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Modelling Decision Making in Communal Areas of Namibia: Do Prevailing Strategies of Family Labour Allocation Coincide with Objectives of Peasant Farmers?

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Abstract

In Namibia's Kavango region, forests vanish due to population pressure and intensified land use. The dominant farming system is a mixture of subsistence cropping and livestock keeping without mechanisation. The objective of this case study, embedded in a wider project, BIOTA Southern Africa, is to construct a dynamic bio-economic optimisation model of a communal village. Our paper describes the identification of the objective function (utility maximization) and provides insights into the family labour economy by answering the question: Are the prevailing strategies of labour allocation consistent with the identified objectives?

The arguments and weights of the utility function were identified through conjoint analysis (CA). Labour supplies and inputs were estimated from data analysis of semi-structured peasant farmer interviews. Since animal husbandry is not absorbing the highest amount of family labour and being simultaneously the most important objective, this paper shows that objectives of farmers and their labour allocation strategies do not automatically coincide.

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1. Introduction

The Kavango region is located in North-eastern Namibia and boarders Angola to the North. It is characterised by a semi-arid climate with an average rainfall of 550 mm per annum during one rainy season (from October to April) (YARON, *et al.,* 1992). The natural vegetation consists of fairly tall woodland and tree savannah. Old dune systems cause that vegetation varies considerably between sandy dunes and the more clay containing soils in the interdune valleys. Most of these interdune areas are preferred for cultivation (JONES; COWNIE, 2001). Sandy dune areas are meagre of nutrients and the major soil element, Kalahari sand, allows only little water retention (MAWRD, 2003).

The dominant farming system is a mixture of subsistence dry-land cropping and livestock keeping. Villagers use a modified slash and burn technique to cultivate new land (YARON, *et al.*, 1992). Crops are planted in a mixture of predominantly grains and some vegetables on the field. Millet (mahangu) is the main crop; about 75% of the cultivated area is used for its production. Animal husbandry concentrates on cattle and goat keeping. In general the agricultural system is fairly labour intensive. Apart from ox-drawn ploughing most field work is done manually or with very simple tools (knives, axes, hoes) (JONES; COWNIE, 2001).

One of the major socio economic problems, apart form poverty and lacking health institutions, is population pressure. The local population has grown rapidly from 1951 onwards with the highest population growth rate being 7.5% between 1970 and 1981 (JONES & COWNIE, 2001). A population estimate for the year 2000 shows that about 179,000 people are living in Kavango region. This makes up to 10% of all Namibians on roughly 5.5% of Namibia's total area (JONES; COWNIE, 2001). Projections assume that growth rates are 1.5% for the next years dropping to below 1% as a result of HIV/AIDS infections (JONES; COWNIE, 2001).

2. Study area and objectives

Data used in this study were collected in the villages of Mutompo, Epingiro, Cove and Cassava located in the Kapako constituency, about 60 Km from the biggest town in Kavango (Rundu). Kapako has the second highest population (21,200) within Kavango region (JONES; COWNIE, 2001). Although population pressure is more significant along the Kavango River with up to 100 people per Km^2, population density increases in the inland regions as well. In the research area we can find localised population densities of between 10 to 40 people per Km2 (JONES; COWNIE, 2001). Due to this density, land use seems to be no longer moderate. Determined by aspirations to generate short-term benefits through heavy resource extraction, peasant farmers increase field numbers and shorten fallow periods.

All four villages can be described as typical inland villages of Kavango region. Villagers face imperfect labour markets, high transaction costs, and a poor infrastructure with lacking health institutions. Major crops are millet, maize and sorghum grown in alternation with different sorts of beans, melons and pumpkins. Animal husbandry is quiet extensive and skewed, for instance less than 60% of interviewed households own livestock and slightly more than 30% of households own livestock herds with more than 20 heads.

Cattle and goats are rather used as bank accounts and status symbols than kept for nutrition or selling purposes. Main threats to local biodiversity are de-forestration and soil degradation due to man made bush fires, for clearing new fields for cropping and illegal tree cutting, for doing wood carvings (YARON *et al.,* 1992).

The objective of this case study, embedded in a broader project, *BIOTA Southern Africa*, is to construct a dynamic bio-economic programming model, which intends to depict inter-temporal resource use of a communal village in Namibia. The model is supposed to balance trade-offs between the conservation of natural resources, food security for inhabitants and income aspirations. Short and long-term costs and benefits are balanced by the dynamic character of the model. By means of bio-economic modelling we intend to find management options which are both suitable under the prevailing conditions and biodiversity conserving. In order to suggest alternative management strategies which seek to maintain or even improve biodiversity in an area with high poverty, it is imperative to analyse farmer's objectives. Particularly in rural peasant communities with subsistence farming systems, where family labour is the most valuable input, a quantification of labour supplies and requirements is important. To identify technologies and opportunities in terms of family work loads reductions and alleviation of food shortcomings, recommendations must fit into peasant's preferences and constraints.

Our paper will describe the empirical identification of peasant farmer objectives and provide insights into the family labour economy in the research area by answering the following questions: a) what are objectives of peasant farmers? b) do differences in objectives occur between genders? c) what are family labour supplies and inputs? d) what are differences in work loads and tasks between genders? e) what are seasonal peaks and troughs in labour requirements? f) what are prevailing household strategies of labour allocation? and g) are these strategies consistent with objectives of peasant farmers?
The remainder of this paper is organised as follows. First, we will commence with some references to literature of identifying objectives and labour use strategies. In the subsequent section, we present and discuss our results. Finally, we summarise our main results and conclusions and suggest further analysis and modelling tasks.

