 5, two observations were striking outliers. One household has a remarkably high income from self-employment outside the agricultural sector generating two-thirds of the activity income of all households. Another household gains almost 28% of its total income from livestock production. As these are highly exceptional cases they have been excluded from the regression analysis. The number of observations used in the regression analysis therefore dropped to 291, which is equivalent to a weighed number of 287.

3.6.1 Total household income

To determine the influence of internal and external factors on the total household income, which is a continuous variable, ordinary least square (OLS) estimation has been used to estimate the linear model

$$(14) \qquad \ln(Y) = \beta\ X + \mu\,,$$

where Y denotes the total household income and x the vector of variables influencing income. Beta is the vector of coefficients which will be estimated and μ is the unobservable random disturbance or error term. Similar models on total household income have been widely used in the literature, for example in Corral and Reardon

[11] The programming codes for the various models are available on request from the author (stefan.schwarze@gmx.de).

(2001) and de Janvry and Sadoulet (2001). The computer package Stata 8.0 has been used for the estimation of this model.

OLS estimators are best linear unbiased estimators (BLUE) under specific assumptions (see for example Greene, 2003, Wooldridge, 2003). Violating these assumptions can lead to biased estimates. In this context, Gujarati (1995) highlights the consequences of heteroskedascity and multicollinearity to the results of OLS estimation.

Heteroskedascity, a situation where the variance of the error term differs across observations, leads to unbiased estimates, but the usual standard errors and t-statistics are no longer valid. Therefore, there has been a lot of attention in the econometric literature on tests for detecting heteroskedascity (for an overview see Gujarati, 1995, and Wooldridge, 2003). We applied the Breusch-Pagan-Godfrey test for heteroskedascity as described in Gujarati (1995), which can be implemented into Stata 8.0. Using the natural logarithm of the total household income as the dependent variable, the hypothesis of homoskedascity is rejected at the 10% significance level, but not at the 5% level. This indicates slight heteroskedascity in the model. Due to this finding, the Huber-White heteroskedascity-robust estimator has been used which is able to produce valid standard errors, t-statistics, and F-statistics.

Another area of concern is the multicollinearity among the independent variables, which describes a situation where high linear relationships between the explanatory variables exist. In case of high multicollinearity the OLS estimates have large variances and co-variances and the models tend to be sensitive to small changes in the data. We used the Variance Inflation Factor (VIF) and the Condition Index (CI) as indicators of the presence of multicollinearity. The VIF measures the variance in the regressor that cannot be accounted for by the other independent variables and shows in our model no values greater than the cut-off value of 10 (Gujarati, 1995). As the VIF is not free of criticism the CI is also applied, which is defined as

$$(15) \qquad CI = \sqrt{\frac{Maximum\ eigenvalue}{Minimum\ eigenvalue}}.$$

In our model the CI is 16, which is well below the cut-off point of 30 suggested by Belsley et al. (1980).

3.6.2 Participation in income activities

Participation in an income activity is measured by a binary variable which is zero if the household does not participate in an activity. In this case the income generated from this activity is a missing value. The binary variable takes on the value one, if the household generates income from this activity. We are interested in how the vector of explanatory variables X influences the possibility that the binary dependent variable Y takes on the value 1. The binary response Probit model can be written as

$$(16) \qquad P(Y = 1/ X) = G(\beta X),$$

where G(.) is the standard normal density distribution and β the vector of coefficients, which is estimated by Maximum Likelihood Estimation (MLE). Similar models on total household income have been widely used in the literature, for example in Corral and Reardon (2001) and Lanjouw et al. (2001). The computer package Limdep 7.0 has been used for the estimation of this model.

When estimating Probit models it is important to have a sufficient mix of ones and zeros on your dependent variable. In general, there has to be at least K of each value, where K is the number of independent variables (Greene, 1998). As this requirement is not fulfilled for the variable measuring the gender of the head of the household, it has been dropped from the analysis.

3.6.3 Activity income

In the analysis of activity incomes we distinguish seven different activities: annual crop production, perennial crop production, livestock production, collection of forest products, agricultural wage labour, self-employment outside the agricultural sector, and non-agricultural wage labour.

A feature of all these activities is that many households do not participate in them. The percentage of households participating ranges from 82% in annual crop production to just 16% in non-agricultural wage labour. Within the random sample of households, some decide to participate in an activity. If they have chosen to participate in an activity we can measure the income from it. Since unobserved characteristics of participants, which differentiate them from non-participants, may also have an influence on the income, estimation of the coefficients may be biased. This bias is called sample or more precisely self-selection bias (Wooldridge, 2002). The most common approach used in the literature to account for sample selection is the Heckman two-step estimator, commonly referred to as the Heckit model. In similar settings such models have been used, for example in Lanjouw (2001). Sample selection models are generalisations of Tobit models[12]. Whereas in Tobit models the selection process is modelled implicitly as being determined by the same variables that explain income, the Heckman selection model explicitly models the decision to participate in an activity and the income generated from this activity in two different equations (Wooldridge, 2002). Despite this drawback, Tobit models are also used in the analysis of income activities, as for example in de Janvry and Sadoulet (2001).

Beside the nature of the dependent variables, another distinct feature of activity choice is its simultaneity. The household does not decide for each activity separately whether it should for example, use its resources in this activity. It can choose to use its assets in different activities at the same time and the choice of an activity is linked to the other activities and depends on them. To reflect the simultaneity of the household members' decision between the different activities, system methods of estimation like Three-stage least squares (3SLS) estimation, are required. They make full use of the information contained in the variables of the system because they also take also into account interactions between them (Greene, 2003).

As the commonly used Heckit model is not able to account for the simultaneity of activity choice and in Tobit models the selection process is modelled only implicitly, another approach is followed. Taylor and Yunez-Naude (2000) use a model

[12] See next section for a description of Tobit models

which considers selectivity as well as simultaneity of activity choice to estimate the returns of schooling to different activities. Their application involves a simultaneous equation model in which the dependent variables are censored by unobserved latent variables. Moreover, they also control for the endogeneity of activity choice. The econometric approach follows a generalisation by Lee (1978) of an estimation principle by Amemiya (1977).

In the first stage a Probit similar to the one described in the previous section is estimated using the full set of explanatory variables. Based on the Probit estimates, the activity specific inverse Mills ratios (IMR) are calculated. They are included as right-hand variables in the corresponding activity income equations and correct for the endogeneity of activity choice. The system of activity income equations is then estimated jointly for the full household sample using 3SLS. Hence, we are also able to exploit the information contained in the cross-equation error terms. Only assets which are expected to affect the income level of that activity are included as explanatory variables in the corresponding income equation. The estimated coefficients are the absolute effect of one-unit changes in the corresponding explanatory variables on activity incomes. They are also called selectivity-corrected activity income estimates (Taylor and Yunez-Naude, 2000). Winters et al. (2002) and Yunez-Naude and Taylor (2001) used the same approach in similar settings. The computer package Limdep 7.0 has been used for the estimation of this model.

Using the IMR as an instrumental variable to model the endogeneity of the selection process has been criticised due to problems in identification (see for example Deaton, 1997). A high correlation between the explanatory variables used in the choice and in the income model can lead to collinearity between the IMR and the other independent variables in the activity income equations. This can make the estimation sensitive to small changes in the data (Puhani, 2000). Therefore, we again used the CI as proposed by Leung and Yu (1996) to detect collinearity. In our model all the CIs are around 25, which is below the cut-off point of 30 suggested by Belsley et al. (1980).

3.6.4 Income diversity

Both dependent variables measuring income diversity, the share of non-agricultural income and the Shannon equitability index, are continuous variables but with a limited range between zero and 100. Moreover, in both cases there is a large share of observations with zero values meaning that households do not participate in non-agricultural activities and that they derive their income from one source only, respectively. Conventional regression methods fail to take into account the qualitative difference between zero and continuous observations. Therefore, we apply Tobit models which have been originally developed for censored data, but which are also used for corner solution models (Wooldridge, 2002). The computer package Limdep 7.0 has been used for the estimation of this model.

The Tobit model in case of censoring at zero can be written as

(17) $Y_i^* = \beta x_i + \mu_i$ and (18) $Y_i = \max(0, Y_i^*)$.

Y_i is the observed censored variable, which is equal to the unobserved latent variable Y_i^*, when Y_i^* is bigger than zero. In all other cases Y_i is equal to zero. The coefficients are estimated by MLE, where the likelihood consists of the product of expressions for the probability of obtaining each observation. For each observation greater than zero this expression is just the height of the appropriate density function representing the probability of getting that particular observation. For observation equal or smaller than zero it is the probability of getting an observation below or equal zero, which would be the integral below the limit of the appropriate density function.

The estimated coefficients identify two effects (see Wooldridge, 2002):

1) The effect of an independent variable on the probability of having income for the non-participating households (the censored observations)

2) The effect of the explanatory variables on the income share for the households participating

These two effects can be distinguished by a decomposition technique proposed by Mc Donald and Moffit (1980).

Two specification issues are highlighted in the literature (Greene, 2002, Wooldridge, 2002). Tobit estimates are generally inconsistent if the error terms are heteroskedastic or distributed non-normal. An informal way to evaluate a Tobit model is proposed in Wooldridge (2002). He suggests comparing the Probit estimates with the Tobit estimates divided by the disturbance standard deviation σ. The sign and the magnitudes of the significant explanatory variables should be similar. This holds true for the Tobit models estimated in this study.

3.7 Summary

This chapter presented the methodology used to answer the research questions of this study. The sampling frame for the selection of households used the methods of clustering and stratification. Data was collected through a standardised, formal questionnaire from 301 randomly selected households in. Due to disproportional sampling of the households sampling weights are used in the descriptive and causal analysis. We apply t-test and Analysis of Variance as well as their non-parametric equivalents, the Mann-Whitney test and the Kruskal-Wallis test, to test for statistical significant differences among groups in the descriptive analysis. Furthermore, this chapter discussed features and limitations of the econometric models applied in the causal analysis. The determinants of total household income are estimated using Ordinary Least Squares estimation. Probit models are used to investigate factors influencing activity choice. In the analysis of activity incomes Lee's generalisation of an estimation principle by Amemiya is applied, which takes into account simultaneity and endogeneity of activity choice. The chapter ends with a discussion of Tobit models used in the model on income diversity.

Before going into the causal analysis, the next chapter describes the results of the descriptive analysis of the incomes and activities engaged by rural households.

Chapter 4

4 Descriptive analysis of income and activities

This chapter presents the results of the descriptive analysis of income and activities engaged by rural households. The analysis follows the differentiation of activities introduced in the previous chapter according to sectors and functions. Moreover, agricultural self-employment is divided into crop production, livestock production and the sale of forest products. This leads to six different income activities differentiated throughout this chapter. After illustrating the composition of the total household income over all households it is shown how this mixture changes according to different socio-economic groups. The different activities are then explored in detail with special emphasis on regional differences. After evaluating income shares and the degree of income specialisation, the final section looks at the distribution of income.

4.1 Income and activities

On average, households in the research area earned a total income of around IDR 5.9 mill with agricultural activities as the most important source (see Table 3).

Table 3: Income and participation by activity

	Total	in %
Total household income		
Mean household income (IDR 1000)	5909	100
Agricultural income - Self-employed		
Mean income for all households (IDR 1000)	3521	59
Number of households participating	278	96
Mean agricultural income households participating (IDR 1000)	3666	62
Mean total income households participating (IDR 1000)	5923	100
Crop Income		
Mean income for all households (IDR 1000)	2626	44
Number of households participating	272	94
Livestock Income		
Mean income for all households (IDR 1000)	477	8
Number of households participating	183	63
Income from forest products		
Mean income for all households (IDR 1000)	399	7
Number of households participating	49	17
Agricultural income - Wage labour		
Mean income for all households (IDR 1000)	626	11
Number of households participating	134	46
Mean agr. wage lab. income households participating (IDR 1000)	1356	25
Mean total income households participating (IDR 1000)	5396	91
Non-agricultural income - Self-employed		
Mean income for all households (IDR 1000)	991	17
Number of households participating	51	18
Mean self-employed income households participating (IDR 1000)	5649	53
Mean total income households participating (IDR 1000)	10680	181
Non-agricultural income - Wage labour		
Mean income for all households (IDR 1000)	766	13
Number of households participating	50	17
Mean non-agr. wage lab. income households participating (IDR 1000)	4475	37
Mean total income households participating (IDR 1000)	11948	202

Source: STORMA project A4 household survey

Number of observations=290

Agricultural self-employment and wage labour activities together contribute to 70% of total household income, with the remaining 30% coming from non-agricultural activities. This confirms findings of a literature review by Reardon et al. (1998) reporting that about 35% of rural incomes in Indonesia stem from non-agricultural activities. However, a study from the sub district of Lampung, Indonesia, reported a non-agricultural income share of only 20% (Jatileksono, 1994), indicating large differences between regions. The most important activity is crop production, which accounts for about 44% of the total income. This is followed by income from enterprises and rents (17%) and non-agricultural wage labour (13%). However, participation of the households in the latter activities is much lower. Of the 290 households, only 51, which is equivalent to 18%, reported income from non-agricultural self-employment. In the case of wage labour activities outside agriculture, just 50 households earned income from this activity. In contrast, 94% take part in cropping activities. But income from non-agricultural activities is a much more important income source for participating households. The 51 households with income from non-agricultural self-employment gained on average IDR 5.6 mill from this activity, which is equivalent to 53% of their total household income of IDR 10.7 mill. Moreover, their total household income is 81% higher than the average income of IDR 5.9 mill. The same applies for non-agricultural wage labour income: participating households generate 37% of their total income from this activity and their total household income is 102% higher than that of the average household.

Non-agricultural income accounts for almost one-third of the total household income over all groups, but how does this change if we look at different wealth groups? Applying the poverty index introduced in Chapter 3, Table 4 shows incomes and activities differentiated by poverty terciles: poorest (poverty group 1), poor (poverty group 3), and less-poor households (poverty group 3).

Statistically significant differences between socio-economic groups exist in the total household income as well as in all the activity incomes except in the income from agricultural wage labour. The average income of poverty group 3 is more than three times higher than the average income of poverty group 1. The differences are

even more striking in the case of incomes from non-agricultural activities. Less-poor households generate on average 23 times more income from non-agricultural self-employment and 6 times more from non-agricultural wage labour than the poorest households.

Moreover, the number of households participating is also statistically different between socio-economic groups for all activities except agricultural self-employment. Participation in agricultural wage labour activities is comparatively low for households that are better off, whereas it is the other way round for non-agricultural activities. In non-agricultural self-employment 26% and in non-agricultural wage employment 25% of the less-poor households participate. In contrast, only 7% of the poorest households are engaged in non-agricultural self-employment and only 10% participate in non-agricultural wage labour activities.

