Agricultural Household Types in Upland Sulawesi, Indonesia – A Classification Approach –

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Abstract

The land use patterns of households in the Lore Lindu region (Central Sulawesi) are currently highly-dynamic. Traditional subsistence products like wet rice are more and more substituted by cash crops, particularly by cacao. In the light of this regional land use change, this paper supplies a quantitative tool which facilitates the investigation of current land use patterns on household level in any villages in the Lore Lindu region. The development of this tool is exemplified by the use of land use data on household level in three study villages. This approach includes the creation of agricultural household types based on a cluster analysis. In order to ensure the practicability of the calculations, a simplified modification of the method is also given. The application of this tool allows for the production of a manageable database on land use in further villages of the region.

Introduction

A large number of studies within the scope of the STORMA project have regarded land use patterns and dynamics in the Lore Lindu region on different scales: from macro-scale (whole region) and meso-scale (village comparison) down to micro-scale (household level). Up to now, a detailed quantitative description concerning the land use patterns of all households living in specific sample villages in the region is lacking. However, such a comprehensive description on household level might be a useful source of data for further studies.

As former STORMA investigations on macro- and meso-scale have shown, the present land use strategies of the households in the Lore Lindu region have developed for several decades. The actual land use patterns in the villages of the region are dominated by wet rice cultivation in plain areas and the cultivation of cacao, coffee and maize in steeper areas. Vegetables and fruits are cultivated close to the dwellings. Another remarkable land use type is the local cultivation of e.g. cloves, vanilla or coco palms. Livestock farming plays a certain role, but its importance decreases more and more.

Since the late 1970s, the traditional cultivation of subsistence products like wet rice in plain areas became more intensified and mechanized. On the other hand, this land use type was gradually complemented or even partially replaced by the cultivation of cash crops for export (cf. Weber 2006: 171f.; Weber et al. 2007: 424). Since the early 1980s, the perennial cacao plant which is usually cropped in uphill areas and mountain sides entered in the Lore Lindu region (Weber 2006: 175). Until today, this cropping type boomed. This was particularly triggered by the increasing world market price of cacao in the mid-1990s, which made cacao become the “new golden crop” in the Lore Lindu region (Abdulkadir-Sunito/Sitorus 2007: 174; cf. also Abbate 2007). In many cases, plots which were formerly used for cultivation with annual subsistence products or plots which were recently cleared from forest were now transformed into cacao plots (Weber et al. 2007: 424). As a result, the cash crop-orientation of the farmers in the region leads to the reclamation of rainforest margins. This process continues until today. However, Weber/Faust (2006: 239f.) note that the dimension of the land use change towards cacao differs from village to village within the research region.

In order to investigate the land use characteristics of the households in different villages, this study uses household census data of three villages (Toro, Bulili and Lempelero) which represent three different village types. This analysis includes the classification of the households in the study villages by land use aspects, which is based on the development of a quantitative method by using cluster analysis techniques. This classification appears necessary due to the large and unmanageable pool of land use data on household level.

In a first step, the sample villages will be described and the database as well as the applied methods will be introduced. Afterwards, the results of the land use classification of the households in the three villages will be outlined. The paper ends with a discussion of the methods and the results. This includes an outlook concerning possible future extensions and applications of the study's method and results.