3. Methodology

3.1 Conjoint analysis

Production and consumption decisions are usually non-separable for peasant households in developing countries and intra-household labour allocation plays a major role (HADDAD, *et al.*, 1997). Therefore, the objective function of a peasant household model maximizes utility rather than profits. The arguments and weights of the utility function can be empirically identified through conjoint analysis (CA). CA is a method that raises values for the overall utility on the basis of preference judgments of decision makers in a given choice setting (KLEIN, 2002).

The theoretical foundation of CA emerges from consumer theory developed by Lancaster, who assumes that utility is deduced form different features (factors) of goods (TANO *et al*., 2002). Each good can be characterised as a combination of different levels of concrete product factors. The consumer is deciding on a specific combination of these factors whether to buy or not to buy this product. An important part is how the levels of the different factors are weighted, relative to each other, during the process of decision making. Preferences are then defined as the result of a utility comparison (KLEIN, 2002).

One advantage of using this tool is to identify the importance of different factors relative to one another. Another major implication of CA is that the overall utility for a good can be disaggregated into separate utilities for its factors. With respect to the utility function, this procedure transforms into using the factors of goods as the arguments and the relative importance as the weights of the function (TANO*, et al*., 2002).

For determining relevant factors, all factors, which are important for building the preference of respondents, have to be considered. If important factors are neglected, results of the analysis become invalid. The empirical levels (for weights) of the factors should be realistic, easy to communicate, and have to have a realistic range to avoid distortion. For the experimental design of CA different bundles of concrete levels of achievements, in order to generate utility, are to be presented to respondents on so called profile cards. One profile card consists of a mixture of desirable and non-desirable levels and in accordance with decision making these profile cards are ranked (KLEIN, 2002).

Since the early 1970's, CA has been used in marketing studies of consumer goods in industrialised economies (KLEIN, 2002; TANO, *et al*., 2002). Therefore, this approach needs to be modified to become appropriate for countries where illiterate levels are high; educational levels are low and language differences occur. This makes data collection complex and pictorial representation is required (TANO, *et al*., 2002).

3.1.1 Identification and profiling of activities

In our study we identified, as relevant factors, a) animal production activities; b) crop production activities; c) other activities using natural resources; d) off-farm labour activities; and c) family, cultural and social activities. These factors and their corresponding levels were obtained by interviews with inhabitants and key-informants (table 1 below).

Table 1: Considered factors and their corresponding levels

Levels / Factors	Level 1	Level 2	Level 3	Level 4
Animal production activities (APA)	0 cattle 0 goats	10 cattle 6 goats	20 cattle 11 goats	30 cattle 17 goats
Crop production activities (CPA)	insufficient	sufficient	surplus	
Other activities using natural resources (OAUNR)	sufficient	surplus		
Off-farm labour activities (OLA)	0 N$ per month	100 N$ per month	300 N$ per month	600 N$ per month
Family, social and cultural activities (FSCA)	4 days per month	8 days per month	12 days per month	

Source: Own illustration

Through the corresponding software package in SPSS, an orthogonal design was produced with 20 profile cards (including 4 holdout cards). Furthermore, we designed information sheets for respondents which explained the factor components, factor symbols, used on the profile cards, and the corresponding levels.

Figure 1 on page 18 illustrates, as an example, the information sheet for crop production activities. Included factor components, given different levels of achievement, are millet, maize, sorghum and other crops such as legumes and vegetables. These components are represented on the profile cards by the picture in the middle which is the factor symbol. The three distinguished factor levels of crop production activities are a) insufficient, which means the household has to buy crop or crop products to satisfy the needs of the family; b) sufficient, which means the household has enough to satisfy its needs; and c) surplus, which means the household has more than enough to satisfy its needs, the family can sell some crops or crop products.

