FACTORS DETERMINING THE KNOWLEDGE AND USE OF PALMS IN THE WESTERN AMAZON

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FOREWORD

This study was carried out within the framework of the projects ***West Amazonian Piassaba Fibre-documenting traditional knowledge about a little known source of plant fiber and its possible management*** a cooperation between the Department of Systematical Botany of Aarhus University in Denmark and the Faculty of Biological Sciences of the National University of Peruvian Amazon in Iquitos (Peru) and ***Biodiversity and Economically Important Species in the Tropical Andes (BEISA)*** a cooperation between the Department of Systematical Botany of Aarhus University in Denmark in cooperation with the Faculty of Agricultural Sciences of National University of Loja (Ecuador), the Department of Biological Sciences of the Catholic University of Ecuador and the Institute of Ecology of Universidad Mayor de San Andres (La Paz, Bolivia).

The information analyzed in the present work includes ethnobotanical data collected during three field trips conducted in July-August 2003 and in May 2004 in the area of Pastaza fan in the northeast of the Peruvian Amazonian as well as earlier field work conducted in April-May 2005 in the Madidi region in the northeast of Bolivia. The fieldwork was done together with Henrik Balslev, Cesar Grandez, Tina Knudsen and Ulrik Lyng.

The topic of this study is the relationship between people and their natural surroundings, here in the form of their knowledge and use of resources. Local or traditional knowledge of different aspects of the natural environment has in recent decades increasingly attracted the interest of researchers and decision markers promoting sustainable use of natural resources. At the base of this lies the assumption that local knowledge and management systems are sustainable, because they have stood the test of time and have evolved within a local social and natural context, which they are therefore presumably adapted to. Research on local knowledge and resource management has consequently aimed mainly at documenting local knowledge, practices and institutions, and at testing whether the systems are indeed ecologically, economically and socially sustainable.

Growing concern that local knowledge and management systems as well as the natural systems they deal with are rapidly disappearing has led a more recent research focus investigating which factors may contribute to the erosion or preservation of knowledge and management practices. The ways in which knowledge and management systems are influenced by changes in natural as well as social and economic systems are decisive for their potential as tools for future natural resource management.

Based on interviews with local people, their own statements about actions and perceptions of the natural surroundings, here in the form of palms, and their relation with the economic, political and socioeconomic factors, this study aims at promoting a better understanding of the intricate interrelationships between people and their surrounding.

The report is presented in the format of a manuscript prepared to be submitted to the journal Biodiversity and Conservation.

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CONTENS

ABSTRACT

Both communities and individuals have used different livelihood strategies in the rainforest, most of these being strategies that combine subsistence activities with others aimed at generating profits. The analysis of the interaction between man and forest, and the factors that affect this relationship, here in the form of palms, is the main subject dealt with in this investigation. We have quantitatively evaluated the social and cultural importance of different resources, distribution and categories in order to reference as basic information management planning and implementation of development and conservation programs. We work in 12 villages in two regions of the Western Amazon, where investigated which palms species were found and used. The relative importance of each palm species is evaluated, in terms of different aspects of their use, number of people using them and the degree of consensus among informants regarding the uses of a palm. From this analysis we found that the importance of the used palm species is a function of their applications and potential use for certain purposes and that are the characteristics linked to the specific use of a species that determines the degree to which a particular species of palm is used and valued. We also investigated if there were any patterns in the distribution of informant's knowledge and whether such patterns could be related to socio-economic factors. The community of residence emerges as the variable that is most influential on the knowledge of palms. The educational level achieved, age, the length of time in residence and wealth, proved to be positively correlated to the knowledge and use of palms, but, all of these variables together with ethnicity and place of birth showed that their effect differs according to the type of use of the palms. Sustainable use of native palms should be encouraged as it may contribute positively to village economy and knowledge preservation, and may provide incentives for preservation of the forest.

INTRODUCTION

The value of local knowledge in the efficient use of resources is well recognized (Boom 1987, Prance *et al.* 1987, Phillips *et al.* 1994). Nevertheless, although this knowledge is of central importance to the conservation of the tropical rain forest, the factors that affect the way people regard and use these resources are not yet fully understood and as such, insufficient (Peters *et al.* 1989, Coomes 1995, Campos and Ehringhaus 2003, Lawrence *et al*. 2005).

Both communities and individuals have used different livelihood strategies in the rainforest, most of these being strategies that combine subsistence activities with others aimed at generating profits (Blecher *et al.* 2005) The choice of these strategies is guided by the perceived cost-benefit relationship linked to the different options available (Ostrom 1988, Ladio and Lozada 2000), and the influence of social, economic, political and/or ecological factors operating on different levels (Coomes and Barham 1997, Pichón 1997, Byg and Balslev 2004).