Table 4: Income and participation by activity and poverty group

Poverty Group	1		2		3	
	Total	in %	Total	in %	Total	in %
Total household income						
Mean total household income (IDR 1000)	3619	100	3807	100	11134	100
N	102	100	102	100	86	100
Agricultural income - Self-employed						
Mean income (IDR 1000)	2643	73	2044	54	6320	57
Number of households participating	98	96	98	96	82	95
Crop income						
Mean income (IDR 1000)	1668	46	1636	43	4940	44
Number of households participating	93	92	97	95	82	95
Livestock income						
Mean income (IDR 1000)	213	6	109	3	1228	11
Number of households participating	74	73	53	52	56	65
Income from forest products						
Mean income (IDR 1000)	755	21	260	7	140	1
Number of households participating	31	30	15	14	4	4
Agricultural income - Wage labour						
Mean income (IDR 1000)	631	17	714	19	516	5
Number of households participating	48	47	59	58	27	31
Non-agricultural income - Self-employed						
Mean income (IDR 1000)	116	3	393	10	2744	25
Number of households participating	7	7	22	21	22	26
Non-agricultural income - Wage labour						
Mean income (IDR 1000)	223	6	653	17	1547	14
Number of households participating	10	10	18	18	21	25

Source: STORMA project A4 household survey
Number of observations=290

These differences are also reflected in the percentage shares in total income by activity[13]. Own account agricultural activities are the most important income source for all socio-economic groups, but for the poorest households it contributes almost three-quarters to their total household income. For the other groups it accounts for only 54% and 57%, respectively. The same also applies for agricultural wage labour income. It is most important for the poorest households and less important for the poor and less-poor households. For income derived from outside the agricultural sector it is the other way round. It is particularly important for households that are better off. They generate 25% of their total household income from self-employment outside agriculture, whereas it accounts for only 3% of the income of the poorest households. In the case of non-agricultural wage labour income the picture is not as clear, as it plays an important role especially for poverty group two. This can be explained by the different types of non-agricultural wage labour activities which are a mix of unskilled jobs like working in construction, and skilled jobs like teachers.

An important activity for the poorest households is the selling of forest products and fishing: 32% of them participate in these activities generating 21% of their total household income. For the poor households it accounts for only 7% and for the non-poor this income source is no longer relevant.

4.2 Agricultural self-employed income

Agricultural self-employed income consists of all own-account activities within the agricultural sector, which is income from crops, livestock, and fishing and forest products.

[13] These shares are calculated as the mean activity income over all households divided by the mean of total household income over all households. Therefore it is not possible to apply statistical tests on differences between socio-economic groups.

4.2.1 Crop income

Crop income accounts for 44% of the total household income with 56% generated from perennial crops and 44% from annual crops. The most important crops in terms of income are cocoa and paddy rice accounting together for 57% of the net crop income. Other important crop production activities are maize and coffee cultivation with a share in crop income of 9% and 13% respectively. It is also interesting to note that 70% of the input expenditures go into paddy rice production, whereas all other crops except maize receive only a very small part of the inputs in relation to their share in gross crop income (see Table 5).

Table 5: Participation, share in gross income, share in input expenditures, and share in net income by crop

Crop	Number of households growing	Share in gross income in %	Share in input expenditures in %	Share in net income in %
Paddy rice	156	36	70	24
Maize	112	8	8	9
Upland rice	37	4	1	5
Vegetables	54	3	1	4
Other annual crops	52	2	1	3
All annual crops	236	54	81	44
Cocoa	211	29	17	33
Coffee	121	10	1	13
Coconuts	62	3	0	4
Bananas	77	3	0	4
Other perennial crops	121	1	0	1
All perennial crops	221	46	19	56

Source: STORMA project A4 household survey

Number of observations=272

Paddy rice and cocoa are the most important crops in the research area but with large regional differences (see Table 6). Paddy rice production is concentrated in the sub district of Sigi-Biromaru, whereas a high share of the cocoa production takes place in Palolo. Also, the production of coffee is mainly concentrated in one

sub district. Other crops which are regionally important are upland rice in Kulawi and vegetables, coconuts and bananas in Sigi Biromaru.

Table 6: Share in net income by crop and region

Crop	Lore Utara	Palolo	Sigi Biromaru	Kulawi
Paddy rice	4.8	3.0	13.9	2.7
Maize	3.6	2.9	0.9	1.2
Upland rice	0.0	0.0	0.0	4.6
Vegetables	1.3	0.0	2.7	0.0
Other annual crops	1.3	0.1	1.2	0.3
All annual crops	11.0	6.0	18.6	8.8
Cocoa	0.5	22.5	2.6	7.5
Coffee	2.8	1.2	0.1	9.0
Coconuts	0.0	0.0	4.4	0.1
Bananas	0.1	0.0	2.5	1.0
Other perennial crops	0.9	0.1	0.4	0.1
All perennial crops	4.3	23.8	9.9	17.6
Total	15.3	29.8	28.6	26.4

Source: STORMA project A4 household survey
Number of observations=272

4.2.2 Livestock income

Livestock income accounts for 8% of the total household income with 183 households participating in this activity. The most important species in terms of income are cattle contributing almost 38% to the income from livestock. Pigs, buffaloes, and poultry are other important sources of income (see Table 7).

In comparison to its income share the number of households participating in cattle and especially in buffalo production is low. Despite the high share of buffaloes in livestock income only one household reported income. This household owns 27 heads and is responsible for the total income from buffaloes.

Table 7: Livestock income and participation by type

	Number of heads	Households participating (%)	Income (%)
Buffaloes	27	1	21
Cattle	232	10	38
Horses	13	1	1
Goats	40	1	0
Pigs	226	21	22
Poultry	1503	87	17
Total	2040	100	100

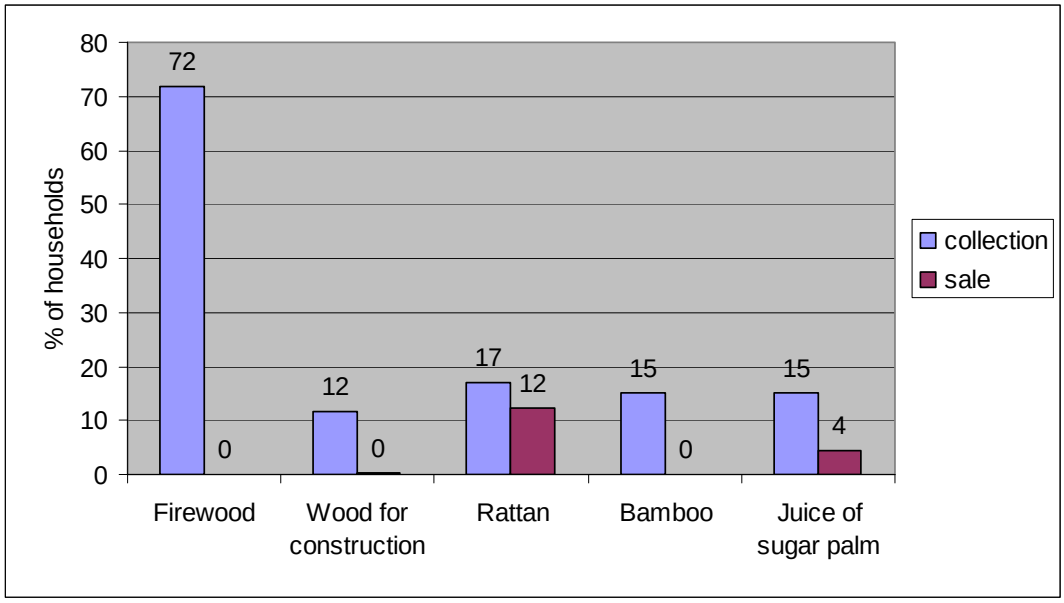
Source: STORMA project A4 household survey

Number of observations=183

4.2.3 Income from forest products

Forest products include the collection of wood, rattan, bamboo, the juice of the sugar palm as well as the hunting and collection of animals and their products. The ladder activity was not reported by any single household, which indicates that it is less important in the research area. Another reason might be that it is forbidden to hunt and collect animals inside the LLNP. Figure 5 shows the percentage of households collecting and selling the various forest products. In the calculation of income from forest products only the sales were included. Bamboo and firewood are collected for home consumption only and not sold. In the case of firewood, 72% of the households collect firewood, but no one sells it. In contrast, of the 17% of the households collecting rattan, 12% reported selling it.

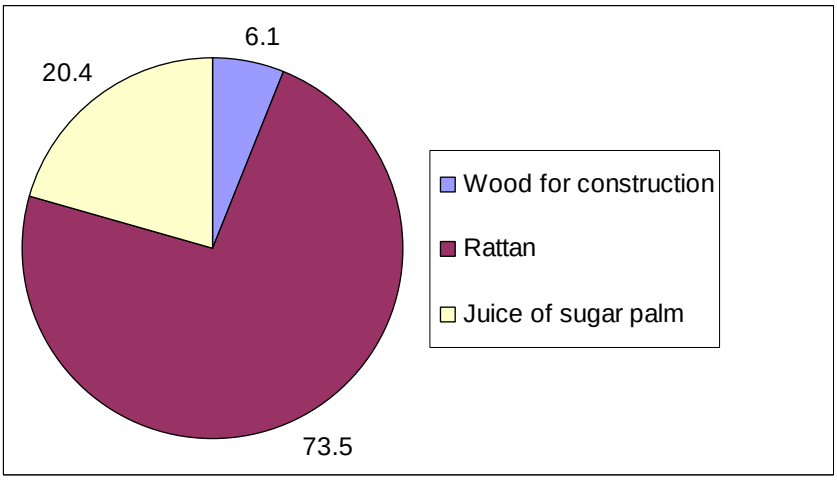
Figure 5: Collection and sale of forest products



Source: STORMA project A4 household survey. Number of observations = 290

The sale of forest products accounts for 7% of the total household income with almost three-quarters originating from the sale of rattan. Around 20% of the income originates from selling the juice of the sugar palm and the remainder from selling wood for construction (see Figure 6).

Figure 6: Income from the sale of forest products by product



Source: STORMA project A4 household survey. Number of observations = 49

As rattan is the most important forest product and because rattan extraction is of special interest of the SFB, we further investigate which socio-economic group of households collect and sell rattan by differentiating them into poverty terciles: poorest (poverty group 1), poor (poverty group 2), and less-poor households (poverty group 3). The percentage share of households collecting and selling rattan drops significantly with increasing wealth. The share of households collecting and selling rattan is highest among the poorest households with 37.2% of them participating in the collection and 27.5% in the selling of rattan. In contrast, only 3.0% of the less-poor households collect rattan and only 2.2% sell it.

Table 8: Collection and sale of rattan by poverty group

Poverty group	No. of households	Households collecting rattan (%)	Households selling rattan (%)
1	102	37.2	27.5
2	102	8.3	6.2
3	86	3.0	2.2
Total	290	16.9	12.4

Source: Storma project A4 household survey

The regional distribution of income from forest products shows that more than 50% of it originates in the sub district of Kulawi (see Table 9). The remaining income is pretty evenly distributed between the remaining sub districts. The same applies for the regional distribution of the households participating.

Table 9: Income from forest products by region

	No. of households	Households (%)	Income (1000 IDR)	Income (%)
Lore Utara	8	16	22214	19
Palolo	5	10	14443	13
Sigi Biromaru	10	20	19468	17
Kulawi	26	53	59381	51
Total	49	100	115506	100

Source: Storma project A4 household survey

4.3 Self-employed income outside agriculture

Income from self-employment outside the agricultural sector accounts for 17% of the total household income with 18% of the households participating. The most important source is trade, accounting for 57% of the income from self-employment, but with only six households participating (see Table 10). One wood trader alone generates more than two-thirds of the total self-employed income outside agriculture. Other important activities are shops/food stalls and small-scale industries which generate 23% and 12% of the income from this activity.

Table 10: Self-employed income outside agriculture by activity

	Number of households	Households (%)	Income (IDR 1000)	Income (%)	Mean income (IDR 1000)
Shop/warung	23	37	65873	23	2904
Craft	8	13	8323	3	1249
Trader	6	10	164744	57	36543
Small Scale Industry	11	17	33667	12	2961
Other	2	3	5292	2	4381
Renting	13	21	9344	3	778
Total	63	100	287243	100	4559

Source: STORMA project A4 household survey
Number of observations=51

The regional distribution shows that participation is highest in the sub district of Sigi Biromaru with 32 households engaged (see Table 11). This sub district has the highest population density and the best infrastructure, for example the most dense road network. The regional distribution in terms of income is highly biased by the above-mentioned trader, so that 61% of the income from self-employment is generated in the sub district of Palolo alone.

Table 11: Self-employed income outside agriculture by region

	Number of households	Households (%)	Income (IDR 1000)	Income (%)
Lore Utara	9	14	44096	15
Palolo	15	24	176426	61
Sigi Biromaru	32	51	46058	16
Kulawi	7	11	20663	7
Total	63	100	287243	100

Source: STORMA project A4 household survey

Number of observations=51

4.4 Agricultural wage labour income

The sample consists of 1057 individuals more than 14 years old, of whom 231 (22 %) are engaged in agricultural wage labour activities. In contrast, only 59 individuals, which is equivalent to 6% of the individuals in the sample, are engaged in non-agricultural wage labour activities.

Wage labour in forestry plays a minor role with 6% of the workers participating compared to agriculture with 94% of the workers participating (see Table 12). This is also reflected in the income gained: 82% of the income in this category is generated in agricultural activities. Nevertheless, mean incomes and mean days employed are higher in forestry than in agriculture. The share of daily labourers in agriculture with 96% is very high, whereas in forestry it is only 27%. In forestry, other arrangements like contract work predominate.

Table 12: Distribution of workers, days employed, and income by agricultural wage labour activity

	Workers (%)	Income (%)	Mean income (IDR 1000)	Mean days employed	Daily labourers (%)
Agriculture	94	82	687	68	96
Forestry	6	18	2261	85	27
Total	100	100	784	69	91

Source: STORMA project A4 household survey
Number of observations=231

There is also a great variation in agricultural wage earning activities among the sub districts (see Table 13). It is particularly important in the sub districts of Palolo and Sigi Biromaru. 38% of the workers engaged in agricultural wage labour live in the sub district of Palolo and 33% in Sigi Biromaru. Comparing the number of workers with the number of individuals in the sample shows that in Palolo 35% of all the individuals participate in agricultural wage labour. In contrast, in Lore Utara only 12% of the individuals in the sample are engaged in this activity.

Table 13: Distribution of workers and income from agricultural wage labour activities by region

	Workers (%)	Income (%)	Mean income (IDR 1000)	Individuals in sample	Wage earners (%)
Lore Utara	11	17	1287	207	12
Palolo	38	34	704	252	35
Sigi Biromaru	33	33	781	338	23
Kulawi	18	15	665	260	16
Total	100	100	784	1057	22

Source: STORMA project A4 household survey
Number of observations=231

Considering the income derived shows the same picture (see Table 13). Around one-third of the income originates in Palolo and Sigi Biromaru each. It is remarkable that the mean income per worker in Lore Utara is more than 80% higher

than the mean income in Palolo. This can be explained by the high share of workers in forestry in Lore Utara, who have higher incomes.

All age groups are engaged in agricultural wage labour activities, with 35% between 25 and 34 years old (see Table 14). This age group gains almost 40% of the income and also has the highest mean income per worker. The majority of workers attended at least primary school. Only 5% of the workers never attended school. The influence of education on mean incomes is not very clear, but the mean income of workers who completed junior high school is highest with IDR 1.1 mill per worker.