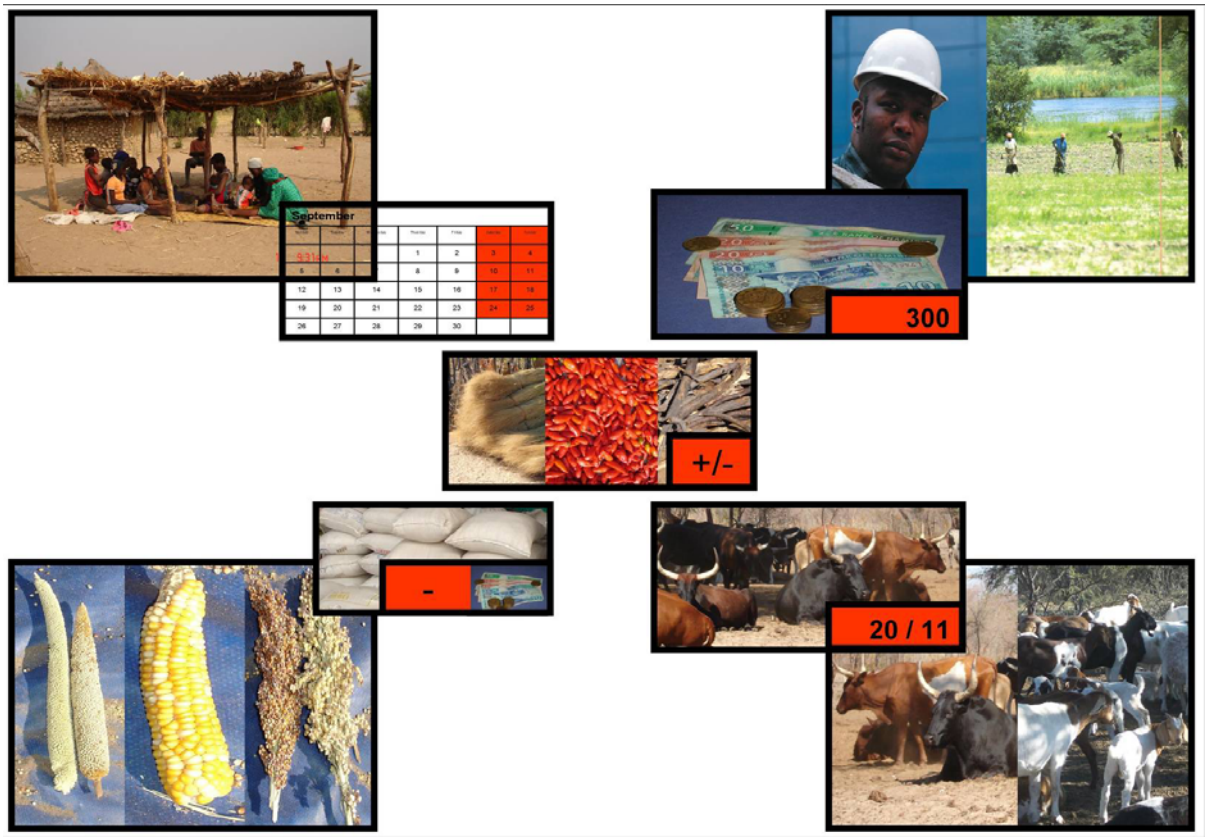
Animal production activities encompass cattle and goats. The levels range from zero cattle and goats to 30 cattle and 17 goats. The ratio between cattle and goat numbers was obtained by accompanying farming system research.

Off-farm labour activities include wage labour and casual work. Wage labour is defined as all labour activities which can be done outside the community, for example working a) in mines, b) for a road construction company or c) for commercial farmers. Casual work encompass all forms of labour activities which can be done within the community for other inhabitants such as a) ploughing, b) weeding, c) harvesting, d) clearing, or e) part-time employments like cattle and goat herding. All labour activities are encountered in cash income. We defined 4 different levels ranging from 0 up to 600 N$ (≈ 100 US$) per month.

The factor components of ‘other activities using natural resources’, which can take on the levels ‘sufficient’ and ‘surplus’, are a) grasses, like reed or thatching grass; b) wood, including wood for constructions and carvings, and fire wood; and c) wild tree and field fruits.

Finally family, cultural and social activities include every activity which is somehow related to leisure, like spending time a) in town, b) in other villages, c) in the own household, or d) for social and cultural obligations. We identified three levels ranging from 4 days per month up to 12 days per month. Figure 2 below, illustrates one of 20 profile cards which have been used in this analysis with one possible mixture of levels.

Figure 2: Profile card



Source: Own illustration [top left corner: factor symbol of family, cultural and social activities/ factor level: 8 days; top right corner: factor symbol of off-farm labour activities/ factor level: 300N$ per month; bottom left corner: factor symbol of crop production activities/ factor level: insufficient; bottom right corner: factor symbol of animal production activities/ factor level: 20 cattle and 11 goats; central: factor symbol of other activities using natural resources/ factor level: sufficient]

3.1.2 Interview procedure

To assure equal interviews, we designed a manuscript which explained the information sheets, profile cards and the whole procedure. This was translated into the local language Ru-kwangali. CA included a random sample of 66 households in all four villages as described in the section ‘study area and objectives’. Respondents were asked a) to consider each card as a possible future life situation and b) to take all factors into account. Furthermore, household respondents were advised that there are no right or wrong orders as long as the rankings and decisions represent their personal preference.

Due to the fact, that it can be difficult to rank all 20 cards immediately, they were guided to take a rough choice, while classifying all 20 cards in one of the three categories a) prefer, b) reject or c) neither prefer nor reject. Subsequently, respondents were instructed to rank the cards of the three categories comprehensively according to declining preferences.

3.2 Family labour economy

Parallel to CA for identifying the objective function we investigated the labour economy of the villages. Dominant labour tasks for peasant farm households are farm operations, maintenance and additional non-farm activities, such as trading, handicrafts, or off-farm labour employments. In general, substantiations for family labour allocation in semi-arid agriculture in Africa stem from multiple surveys of rural households (BYERLEE, 1979).

To obtain a rough overview of daily labour activities of rural peasant households, a literature survey was conducted (table 2) resulting in the following assertion:
Although labour inputs for farm operations are quite similar with on average 1000 – 1200 hours per year, literature data about labour hours spend for maintenance or off-farm labour activities as well as gender specifications are rare.