A better understanding of the interactions between man and forest as well as factors that influence this dynamic process may be obtained by analyzing local people's knowledge and use of rainforest resources. This may tell us something about the way in which local knowledge and management systems have developed, the way populations have undergone a parallel process of change in response to evolving circumstances, and the factors that have affected this response with respect to the use and conservation of resources (Oldfield and Alcorn 1987, Wiersum 1997).

The analysis of the interaction between man and forest, and the factors that affect this relationship, is the main subject dealt with in this investigation. We have quantitatively evaluated the social and cultural importance of different resources, distribution and categories in order to reference as basic information management planning and implementation of development and conservation programs in study sites. The plant-human

interaction is exemplified by the knowledge about and use of palms in two regions of the Western Amazon. The general importance of palms for inhabitants of the tropics has been the focus of numerous studies. They are the plants most commonly used by indigenous and non-indigenous populations in the Amazon (p.e. Balick 1984, Plotkin and Balick 1984, Balslev and Barfod 1987, Bates 1988, Galeano1992, Borchsenius *et al.* 1998, Khan and Henderson 1999) and since they play a key role in the subsistence strategies utilized by many different communities this facilitates to realize comparisons to different levels (Mejia 1988, Anderson 1991, Byg and Balslev 2004).

The approach taken in this study is to analyze different aspects of the way palms are used and their relation with the ecological, political and socioeconomic factors. First, the diversity of palm species known and used, and the relative contribution of each species to the daily life of community members is assessed. Second, the relative importance of each palm species is evaluated, in terms of different aspects of their use, number of people using them and the degree of consensus among informants regarding the uses of a palm. The species that are considered to be important are frequently those that are used for a more diverse range of purposes and by a larger number of people. This increases the likelihood that the most used species are vested with local cultural values, which in turn means that it becomes easier to orientate usage towards more conservationist practices (Byg and Balslev 2001). Therefore, it is analyzed which properties or features of usage make certain species important and what is the potential of utilization of these properties to promote the conservation of palms. Finally, it was investigated whether any patterns of distribution of knowledge and the use of palms among informants could be identified. This involves trying to discern the different relationships that exist with respect to the knowledge of palms, and the socioeconomic characteristics surrounding each informant. Such relationships are of practical importance with regard to nature conservation, as they can indicate which groups in society are most dependent on natural resources and what mechanisms drive resource exploitation (Byg and Balslev 2004).The socioeconomic factors include differences on an individual level (e.g. gender, ethnicity, age, place of birth, educational attainment, wealth, etc.), and differences on a community level (e.g. accessibility, ethnic origin of the community).

STUDY AREA

The Western Amazon is one of the most diverse ecosystems in the world (Gentry 1988). It is covered by a great mosaic of different physiographic and vegetational units that respond to its wide variation in topography, soils, systems of drainage and hydrology (Tuomisto *et al.* 1995). Although a large part of the western Amazon basin is covered by tropical rain forest which has its main development in the lowlands, the Andean influence is also in terms of its variation, since it includes the forest that are developed in the area of contact with some of the steepest and highest mountain chains of the planet: the Andes (Eva and Huber 2005). The area has long been inhabited both by numerous groups of indigenous peoples who have been established there for hundreds of years and by groups which have their origins in the process of colonization that began in the 16th century and which became more intense throughout the 20th century (Gari 2001). The main productive activities of these local populations include agriculture, cattle farming, the extraction of timber, and further subsistence activities such as hunting, fishing, crafts and gathering resources from the forest (Wiersum 1997).

This study was realized in 12 western Amazonian villages (Table 1), 6 of which are to be found inside the area to the Pastaza Fan, in the Department of Loreto in the northeast of Peru (Fig.1b), inside a lowland area which does not exceed 130 m in altitude. The remaining six villages are to be found in the northeast of the Madidi region in the province of Abel Iturralde in the Department of La Paz in the northeast of Bolivia in the vicinity of the Madidi National Park (PN-ANMI) (Fig.1c). It is an area of transition between the Andes and the lowlands, and is characterized by gradual topological changes that begin with ranges of peaks that reach 500 m which become expanses of alluvial plains with extensive areas of flatland that do not exceed 300 m in altitude (CDC-UNALM / WWF-OPP 2002, Beck *et al.* 2002).

Both areas are inhabited by indigenous peoples, as well as colonists. The latter have come from adjacent highlands and other nearby regions in the lowlands. The majority of the colonists arrived in the wake of external economic and productive activities (e.g. oil prospecting in Pastaza and the sugar industry in Madidi) during the 1970's and 1980's (MEM/DGAA 1998, Silva *et al.* 2003).