Table 14: Distribution of workers and income from agricultural wage labour activities by age group and level of education

	No. of workers	Workers (%)	Income (%)	Mean income (IDR 1000)
Agegroup				
15-24	62	27	28	801
25-34	82	35	39	875
35-44	46	20	20	788
45-54	29	13	9	529
>=55	11	5	4	678
Education				
never attended school	12	5	4	626
attended primary school	25	11	6	454
completed primary school	115	50	47	740
attended junior high school	21	9	10	883
completed junior high school	30	13	19	1126
attended senior high school	8	3	3	781
completed senior high	21	9	11	916
Total	231	100	100	784

Source: STORMA project A4 household survey

Considering that 48% of the population aged 15 and above are female, they are not adequately represented in agricultural wage labour activities (see Table 15). Only 27% of the individuals engaged in wage labour activities are female. Their income share of 15% is even lower. Lower wages and shorter employment periods

result in mean incomes of IDR 433,000 which is only 47% of the income of male workers.

Table 15: Distribution of workers and income from agricultural wage labour activities by gender

	No. of workers	Workers (%)	Income (%)	Mean income (IDR 1000)	Mean days employed
male	169	73	85	914	78
female	62	27	15	433	46
Total	231	100	100	784	69

Source: STORMA project A4 household survey

4.5 Non-agricultural wage labour income

In contrast to agricultural wage labour activities, participation in non-agricultural wage labour activities is low. Nevertheless, the 59 workers engaged generate an income which is higher than the one gained from agricultural wage labour activities.

The most important source of non-agricultural wage employment in terms of participation is the service sector, for example employment in food stalls or shops (see Table 16). 36% of the workers are employed in this category. The most important employer in terms of income is the state, where 56% of the wage labour income is generated. Another important activity is employment in construction, with 25% of the workers participating in it generating 14% of the income. In contrast to employment in the service sector and by the state, in construction more than two-thirds of the workers are employed as daily labourers.

Table 16: Distribution of workers, days employed, and income by non-agricultural wage labour activity

	Workers (%)	Income (%)	Mean income (IDR 1000)	Mean days employed	Daily labourers (%)
Construction	25	14	2013	113	67
Service	36	24	2456	156	10
Governmental employee	24	56	8600	308	7
Other	15	7	1588	179	27
Total	100	100	3695	186	26

Source: STORMA project A4 household survey
Number of observations=59

Again, there are great differences in non-agricultural wage earning activities among the sub districts (see Table 17). It is particularly important in the sub districts of Lore Utara and Sigi Biromaru. 38% of the workers engaged in non-agricultural wage labour live in the sub district of Sigi-Biromaru and 31% in Lore Utara. Comparing these figures to the number of individuals in the sample shows that in Lore Utara about 9% of the individuals participate in non-agricultural wage labour. In contrast, in Kulawi only 3% of the individuals in the sample are engaged in this activity.

Table 17: Distribution of workers and income from non-agricultural wage labour activities by region

	Workers (%)	Income (%)	Mean income (IDR 1000)	Individuals in sample	Wage earners (%)
Lore Utara	31	52	6162	207	9
Palolo	18	11	2222	252	4
Sigi Biromaru	38	27	2605	338	7
Kulawi	12	10	2960	260	3
Total	100	100	3695	1057	6

Source: STORMA project A4 household survey
Number of observations=59

Compared to the workers engaged, the income derived is high in the sub district of Lore Utara. Here, 52% of the income from non-agricultural wage labour is

derived and mean incomes are at least two times higher than in the other sub districts. This can be explained by the comparatively high share of governmental employees in this sub district.

All age groups are engaged in non-agricultural wage labour activities, with almost two-thirds being younger than 35 years (see Table 18). The mean income rises until the age of 44 before declining again. 93% of the workers finished at least primary school and only one worker never attended school. Better education leads to an increase in income from non-agricultural wage labour. Individuals who completed primary school receive on average only IDR 2.6 mill, whereas individuals who finished senior high school receive on average IDR 6.3 mill.

Table 18: Distribution of workers and income from non-agricultural wage labour activities by age group and level of education

	Number of workers	Workers (%)	Income (%)	Mean income (1000 IDR)
Agegroup				
15-24	16	28	17	2304
25-34	21	35	26	2771
35-44	11	18	34	7009
45-54	9	15	22	5319
>=55	3	5	1	829
Education				
never attended scho	1	1	0	150
attended SD	4	6	2	970
completed SD	16	26	19	2626
attended SMP	1	2	0	262
completed SMP	11	19	15	2908
attended SMA	6	11	4	1369
completed SMA	18	30	51	6321
University	0	0	10	0
Total	59	96	100	3711

Source: Storma project A4 household survey

Number of observations=59

As in agricultural wage labour, the participation of women in non-agricultural wage labour activities is much lower than of men (see Table 19). Only 10 women,

which is equivalent to 17% of all workers, are engaged in these activities. However, in contrast to agricultural wage labour activities, their mean income is about 14% higher compared to the mean income of male workers because a high share of women are employed for example as teachers by the state. Additionally, the share of daily labourers, which receive a lower wage, is higher for men leading to shorter employment and lower average incomes.

Table 19: Distribution of workers and income from non-agricultural wage labour activities by gender

	Number of workers	Workers (%)	Income (%)	Mean income (IDR 1000)	Mean days employed
male	49	83	81	3610	179
female	10	17	19	4124	217
Total	59	100	100	3695	186

Source: STORMA project A4 household survey

4.6 Income shares and income specialisation

The previous sections of this chapter focussed on participation and activity incomes. The percentage shares in activity incomes were calculated by dividing the mean income from an activity by the mean total income over all households. These figures already provide an insight into the importance of activities in the region. A third useful variable describing income activities is the income share of an activity, which is the mean of the percentage share of the income from an activity in total household income. As activity incomes highlight the importance of an activity for the region, the income shares show the importance of an activity at the household level.

Agricultural self-employment is also the most important activity in terms of income shares (Table 20). On average, households derive 63% of their income from these activities. Moreover, households gain on average almost 50% from cropping activities. The big share of agricultural wage labour income is striking. The income share of 20% is much higher than the percentage share in activity income (see Table

3), where agricultural wage labour income accounts for only 9%. This indicates that households with a big share of agricultural wage labour income have comparatively low total incomes and therefore their derived incomes have a relatively small weight when calculating the percentage share in activity incomes.

Table 20: Income shares by activity

	Mean	Std. dev.
Agricultural income - Self-employed	63	37
Crop Income	49	36
Livestock Income	7	14
Income from forest products	7	21
Agricultural income - Wage labour	20	30
Non-agricultural income - Self-employed	7	21
Non-agricultural income - Wage labour	10	26

Source: STORMA project A4 household survey
Number of observations=290

In the case of non-agricultural activities it is the other way round with relatively small income shares. The share of non-agricultural self-employed income is just 7% (see Table 20) compared to the share of 17% in activity incomes (see Table 3) and the mean income share of non-agricultural wage labour is only 10% compared to 15%. Here, it indicates that households with a big income share also have comparatively high total incomes and therefore their derived incomes have a relatively high weight when calculating the percentage share out of activity incomes.

The average income shares just presented indicate how important the different activities are for the income generation of rural households, but the average figures do not say much about the dependence of households on a single activity. Therefore, households are classified as specialised if one activity accounts for more than 50% of its income. If one activity accounts for more than 75% of the total household income the household is classified as highly specialised.

Following this classification, only 2% of the households are not specialised in only one income generating activity (see Table 21). There are just 6 households in

the sample which generate less than 50% of their income from one of the income categories distinguished alone. The highest degree of specialisation is in agricultural self-employment. 63% gain more than half and 39% more than three-quarters of their income from agricultural self-employment. In this category, crop production is the most important activity for rural households. Almost 50% of the households derive more than half of their income from crop production. About one-third of the households are highly specialised in crop production. All other activities show a much lower specialisation due to the low participation rates.

Table 21: Income specialisation

Household is...	% of households	% of hhs. participating
Not specialised	2	-
Not highly specialised	42	-
Specialised in agricultural self-employment	63	65
Highly specialised in agricultural self-employment	39	41
Specialised in crop production	49	52
Highly specialised in crop production	33	36
Specialised in livestock production	3	5
Highly specialised in livestock production	1	1
Specialised in sale of forest products	6	37
Highly specialised in sale of forest products	4	23
Specialised in agricultural wage labour	19	41
Highly specialised in agricultural wage labour	7	16
Specialised in non-agricultural self-employment	6	35
Highly specialised in non-agricultural in self-employment	4	24
Specialised in non-agricultural wage labour	9	53
Highly specialised in non-agricultural wage labour	7	40

Source: STORMA project A4 household survey
Number of observations=290

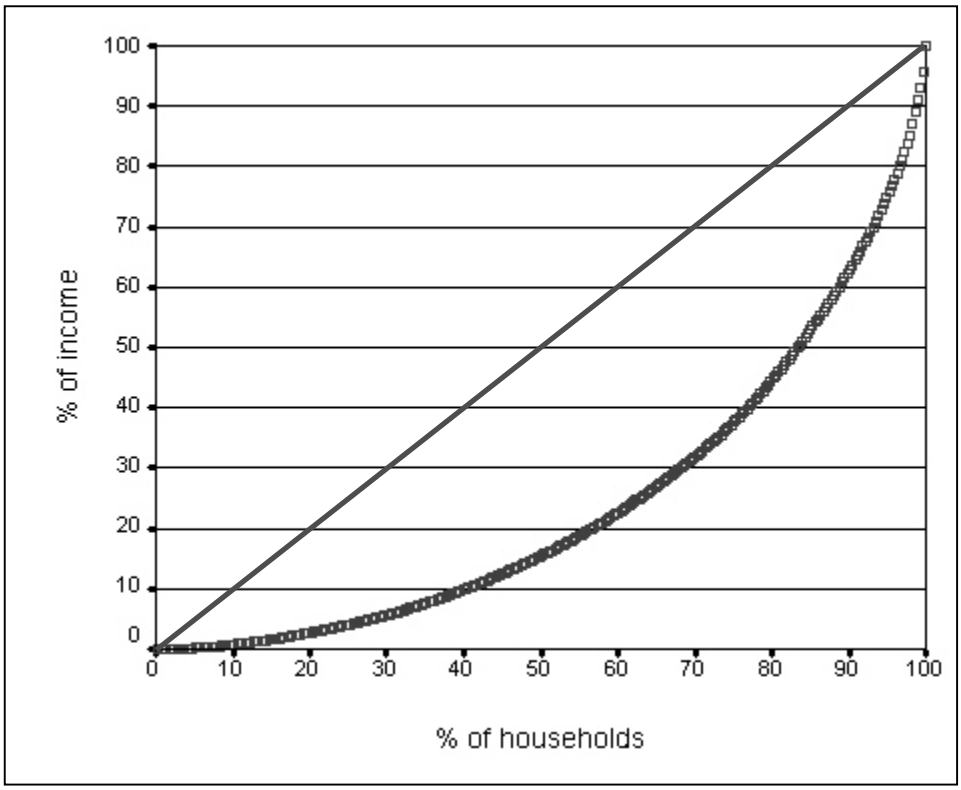
Comparing the results to the number of households participating also shows a high degree of specialisation in the activities outside the agricultural sector (see Table 21). 35% gain more than half and 24% more than three-quarters of their income from non-agricultural self-employment. In non-agricultural wage employment even more than 50% of the participating households are specialised and 40% gener-

ate more than three-quarters of their income from this activity. These figures show that non-agricultural wage employment generates, on average, a bigger income share than crop production. This shows the importance of non-agricultural wage employment for participating households.

4.7 Income distribution

Analysing the income by poverty groups has shown large differences in income between socio-economic groups indicating inequalities in the distribution of income. This will be explored in more detail by evaluating the Lorenz curve and the Gini coefficient[14].

Figure 7: The Lorenz Curve



Source: STORMA project A4 household survey

[14] Computational details are given in Chapter 3.5.

The Lorenz curve (see Figure 7) as well as the Gini coefficient, which is 0.52, show a rather unequal distribution of income among the households. Comparing the Gini coefficient measured with other sources is rather difficult because most of them used data on consumption expenditures per capita. An exception is Asra (2000), who calculated Gini coefficients based on household income. For the whole of Indonesia as well as rural areas only, the Gini coefficient dropped from 0.51 in 1977 to 0.43 in 1982 (Asra, 2000). Figures for the period after 1982 have not been found.

4.8 Summary

This chapter presented the results of the descriptive analysis of income and activities. Agricultural activities are the most important source of income for rural households in the region contributing to 70% of total household income. The remaining 30% originates from non-agricultural activities indicating its importance. However, participation in the latter activities is much lower with just around 18% compared to 96% in agricultural activities. Differentiation between different wealth groups shows that activities outside the agricultural sector are particularly important for the less-poor households. Within agricultural activities the most important source of income is crop production with the most important crops being irrigated rice and cocoa. Nevertheless, large regional differences exist. After the analysis of activity participation and incomes we focus on income shares describing the importance of activities at the household level. The share of non-agricultural income of 7% is much lower than its share in activity income. This indicates that households with a high share of non-agricultural income also have a comparatively high total income. Based on the income shares we evaluated the dependence of households on a single activity. Only 2% of the households generate less than 50% of their income from one source. In contrast, 39% of the households generate more than three-quarters of their income from a single activity indicating a specialisation of households. Applying a Lorenz curve in the last section of this chapter shows a rather uneven distribution of income among the households.

Before analysing the factors influencing the described variables by econometric modelling they need to be further evaluated. The next chapter presents the descriptive analysis of the influencing factors introduced in Chapter 2.

Chapter 5

5 Descriptive analysis of factors influencing income and activity choice

Before analysing the influencing factors on participation and incomes by econometric modelling it is necessary to further evaluate these factors. This chapter describes the socio-economic factors influencing activity choice and incomes introduced in the conceptual framework. Emphasis is placed on the variables, which are included in the econometric models in the next chapter. After analysing the possession of land and its differences between regions, other assets owned by rural households are described in the first section of this chapter. The demographic structure of rural households and the educational background of its members are then described. The third section describes the access to social capital, the pattern of migration and the ethnic composition. After evaluating the participation in credit markets the last section in this chapter briefly describes the access to road infrastructure.

5.1 Physical capital

Physical capital consists of land, livestock, and other assets. As the possession of livestock has been already described in the previous chapter the analysis here is limited to the other two categories of physical capital.

5.1.1 Possession of land

Households in the research area own on average 1.8 ha of land, but with statistically significant differences among the sub districts (see Table 22). Households in the sub district of Lore Utara own on average 2.7 ha, whereas households in Sigi Biromaru possess just above one hectare. As we will see later, these variations can be explained by the qualitative differences of the land.

Table 22: Share of land owned by sub district

	Lore Utara	Palolo	Sigi Biromaru	Kulawi	Total
zero ha	0.0	9.5	5.7	1.0	4.5
0 - 1 ha	20.3	23.8	48.6	23.4	32.0
1 - 2 ha	27.0	37.2	32.0	30.2	31.9
2 - 3 ha	20.9	10.5	6.3	21.4	13.4
3 - 4 ha	10.9	10.5	4.9	3.5	6.9
4 - 5ha	4.8	1.9	0.0	12.7	4.3
>= 5 ha	16.1	6.7	2.4	7.7	7.0
Mean land owned in ha	2.7	1.8	1.1	2.3	1.8

Source: STORMA project A4 household survey
Number of observations=290

The share of households owing no land at all is 4.5% ranging from zero percent in the sub district of Lore Utara to almost 10% in Palolo (see Table 22). These households rent or borrow their homestead and all the land they cultivate. Almost one-third of the households own less than one hectare in the region and around two-thirds own less than two hectares. The high share of households owning more than five hectares in Lore Utara is remarkable.