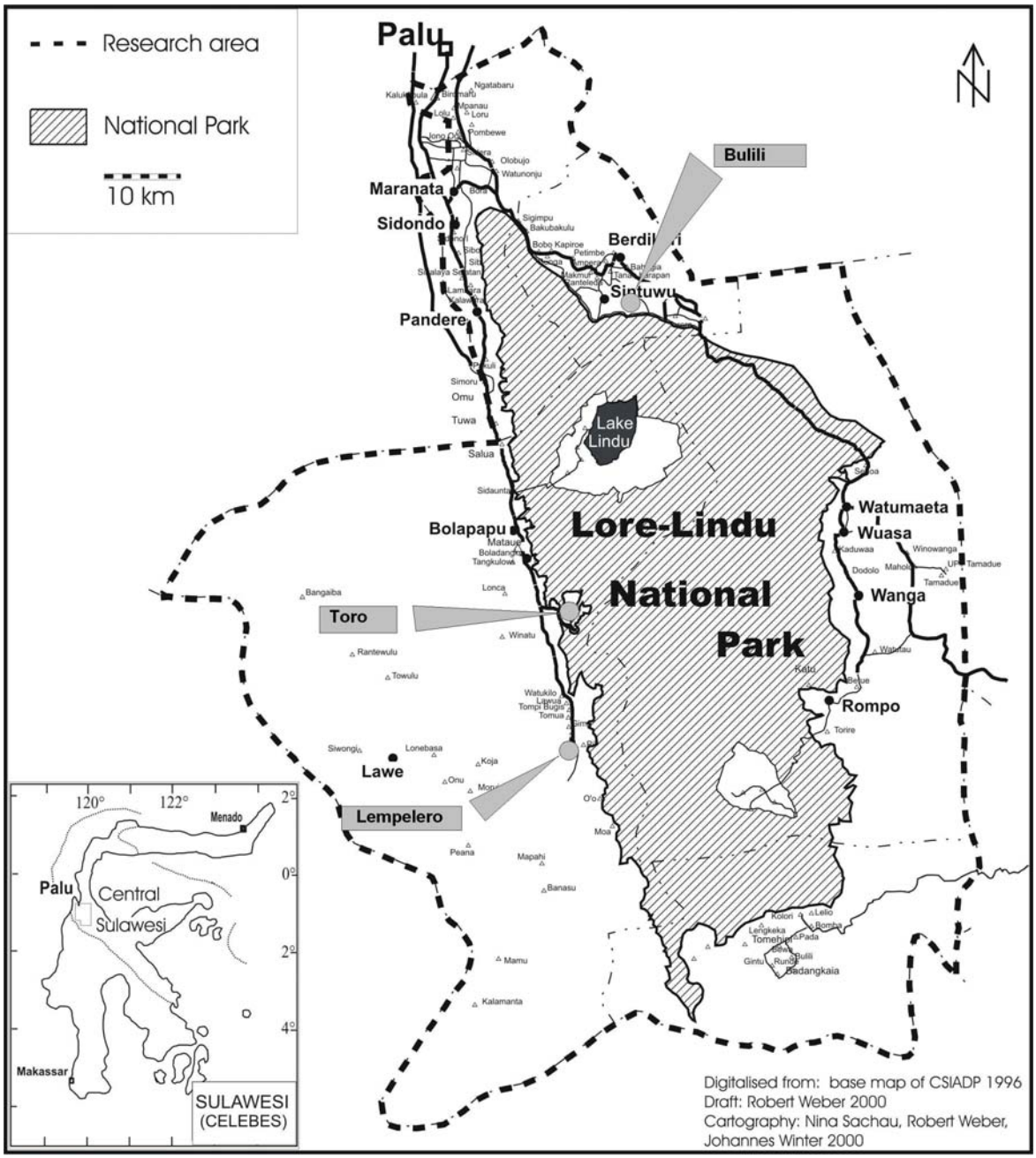
Study villages

Besides the mentioned local differences in the dominating land use patterns, the villages in the Lore Lindu region also show a high diversity in terms of their demographic and socio-cultural situation (Faust et al. 2003: 9). These aspects formed the basis for the construction of three different village types which leads to the selection of the sample villages in this study: Toro, Bulili and Lempelero. They differ with regard to the dynamics of the migratory composition and the transformation process of their populations. The following map shows the location of the three study villages within the research region (see Figure 1).

Toro, in the western part of the Lore Lindu region (Kecamatan Kulawi), is almost totally enclosed by the Lore Lindu National Park. The village is slightly remote from the main street to the district capital Palu. Its population amounts more than 2,100 (2004). The population structure can be characterized as traditional and static. There are only minor migration processes which even decreased steadily during the last 15 years (cf. Weber et al. 2007: 421). Various factors like the ethnic composition or the welfare distribution of the households are homogenous and stable. In conclusion, the village stands out from the regional average (cf. Schwarze et al. 2005: 14f.). It represents the "static type of village" (cf. Weber et al. 2007: 421).

Bulili on the other hand is a young and extremely dynamic migrant village. It is located in the Kecamatan Palolo in the northeast of the Lore Lindu region. The village was only founded in the 1970s. It has a population of slightly less than 1,000. Less than 5% of the household heads are born in the village. A large share of the village's inhabitants belongs to non-local ethnic groups (46.7%). Most of these people originate in the province South Sulawesi (79.4%). The rest of the village's population is formed by local and regional migrants. Weber et al. (2007: 421) characterize the corresponding village type as "quite dynamic or post transitional".