Table 2: Yearly family labour inputs

Labour / **Authors**	**Labour spend for farm operations**		**Labour spend for maintenace**		**Labour spend for off-farm labour activities**	
	hours per year (h/y)	gender specification	hours per year (h/y)	gender specification	hours per year (h/y)	gender specification
Cleave 1974 (quoted in Benson)	1000 - 1200	no specification	no data		no data	
Malton 1977 Nigeria (quoted in Byerlee)	700 - 1300	male	no data		no data	
Malton 1977 Sierra Leone (quoted in Byerlee)	900	female	no data		no data	
Tripp 1978 Ghana (quoted in Byerlee)	1500	male	657	male	560	male
	1070	female	1606	female	670	female

Source: Own calculation based on BENSON, 1979 and BYERLEE, 1979

In terms of seasonality it is of high importance to elicit strategies which can be used to combat peak work loads. For cropping activities, particularly in areas with only one rainy season, peaks and troughs are typical. Both need to be balanced by the household decision maker. Cleave (quoted by BENSON, 1979) estimates that due to seasonality 15 to 50% of the underutilisation of labour in Africa can be explained. Seasonality might be combated by changing or diversifying cropping systems to spread labour needs, by using existing labour more cost-effective in peak seasons or by introducing (removing) activities to absorb (release) labour during trough (peak) periods (BENSON, 1979), (BYERLEE, 1979).
Water supply is generally the most important variable shaping seasonality. Consequently there is a relationship between rainfall patterns and labour use. Cleave (quoted by BENSON, 1979) demonstrates that, in areas with a definite dry season, cropping activities follow the first rains. Furthermore, he indicates that weeding as the major labour consuming task in the farming system is the most important cause of seasonal pressures (BENSON, 1979). These are only some of the facts leading to the conclusion of a peak season labour bottleneck in most areas of Africa (BYERLEE, 1979).

As another aspect in labour allocation we have to consider conventions and traditions. Since studies have begun to focus on the roles assigned to sexes, conventions concerning gender specific activities are known in all human cultures. In general work tasks in and around the homestead such as cooking, firewood and water collection is commonly assigned to women. However, often there is no cross-cultural uniformity concerning which gender performs a particular activity. Besides, sex-specific conventions are by no means fixed; for example the absence of a spouse might result in compromises with ideal behaviour (BENSON, 1979). Attributable to male migration, nowadays women are often forced to carry out all tasks that were traditionally in men's spheres (TOVIGNAN, 2005). Nevertheless, the economic roles of men and women are fairly complementary rather than competitive. In households with nuclear families, wife and husband might cooperate in the same activity or undertake those of the opposite gender (BENSON, 1979).
In general ploughing is defined as a male task and men often tended cattle or cultivate cash crops. Women have primary responsibility for subsistence crops and the processing of grain (BENSON, 1979; TOVIGNAN, 2005). In some areas of Africa (Ghana, Sierra Leone) the largest contributors to weeding and processing activities are female labourers whereas young males are engaged in pest-scaring and labour selling activities. Although there is gender and age specification in labour tasks within African countries there seems to be no reason to assume that this specialisation is strictly enforced (BYERLEE, 1979). In conclusion, the greater the labour requirement of the farming system, the greater is the input by both men and women (BENSON, 1979).

3.2.1 Family labour economy in Kavango region

In analysis of the peasant family labour supply and requirements the number, age and skills of the farm family members have to be taken into account. Within the Kavango region the average household size is 9.3 persons. Household members can be divided into producers (between 16 and 60 years) and dependents (children under 16 and adults above 60 years). The average number of producers per household is 4.7 with 60% of households having between 3 and 6 producers. About one third of households have one wage earner (MAWRD, 1996; MAWRD, 2003).

Variations in rains between years cause agricultural activities to be not definitely tied to individual months. For instance ploughing and planting can begin as early as October or as late as December (YARON, *et al.,* 1992). Weeding, as the most labour intense component of crop production, is done two to three times during a cropping season. Harvesting and threshing are done manually from June up to August (JONES; COWNIE, 2001).
The busiest months for livestock management are January, February and March (DENIAU, *et al.,* 1997).

Within the Kavango region a breakdown of labour tasks signifies that more than 70% of the time spent on field activities is provided by household members (MAWRD, 1996). More than half of the labour time is spent by females and only 5% is supplied by dependents (JONES; COWNIE, 2001). In general planting activities are done by female household members (MAWRD, 1996). Women are commonly more involved in cultivation and men are responsible for land clearing and preparation (JONES; COWNIE, 2001). Within animal husbandry there is a strong division of labour: men are mainly in charge of cattle and goats whereas women are solely responsible for poultry and pigs (DENIAU, *et al*., 1997).