The area owned can be differentiated into the homestead including the home garden, agricultural land (irrigated and rainfed land), and other land (see Table 23). The latter category mainly consists of forest gardens where crops are sparsely planted inside the natural forest. In all sub districts except Lore Utara, agricultural land accounts for more than 90% of the total land owned and the homestead and other land are not important. The sub district of Lore Utara is an exception where other land plays a role accounting for 10% of the land owned in this sub district.

Table 23: Share of land owned by type of land and sub district

	Lore Utara	Palolo	Sigi Biromaru	Kulawi	Total
Homestead	2.9	3.6	5.6	1.3	3.1
Agricultural land	87.4	96.2	93.5	97.3	93.6
Other	9.7	0.2	0.9	1.5	3.3

Source: STORMA project A4 household survey
Number of observations=290

Rainfed land accounts for more than 80% of the agricultural land but with large differences among the regions (see Table 24). In the sub district of Kulawi the share of rainfed land is more than 94%, whereas in Sigi Biromaru it is just above 60%. Here, the share of irrigated land is almost 40% and much higher than in the other sub districts.

Table 24: Share of agricultural land owned by type of land and sub district

	Lore Utara	Palolo	Sigi Biromaru	Kulawi	All districts
Irrigated land	22.9	15.0	39.5	5.6	19.2
Rainfed land	77.1	85.0	60.5	94.4	80.8

Source: Storma project A4 household survey
Number of observations=290

The main reason for the variations among the sub districts is the differences in the area of rainfed land owned. On average, the households in the region own 1.4

ha of rainfed land, but with statistically significant differences among the sub districts. In the sub district of Sigi Biromaru they possess just 0.6 ha of rainfed land (see Table 25). Moreover, more than 50% of the households do not own rainfed land at all. In contrast, the households in Kulawi own on average 2.1 ha and 97% of the households own rainfed land. It is a similar situation in the sub districts of Lore Utara and Palolo, where almost 90% and 84% of the households own rainfed land. The high share of households in the sub districts of Lore Utara and Kulawi owning more than two hectares of rainfed land is remarkable. In Lore Utara more than 40% of the households possess more than two hectares of rainfed land and in Kulawi this share is more than 44%.

Table 25: Share of rainfed land owned by sub district

	Lore Utara	Palolo	Sigi Biromaru	Kulawi	All
zero	10.3	16.2	50.9	3.0	24.5
0 - 1	24.0	19.1	26.2	24.3	23.7
1 - 2	28.1	42.9	16.7	28.4	27.5
2 - 3	21.8	7.6	3.0	21.4	11.7
3 - 4	4.2	5.7	0.8	7.5	4.1
4 - 5	3.8	1.9	0.0	8.7	3.2
>= 5	7.9	6.7	2.4	6.7	5.4
Mean rainfed land owned in ha	1.8	1.5	0.6	2.1	1.4

Source: Storma project A4 household survey
Number of observations=290

Compared to rainfed land, the average area of irrigated land owned by households in the research area is much lower. This is no surprise since the production of paddy rice is much more intensive in terms of chemical inputs (see previous chapter) and labour than the production of all other crops like cocoa. Moreover, the availability of irrigated land is much more limited than that of rainfed land because it requires suitable land and high investments to establish. Therefore, around 13% of the households own on average more than 1 ha and more than 56% do not own any irrigated land at all. This leads to an average possession of irrigated land of just 0.3 ha per household (see Table 26), but with statistically significant differences among the sub

districts. It is striking to see the high share of households in Kulawi, which do not possess any irrigated land. More than 77% of them do not own irrigated land. In the village of Lawe, situated in the western part of Kulawi, irrigated land is not available at all. Due to its location on a hilltop with steep slopes there is no flat land suitable for irrigation.

Table 26: Share of irrigated land owned by sub district

	Lore Utara	Palolo	Sigi Biromaru	Kulawi	All
zero ha	40.1	51.4	53.7	77.7	56.5
0.0 - 0.5 ha	14.8	22.9	4.1	8.5	11.3
0.5 - 1.0 ha	26.6	13.3	23.6	9.8	18.5
1.0 - 1.5 ha	6.9	8.6	12.2	3.0	8.3
1.5 - 2.0 ha	3.4	3.8	1.1	1.0	2.1
2.0 - 2.5 ha	3.8	0.0	4.4	0.0	2.2
>= 2.5 ha	4.4	0.0	0.8	0.0	1.1
Mean irrigated land owned in ha	0.5	0.3	0.4	0.1	0.3

Source: Storma project A4 household survey
Number of observations=290

The productivity of irrigated land is among other factors influenced by the type of irrigation system. There are three different systems of irrigation which are differentiated by the way the water level is controlled. The technical irrigation system involves a permanent irrigation infrastructure with locks, separate drainpipes and tertiary water supply channels. This allows complete control of the water level on the fields. The semi-technical irrigation system lacks tertiary channels so that the water supply cannot be fully controlled. The simple irrigation system is rainfed and has only temporary ditches enabling only limited control of the water inflow (Direktorat Jenderal Pengairan, 1986).

Table 27: Share of irrigated land owned by type of irrigation

	Lore Utara	Sigi Palolo	Sigi Biromaru	Kulawi	Total
Simple irrigation	42.3	90.3	4.2	52.2	37.2
Semi-technical irrigation	57.7	9.7	37.3	30.0	37.6
Technical irrigation	0.0	0.0	58.5	0.0	25.2

Source: STORMA project A4 household survey
Number of observations=126

Table 27 shows the distribution of the different irrigation systems in the research area by sub district. Technical irrigation systems exist in the sub district of Sigi Biromaru only, where it accounts for almost 59% of the irrigated area. In contrast, in Palolo simple irrigation systems are found on more than 90% of the irrigated land. In the sub districts of Kulawi and Lore Utara a mix of simple and semi-technical irrigation systems exists. The latter technology accounts for 30% and almost 58%, respectively.

Maertens (2004) reports that in most villages a production system based on irrigated land exists besides a rainfed system. As this result is based on village survey data, we will test whether this phenomenon can also be observed at the household level. The descriptive analysis shows that almost 40% of the households which own agricultural land, possess rainfed as well as irrigated land (see Table 28). 48.9% of the households own rainfed land only and the remaining households own irrigated land only.

Table 28: Share of land owned by type

	Number of households	Percentage shares		
Total	290	100.0		
Own land	277	95.5	100	
Own agricultural land	247	85.2	89.2	100
Own rainfed land only	121	41.7	43.7	48.9
Own rainfed and irrigated land	98	33.8	35.4	39.6
Own irrigated land only	28	9.7	10.1	11.3

Source: STORMA project A4 household survey

To investigate this issue further we perform a non-hierarchical cluster analysis based on the share of irrigated land in agricultural land owned. The households are classified into three groups: I rainfed land is the most important type of agricultural land owned; II rainfed and irrigated land is owned; III mainly irrigated land is owned.

Table 29: Clustering of households according to the type of agricultural land owned

	Number of households		Share in % wetland		Share in % dryland	
Cluster	total	in %	Mean	Stddev.	Mean	Stddev.
I Rainfed land	146	59.2	2.3	5.6	97.7	5.6
II Rainfed/irrigated land	66	26.6	40.9	12.0	59.1	12.0
III Irrigated land	35	14.2	96.4	8.8	3.6	8.8

Source: STORMA project A4 household survey
Number of observations=254

26.6% of the households are classified as rainfed and irrigated land owners, whereas almost three-quarters of them own just rainfed or irrigated land (see Table 29). In contrast, Maertens (2004) reports that 35% of the villages have a mixed system. The results of the cluster analysis provide less evidence for the co-existence of an irrigated and rainfed land system at the household level compared to the village level.

5.1.2 Other assets

This group of assets comprises all other assets owned by households with the exception of land and livestock. Some of them have been used for the computation of the poverty index and thus the value of other assets owned is highly correlated with the poverty index (see Chapter 3).

42% of the total value of the group of other assets are transportation assets, like motorcycles and cars. Home furnishings, like tables and chairs, account for 25% and electronics, like televisions, for 15% of the total value of other assets possessed by households in the research area.

On average, the households own other assets of almost IDR 3.5 mill (see Table 30). In the sub districts of Palolo and Lore Utara the households own more other assets than on average, whereas in Sigi Biromaru and Kulawi they own less than the average. Of note is the high value owned in Lore Utara which is more than twice the average value, and the low value in Kulawi which is less than half of the average.

Table 30: Mean value of other assets owned by sub district

Mean value of other assets	Lore Utara	Palolo	Sigi Biromaru	Kulawi	Total
IDR 1000	7173	3953	2544	1616	3463
in %	207	114	73	47	100

Source: STORMA project A4 household survey
Number of observations=290

5.2 Human capital

As the literature review in Chapter 1 has shown, human capital plays an important role in determining activity choice. In this section we further explore differences in the size of the family which determines the available family labour, and the education of its members will be analysed.

Households in the region consist on average of 5.3 members (see Table 31). 3.6 members, which is equivalent to 69% of the household members, are adults aged 15 years and above. Statistically significant is the difference in household size and the number of adult household members between the sub districts of Lore Utara and Sigi Biromaru. Households in the latter sub district are smaller and consist of less adult members compared to households in Lore Utara.

Table 31: Household composition by sub district

Average number of...	Lore Utara	Palolo	Sigi Biromaru	Kulawi	All districts
Household members	5.8	5.4	4.8	5.5	5.3
Males	3.2	2.8	2.3	3.0	2.8
Females	2.6	2.6	2.4	2.5	2.5
Adults (age 15 and above)	4.1	3.8	3.3	3.8	3.6
Children (age 14 and below)	1.7	1.6	1.5	1.7	1.6

Source: Storma project A4 household survey
Number of observations=290

Apart from the number of family workers available, their education influences incomes and activity choices. The illiteracy rate in the region is 8.9% and on average 5.6% of the adults never attended school (see Table 32). The wide majority of individuals completed at least primary school. On average, 83.6% of the adult members of the household finished at least primary school, but with statistically significant differences among the sub districts. The rate is highest in Lore Utara with 91.0% and lowest in Sigi Biromaru with 79.6%. The percentage share of members that finished school decreases with the level of schooling. On average, 30.7% of the adult household members at least finished secondary school. Again, significant differences between the sub districts exist. The highest share of secondary school completion is in Lore Utara with of 54.2%. On average, 12.4% of the household members completed high school, with the same statistically significant differences among the sub districts as in the case of secondary schools.

Table 32: Level of education by sub district

	Lore		Sigi		
	Utara	Palolo	Biromaru	Kulawi	Total
Illiteracy rate in %	6.6	6.7	11.2	9.3	8.9
Percentage share of adults...					
never attended school	2.8	4.6	7.6	5.8	5.6
completed primary school	91.0	87.1	79.6	80.8	83.6
completed secondary school	54.2	31.5	31.7	10.9	30.7
completed high school	26.5	11.4	11.9	3.8	12.4

Source: STORMA project A4 household survey
Number of observations=290

The illiteracy rate for females and the share of female household members who never attended school is a little bit lower than the rates for male household members (see Table 33), but the difference is not statistically significant. Completion rates of female household members are lower than for male members, but with the exception of the share of members that completed high school, this difference is not significant. In contrast to primary and secondary school, female household members have lower access to high schools than male members. The share of female members that completed high school is 9.1%, whereas the rate for male members is 15.8%.

Table 33: Education by gender

	Male	Female	All members
Illiteracy rate	9.0	8.8	8.9
Percentage share of adults...			
never attended school	5.6	5.5	5.6
completed primary school	85.2	82.7	83.6
completed secondary school	31.8	29.4	30.7
completed high school	15.8	9.1	12.4

Source: STORMA project A4 household survey
Number of observations=290

5.3 Social capital

Social capital measures the access to social networks and institutions. These include all kinds of formal institutions, like farmers associations, sport groups, and religious groups. Moreover, we also asked the members to self-evaluate how active they were in decision-making processes of these organisations. Besides membership of formal organisations, the ethnic affiliation and the time the household has lived in the village are also evaluated since they can influence access to informal networks.

Groups and organisations considered here are, for example, religious groups, farmer organisations, and neighbourhood groups. On average, households are members of 2.8 different organisations (see Table 34). The number of memberships per adult household member is 0.8. 23% of the households are not members of any organisation. The number of memberships is statistically significantly higher in Lore Utara compared to all other sub districts. Moreover, in Lore Utara the number of memberships is significantly higher than in Kulawi and Palolo and the share of households without any membership is significantly lower than in Sigi Biromaru.

Table 34: Membership in organisations by sub district

	Lore Utara	Palolo	Sigi Biromaru	Kulawi	Total
Number of memberships	4.4	2.0	2.8	2.3	2.8
Number of memberships per capita	1.1	0.5	0.9	0.6	0.8
% of households without any membership	9	24	29	22	23

Source: STORMA project A4 household survey
Number of observations=290

64.5% of the respondents regarded religious groups as the most important organisations they are members of. 66.2% of the head of the households and 62.8% of the spouses consider religious groups as the most important organisation (see Table 35). 20.3% of the head of the households, which are mainly men, regard farmers organisations as their most important organisation. In contrast, 34.4% of the spouses considered neighbourhood groups ("Dasa wisma") as the most important group they are members of. In these groups, the women of around ten households in a neighbourhood meet for various activities.

Table 35: Most important organisations

	Head of household	Spouse	All
Religious groups	66.2	62.8	64.5
Neighbourhood groups	0.7	34.4	18.0
Farmers organisations	20.3	0.0	9.9
Other groups	12.8	2.8	7.7

Source: STORMA project A4 household survey
Number of observations=290

The respondents were asked to assess their meeting attendance and the labour days spent on the organisation as well as to estimate how active they are in the decision-making processes of the organisation. On average, the head of the households evaluated their activity in decision-making with 2.5, which on the applied scale is in the range of active to very active (see Table 36). Their spouses assessed their activity with 2.4. Mean meeting attendance of the household head is 1.9 per month and of the spouses 2.4 over all groups. Meeting attendance in the case of religious groups by the head of the households as well as by the spouses is higher than compared to the other groups. The same applies for the labour days spent on an organisation. Mean labour days spent by the head of the households is 2.9 days per month and by the spouses 3.7 days over all organisations. Here again, the labour days in the case of religious groups by the head of the households as well as the spouses is higher than the meeting attendance of the other groups.

Table 36: Meeting attendance, activity in decision-making, and labour days spent in the most important organisation

	Meeting attendance per month	Decision making index*	Labour days spent per month
Head of household			
Religious groups	2.5	2.5	3.9
Neighbourhood groups	0.3	3.0	0.5
Farmers organisations	0.8	2.4	1.0
Other groups	0.6	2.6	0.9
All groups	1.9	2.5	2.9
Spouse			
Religious groups	3.1	2.5	4.8
Neighbourhood groups	1.3	2.3	2.0
Farmers organisations	-	-	-
Other groups	0.8	2.0	1.1
All groups	2.4	2.4	3.7

Source: STORMA project A4 household survey

Number of observations=290

* 1: less active; 2: active; 3: very active

Besides membership of formal organisations and groups, the ethnic affiliation can also be seen as social capital. Nevertheless, the influence of ethnicity is much wider than providing additional access to networks. Traditions are influenced by the ethnic group the household belongs to, e.g., land use.