Figure 1: Map of the location of the study villages within the Lore Lindu region.



Lempelero is located in the Gimpu valley (Kecamatan Kulawi). Compared with Toro and Bulili, this village holds a middle position in the continuum of population dynamics in the region. It has about 600 inhabitants and was only founded in the year 1972. The three hamlets of the village (*dusun*) are up to ten kilometers distant from each other (cf. Weber 2006: 63). The major *dusun* of the village is located at the main street to Palu which ends here (cf. ibid.: 63). Especially in the first years of the new millennium, a remarkable in-migration process has set in. Therefore, Lempelero can be characterized as "village in transition" (Weber et al 2007: 421).

Data source

In 2004, a household census was conducted in the three study villages by STORMA sub-project A1. Nearly all household heads – with a few exceptions – have been interviewed. Because of it, the survey gives a very realistic picture of the situation in the three villages at a particular point in time, i.e. 2004.

Box 1: Number of interviewed household heads.

Toro: N = 521 Households
Bulili: N = 229 Households
Lempelero: N = 148 Households
Entire Sample: N = 898 Households

The census was based on standardized questionnaires. It comprises data related to the topics listed in Box 2.

Box 2: Topics of the A1-Household Census, conducted in 2004.

Demographic data on the household members
Migration history of the head of household
Land access and land use patterns of the household
Use of forest resources
Household decisions
Customs and traditions (e.g. festivals, rituals, and so on)
Data on labor trade and market access
Data on livestock farming
Data on household income
Socio-cultural relationships
Information on water use of the household
Data on dwelling situation, food consumption and possession of assets of the household
Environmental perception

The resulting variables on land use in the three villages found the database for this study. The general land use pattern in the three villages will be described later.

Methods

In order to describe the land use in the three study villages on household level, the multivariate cluster analysis method is used. As a result, the households of the entire sample are classified by land use aspects.

The aim of such classification procedures is to transform an initially unmanageable totality of objects with various attributes into a small and manageable number of groups (reduction of information). The elements of each of these groups should be as similar as possible (high internal homogeneity), whereas the groups should differ among each other as far as possible (external heterogeneity).

Cluster analysis is a special type of grouping procedures. It is connected with a high degree of calculation effort, so that it is usually aided by computers. The major advantage of this method can be seen in its ability to process simultaneously a large number of classification variables. It classifies step by step objects into groups. The underlying classification rule is to maximize the similarity of the objects (respective to minimize their distances to each other) with reference to certain classification variables which have been selected *a priori*. The required internal homogeneity (see above) of the groups arises from the inclusion of the similarity of the objects.

After classifying all objects into groups, a characterization of these groups in terms of content and statistics follows as well as the naming of the groups.

During the operation, the user of a cluster analysis has to come to several decisions. He has to choose adequate classification variables, select a distance measure and a clustering algorithm. In this study, the Squared Euclidean Distance is selected as a measure for the distance between two objects – here: households – in regard to the classification variables. This is the sum of the squared differences between the values of all classification variables of the two regarded households. The Ward's method is chosen as clustering algorithm, in order to merge the objects step by step into groups. As underlying criterion, the fusion process should produce on each step the smallest possible increase in the error sum of squares (= the total sum of squared deviations from the mean of a cluster). Backhaus et al. (2006: 528) characterize the Ward's method under specific conditions as a comparatively "very good fusion algorithm". Nevertheless, a handicap of this method can be seen in its nature of forcing classes on data sets which in fact do not possess distinct tendencies of concentration.

In the end of the operation, the optimum number of clusters has to be identified. For this purpose, a coordinate system with the decreasing number of clusters on the x-axis and the associated growth of the error sum of squares on the y-axis can be regarded (so-called elbow criterion; cf. Backhaus et al. 2006). An angle in the graph is an indication for the optimum number

of clusters. Nevertheless, this decision is usually largely subjective due to the fact that such an angle is often not clearly observable.

For further details on the steps of the cluster analysis method cf., for example, Kluge 1999; Vogel 1975; Backhaus et al. 2006.