3.2.2 Data collection

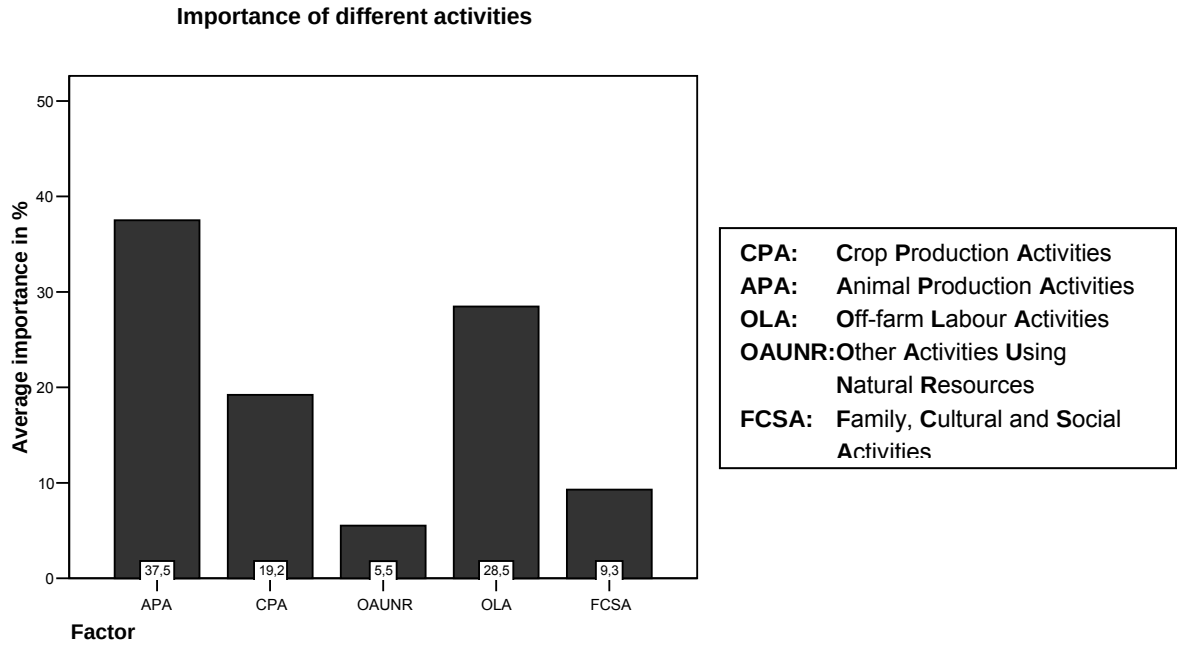
In the current research phase, our empirically collected data of the family labour economy are analysed for identifying household strategies of labour allocation. The farming system research encompassed a random sample of 45 households in the villages described in the section ‘study area and objectives‘; an exception is Cassava. The survey included a mixture of open and closed questions with one focus being on labour supply and requirements of a family. Since dependents supply solely 5% of family labour in the Kavango region (JONES; COWNIE, 2001), child labour was not explicitly analysed. As an outcome of the survey we obtained a family labour profile answering the following summarised question: a) which tasks are done, b) at what time of the year, c) for how many days or months, d) with how many family members (producers), c) working how many hours per day or month, and d) being of which gender?

4. Results and discussion

4.1 Objectives of peasant farmers in the research area

Results of CA quantitatively prove a high preference for animal husbandry (37.5%) followed by off-farm labour (28.5%) and crop production (19.2%) (figure 3 below). The fact that only 58% of interviewed households own livestock and only 33% of households own livestock herds with more than 20 heads can be interpreted as a criterion for poverty and ineffective livestock management. It is questionable why so many households are short of livestock although cattle have a social utility as symbolic capital.

Figure 3: Relative importance (%) of household activities



Source: Own calculation (n=66)

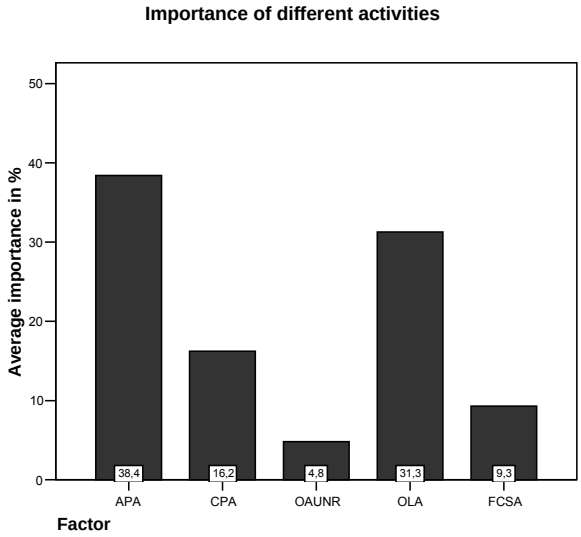
While off-farm labour is the second important activity it is pursued by only half of households. This might be due to failing and imperfect labour markets. Remarkable is that utility from 'other activities using natural resources' is very low (5.5%). In the research area the illegal cutting of trees for selling carved artefacts is fairly common (YARON, *et al.*, 1992), tough market values are low. The products of one tree are traded at an average market price of 350 N$ (≈60 US$), for comparison a cow sells at an average price of 1500 N$ (≈250 US$). This example indicates that merchantable fractions of local trees are not perceived as a scarce resource by the majority of inhabitants. The observed low market value matches with the discovered low utility.

A Pearson's R of R= 0.996 and a Kendal's Tau of T=0.950 specify that the internal validation of the estimated results is adequate. Pearson's R is measuring the correlation between the estimated value of total utility and the empirical rankings. Kendal's Tau is measuring the correlation between the empirical rankings and the estimated rankings. Both correlation coefficients can take a value of 0 (no correlation) up to 1 (high correlation).

It is notable, that the breakdown of respondents in livestock owners and non livestock owners shows only slight differences of about 1% for animal production and off-farm labour activities.

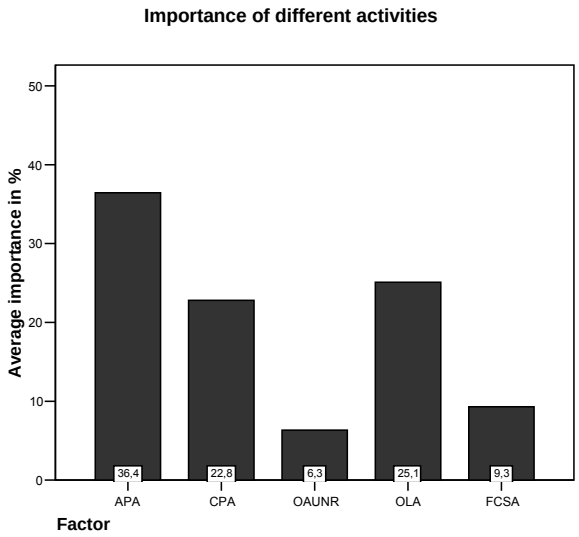
In contrast the decomposition in men and women respondents demonstrates, that women (22.8%) seem to assign crop production activities a higher utility level than men (16.2%) (figure 4a and 4b). This might be an indicator that women are more anxious to assure an adequate nutrition of the family. On the other hand women (25.1%) do not value off-farm labour activities as high as men (31.3%). Within the research area wage labour is generally more respected than casual work. However, men face better chances to participate in wage-labour activities than women.