In the Pastaza area, boat transport is the main route of communication among the communities that are located along the numerous rivers in the fan area. The area possesses an infrastructure made up of basic services such as education and health, which is available only to a few. These services consist of medical posts, which are badly equipped, since hospitals only exist in large population centers and schools which do not go further than the third level of schooling (MEM/DGAA 1998, Escobendo and Ríos 2003). In Madidi, the human settlements are linked by local byways that connect the larger urban centers (e.g. San Buenaventura, Tumupasa, and Ixiamas). The basic services are restricted to small medical/health posts in certain communities, although since there are paths or roads, inhabitants have access to larger health centers, which are located in the largest settlements; most communities have schools, but these provide only a very basic level of education with the exception of some that reach an intermediate level (WCS-Bolivia *et al.* 2003).

METHODS

The data used in this study was collected during three periods of fieldwork, corresponding to July 2003, May 2004, and the period between April and May 2005. The survey is based on interviews that were carried out using questionnaires with fixed questions covering a range of socio-economic information (gender, age, education, ethnicity, place of birth, time living in a particular community, number of crops) and direct questions about their knowledge of useful palms. The formulation of the questions about the use and knowledge of palms focused on the different use categories established *a priori* (Table 2). For each mentioned species, it was asked which parts of the palm were used for each use category. The main language used in the interviews was Spanish or a traditional language with the help of an interpreter when the informant spoke a different language (Urarina, Tacana, Quechua or Aymara). In the interviews, local names for the palms were used.

Two hundred and seventy eight interviews were carried out; 149 of these in the six villages localized inside the Pastaza Fan and 129 in Madidi. These interviews included 129 indigenous informants and 149 that were considered to be non-indigenous, which included, "colonists", rural inhabitants and/or inhabitants of a mixed ethnic origin. Between 11 and 36 informants were interviewed for each community depending on its size, but there was an attempt to interview all of the adults in each community. The age range of the informants was between 16 and 85 years, and the gender distribution was male 162 informants and 116 female (Table 1).

Complementary data were obtained *in situ,* i.e. in the field, with respect to the use of the palms and about their common names with the help of key informants (those with the broadest depth of knowledge) using transect of 500x5 m, established in the forest areas nearby the villages being studied. The interviews were open and semi-directed and the same questions were repeated for each of the species of palm encountered. This information

enabled the analysis to validate the scientific name of the palms mentioned in the interviews. Additionally, all of the species were documented and the specimens deposited in the herbariums AMAZ, LPB and AAU (acronyms of herbarium as Holmgren *et al.* 1990).

We used the Shannon-Wiener Diversity Index (H) and Pielou´s Evenness (J) index in order to evaluate quantitatively the knowledge and use of palms (Begossi, 1996). Shannon-Wiener (some times referred to as Shannon´s entropy) is an information theory index, based on proportional abundance of species (or uses). It represents a function of the richness of species and the relative abundance or degree of dominance of uses (i.e reports) amongst species, usually referred to as evenness or equitability. The proportion of species *i* relative to the total number of species (p_i) is calculated, and then multiplied by the natural logarithm of this proportion (ln p_i). The result is then added up across species, and multiplied by -1 (Legendre and Legendre 1998, McCune and Grace 2002):

$$\mathbf{H} = -\sum_{i=1}^{S} \boldsymbol{pi} \ln \boldsymbol{pi}$$

Pielou´s Evenness index (some times referred to as Shannon's equitability, E_H) measures the proportion of the diversity observed with relation to the maximum awaited diversity and can be calculated by dividing H by H_{max} (here H_{max} = ln S, and S is the number of species). Equitability assumes a value between 0 and 1 with 1 being complete evenness (i.e. all the species are equally abundant) (Legendre and Legendre 1998, McCune and Grace 2002).

$$\mathbf{J = H / H_{max} = H / \ln \boldsymbol{S}}$$

In order to obtain a measurement of the diversification of palm use on the level of geographic location, gender and ethnic group, we used these indexes to calculate the values for the total diversity (SE_{tot}) and the total Equitability (SE_{tot}) of the all useful palms (Table 3). In the same way, seven different measurements for the use of palms and their importance (Phillips and Gentry 1993a), were calculated for all of the species reported during this study (Table 4). The different measurements of use and knowledge relevant to palms were statistically evaluated in order to detect possible correlations by means of Spearman and Kendall's non-parametric analysis (Zar 1996, Höft *et al.* 1999).

Three additional measurements of informants' knowledge and use were calculated (Table 5) and related to the socioeconomic variables analyzed (Table 6). A stepwise linear regression was applied in order to relate all of the measurements of knowledge and use provided by the informants with the socioeconomic variables. In all of the analyses these measurements were utilized as dependent variables while the socioeconomic variables were used as independent or explanatory variables (Table 6). Prior to the analysis, the explanatory and dependent variables which did not demonstrate normal distribution were transformed in order to obtain skewness and Kurtosis values between –1 and +1, this variables were: log (total number of crops) to general level, and log (education) and square (number of people living in the same house) in the Pastaza Fan.