Overview of the general land use patterns in the sample villages

All three villages are dominated by agriculture (more than 90% of the households in each village cultivate agricultural land; cf. Table 1).

The land use pattern in Bulili is almost completely dominated by cacao.

In Lempelero, cacao cropping is the dominating land use type, too. Besides this, maize cultivation has a certain importance in this village.

In contrast to Bulili and Lempelero, wet rice cultivation (*padi sawah*) plays an important role in Toro. Nevertheless, the major crop in Toro as well is cacao. Further cropping types are only of little importance. The degree of diversification is comparatively high in Toro. This is mainly caused by the high rate of households in this village which combine cacao and rice cultivation at the same time.

Farmers in Toro cultivate on average smaller-sized agricultural areas than farmers in Bulili and especially in Lempelero. Nevertheless, the agricultural structure in all three villages is dominated by small-sized farming. The average number of plots per household is the highest in Toro.

The availability of land is evaluated relatively well by the households in Toro and Bulili, whereas the majority of the households in Lempelero evaluate the land availability medium, bad or very bad.

The use of fertilizers and pesticides is in Toro less common than in the other two villages. On the other hand, the employment of field laborers is more common in Toro.

Neighbors as well as the own family are the major sources of information on land use decisions for the households in all three villages. However, in Toro and Lempelero also external advisors such as public consultants, village institutions, non-governmental organizations or media play a certain role, whereas these sources have nearly no influence in Bulili at all.

Table 1: Overview of various land use aspects in the three study villages.

Land use aspects:	Means/ Shares:			
	Toro	**Bulili**	**Lempelero**	**Entire sample**
No. (%) of households with agriculture	510 (97.9%)	218 (95.2%)	140 (94.6%)	868 (96.7%)
Av. area share of cacao	62.8%	97.7%	88.5%	75.7%
Av. area share of wet rice	31.1%	0.1%	0.0%	18.3%
Av. area share of coffee	2.4%	0.0%	0.2%	1.4%
Av. area share of maize	1.2%	1.2%	7.7%	2.2%
Av. area share of other crops	2.5%	1.1%	3.6%	2.3%
Av. degree of diversification	23.8%	1.0%	6.3%	15.2%
Av. total area of all cultivated plots of a household (ares)	126.4	149.6	176.4	140.3
Av. no. of plots per household	2.3	1.4	2.1	2.0
Evaluation of actual land availability				
- medium, bad or very bad:	22.9%	33.0%	60.0%	31.5%
- good or very good:	77.1%	67.0%	40.0%	68.5%
Employment of field laborers? [a]				
- Yes:	57.6%	30.7%	50.7%	49.8%
- No:	42.2%	68.8%	48.6%	49.9%
Use of fertilizers?				
- Yes:	19.4%	39.0%	20.0%	24.4%
- No:	80.6%	61.0%	80.0%	75.6%
Use of pesticides? [a]				
- Yes:	32.4%	48.2%	52.9%	39.6%
- No:	67.6%	51.8%	46.4%	60.3%
Information sources on land use decisions (multiple answers were permitted):				
- Family members	79.8%	89.9%	70.0%	80.8%
- Neighbors	42.2%	55.5%	59.3%	48.3%
- NGO's	4.1%	1.8%	5.0%	3.7%
- Public Consultants	15.1%	1.4%	22.1%	12.8%
- Media	5.3%	0.5%	4.3%	3.9%
- *Kepala Desa* (=Head of the village)	25.5%	3.2%	4.3%	16.5%
- *Lembaga Adat* (=Council of Elders)	7.5%	0.0%	0.0%	4.4%
- Self studies	50.0%	45.0%	50.0%	48.7%

Note:

a Minor deviations of the percentage sums from 100% due to missing values.

Data source: STORMA-A1 Household census (2004) (N=868).

First land use classification of the sample households

In this study, a hierarchical-agglomerative cluster analysis is applied. The aim is to produce a few homogenous groups which express the various land use patterns of the households as precisely as possible.

Seven classification variables are extracted out of the large pool of census variables on land use aspects (see Table 1):

- Average area share of cacao
- Average area share of wet rice
- Average area share of coffee
- Average area share of maize
- Average area share of other crops (e.g. fallow land, spices, vanilla, etc.)
- Average degree of diversification
- Average total area of all cultivated plots of a household (ares).