Figure 4a: Relative importance (%) of household activities for men



Source: Own calculation (n=36)

Figure 4b: Relative importance (%) of household activities for women



Source: Own calculation (n=30)

CPA: **C**rop **P**roduction **A**ctivities
APA: **A**nimal **P**roduction **A**ctivities
OLA: **O**ff-farm **L**abour **A**ctivities
OAUNR: **O**ther **A**ctivities **U**sing **N**atural **R**esources
FCSA: **F**amily, **C**ultural and **S**ocial **A**ctivities

4.2 Family labour economy in the research area

Labour supplies of households within the research area are similar to already cited figures for the whole Kavango region. The average household size is 9 persons and the average number of producers per household is 4 (2 male and 2 female).

In general the core labour duties of peasant households can be differentiated in a) crop production tasks, b) animal production tasks, c) natural resource production tasks, d) maintenance tasks, and e) off-farm labour tasks.

In table 3 blow we calculated the average total labour input of a household with 4 producers. A typical household spends more than 2000 hours per year for crop production. Notably, animal production consumes only 25% of total labour input, which is 5% less than maintenance activities.

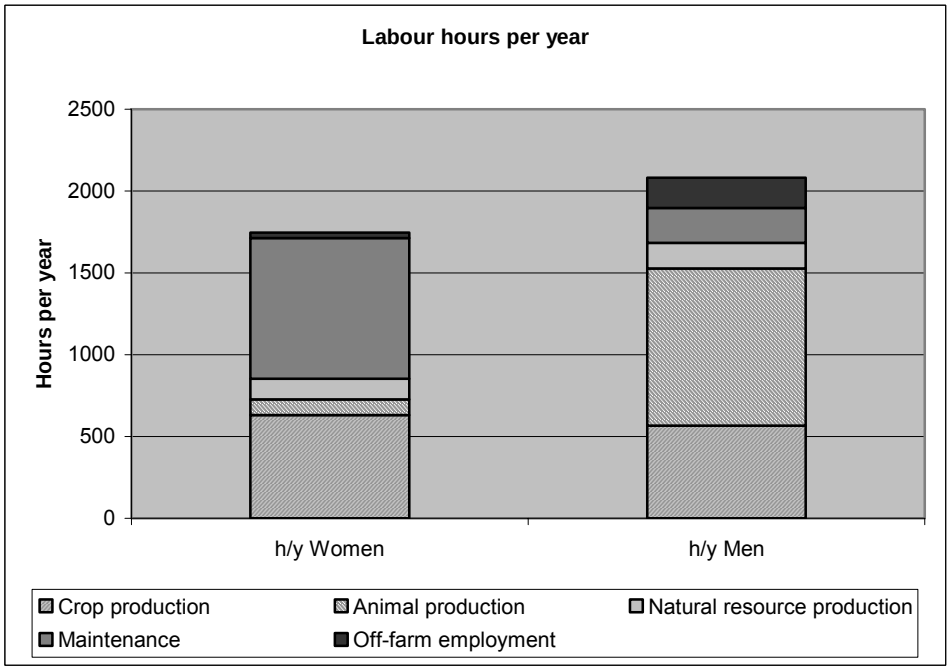
Table 3: Average total labour input per household

Labour hours / Task	Total of household	
	hours per year (h/y)	percent of total (%)
Crop production	2108	33
Animal production	1691	25
Natural resource production	489	7
Maintenance activities	1992	30
Off-farm labour activities	357	5
Total	6637	100

Source: Own calculation (n=45)

As can be seen in figure 5 below, gender specification exist for animal husbandry, maintenance and off-farm labour. Both sexes are responsible for crop production with almost the same dimensions.

Figure 5: Work loads in hours per year of male and female family members



Source: Own calculation (n=45)

In more detail we identified activities and their gender specification in cases where this was applicable (table 4 below). Apart from planting and ploughing, which are gender specific tasks, crop production is done together by both men and women. In terms of animal production, women are in charge of milking. Though, by category, male household members are responsible for herding livestock during the cropping season, it has to be revealed that this task is actually done by younger school boys. However, in most of the cases, herding was reported by respondents as an adult task. Therefore, the total hours worked by adult men, and specifically the herding tasks, might be overestimated in the following figures and tables. A strong gender specification can be seen for maintenance activities, where women supply the major part.