80.2% of the households are categorised as indigenous households, with Kaili and Kulawi being the biggest group (see Table 37). Both account for more than 68% of the households in the research area. 19.8% of the households are classified as non-indigenous, with the Bugis as the biggest ethnic group accounting for 8.3% of the households.

Table 37: Ethnic groups

	Number of households	Share of households in %	Share of households in %
Indigenous ethnic groups	232	80.2	100.0
Kaili	100	34.6	43.2
Kulawi	99	34.1	42.5
Lore	33	11.5	14.3
Non-indigenous ethnic groups	57	19.8	100
Bugis	24	8.3	42
Minahasa	5	1.7	8
Toraja	5	1.6	8
Jawa	3	1.1	6
Other	21	7.2	36
Total	290	100.0	

Source: STORMA project A4 household survey

The shares of non-indigenous households are statistically significantly different among the sub districts. In the sub districts of Lore Utara and Palolo the share of these ethnic groups is 33.2% and 47.6%, respectively (see Table 38). In contrast, in Sigi Biromaru and Kulawi only 7.1% and 2.0% of the households are categorised as non-indigenous.

Table 38: Share of non-indigenous households by sub district

	Lore Utara	Palolo	Sigi Biromaru	Kulawi	Total
Indigenous ethnic groups	66.8	52.4	92.9	98.0	80.2
Non-indigenous ethnic groups	33.2	47.6	7.1	2.0	19.8

Source: STORMA project A4 household survey
Number of observations=290

The head of the household and the spouse were also asked whether they have lived in the village all their life. 38% of the households have been classified as non-migrant households as both the head of the household and the spouse have never lived in another village (see Table 39). 34.1% of the households have been classified

as migrant households as the head of the household and the spouse used to live in a different village. In the remaining 28% of the households, either the head of the household or the spouse migrated into the village.

Table 39: Share of migrant households by sub district

	Lore Utara	Palolo	Sigi Biromaru	Kulawi	Total
Non-migrant household	31.7	4.8	38.8	73.7	38.0
Migrant household	23.6	78.1	30.5	4.4	34.1
Head of household only migrated in	26.8	9.5	18.8	13.9	16.9
Spouse only migrated-in	17.9	7.6	11.9	7.9	11.1

Source: STORMA project A4 household survey
Number of observations=290

The share of migrant households is statistically significantly different between the sub districts. In the sub district of Kulawi 73.7% of the households are classified as non-migrant households, whereas in Palolo 78.1% of the households are migrant households. In the remaining sub districts migrant household also contribute to a considerable share of the households. In the sub districts of Lore Utara and Sigi Biromaru migrant households make up 23.6% and 30.5%, respectively. These results are not surprising since there is a relationship between migration and ethnicity. 72.2% of the non-indigenous households are also classified as migrant households, whereas the share in the case of the indigenous households is only 24.6%.

Concerning the migrant households, another area of concern is the year the head of the household came to the village. More than half of migrant households came before 1981, which shows that migration in the research area is not a new phenomenon (see Table 40). Just 15% of the migrant households came in the last five years. Among the sub districts with a considerable share of migrant households, in Lore Utara more than one-third came in the last five years. As almost another third came between 1991 and 1995, migration in this sub district can be regarded as a comparably new phenomenon. In Palolo, the sub district with the highest share of migrant households, more than 31% came in the last ten years, but 40.2% migrated

before 1981. Migration into this sub district has been taking place for decades and is still going on. In contrast, 87.8% of the migrant households in Sigi Biromaru came before 1981 and only a few arrived later.

Table 40: Share of migrant households by year of migration and sub district

Year of migration	Lore Utara	Palolo	Sigi Biromaru	Kulawi	Total
after 1996	33.5	18.3	3.7	0.0	14.9
1991-1995	31.9	23.2	4.3	0.0	17.5
1986-1990	25.8	7.3	4.3	19.4	9.0
1981-1985	4.4	11.0	0.0	22.6	7.0
before 1981	4.4	40.2	87.8	58.1	51.7

Source: STORMA project A4 household survey
Number of observations=99

Where do the migrant households come from? 62.8% of the migrant households came from the same province of Central Sulawesi, but from another district (see Table 41). 26% originated from other provinces on Sulawesi and only 3.9% came from outside Sulawesi. In Lore Utara, the sub district with a high share of recent migration, 56.6% of these households came from other provinces on Sulawesi, mainly South Sulawesi. In contrast, almost 90% of the migrants in the sub district of Sigi Biromaru originated in the same province, but from another district. In Palolo most of the migrants also came from the same province, but 31.7% originated from other provinces on Sulawesi.

Table 41: Share of migrant households by origin and sub district

Village	Lore Utara	Palolo	Sigi Biromaru	Kulawi	Total
in the same district	11.5	4.9	2.7	77.4	7.2
in the same province, but other district	31.9	58.5	87.6	0.0	62.8
in another province on Sulawesi	56.6	31.7	5.4	22.6	26.0
outside Sulawesi	0.0	4.9	4.3	0.0	3.9

Source: STORMA project A4 household survey
Number of observations=99

5.4 Financial markets

As shown in the conceptual framework in Chapter 2, external factors might also influence activity choice. In this regard, many authors highlight the role of financial markets. This section will describe the households' participation in credit markets for the research region.

Almost 55% of the households received a loan. The results are slightly different among the sub districts, but they are not statistically significant (see Table 42). 11.6% of the households received an informal loan of less than IDR 30,000 IDR in the eight weeks prior to the survey and 40% received a higher informal loan within the previous eight months. The number of households which received a formal loan[15] is much lower at 12.6%. This is especially interesting when considering the long recall period of five years. In the sub district of Palolo, not one single household reported a loan from a formal institution. Significantly higher is the share of households who received a formal loan, in the sub districts of Lore Utara and Sigi Biromaru at 24% and 18%, respectively. The share of households receiving a loan from the Bank Rakyat Indonesia (BRI) is 6.2% and accounts therefore for around 50% of the share of households reporting a formal loan.

Table 42: Share of households received loan by source and sub district

	Lore Utara	Palolo	Sigi Biromaru	Kulawi	Total
Loan received	52.5	46.7	59.8	57.3	54.9
Informal loan < IDR 30,000 received	6.2	12.4	15.5	9.2	11.6
Informal loan > IDR 30,000 received	30.5	41.9	40.8	44.9	40.2
Formal loan received	23.6	0.0	18.5	7.8	12.6
Loan from BRI received	15.7	0.0	5.7	6.0	6.2

Source: STORMA project A4 household survey
Number of observations=290

[15] The category of formal loans includes credits from cooperatives, by credit programmes and also loans from the Bank Rakyat Indonesia.

As well as the question of whether households received a loan, the actual amount received is also of interest. On average, the households that received a loan got IDR 984,000 (Table 43). In Lore Utara the amount received is more than IDR 2.8 mill and much higher than in the sub district of Palolo. There, the households received an average loan of around IDR 250,000. The average amount received from formal sources in the last five years is IDR 3.8 mill. In Lore Utara, the households received credits of IDR 5.5 mill on average, whereas in the sub district of Sigi Biromaru the amount is just IDR 2 mill.

Table 43: Average loan received by source and sub district in IDR 1000

	Lore Utara	Palolo	Sigi Biromaru	Kulawi	Total
Loan received	2820	250	730	713	984
Informal loan < IDR 30,000 received	28	20	21	22	22
Informal loan > IDR 30,000 received	620	272	156	240	268
Formal loan received	5452	-	2000	3831	3403
Loan from BRI received	6864	-	5029	5000	5839

Source: STORMA project A4 household survey

Note: Only households that received a loan are included

On average, the households used 23% of the loan they received for agricultural purposes like chemical inputs and land preparation (see Table 44). In the sub district of Sigi Biromaru, 37% was spent on agriculture, whereas in Kulawi it was just 8%. Moreover, informal credit below IDR 30,000 is almost entirely used outside agricultural production, whereas the share for higher informal credit is 22%. 42% of the formal credits are spent for agricultural purposes, whereas the share for loans from the BRI is just 24%. This can be explained because credit programmes and cooperatives focus their credits directly on agricultural production. In contrast, the BRI prefers to provide loans for micro-enterprises and only gives loans for agricultural purposes if secured by land property with official title.

Table 44: Share used for agriculture by source and sub district

	Lore Utara	Sigi			
		Palolo	Biromaru	Kulawi	Total
Loan received	23	16	37	8	23
Informal loan < IDR 30,000 received	0	0	5	0	3
Informal loan > IDR 30,000 received	18	19	37	7	22
Formal loan received	38	-	51	24	43
Loan from BRI received	13	-	43	17	24

Source: STORMA project A4 household survey

Note: Only households that received a loan are included

5.5 Road infrastructure

There are two main asphalt roads connecting the provincial capital of Palu with the research area (see Maertens, 2004). One road runs south along the western side of the National Park connecting the sub district of Kulawi with Palu. The other road connects Palolo and Lore Utara along the eastern side of the national park. In general, every village located on these two roads is easily accessible. Nevertheless, the sections connecting Lore Utara and Kulawi are prone to landslides after heavy rains, causing temporary road closure (ANZDEC, 1997). Both roads pass through the sub district of Sigi Biromaru where additional tarmac roads between almost all villages also exist.

Out of our sample villages, nine are located along a tarmac road. Nevertheless, even in these villages some households live more than one hour away from the next tarmac road. The villages of Sintuwu in Palolo and Rompo in Lore Utara are connected by gravel roads, which are often closed after heavy rains. The only exception in terms of accessibility is the village of Lawe in the western part of Kulawi, which is about one day travelling by foot or horse from the nearest tarmac road.

This situation is reflected in the mean walking distances from the homestead to the nearest tarmac road. In Kulawi the distance to the next road is with an average

of 5.4 hours, higher than in all the other villages (Table 45). In contrast, in Sigi Biromaru almost all households live along or very close to tarmac roads.

Table 45: Distance to tarmac road by sub district in walking hours

	Minimum	Maximum	Mean	Std.dev.
Lore Utara	0.0	5.0	0.3	0.7
Palolo	0.0	5.0	0.4	0.8
Sigi Biromaru	0.0	1.0	0.0	0.1
Kulawi	0.0	13.0	5.4	5.8
Total	0.0	13.0	1.4	3.6

Source: STORMA project A4 household survey
Number of observations=290

5.6 Summary

This chapter described the socio-economic factors influencing activity choice and incomes introduced in the conceptual framework. As crop production is the most important activity in the region the chapter begun with a description of the possession of land. Households in the research area own on average 1.8 ha of land and the share of landless households is 4.5%. Only 20% of the agricultural land can be irrigated and is therefore suitable for paddy rice cultivation. Using a cluster analysis, 63% of the households are classified as either rainfed or irrigated land owners providing less evidence for the co-existence of a rainfed and irrigated land system at the household level. Concerning the access to human capital, households consist on average of 5.3 members, of which 3.6 members are adults. The illiteracy rate is 8.9% and the share of household members that never attended school is only 5.6%. Besides these internal factors, external factors influencing the decision making of households were also described. 55% of the households received a credit overwhelmingly from informal sources. Only 12.6% of the households reported a formal credit in the last five years. Concerning road infrastructure, nine of our sample villages are located along a tarmac road, two villages are connected by gravel roads, and one village is reachable only by foot.

As this chapter provided a partial analysis only, the following chapter explores causal relationships by econometric modelling. It analyses the influence of the previously described factors on total household income, activity choice and income, and on diversification.

Chapter 6

6 Results of the econometric analysis

This chapter presents the results of the econometric models used in this thesis. The influence of internal and external factors as described in the conceptual framework on total household income, on participation in income activities as well as on activity incomes is analysed. In the latter we consider endogeneity as well as simultaneity of the activity choice. In the last section, the influence of internal and external factors on income diversification is evaluated. The following table presents the descriptive statistics of all dependent variables used in the models.

Table 46: Descriptive statistics of the dependent variables

Dependent variable	Min.	Max.	Mean	Std.dev.
Logarithm of total household income	10.3	17.7	14.9	1.1
Participation in annual crop production	0.0	1.0	0.8	0.4
Net income from annual crops (1000 IDR)	-1023.0	18831.5	1181.5	1910.8
Participation in perennial crop production	0.0	1.0	0.8	0.4
Net income from perennial crops (1000 IDR)	-1792.5	37660.1	1455.9	3881.9
Participation in the sale of forest products	0.0	1.0	0.2	0.4
Income from forest products (1000 IDR)	0.0	19440.0	403.4	1514.0
Participation in livestock production	0.0	1.0	0.6	0.5
Net-Income from livestock production (1000 IDR)	-2541.2	8156.3	290.3	1002.6
Participation in agric. wage labour activities	0.0	1.0	0.5	0.5
Agricultural wage income (1000 IDR)	0.0	7488.0	608.9	1149.2
Participation in non-agric. wage labour activities	0.0	1.0	0.2	0.4
Non-agricultural wage income (1000 IDR)	0.0	21956.4	772.5	2598.1
Participation in self-employment activities	0.0	1.0	0.2	0.4
Net-income from non-agricultural self-employment (1000 IDR)	-90.0	36000.0	418.0	1976.9
Share of non-agricultural income (%)	0.0	100.0	16.8	31.3
Shannon equitibility index (%)	0.0	10000.0	8315.6	3125.8

Source: Storma project A4 household survey

Number of observations=291

In all models a common set of explanatory variables has been used to enable comparisons of the influence of variables across models. The education of the head of household, measured in years in school for example has been used in all models as a proxy for education. It is now possible to compare its influence on the total household income, on participation, on activity income as well as on diversification. In some models additional variables have been used to avoid misspecification. Theory for example suggests that risk has an influence on diversification. Therefore, a proxy for risk has been used in this model. Table 47 gives an overview of the descriptive statistics of the explanatory variables used in the models.

Table 47: Descriptive statistics of the explanatory variables

Variable	Empirical proxy	Min.	Max.	Mean	Std.dev.
Physical Capital	Total area owned (ha)	0.0	11.4	1.8	1.8
	Irrigated area owned (ha)	0.0	4.5	0.3	0.5
	Rainfed area owned (ha)	0.0	10.5	1.3	1.7
	Value of all other assets (IDR 1000)	0.0	170195.0	3300.1	9235.3
	Livestock units owned	0.0	6.4	0.6	0.9
Human Capital	Dependency ratio	0.0	5.0	0.7	0.6
	Age of head of household in years	20.0	83.0	43.1	14.0
	Years in school of head of household	0.0	12.0	6.6	3.2
	Female headed household (1=yes)	0.0	1.0	0.0	0.2
Social Capital	Social capital index	0.0	1600.0	196.2	249.5
	Ethnicity of head of household (1=non-indigenous)	0.0	1.0	0.2	0.4
Financial markets	Household received loan from BRI in last 5 years (1=yes)	0.0	1.0	0.1	0.2
Infrastructure	Walking distance house - road (hours)	0.0	13.0	1.4	3.6
Risk	Number of crops failed in last five years	0.0	5.0	0.6	0.8
location	Sub district dummy for Palolo	0.0	1.0	0.2	0.4
	Sub district dummy for Sigi Biromaru	0.0	1.0	0.4	0.5
	Sub district dummy for Kulawi	0.0	1.0	0.2	0.4

Source: STORMA project A4 household survey

Number of observations=291

6.1 Total household income

Since all households obtained an income, the total household income equation is estimated by OLS using the Stata 8 software package. The fit of the model is quite reasonable compared to models in the literature on total household income with an R^2 of 18%. Table 48 shows the results with coefficients with a significance level greater than 90% in bold.