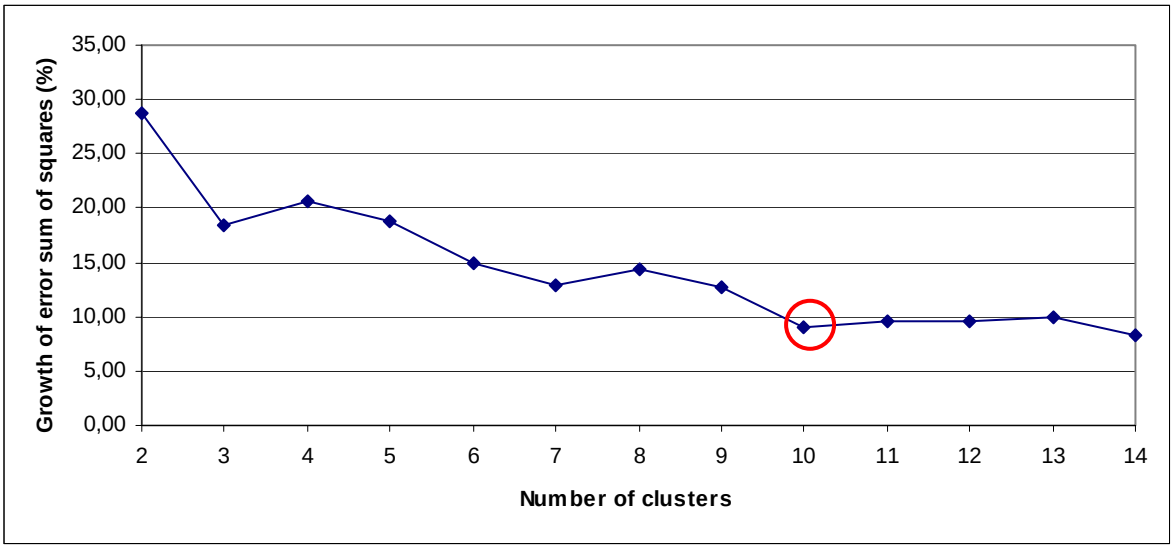
As several cross tabulations showed, these variables correlate to a high degree with other land use variables of the census. So, they form suitable land use indicators for this study.

In the run-up to the calculations, it is necessary to eliminate some outliers and to standardize the variables.

The cluster analysis in this study was calculated by the statistics software SPSS. As distance measure, the Squared Euclidean Distance is selected, whereas the Ward's method is chosen as clustering algorithm (see above).

The 'elbow criterion' shows that the optimum number of clusters in this study is 10 (see Figure 2).

Figure 2: Growth of error sum of squares that comes along with decreasing number of clusters (in %).



Data source: STORMA-A1 Household census (2004) (N=847).

Except for 30 households with no agriculture (11 in Toro, 11 in Bulili, 8 in Lempelero), all households in the sample are now sorted into one of ten land use clusters.

In the following, the ten clusters will each be named and characterized by land use aspects. Table 2 shows an overview of the produced clusters as well as the size of each cluster and the distribution of the clusters among the three villages. The clusters are ordered first by cropping type and second by size of area.

Table 2: Overview of the produced clusters.

	Cluster:	Av. area size (in ares)	Av. area share of cacao	Av. area share of wet rice	No. of households in…			
					Toro	Bulili	Lempelero	*Total*
Wet Rice	8: Small-scaled wet rice farmers	56.4	0.5%	99.5%	37	0	0	***37***
Cacao-Rice-Combining	3: Small-scaled cacao-rice-combiners	74.4	41.8%	57.5%	105	0	0	***105***
	2: Medium-scaled cacao-rice-combiners	105.0	72.2%	27.6%	114	0	0	***114***
	1: Large-scaled cacao-rice-combiners	277.9	52.2%	45.8%	33	0	0	***33***
Cacao	4: Small-scaled cacao farmers	66.2	99.7%	0.2%	112	135	65	***312***
	7: Medium- to large-scaled cacao farmers	193.7	99.2%	0.7%	31	57	35	***123***
	6: Very large-scaled farmers, mainly cacao	546.5	82.6%	6.3%	23	19	23	***65***
Others	5: Coffee farmers	130.1	33.0%	20.0%	22	0	0	***22***
	10: Maize farmers	133.6	39.0%	4.4%	9	3	14	***26***
	9: Farmers with mainly other crops	141.3	31.2%	12.2%	24	4	3	***31***
Total		***140.3***	***75.7%***	***18.3%***	***510***	***218***	***140***	***868***

Data source: STORMA-A1 Household census (2004) (N=868).