Table 4: Work loads in hours per year and task for men and women

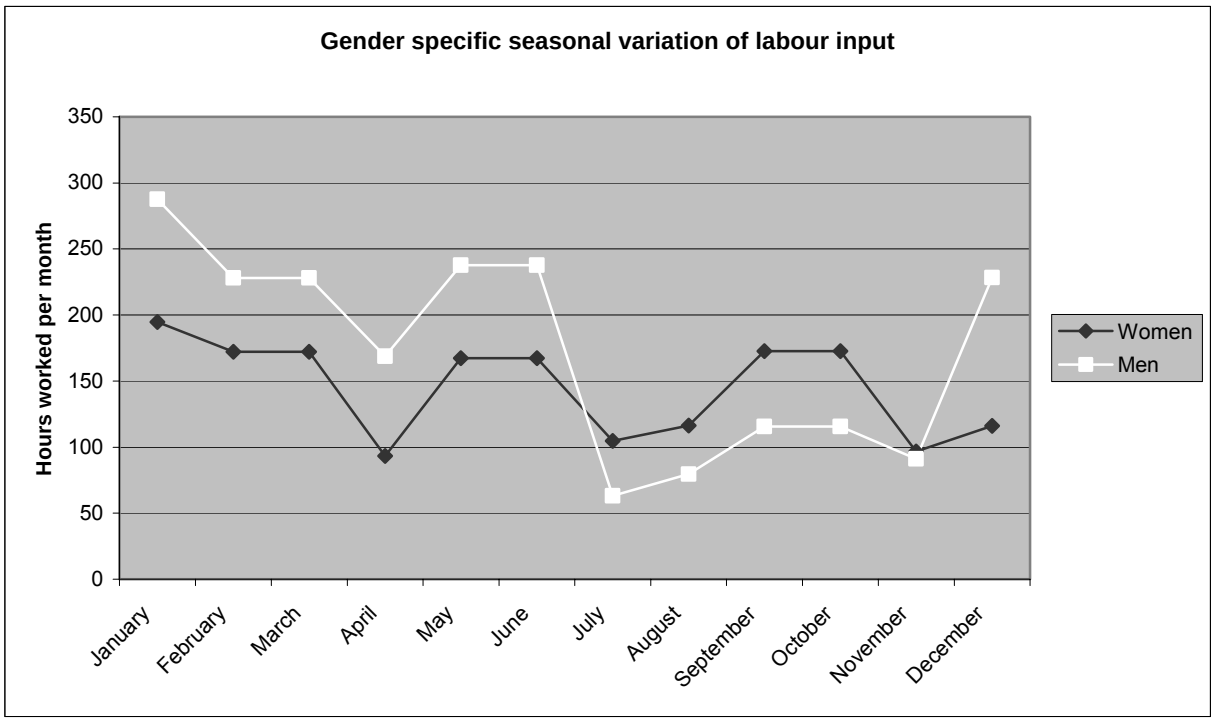
Task	Women	Men
	hours per year (h/y)	hours per year (h/y)
Crop production total	**631**	**566**
Ploughing	0	178
Planting	68	0
Weeding	233	159
Harvesting	156	102
Threshing	31	27
Clearing	143	100
Animal production total	**96**	**961**
Milking	96	0
Herding	0	961
Natural resource production total	**126**	**157**
Collecting wild field fruits	35	49
Collecting thatching grass	91	107
Maintenance activities total	**859**	**212**
Collecting firewood	132	0
Fetching water	304	0
Preparing meals	332	0
Washing clothes	91	0
Cleaning settlement	0	127
Repairing and building tasks	0	85
Off-farm labour activities total	**34**	**186**
Casual work	3	18
Wage labour	31	168
Total	**1746**	**2082**

Source: Own calculation (n=45)

In total men are working slightly more than 2000 hours per year and women about 1700 hours per year. If we assume that adult men are contributing only one quarter of the necessary herding labour, their total work load decreases to about 1360 hours. As a first major call on labour, weeding absorbs the bulk of labour input in terms of crop production for both, male and female family members. A second major call on female labour is maintenance, where activities such as meal preparing and water fetching consume more than 600 hours per year. Child care, another responsibility of women, is not explicitly mentioned in this study because it is dominantly done alongside with other tasks, such as maintenance or crop production activities.

The seasonal variation in labour requirement can be observed from figure 5 below. A first labour peak occurs during the rainy season between October and April for both genders. Predominantly for men, crop production and animal husbandry tasks overlap during this time. The second but smaller peak occurs in May and June where major labour duties are harvesting and threshing. In general women's labour efforts are more equally distributed within one year. This might be due to the balancing character of maintenance activities, which do not vary in the succession of a year. On average men are working 7 and women 6 hours per day, while in peak seasons the work load amounts to 12 respectively 9 hours per day. Seasonal labour peaks and troughs vary with the rainfall and might be even shifted by two months.

Figure 5: Seasonal variation of work loads for male and female family members



Source: Own calculation (n=45)

5. Conclusions and outlook

As a summary, CA has shown that in terms of objectives, the most important household activity of peasant farmers is animal husbandry. However, there is a slight difference in the degree of second and third-class objectives between genders. While both sexes value off-farm labour as the second-rate objective, women assign crop production activities higher utility levels than men.

In contrast to the findings regarding priorities and importance, the strongest labour allocation is towards cropping. Family labour supplies in the research area are similar to those of the whole Kavango region with about four producers per household. For an average household crop production is the major labour consuming task. In general women allocate more time for maintenance tasks and male household members for animal husbandry. Both genders have to cope with two labour peaks, one during the rainy season and the other one during the harvesting and threshing period. Before a new cropping cycle begins the tow months July and August cause an easing of labour shortages. In general labour inputs of women are more equally distributed within one year due to the high fraction of maintenance activities which do not vary between seasons.

Since animal husbandry absorbs only 25% of total family labour and being simultaneously the most important objective, this study shows that objectives of farmers and their labour allocation strategies do not automatically coincide. However, male family members are in charge of animal husbandry and at the same time allot livestock production the highest utility level. Women, who value the importance of crop production activities higher than men, contribute the major part to this task.