The physical capital endowment turned out to be an important determinant of total household income. An additional hectare of land owned raises income by 8% and an additional livestock unit by 16%. The value of other assets owned also has a positive and statistically significant, but very small influence on income.

Table 48: Ordinary least square regression results for total income

Variables	Coefficient	t-value
Total area owned (ha)	**0.08**	**2.20**
Value of all other assets (IDR 1000)	**0.00**	**2.19**
Livestock units owned	**0.16**	**2.65**
Dependency ratio	**-0.25**	**-1.86**
Age of head of household in years	0.00	0.61
Years in school of head of household	0.01	0.20
Female headed household (1=yes)	-0.16	-0.71
Social capital index	0.00	-0.34
Ethnicity of head of household (1=non-indigenous)	0.24	1.14
Household received loan from BRI in last 5 years (1=yes)	0.33	1.10
Walking distance house - road (hours)	-0.02	-0.99
Sub district dummy for Palolo	-0.47	-1.78
Sub district dummy for Sigi-Birumaru	-0.27	-1.44
Sub district dummy for Kulawi	0.16	0.76
Constant	14.80	36.28
R-square	0.18	
F-value	6.11	

Source: STORMA project A4 household survey

Coefficients with a significance level greater than 90% are in bold. Number of observations=291

Four different empirical proxies to measure the influence of human capital have been used. The dependency ratio, which measures the ratio of children and elderly household members to adults, has a statistically significant negative influence. This means that the more children and elderly in relation to adults are members of a household the less the household income. An increase in the ratio by one unit increases income by 25%. The influence of education is weak and not statistically significant. An additional year spent in school by the head of the household increases average income by 1%.

Although not statistically significant, ethnicity and participation in formal credit markets have a strong influence on total household income. Belonging to a non-indigenous ethnicity increases total income by 24% and borrowing from formal sources within the last five years increased income by 33%.

The next section shifts the focus from the total income to the determinants of participation in different activities.

6.2 Participation by activity

In the analysis of participation we differentiate seven different income sources which are important for rural households in the research area. Non-agricultural activities, the selling of forest products, and perennial crop production are of special interest in terms of rural development and the overall objectives of STORMA. The seven different binary Probit models are estimated by MLE using the Stata 7 software package. The percentage of correctly predicted observations is on average 78%. This value ranges from 68% correctly predicted observations in the agricultural wage labour model to 83% in the models of annual crop production and non-agricultural activities. Table 49 presents the regression results, with coefficients with a significance level greater than 90% in bold. The coefficients in the table represent the percentage change in the probability for an infinitesimal change in each independent, continuous variable and the discrete change in the probability for dummy variables. All other variables are taken at their means.

The possession of land has a strong positive influence on the participation in crop production. An additional hectare of irrigated land increases the probability of participation in annual crop production by 20% and in perennial crop production by 19%. The first relationship is not surprising since annual crops are grown on irrigated as well as rainfed land. In the case of perennial crops, which are grown on rainfed land only, the positive influence of irrigated land owned may indicate that participation in the production of perennial crops, which are mainly cash crops, requires at least some production of rice for home consumption. The possession of irrigated land reduces the likelihood of participation in agricultural wage labour activities, since the production of rice is very labour intensive compared to the production of rainfed crops. The same applies to participation in the selling of forest products. An additional hectare of irrigated land decreases the likelihood of participation in this activity by 15%. However, the possession of rainfed land increases the probability of participation in the selling of forest products even though its influence is comparatively weak.

The possession of other assets reduces participation in all activities except self-employment outside agriculture. This relationship is statistically significant for agricultural wage labour and non-agricultural self-employment income. This indicates that less-poor households are more likely to participate in the latter activity, whereas poorer households tend to participate in agricultural wage labour activities.

The possession of livestock positively influences participation in the production of annual crops, since cattle and buffaloes are used for land preparation in paddy rice production. However, the overall effect is not strong. An additional livestock unit owned, which is, for example, equivalent to one buffalo, increases the likelihood of participation by only 5%.

The education of the head of household discourages participation in the sale of forest products, but has no statistically significant influence on the other activities. In all activities the estimated influence of education is rather small. Holding other variables constant, a one-year increase in the household heads' schooling decreases the probability of participating in the sale of forest products by only 1%.

Table 49: Probit results for activity participation

	annual crops		perennial crops		livestock production		forest products	
Variables	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Irrigated area owned (ha)	**20.38**	**2.46**	**18.54**	**2.55**	9.55	1.41	**-14.89**	**1.96**
Rainfed area owned (ha)	0.07	0.16	**7.46**	**2.12**	**4.95**	**2.57**	**2.69**	**2.56**
Value of all other assets (1000 IDR)	-3.0E-05	0.77	-1.7E-04	0.87	-1.9E-04	0.62	-1.2E-03	1.42
Livestock units owned	**4.56**	**2.82**	1.39	0.51	**21.85**	**3.13**	0.71	0.36
Dependancy ratio	-0.58	0.62	3.60	0.95	4.19	0.83	2.50	0.97
Years in school of head of household	0.14	0.65	-0.24	0.28	1.48	1.39	**-1.11**	**1.92**
Social capital index	-3.3E-03	0.99	**2.3E-02**	**1.74**	-1.1E-03	0.07	5.1E-03	0.69
Ethnicity of head of household (1=non-indigenous)	-0.53	0.26	-3.66	0.49	10.49	1.10	**-8.13**	**2.16**
Household received loan from BRI in last 5 years (1=yes)	**-18.72**	**2.43**	**17.06**	**2.67**	17.26	1.62	-8.26	1.37
Walking distance house - road (hours)	**0.87**	**4.30**	1.27	1.05	**4.94**	**4.61**	**-1.86**	**3.31**
Kecamatan dummy for Palolo	**-8.79**	**2.30**	**13.56**	**1.98**	**17.06**	**1.75**	-8.03	1.38
Kecamatan dummy for Sigi-Birumaru	-4.20	1.70	8.10	1.28	**20.69**	**2.68**	**-10.97**	**2.66**
Kecamatan dummy for Kulawi	-4.76	1.60	**17.32**	**2.55**	**26.92**	**3.42**	**9.81**	**1.76**
Constant	0.86	1.85	-0.46	1.16	-1.33	3.64	-0.18	0.48
Pseudo R-square	0.33		0.17		0.20		0.22	
% correctly predicted	83		77		70		82	

Source: Storma project A4 household survey.

Notes: The coefficients in the table are the percentage change in the probability for an infinitesimal change in each independent, continuous variable and the discrete change in the probability for dummy variables. Number of observations=291.

Coefficients with a significance level greater than 90% are in bold.

Probit results for activity participation (continued)

	agricultural wage labour		non-agricultural wage labour		non-agricultural self-employment	
Variables	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Irrigated area owned (ha)	**-13.30**	**1.72**	1.01	0.21	4.78	1.12
Rainfed area owned (ha)	0.56	0.23	**-2.09**	**1.86**	1.14	0.90
Value of all other assets (1000 IDR)	**-3.4E-03**	**2.45**	-3.5E-05	0.30	**1.2E-03**	**3.44**
Livestock units owned	-2.50	0.62	-2.29	1.02	0.69	0.25
Dependancy ratio	**-9.82**	**1.81**	0.10	0.03	-1.76	0.56
Years in school of head of household	-0.94	0.79	1.03	1.29	-1.09	1.56
Social capital index	2.3E-02	1.50	5.7E-03	0.66	2.5E-04	0.03
Ethnicity of head of household (1=non-indigenous)	**-18.10**	**1.69**	-0.37	0.06	**11.42**	**1.70**
Household received loan from BRI in last 5 years (1=yes)	-9.85	0.69	**25.89**	**2.80**	-4.15	0.55
Walking distance house - road (hours)	**-2.98**	**2.07**	**-2.83**	**2.82**	0.06	0.07
Kecamatan dummy for Palolo	**42.90**	**3.67**	**-9.77**	**1.68**	-7.30	1.16
Kecamatan dummy for Sigi-Birumaru	**17.21**	**1.82**	**-8.02**	**1.74**	**19.97**	**2.92**
Kecamatan dummy for Kulawi	-0.02	0.00	-4.56	0.92	-0.60	0.08
Constant	0.24	0.70	-0.90	2.57	-1.36	3.50
Pseudo R-square	0.19		0.15		0.17	
% correctly predicted	68		83		83	

Source: Storma project A4 household survey.

Notes: The coefficients in the table are the percentage change in the probability for an infinitesimal change in each independent, continuous variable and the discrete change in the probability for dummy variables. Number of observations=291.

Coefficients with a significance level greater than 90% are in bold.

Social capital leads to increased participation in the production of perennial crops, but has no statistically significant influence on the other activities. A reason for this might be that cacao, the most important perennial crop, is a comparatively new crop for the farmers in the research area. More than two-thirds of the cocoa plots are less than 5 years old. Farmers often get to know of a new crop by the experiences of other farmers. Moreover, other farmers are often the most-trusted and only source of information on how to start the cultivation. Meetings of social organisations are a good opportunity to meet other farmers and discuss such issues. The econometric analysis seems to reveal the importance of social capital in the adoption process of a new crop.

Indigenous households tend to participate in agricultural wage labour and in the selling of forest products, whereas non-indigenous households are more likely to participate in non-agricultural self-employment. Belonging to a non-indigenous ethnic group decreases the probability of participation in the sale of forest products by 8% and in agricultural wage labour activities by 18%. On the other hand, it increases the likelihood of participation in non-agricultural self-employment by 11%. All three relationships are statistically significant.

Borrowing money from the BRI plays an interesting role in determining activity participation. It statistically significantly discourages participation in annual crop production, but encourages participation in the production of perennial crops and non-agricultural wage labour. The latter influence is particularly strong, increasing the probability of participation by 26%. When a household received a loan in the last five years the probability of participating in annual crop production decreased by around 19%, whereas the likelihood of participating in perennial crop production increased by 17%. This result suggests that formal loans are used to start the production of perennial crops, mainly cocoa, and therefore might accelerate the conversion of forest into cocoa plantations.

Infrastructure, measured by the walking distance to the next road, has a strong influence on participation in almost all activities. The longer a household needs to get to the next road, the more likely it will participate in crop and livestock produc-

tion. This relationship is statistically significant in the case of annual crop production and livestock production. Every hour further away from a tarmac road increases the likelihood to participate in annual crop production by 1%. On the other hand, increasing distance reduces the likelihood of participating in wage labour activities and in the selling of forest products. The latter result is somewhat surprising because in general, forest products are associated with remote areas. This could be due to the fact that we only considered the selling of forest products, and the sale of rattan requires good road infrastructure. With every hour of increasing distance to the road the probability of participating in non-agricultural wage labour employment decreases by almost 3%. The only exception in the influence of roads is non-agricultural self-employment, where the coefficient and the t-ratio are very low, indicating that it has no influence on participation. In line with the descriptive results, this reflects the fact that the rural non-agricultural self-employment sector is dominated by small enterprises serving local markets independent of the existence of tarmac roads.

Finally, a number of regional variables turned out to statistically significantly influence participation in particular activities, which indicates the existence of certain regional factors that are not controlled for in the regression models.

6.3 Income by activity

While the previous section evaluated the probability of participation in activities, this section analyses factors influencing the level of income from each activity. The same income activities as before are used with the same set of explanatory variables, but only those physical assets that are expected to influence the income level of a certain activity are included. The income equations are estimated jointly, applying a generalisation of the Lee two-stage estimator proposed by Amemiya as described in Chapter 3. The Limdep 7.0 software package was used for estimation. The fit of the models measured by the R-square ranges from 60% to 80%. Table 50 presents the regression results, with coefficients with a significance level greater than 90% in bold. The coefficients in the table are the estimated absolute effects of one-

unit changes in the corresponding explanatory variables on activity incomes. They represent effects of explanatory variables on activity incomes given participation and thus are also called selectivity-corrected activity income estimates.

As expected the area of land owned plays an important role not only in crop production, but also in the selling of forest products and in wage labour activities. An additional hectare of irrigated land increases income from annual crop production by IDR 399,000 IDR, which is equivalent to 34%. The area of rainfed land owned has almost the same effect on income from perennial crops controlled for participation. The absolute gain in income from perennial crops is IDR 680,000 or 47%. Besides its influence on annual crop production, irrigated land also has a strong influence on the income from forest products and agricultural wage labour. Each additional hectare owned decreases income from the sale of forest products by IDR 356,000, which is equivalent to a reduction of 88%. Furthermore, an additional hectare of irrigated land reduces income from agricultural wage labour by IDR 248,000. Thus, the very labour intensive production of paddy rice not only reduces the likelihood of participation, it also reduces the income gained from these activities. Moreover, the results indicate that the ownership of land reduces the income gained from wage labour activities in general.

In contrast to land, the effect of the value of other assets owned on activity incomes is small, and with the exception of non-agricultural self-employment income not statistically significant. This result is not surprising because the category other assets also includes non-productive assets, like radios and televisions, which are not used in the production process.

The possession of livestock leads not only to increased participation in annual crop production and livestock production, but also positively influences income gained from these activities. Both relationships are statistically significant.

Table 50: Selectivity corrected estimates of income equations

	annual crops		perennial crops		livestock production		forest products	
Variables	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Irrigated area owned (ha)	**399.7**	**1.93**	289.8	0.70	122.1	1.11	**-355.7**	**-2.51**
Rainfed area owned (ha)	108.5	1.72	**680.1**	**4.84**				
Value of all other assets (IDR 1000)							-2.9E-03	-0.72
Livestock units owned	**559.9**	**4.83**			**370.8**	**5.96**		
Dependency ratio	-222.8	-0.76	-402.7	-1.13	-9.0	-0.10	76.7	0.64
Years in school of head of household	**60.3**	**1.79**	-83.7	-1.17	14.1	0.79	**-60.3**	**-2.47**
Social capital index	**0.9**	**2.04**	-0.2	-0.38	0.3	1.08	0.2	0.73
Ethnicity of head of household (1=non-indigenous)	298.2	1.08	**1208.3**	**2.00**	15.4	0.10	-87.1	-0.42
Household received loan from BRI in last 5 years (1=yes)	374.8	0.35	182.5	0.15	**456.3**	**2.01**	-319.4	-1.01
Walking distance house - road (hours)	28.6	0.77	-18.0	-0.16	**-33.5**	**-1.79**	**-120.9**	**-4.80**
Sub district dummy for Palolo	-429.2	-1.36	**1988.8**	**2.84**	-108.2	-0.61	**-464.6**	**-1.89**
Sub district dummy for Sigi-Birumaru	244.7	0.63	1047.5	1.60	-180.1	-1.10	**-508.1**	**-2.24**
Sub district dummy for Kulawi	-254.9	-0.69	**1317.7**	**1.70**	**338.3**	**1.66**	**692.0**	**2.52**
Inverse Mills ratio	**863.5**	**4.23**	**847.1**	**2.81**	**184.7**	**2.53**	**1299.5**	**11.09**
Constant	438.1	0.20	132.6	-0.03	218.6	-0.33	1157.0	3.89
Pseudo R-square	0.60		0.71		0.66		0.80	

Source: STORMA project A4 household survey

Coefficients with a significance level greater than 90% are in bold.