The table shows that all five clusters whose households cultivate wet rice (Clusters 1, 2, 3 and 8) or coffee (Cluster 5) only appear in the village of Toro. The other clusters appear in all three villages. In the following, all clusters will be characterized.

- **Wet Rice-farmers: Cluster 8** (N=37) contains small-scaled wet rice farming households. The average size of agricultural land per household is the smallest of all clusters. This

cluster appears only in Toro, as traditional wet rice farming doesn't play any role in the other two villages.

These households plant wet rice on small plots (in most cases only one plot per household) close to their dwellings. Other agricultural products are of no importance nearly at all, so the diversification ratio is just above 0. The households partly sell their harvests, but their input is low (e.g. employment of field laborers: only 27% of the households, pesticides: only 21.6%). The own family acts as main information source on land use, whereas external advice is not common for these households. This fact underlines the traditional character of wet rice cropping, with a low degree of innovation. The households in question just "know what to do", so they don't need any external advice. The knowledge about wet rice cropping is part of the tradition of these families.

- **Cacao-rice-combiners:** The clusters 3, 2 and 1 are formed by farming households which simultaneously cultivate cacao and wet rice on different scales. These clusters only appear in the village of Toro.

  The households of **cluster 3** (N=105) cultivate small-sized total agricultural areas (Ø 74.4 ares). On the other hand, their farming intensity is average (concerning fertilizers, etc.). The Council of Elders serves only for a few of these households as information source on land use. Because of the predominance of wet rice area in comparison to cacao area (Ø 57.5% vs. 41.8% of the total area), these households are presumably in an early stage of transition from traditional wet rice cropping to cash crop production.

  Cluster 2 (N=114) consists of households which mainly plant cacao, in combination with somewhat wet rice farming. The average area size (105.0 ares) is slightly lower than in the entire sample, so that this farming type can be described as medium-scaled cacao-rice-combination. The use of pesticides as well as the employment of field laborers is relatively common for these households. So, the intensity of agricultural production is comparatively high. The consultation of family members as information source on land use is not very common for these households. These farmers might be in a later stage of transition from traditional wet rice cropping to cash crop production, due to their higher share of cacao cropping area.

  The households of **Cluster 1 (N=33)** also combine wet rice and cacao cropping, but on a large scale. The average area size (277.9 ares) is the second largest of all clusters. The households own Ø 3.4 plots, which is well above average. Besides the large area size and the large number of plots, several other aspects indicate the high input into the agriculture of these households (e.g. employment of field laborers, use of fertilizers and pesticides, etc.). The farmers of this cluster evaluate the soil quality of their plots better than all other

farmers, and the mean slope of the plots is below average. The availability of land is evaluated as "good" or "very good" by the majority of households in this cluster (84.8%). Because of it, these farmers might hold a privileged position concerning their agricultural preconditions. Traditional information sources on land use like neighbors or family members are less important for these households, whereas external sources like public consultants or self studies play a relatively important role.

- **Cacao-farming households:** The cluster 4, 7 and 6 contain households in all three villages which cultivate cacao on almost all of their agricultural area. The clusters differ in terms of the scale of this cultivation type.

  Cluster 4 is the land use cluster with the largest number of households (N=312). The size of the agricultural area of these households is about half as large as the average. That is why they are small-scaled farmers. Other facts indicate the small scale of their production, too (cf. Table 3).

Table 3: Facts on cluster 4-farmers in Toro.

	Ø/ **Toro households in cluster 4**	Ø/ **whole village (Toro)**
Employment of field laborers	39.3%	57.6%
Use of fertilizers	13.4%	19.4%
Use of pesticides	16.1%	32.4%

Data source: STORMA-A1 Household census (2004) (N=112).

Some examples for Toro are listed in the preceding table which compares cluster 4-farmers with all farming households in Toro. Such a comparison would lead to similar results in Bulili and Lempelero as well.