From observations and farming system research we assume that the prevalent livestock management and herding methods are inadequate. In the future this might cause progressively local rangeland deterioration. A delineated hypothesis is that labour shortages due to cropping, though lower weights are given to crop production in the objective function, contribute to a continuous mismanagement of livestock. Apparently, cropping is the basic activity that provides food security. However, there seems to be no labour surplus to accommodate the high aspirations for livestock keeping. Though culturally, as expressed by the treasury function, livestock is the household's priority, our hypothesis is that the lack of financial and human resources impedes growth of livestock herds. Investments in livestock and rangeland quality seem to be out of scope for the local population.

The predominance of hand methods for crop production signifies that labour is a limiting factor. The shortage of either female or male labour may affect yields. Lacking health institutions and increasing HIV/AIDS infection rates might shift the ratio of dependency, and a propensity to less producers leads automatically to labour shortages. To combat these shortcomings or to additionally increase production, adequate labour saving techniques have to be introduced and adopted by farmers.

The still ongoing modelling process shall deliver more suitable management alternatives that combine a sufficient nutrition, conservation and labour allocation level. The question is how the current situation of labour priority in extensive livestock keeping impacts on the environment and if this might be an indicator of preventable overuse of fragile resources.

So far the model includes a) the objectives function, consisting of the identified elements and weights of CA coupled with prevailing household theory; b) livestock population dynamics; c) human population dynamics, including labour; and d) an ecological module on biomass and rangeland deterioration. In the future field research phase model coefficients and thus model results are going to be validated, also according to the field study.

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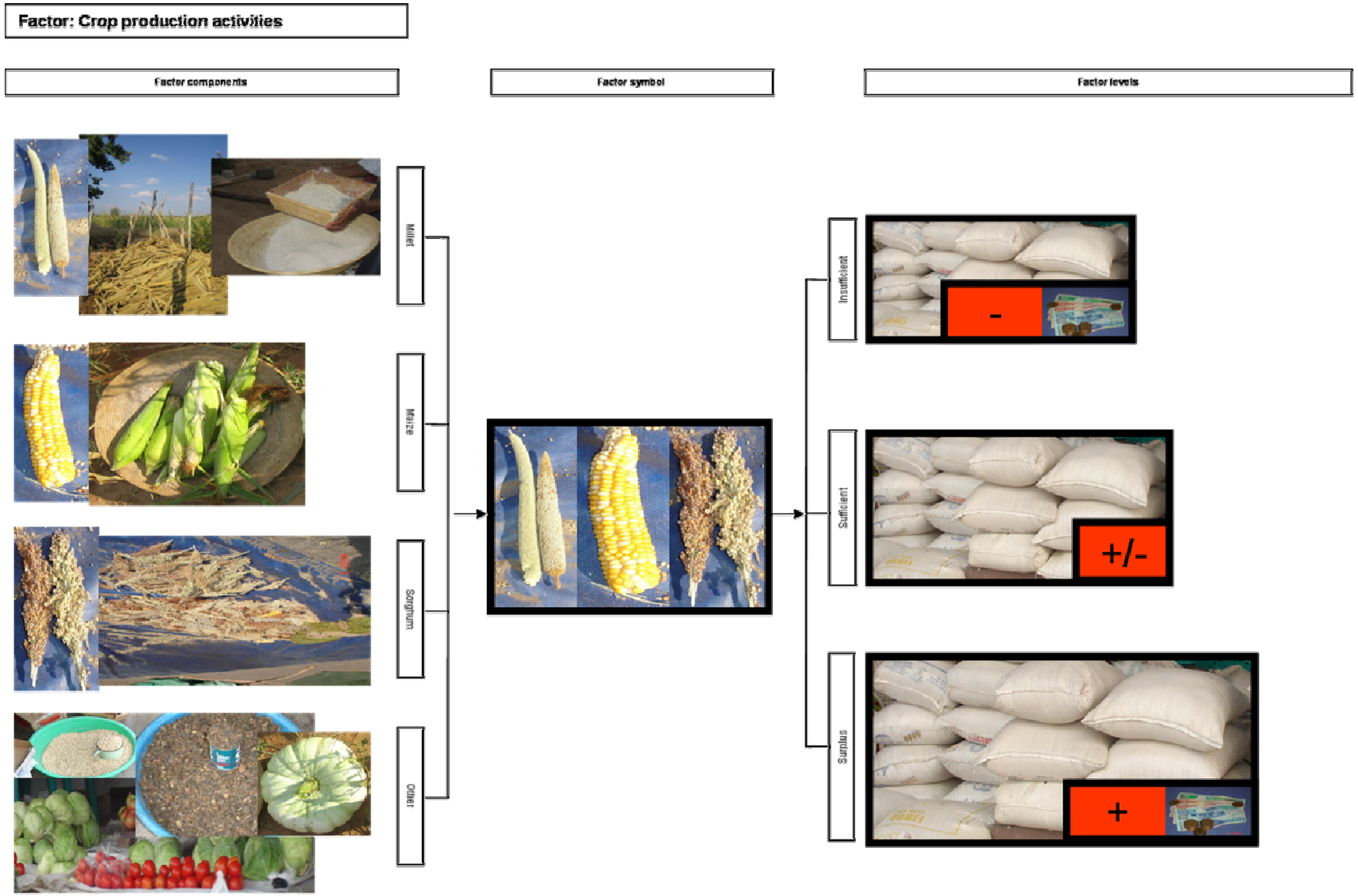
Figure 1: Information sheet for crop production activities



Source: Own illustration