Number of observations=291

Selectivity corrected estimates of income equations (continued)

	agricultural wage labour		non-agricultural wage labour		non-agricultural self-employment	
Variables	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Irrigated area owned (ha)	**-248.0**	**-2.33**	-306.8	-1.42		
Rainfed area owned (ha)	-42.7	-1.19	**-128.0**	**-1.74**		
Value of all other assets (IDR 1000)			-2.3E-02	-0.13	**0.08**	**7.18**
Livestock units owned						
Dependency ratio	**-296.0**	**-3.25**	-167.1	-0.90	-23.51	-0.15
Years in school of head of household	-7.0	-0.37	**110.2**	**2.96**	19.44	0.59
Social capital index	0.1	0.42	-0.3	-0.72	-0.29	-0.65
Ethnicity of head of household (1=non-indigenous)	-204.8	-1.33	258.5	0.81	**585.81**	**2.08**
Household received loan from BRI in last 5 years (1=yes)	**-518.4**	**-2.25**	**2990.9**	**6.25**	-311.23	-0.75
Walking distance house - road (hours)	**-62.7**	**-3.23**	11.8	0.31	-2.67	-0.09
Sub district dummy for Palolo	57.7	0.32	**-1426.0**	**-3.85**	**-551.28**	**-1.74**
Sub district dummy for Sigi-Birumaru	-227.0	-1.31	**-1331.3**	**-3.85**	66.84	0.15
Sub district dummy for Kulawi	-97.2	-0.47	**-1499.6**	**-3.56**	45.49	0.07
Inverse Mills ratio	**859.4**	**11.87**	**2314.7**	**13.32**	**1250.79**	**8.03**
Constant	1238.1	5.34	1415.2	3.01	98.51	0.31
Pseudo R-square	0.72		0.80		0.79	

Source: STORMA project A4 household survey

Coefficients with a significance level greater than 90% are in bold.

Number of observations=291

Education plays an interesting role as a determinant of activity income. A one-year increase in household heads' schooling increases income from annual crop production by IDR 60,000, which is equivalent to a return of 5%. On the other hand, it reduces the gains from the production of perennial crops, although this influence is not statistically significant. As formal education influences management practices this result indicates that management issues are important for the production of annual crops, whereas they do not play such a role in perennial crop production. This is in line with the descriptive analysis in Chapter 4.2.1, which shows that 81% of the cash expenditures for inputs are spent for annual crops, especially paddy rice. Formal education, especially the ability to read and write, is important in the use of chemical inputs, for example to read the description and dosage recommendations on the tins of pesticides. Furthermore, an additional year in school reduces the income gained from the selling of forest products by IDR 60,000, which is equivalent to a reduction of 15%. The highest returns of education are gained in non-agricultural wage labour income. A one-year increase in household heads' schooling is associated with an absolute gain of IDR 110,000, which is equivalent to an increase in non-agricultural wage labour income by 14%. This is in line with findings of similar studies on the role of education from Latin America (Taylor and Yunez-Naude, 2000, Yunez-Naude and Taylor, 2001, Winters et al., 2002). Taylor and Yunez-Naude (2000), for example, report returns of education of 10% to wage labour income.

Social capital has a positive influence on the incomes gained from annual crop production, but has no statistically significant influence on the other activities. The influence of social capital on annual crop production might be explained by the importance of external inputs in its production. Meetings of social organisations are a good opportunity to meet other farmers and discuss the use of chemical fertiliser and pesticides, especially when other sources of information, like the extension service, are often not available.

Ethnic affiliation has a strong and statistically significant effect on income from perennial crop production and non-agricultural self-employment. Although non-indigenous households are less likely to participate in the production of peren-

nial crops, they gain almost IDR 1.2 mill, which is equivalent to an increase of 83%. In non-agricultural self-employment, ethnicity also has a statistically significant influence, with non-indigenous households gaining IDR 585,000 compared to indigenous households.

Participation in formal credit markets has a positive and statistically significant influence on income from livestock production, and both agricultural and non-agricultural wage labour activities. The latter relationship is particularly strong. This might be explained by a change in causality: for households having a high and regular wage income it is much easier to get loans from formal institutions.

The distance to the next road has a statistically significant influence on income from livestock production, agricultural wage labour activities and the selling of forest products. The latter relationship is particularly strong. With every hour of increased distance to the road, the income from forest products decreases by around IDR 120,000, which is equivalent to a drop of 30%. In this activity, distance to roads has the same strong and statistically significant influence on both participation and income. Similar but less strong is the impact of infrastructure on agricultural wage labour income. The influence of roads on income from activities outside the agricultural sector is low and statistically not significant.

In all equations the estimates for the IMR are all positive and statistically significantly different from zero, which indicates that self-selection into activities plays an important role in the generation of income from a certain activity. Moreover, the failure to control for it would have led to biased results.

6.4 Diversification

The term income diversification is often used in the sense of diversification out of the agricultural sector, i.e. as an increase in the share of income from activities which are not related to agriculture. This is examined in the first econometric model, where we look at factors influencing diversification out of the agricultural sector. It is measured by the share of non-agricultural income, both from self-employment and

wage labour, in total household income. But income diversification can also refer to the number of income sources and their relative importance. This is examined in the second model, where we analyse the factors influencing the overall mix of the income measured by the Shannon equitability index. This index takes into account the number of income sources and their share in total household income. It increases with the number of income sources and when the income is more evenly distributed among the different activities. It is calculated from the same activities as considered in the previous sections (for computational details see Chapter 3.3.2). In both regressions we use the same set of explanatory variables whose descriptive statistics are shown in Table 47.

In the first regression on the share of non-agricultural income in total household income the value of other assets owned has a highly statistically significant positive influence (see Table 51). Wealth increases the diversification out of the agricultural sector. Another statistically significant factor influencing the diversification out of agriculture is education. The more years the head of the household spent in school, the greater the household's share in non-agricultural income. Also, participation in formal credit markets has a statistically significant positive impact on the share of non-agricultural income.

Considering the overall degree of diversification, the possession of land and of other assets has no statistically significant influence on the Shannon equitability index, whereas the number of livestock owned by a household increases the overall diversity of income. Social networks also seem to enable household members to extend their participation to new activities. Social capital has a statistically significant and positive influence on diversification. Despite being statistically not significant, the occurrence of shocks related to cropping activities within the last 10 years positively influences the overall diversification. This supports the hypothesis of diversification as an ex-post reaction to the occurrence of shocks.

Table 51: Tobit estimates of the determinants of diversification

	Share of non-agricultural income		Shannon equitibility index	
Variables	Coefficient	t-ratio	Coefficient	t-ratio
Total area owned (ha)	-1.60	-0.55	1.07E-02	1.56
Value of all other assets (IDR 1000)	**8.4E-04**	**2.31**	4.03E-08	0.03
Livestock units owned	-1.12	-0.22	**3.11E-02**	**2.52**
Dependency ratio	-3.80	-0.47	-1.16E-03	-0.06
Years in school of head of household	**2.66**	**1.65**	-5.71E-03	-1.52
Social capital index	-5.8E-03	-0.29	**1.07E-04**	**2.21**
Female headed household (1=yes)	34.41	1.43	6.50E-02	1.10
Ethnicity of head of household (1=non-indigenous)	15.23	1.16	-2.90E-02	-0.91
Household received loan from BRI in last 5 years (1=yes)	**50.29**	**3.07**	-3.70E-03	-0.08
Walking distance house - road (hours)	-0.64	-0.26	1.11E-03	0.28
Number of crops failed in last five years	-4.68	-0.75	1.92E-02	1.39
Sub district dummy for Palolo	**-30.82**	**-1.82**	2.40E-02	0.64
Sub district dummy for Sigi-Birumaru	8.54	0.64	1.97E-02	0.55
Sub district dummy for Kulawi	**-39.40**	**-2.39**	**1.31E-01**	**3.01**
Constant	-34.96	-1.76	2.73E-01	5.70
Prob. > Chi-square	0.00		0.00	
Number of left censored observations	190		32	

Source: STORMA project A4 household survey.

Notes: The coefficients show the marginal effect of the explanatory variables on the latent variable.

Coefficients with a significance level greater than 90% are in bold. Number of observations=291

Comparing the two models we can conclude that the households' wealth positively influences diversification out of the agricultural sector, whereas it has no influence on the overall income diversity. The same applies for the role of participation in formal credit markets. Furthermore, education plays a major positive role in the diversification out of the agricultural sector but it has a negative influence on the overall diversification. Better-educated households have a higher share of income from outside agriculture, but their income stems from fewer sources and is less evenly distributed among these sources.

6.5 Summary

This chapter presented the results of the econometric models used in this thesis. The access to physical and human capital has a significant influence on total household income. The area owned, the value of other assets possessed, as well as the number of livestock and family labourers positively influence total household income. The analysis of activity choice shows the strong influence of the possession of land on the participation in crop production, while the possession of irrigated land reduces the likelihood of participation in agricultural wage labour activities and in the sale of forest products. Richer and non-indigenous households are more likely to participate in non-agricultural self-employment. In contrast, non-indigenous households are less likely to participate in the sale of forest products and in agricultural wage labour activities. Participation in formal credit markets discourages participation in annual crop production, but encourages participation in the production of perennial crops and non-agricultural wage labour activities. The access to roads has a strong influence on participation in almost all activities. The analysis of activity incomes shows that the possession of land has a strong positive influence on the income gained from crop production, while the possession of irrigated land reduces the income gained from agricultural wage labour and the sale of forest products. Similar to its effect on participation, the value of other assets owned has a positive influence on the income from non-agricultural self-employment. Furthermore, the analysis shows that education increases the income gained from non-agricultural wage labour activities and annual crop production. Compared to indigenous households, non-

indigenous households gain more income from perennial crop production and non-agricultural self-employment. The access to tarmac roads has a positive effect on the income from agricultural wage labour and the sale of forest products. Diversification out of the agricultural sector is positively influenced by the wealth of the household, education, and the participation in formal credit markets.

The next chapter summarises the major results related to the research questions presented in Chapter 2.

Chapter 7

7 Conclusions

The research area is characterised by a high share of poor and vulnerable households (Suryahadi and Sumarto, 2001) as well as by a strong increase in population. These people were and are attracted by the income possibilities in coffee and particularly in cocoa production, which is a major source of deforestation and often located inside the Lore-Lindu National Park (Maertens, 2003). This ongoing encroachment threatens the integrity of the park and endangers its unique fauna and flora. Therefore, alternative income sources for rural households are needed which are able to reduce poverty and the pressure on the national park. This study aims to identify and analyse the determinants of income generating activities of rural households in the vicinity of the national park. It helps to identify factors, which are essentially for the design of policies promoting alternative income strategies.

This chapter summarises the major results related to the research questions presented in Chapter 2. The first section presents the results related to the research questions 1 through 6 and the final section draws policy conclusions in relation to research question 7.

7.1 Major results

Among the activities in which rural households in the research area are engaged, agricultural activities are the most important source of income. They account for 70% of the total household income, with 96% of the households participating in this activity. Within this category, most income originates from crop production, with cocoa and paddy rice as the most important crops. Nevertheless, activities outside the agricultural sector also play an important role and contribute 30% to the total income. Compared to this share, participation in non-agricultural activities is much lower. Only 17% of the households generate income from non-agricultural wage labour activities and 18% from non-agricultural self-employment.

Differentiating the income sources by poverty groups show differences between poor and less-poor households in their activities. Participation in agricultural wage labour activities is much lower for less-poor households compared to the poorest households. In contrast, the rate of participation in non-agricultural activities is comparatively higher for households that are better off. Moreover, they generate also much more income from these activities. They derive 39% of their income from activities outside agriculture, whereas it accounts for only 9% of the income of the poorest households.

The econometric analysis shows that the access to physical and human capital has a significant influence on total household income. The size of land owned, the value of other assets possessed, and the number of livestock owned have a positive influence on total household income. Furthermore, the dependency ratio has a negative influence. This means that the more members of working age in relation to children and elderly are in a household, the higher the household income.

Another area of concern in the econometric analysis is the examination of factors determining participation in different activities. The possession of land, social capital and the participation in formal credit markets have a positive influence on the participation in perennial crop production. The level of schooling and the distance to tarmac roads decrease the probability of participating in the sale of forest products. Moreover, non-indigenous households are less likely to participate in this activity. It

is also interesting to note that the possession of irrigated land reduces the likelihood of participation, whereas the area of rainfed land owned has a positive influence on participation in the sale of forest products. Participation in formal credit markets has a positive influence on the participation in non-agricultural wage labour activities, whereas the area of irrigated land owned and the distance to a tarmac road discourages participation in this activity. The value of other assets owned increase the probability of participating in non-agricultural self-employment. Moreover, non-indigenous households are more likely to participate in this activity.

Apart from participation in activities, another econometric model analyses factors influencing the income gained from different activities. As in the case of participation, the possession of rainfed land also has a strong positive influence on the income gained from perennial crop production. Moreover, non-indigenous households gain more income from perennial crop production than indigenous households. The possession of irrigated land, the level of education and the distance to a tarmac road reduce the income gained from the sale of forest products. The analysis also shows that education increases the income gained from non-agricultural wage labour activities. In contrast, the area owned has a negative influence on the income from that activity. Similar to its effect on participation, the value of other assets has a positive influence on the income from non-agricultural self-employment. Furthermore, non-indigenous households gain more income from that activity than indigenous households.

The final econometric model examines factors influencing income diversification. The diversification out of the agricultural sector is positively influenced by the wealth status of the household, the education of the head of household, and the participation in formal credit markets. The number of livestock owned and the access to social capital have a positive effect on the overall degree of diversification.

7.2 Policy conclusions

Based on the results of the descriptive as well as econometric analysis, policy conclusions can be drawn with respect to deforestation and rural development. The

latter topic focuses on poverty alleviation through the promotion of activities outside the agricultural sector.

An important area of concern is the income derived from perennial crops, as coffee and cocoa are a major source of deforestation. The econometric analysis shows that the possession of land, the access to social capital and the participation in credit markets positively influences participation in perennial crop production. The positive influence of the possession of irrigated land on participation in perennial crop production may indicate a food security strategy employed by rural households. Irrigated land for the production of the basic staple rice seems to be a prerequisite for participation in perennial crop production. But the area of irrigated land owned has no statistically significant effect on the income derived. The positive influence of borrowing money from the BRI on participation suggests that such loans are used to start the production of perennial crops, which accelerate the conversion of forest into cocoa plantations. Therefore, formal credits should be redirected into activities which do not threaten the integrity of the national park. Alternatives might include non-agricultural activities, which are constrained by the access to formal credit. Nevertheless, all such policies aiming to protect the park should be accompanied by better law enforcement either through the National Park Authority or community agreements[16].