Cluster 7 (N=123) contains medium- to large-scaled cacao-farming households in all three villages. The size of agricultural land is above-average, and other facts like the employment of field laborers, the use of fertilizers and pesticides underline the large scale of production as well. Surprisingly, this farmer group in Toro and Bulili evaluates the availability of land not as good as the 'average farmer' in each of the villages.

The farmers of **cluster 6** (N=65) are characterized by the exceptional large size of their total agricultural areas (Ø more than 500 ares). They produce among all farmers in the three villages on the largest scale. All of them plant cacao, nearly half of them exclusively (especially in Bulili). The other half combines cacao farming with the cultivation of wet rice, maize, coffee or other crops. The area size of the cluster 6-farmers in Toro even exceeds the size of those in the other two villages (Ø 603.8 ares in Toro compared with 561.6 ares in Bulili respectively 475.8 ares in Lempelero). All other land use variables like the share

of pesticides- or fertilizers-using households underline the large scale of production and farming intensity of these households as well. A remarkable fact is that the houses of these farmers in Toro and Lempelero are comparatively far away from their plots (about Ø 1,500 meters).

- **Coffee farmers: Cluster 5** (N=22) only appears in Toro. The households of this cluster have in common that all of them plant coffee, usually combined with cacao cultivation. The total area size of the households in this cluster is very heterogeneous – it ranges from 3 ares to 239 ares (Ø 130.1 ares). A high degree of employment of field laborers (77.3% of these households) as well as low ratios of households using fertilizers and pesticides (each 18.2%) indicate a high importance of 'man power' instead of agricultural technology. Agricultural advice by traditional village information sources (*Kepala Desa, Lembaga Adat*) is more common for these households than advice by neighbors.
- **Maize farmers: Cluster 10** (N=26) is formed by maize farming households, especially in Lempelero. In addition to their major crop maize, most of these households (22) also plant cacao, some additionally plant other crops, too. The area size distribution is wide-ranged (Ø 133.58 ares). In Toro, the plots of these farmers are located comparatively far away from the houses (about Ø 1,500 meters), and they are steeper than the average. Furthermore, their owners appraise the soil quality as rather bad; as well as the land availability. In contrast to Toro, the plots of the cluster 10-farmers in Lempelero are located comparatively near to the houses (about Ø 700 meters). Other variables like the bad soil quality are similar to Toro's results. In both villages (while there are almost no representatives of this cluster in the third village, Bulili), neighbors are asked for agricultural advice in many cases. On the other hand, traditional village advisors like the *Kepala Desa* are not a common information source.
- **Cluster 9** (N=31) is a highly diverse land use group (Ø diversification ratio: 44.5%, which is the highest of all clusters). It contains households which mainly plant **other crops** than cacao, rice, coffee or maize. These are, for example, spices, vanilla, cassava, coconuts, but also the use of plots as fallow land. Most of these households (24) are located in Toro. In many cases, cacao is planted as minor crop in addition to the main land use types mentioned before. Wet rice is also a common additional crop. The total area size of these households is wide-ranged, with a mean of 141.3 ares. The plots of these farmers are considerably far away from their houses (Ø 1,511 meters); furthermore they are comparatively steep. The cluster-9-farmers have an evident need for external advice; in particular the neighbors as well as public consultants and other external sources are consulted in or-

der to gain land use information. In contrast, family members are of minor importance as an information source concerning land use.

The remaining 30 households of the sample are not farming at all.

Modification of the land use classification

The results of the land use classification described in the preceding chapter represent the mentioned sample of the three study villages. It allows for showing the specific land use structure of these villages which is characterized by the considerable heterogeneity of land use in Toro and partially also Lempelero on the one hand and the dominance of cacao cropping in Bulili on the other hand.

The next step would be to describe the land use structures of further villages in the Lore Lindu region. As it cannot be expected that other villages in the region have similar land use structures, it is necessary to modify the first cluster solution. Another reason for this modification is the need for a more simple practicability as cluster analysis methods are connected with a high effort of data preparation and calculation. The aim is to conduct a classification which separates one cluster from another in a more distinct way.

Hence, some of the formerly built clusters will now be merged and partially even be newly-arranged. In detail, the new clusters can be differentiated by the two terms “specialists” and “combiners”. To classify farming households as specialists, a threshold value of >66% concerning the share of area size of one cropping type is applied. This criterion leads to a large group of households which can be described as cacao specialists, one group of wet-rice-specialists, and one group of specialists concerning coffee, maize or other cropping types. The remaining households are divided into a large group of cacao-rice-combiners and one class of “other combiners or multi-diverse households”.

To define the scale of production of the two large household groups (cacao specialists and cacao-rice-combiners), two threshold values concerning the total area size are applied. The first threshold amounts to 140 ares, the second to 300 ares. These values accord to a large extent with the results from the first cluster solution. Furthermore, the first threshold corresponds approximately to the mean value of area size in the entire sample.

The following tables show the modified cluster solution and the classification criteria for each cluster.

Table 4: Modified cluster solution.

Cluster	Label	Scale	N	N/ Cluster groups
0	No Agriculture		30	
1	Cacao specialists	Small	373	588
2		Medium	150	
3		Large	65	
4	Cacao-rice-combiners	Small	95	134
5		Medium	30	
6		Large	9	
7	Wet rice specialists		69	
8	Other specialists (coffee, maize, other crops)		21	
9	Other combiners or multi-diverse households		56	
		Total:	**898**	

Data source: STORMA-A1 Household census (2004) (N=898).

Table 5: Classification criteria of the modified cluster solution.

Cluster	Classification criteria
0	No agricultural area
1	>66% cacao area; <140ares
2	>66% cacao area; >=140 and <300ares
3	>66% cacao area; >=300ares
4	Cacao- & rice-area: each >33%, OR sum of cacao- & rice-area >75%; <140ares
5	Cacao- & rice-area: each >33%, OR sum of cacao- & rice-area >75%; >=140 and <300ares
6	Cacao- & rice-area: each >33%, OR sum of cacao- & rice-area >75%; >=300ares
7	>66% rice area; all scales
8	>66% coffee area OR >66% maize area OR >66% area of other cropping types; all scales
9	All remaining households with agriculture

Data source: STORMA-A1 Household census (2004) (N=898).

In order to transfer this classification to other villages of the region, it might be necessary to interpret the used criteria and thresholds in a dynamic way. The actual land use structures of the regarded villages have to be decisive. For example, the first scale threshold of a sample could be determined by the mean value of the area size of the sample.

As every determination of a threshold is arbitrary to a certain extent, such a 'revaluation according to the circumstances' might be appropriate. The essential condition is that one threshold should be the same for all sub-samples. This ensures that all regarded households and villages of the entire sample are comparable among each other.

Discussion

The aim of this investigation was to produce a land use classification of the households in the three sample villages. The application of a cluster analysis led to a plausible result.

As mentioned in the preceding chapter, this investigation could be extended by the land use classification of households of other villages in the region, in order to draw comparisons between different village types or even between different villages of one type. As already seen, this requires a modification of the first cluster solution. An example of such a modification for the three sample villages was given in the preceding chapter. Both, the initial clustering result and the modified result, enable the analyst to reflect in an easy way the land use situation in the villages as it was in the year of the census data collection (2004).

Several other studies of STORMA subprogram A have shown that the land use change in the Lore Lindu region is associated with a socio-cultural change as well (cf. e.g. Weber/Faust 2006; Weber et al. 2007). Recent migration dynamics are responsible for a shifting of the original socio-cultural imprint of the regional population. In many cases, in-migrants belonging to allochthonous ethnic groups establish new farming techniques and crops in the region. This group of new inhabitants often has a differing attitude towards the use of forest margins as well. In some cases, in-migrants act as regional "innovators" with regard to certain crops, especially the cash crop cacao (cf. Schippers 2006: 153).

In this context, the household clusters can serve as a basis for further analyses in the Lore Lindu region, i.e. the connection of land use data with socio-cultural aspects. Such an approach was applied by Schippers (2006) in his diploma thesis.

Another forthcoming approach furthermore integrates rural poverty aspects. This approach merely concentrates on the links between rural household poverty and socio-cultural factors. Still in the process of planning is an extension of this approach by land use aspects. This step would enable us to detect the links between all factors of the triangle of household poverty, land use and socio-cultural aspects in the Lore Lindu region. We assume that all of these factors interact with each other, as pre-studies have shown that e.g. specific ethnic groups show characteristic land use patterns and at the same time an exceptional welfare status in the respective village. In terms of an interpretation of such results, qualitative field studies are currently in progress.

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