Apart from deforestation, another area of concern is the sale of forest products, which are mainly collected inside the national park. The level of education and the distance to tarmac roads have a negative influence on the sale of forest products. Therefore, policy measures to reduce the sale of forest products might be to improve the access to education and rethink the proposed road extension plans. In the political discussion, there are still plans to build new roads inside the national park linking, for example, the sub district of Lure Utara with Lore Selatan (ANZDEC, 1997). Alternative plans building these roads further away from the national park boundaries should be preferred.

[16] The effect of various community agreements on conservation in the research area has been evaluated in Mappatoba, 2004

The analysis was designed to enable a thorough investigation of non-agricultural activities, as these might represent a way out of poverty without leading to further deforestation. The descriptive analysis shows that non-agricultural activities are particularly important for less-poor households, whereas poor households are more engaged in agricultural activities. Reardon et al. (1998) call this the "inter-household paradox": the poorest households, while having the greatest need for non-agricultural income, are also the most constrained. The econometric analysis shows that the endowment of other assets is such a constrain. Poorer households, because of their lower endowment with physical capital not related to agriculture, have fewer opportunities to participate and derive income from non-agricultural sources. Therefore, potential non-agricultural activities have to be carefully evaluated as to whether they suit the assets owned by poor households. Agricultural policies or projects aiming to reduce poverty by promoting these activities have to consider this. Otherwise, they will not be able to participate and it will not be possible to reduce poverty by promoting non-agricultural activities.

Apart from the value of other assets owned, another key determinant for income diversification out of the agricultural sector is the participation in formal credit markets. Households that have received a formal loan within the last five years have diversified more of their income out of the agricultural sector than households that did not receive a formal loan. Credit enables households to change their stock in physical capital within a short time to take advantage of income opportunities outside agriculture. Therefore, a possible policy measure is to improve the participation of poor households in formal credit, which are directly targeted towards non-agricultural activities.

Another key factor influencing income from non-agricultural wage labour with high returns is education. A one-year increase in household heads' schooling is associated with an increase in non-agricultural wage labour income by 14%. The improvement of the level of education, especially of junior and senior high schools, is a prerequisite for wage labour employment outside the agricultural sector. Therefore, rural development policies could promote the establishment of additional junior

and senior high schools. But, the demand for better-educated people also has to be improved, especially in the private sector. So far, the state is the most important employer and governmental budgets are tight.

Activities outside the agricultural sector represent an alternative income source without leading to further encroachment. Nevertheless, the descriptive as well as econometric analysis indicate that self-employed income is dominated by small enterprises serving local markets, implying linkages between the agricultural and non-agricultural sector. The business of small shopkeepers and craftsmen in the villages depends on the economic situation of the farmers in their village. Changing the focus of rural development programmes from the agricultural to the non-agricultural sector might create new activities in the villages outside agriculture, but it can also decrease the demand of local farmers to the disadvantage of already existing local shops and craftsmen. Such dependencies call for multisectoral development policies taking into account the multiplicity of activities and their inter-linkages. Reardon et al. (2001, p. 407), in an overview of policy implications for rural non-farm employment in Latin America, drew the conclusions that “the promotion of rural non-agricultural employment and income cannot be made at the cost of developing the agricultural sector. The challenge consists of mobilizing additional investment […].”

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9 Appendix

Table A.1: ANOVA on differences in agricultural wage labour income by poverty group

Agricultural wage income (IDR)

	Quadratsumme	df	Mittel der Quadrate	F	Signifikanz
Zwischen den Gruppen	1.8E+12	2	9.13E+11	.674	.510
Innerhalb der Gruppen	3.9E+14	286	1.35E+12		
Gesamt	3.9E+14	288			

Table A.2: Kruskal-Wallis test on differences in income by poverty group

Ränge

	poverty Groups terciles	N	Mittlerer Rang
Total household income	1	125	153.55
	2	117	146.68
	3	106	229.91
	Gesamt	348	
Farm income (nach Barrett et al.)	1	125	170.36
	2	117	140.05
	3	106	217.41
	Gesamt	348	
Self-employed income (IDR)	1	125	155.16
	2	117	176.77
	3	106	194.81
	Gesamt	348	
Non-agricultural wage income (IDR)	1	125	160.50
	2	117	173.80
	3	106	191.79
	Gesamt	348	

Statistik für Test[a,b]

	Total household income	Farm income (nach Barrett et al.)	Self-employed income (IDR)	Non-agricultural wage income (IDR)
Chi-Quadrat	46.516	33.220	22.324	12.830
df	2	2	2	2
Asymptotische Signifikanz	.000	.000	.000	.002

a. Kruskal-Wallis-Test

b. Gruppenvariable: poverty Groups terciles

Table A.3: Mann-Whitney tests on differences in income by poverty group

Statistik für Test (poverty group 1 and 2)[a]

	Total household income	Farm income (nach Barrett et al.)	Self-employed income (IDR)	Non-agricultural wage income (IDR)
Mann-Whitney-U	6850.000	5865.000	6379.000	6752.500
Wilcoxon-W	13753.000	12768.000	14254.000	14627.500
Z	-.850	-2.660	-3.138	-1.748
Asymptotische Signifikanz (2-seitig)	.395	.008	.002	.080

a. Gruppenvariable: poverty Groups terciles

Statistik für Test (poverty group 1 and 3)[a]

	Total household income	Farm income (nach Barrett et al.)	Self-employed income (IDR)	Non-agricultural wage income (IDR)
Mann-Whitney-U	3544.000	4660.000	5140.500	5434.500
Wilcoxon-W	11419.000	12535.000	13015.500	13309.500
Z	-6.087	-3.883	-4.702	-3.568
Asymptotische Signifikanz (2-seitig)	.000	.000	.000	.000

a. Gruppenvariable: poverty Groups terciles

Statistik für Test (poverty group 2 and 3)[a]

	Total household income	Farm income (nach Barrett et al.)	Self-employed income (IDR)	Non-agricultural wage income (IDR)
Mann-Whitney-U	3409.000	3617.500	5533.000	5559.000
Wilcoxon-W	10312.000	10520.500	12436.000	12462.000
Z	-5.803	-5.370	-1.931	-1.856
Asymptotische Signifikanz (2-seitig)	.000	.000	.053	.063

a. Gruppenvariable: poverty Groups terciles

Table A.4: ANOVA on differences in participation in agricultural wage labour activities by poverty group

Participation in agricultural self-employment activities

	Quadratsumme	df	Mittel der Quadrate	F	Signifikanz
Zwischen den Gruppen	.004	2	.002	.054	.947
Innerhalb der Gruppen	11.020	286	.039		
Gesamt	11.024	288			

Table A.5: Kruskal-Wallis test on differences in activity participation by poverty group

Ränge

	poverty Groups terciles	N	Mittlerer Rang
Participation in collection of forest products	1	125	201.25
	2	117	168.26
	3	106	149.85
	Gesamt	348	
Participation in self-employment activities	1	125	156.74
	2	117	176.74
	3	106	192.96
	Gesamt	348	
Participation in agricultural wage labour activities	1	125	180.02
	2	117	194.65
	3	106	145.75
	Gesamt	348	
Participation in non-agricultural wage labour activities	1	125	161.20
	2	117	174.24
	3	106	190.46
	Gesamt	348	

Statistik für Test[a,b]

	Participation in collection of forest products	Participation in self-employment activities	Participation in agricultural wage labour activities	Participation in non-agricultural wage labour activities
Chi-Quadrat	32.819	18.842	18.506	11.336
df	2	2	2	2
Asymptotische Signifikanz	.000	.000	.000	.003

a. Kruskal-Wallis-Test

b. Gruppenvariable: poverty Groups terciles

Table A.6: Kruskal-Wallis test on differences in land owned by sub district

Ränge

	Code kecamatan	N	Mittlerer Rang
Total area of land owned (ares)	Lore Utara	80	215.59
	Palolo	85	174.63
	Sigi Biromaru	92	118.40
	Kulawi	91	194.97
	Gesamt	348	
Dryland owned	Lore Utara	80	200.93
	Palolo	85	183.74
	Sigi Biromaru	92	104.22
	Kulawi	91	213.69
	Gesamt	348	
Area of sawah fields owned	Lore Utara	80	204.36
	Palolo	85	172.77
	Sigi Biromaru	92	183.39
	Kulawi	91	140.88
	Gesamt	348	

Statistik für Test[a,b]

	Total area of land owned (ares)	Dryland owned	Area of sawah fields owned
Chi-Quadrat	45.726	65.590	22.090
df	3	3	3
Asymptotische Signifikanz	.000	.000	.000

a. Kruskal-Wallis-Test

b. Gruppenvariable: Code kecamatan

Table A.7: Kruskal-Wallis test on differences in household composition by sub district

Ränge

	Code kecamatan	N	Mittlerer Rang
Number of household members	Lore Utara	80	193.83
	Palolo	85	178.61
	Sigi Biromaru	92	144.91
	Kulawi	91	183.58
	Gesamt	348	
Number of adults	Lore Utara	80	192.01
	Palolo	85	177.01
	Sigi Biromaru	92	151.81
	Kulawi	91	179.71
	Gesamt	348	

Statistik für Test[a,b]

	Number of household members	Number of adults
Chi-Quadrat	12.164	7.801
df	3	3
Asymptotische Signifikanz	.007	.050

a. Kruskal-Wallis-Test

b. Gruppenvariable: Code kecamatan

Table A.8: Kruskal-Wallis test on differences in education by sub district

Ränge

	Code kecamatan	N	Mittlerer Rang
Percentage of adults able to write	Lore Utara	80	184.77
	Palolo	85	176.31
	Sigi Biromaru	92	168.76
	Kulawi	91	169.59
	Gesamt	348	
Percentage of adults never attended school	Lore Utara	80	162.80
	Palolo	85	179.08
	Sigi Biromaru	92	177.30
	Kulawi	91	177.68
	Gesamt	348	
Percentage of adults completed SD	Lore Utara	80	199.48
	Palolo	85	174.32
	Sigi Biromaru	92	166.08
	Kulawi	91	161.22
	Gesamt	348	
Percentage of adults completed SMP	Lore Utara	80	227.51
	Palolo	85	183.01
	Sigi Biromaru	92	178.24
	Kulawi	91	116.17
	Gesamt	348	
Percentage of adults completed SMA	Lore Utara	80	214.31
	Palolo	85	172.79
	Sigi Biromaru	92	172.52
	Kulawi	91	143.10
	Gesamt	348	

Statistik für Test[a,b]

	Percentage of adults able to write	Percentage of adults never attended school	Percentage of adults completed SD	Percentage of adults completed SMP	Percentage of adults completed SMA
Chi-Quadrat	2.722	3.578	9.681	58.541	33.423
df	3	3	3	3	3
Asymptotische Signifikanz	.437	.311	.021	.000	.000

a. Kruskal-Wallis-Test

b. Gruppenvariable: Code kecamatan

Table A.9: T-test on differences in education by gender

Test bei gepaarten Stichproben

		Gepaarte Differenzen					T	df	Sig. (2-seitig)
		Mittelwert	Standardabweichung	Standardfehler des Mittelwertes	95% Konfidenzintervall der Differenz				
					Untere	Obere			
Paaren 1	Percentage of male adults completed SMP - Percentage of female adults completed SMP	1.6503	44.78784	2.65797	-3.5816	6.8822	.621	283	.535

Test bei gepaarten Stichproben

		Gepaarte Differenzen					T	df	Sig. (2-seitig)
		Mittelwert	Standardabweichung	Standardfehler des Mittelwertes	95% Konfidenzintervall der Differenz				
					Untere	Obere			
Paaren 1	Percentage of male adults completed SMA - Percentage of female adults completed SMA	6.6499	32.01582	1.90001	2.9099	10.3898	3.500	283	.001

Table A.10: Kruskal-Wallis test on differences in social capital by sub district

Ränge

	Code kecamatan	N	Mittlerer Rang
Number of memberships	Lore Utara	80	229.48
	Palolo	85	139.02
	Sigi Biromaru	92	171.11
	Kulawi	91	162.73
	Gesamt	348	
Number of memberships per capita	Lore Utara	80	227.36
	Palolo	85	136.09
	Sigi Biromaru	92	179.67
	Kulawi	91	158.67
	Gesamt	348	
NNUMS	Lore Utara	80	197.27
	Palolo	85	167.46
	Sigi Biromaru	92	161.43
	Kulawi	91	174.26
	Gesamt	348	

Statistik für Test[a,b]

	Number of memberships	Number of memberships per capita	NNUMS
Chi-Quadrat	36.684	37.614	11.849
df	3	3	3
Asymptotische Signifikanz	.000	.000	.008

a. Kruskal-Wallis-Test

b. Gruppenvariable: Code kecamatan

Table A.11: Kruskal-Wallis test on differences in ethnicity by sub district

Ränge

	Code kecamatan	N	Mittlerer Rang
Ethnicity of head of household	Lore Utara	80	194.23
	Palolo	85	219.43
	Sigi Biromaru	92	150.63
	Kulawi	91	139.32
	Gesamt	348	

Statistik für Test[a,b]

	Ethnicity of head of household
Chi-Quadrat	69.643
df	3
Asymptotische Signifikanz	.000

a. Kruskal-Wallis-Test

b. Gruppenvariable: Code kecamatan

Table A.12: Kruskal-Wallis test on differences in the share of migrant households by sub district

Ränge

	Code kecamatan	N	Mittlerer Rang
DMIGHH	Lore Utara	80	157.82
	Palolo	85	253.65
	Sigi Biromaru	92	163.78
	Kulawi	91	126.06
	Gesamt	348	

Statistik für Test[a,b]

	DMIGHH
Chi-Quadrat	115.433
df	3
Asymptotische Signifikanz	.000

a. Kruskal-Wallis-Test

b. Gruppenvariable: Code kecamatan

Table A.13: Kruskal-Wallis test on differences in the share of households received loan by sub district

Ränge

	Code kecamatan	N	Mittlerer Rang
Household received informal loan <30000 IDR	Lore Utara	80	168.05
	Palolo	85	175.47
	Sigi Biromaru	92	181.48
	Kulawi	91	172.21
	Gesamt	348	
Household received informal loan >30000	Lore Utara	80	158.88
	Palolo	85	178.19
	Sigi Biromaru	92	176.37
	Kulawi	91	182.90
	Gesamt	348	
Household received formal loan	Lore Utara	80	194.32
	Palolo	85	153.00
	Sigi Biromaru	92	183.26
	Kulawi	91	168.30
	Gesamt	348	
Household received loan from BRI	Lore Utara	80	189.10
	Palolo	85	163.00
	Sigi Biromaru	92	172.46
	Kulawi	91	174.47
	Gesamt	348	

Statistik für Test[a,b]

	Household received informal loan <30000 IDR	Household received informal loan >30000	Household received formal loan	Household received loan from BRI
Chi-Quadrat	2.769	3.757	24.724	15.302
df	3	3	3	3
Asymptotische Signifikanz	.429	.289	.000	.002

a. Kruskal-Wallis-Test

b. Gruppenvariable: Code kecamatan