RESULTS AND DISCUSSION

Palm diversity

The 278 informants interviewed reported 38 different species of useful palms across 23 genera (Table 7). *Bactris* is the most diverse genus, with six species reported to be useful. A total of 38 different uses, of those included in the seven categories defined as *a priori*, were registered. 59% of the uses are common to the Pastaza Fan and Madidi, and correspond principally to the use of palms in construction, alimentation and in the manufacture of tools and utensils (Table 8).

The use of palms in alimentation and construction were the two categories that reported the greatest diversity of palm species (Table 9) and the highest number of different uses (Fig. 2). These were also the categories that were most frequently mentioned by the informants (Fig. 3). The use of palms in construction and in the manufacture of tools and utensils were the categories that had the greatest number of shared species between the two sites (Table 9). The consumption of the mesocarp of the fruit, fresh or cooked, and the use of the leaves in the construction of house roofs, are the uses that were most frequently reported (Table 8).

The total species diversity for the overall use of palms reported and the corresponding species equitability value indicate that palm use is relatively homogeneous (Table 10, Fig. 4) throughout all of the villages, although there was a, certain, variability among the villages and individuals Many of the species reported as useful are mentioned by the majority of the informants. This is especially the case with the species common to both places; but there exists also a similar number of species that only are reported by some of the informants, mainly species reported only in one of the areas of study (Fig. 5)

These results show that the effect of the socioeconomic and ecological factors on the knowledge and use of the palms species in the villages, act in a differential way both on the

different species of palms and on the type of use that is done of them. The use of certain species might be guided by their availability in the forest (diversity, density and dominance) (Begossi 1996), we found that it was in areas with high palm richness that people know and use more palms, but also by the effect of other factors such as the availability of social services (i.e. health centers and schools), the proximity of markets and access to external resources which have frequently been suggested as factors that might operate independently or whilst interacting with others (Mejía 1988, Phillips and Gentry 1993b, Mutchnik and McCarthy 1997,Benz *et al.* 2000, Stageggard *et al.* 2002, Byg and Balslev 2004).

In terms of gender, there is no significant difference between the knowledge of men and women, and their knowledge of palms is evenly distributed among all of them (Table 10). Gender related differences in ethnobotanical knowledge between men and women are frequently related to the division of household responsibilities, labor and expertise, control and interests at the intra-household, inter-household and community level. Due to their greater participation in activities that more frequently bring them into contact with the resources of the forest men may gain a greater knowledge of forest plants (Styger *et al.* 1999, Hanazaki *et al.* 2000, Luoga *et al.* 2000, Arnold and Ruíz Perez 2001). In contrast, our results suggest a greater participation of the women in all of the activities linked to the use of resources. Hence, the women possess a level of knowledge which is not restricted simply to that of plants that are directly related to their activities in the house and taking care of the children (e.g. medicinal plants, food and/or crop plants) (Figuereido *et al.* 1993, Stagegaard *et al.* 2002).

In terms of ethnicity, this study reveals that the indigenous communities in Madidi are those that have a greater knowledge and that this tends to be more homogeneous (Table 10). In Pastaza the pattern is reversed, it is the non-indigenous communities that display greater knowledge. The pattern is reversed in terms of the origin of the informants; in general level it is the non-indigenous informants (i.e. the colonials or peasants) that demonstrate both greater and more homogeneous knowledge (Table 10), although this single pattern repeats itself in Pastaza. With respect to the pattern uncovered in Madidi

regarding the origin of the community and the informants, these results are unsurprising, since the indigenous communities are natives of the place and the evolution of their collective system of knowledge over time must have taken place in the same given area and hence, their level of knowledge of this area is more profound (Benz *et al.* 2000, Campos and Ehringhaus 2003, Byg and Balslev 2004). The reverse pattern, which was uncovered with respect to ethnic origin of the informants and communities in Pastaza, has also been reported in other studies and explained as being due to the effect of the accessibility to external resources, which would be acting motivating the learning and the accumulation of knowledge with respect to the use of the resources available in the environment, both because of the interaction with the indigenous peoples in the area and through their own experience of contact with the environment (Atran *et al.* 2002, Byg and Balslev 2004).

Palm importance

Euterpe precatoria is the species which was reported as having the greatest number of overall uses (Table 7), the majority of which are related to construction (Table 9). *Oenocarpus bataua* in the Pastaza Fan and *Attalea phalerata* in Madidi, are the species that have the greatest number of uses in the above two areas respectively, most of which correspond to their usage in construction and alimentation (Table 9).

The different measurements of palm use and importance differed greatly between all species of useful palms, suggesting that might be the characteristics linked to the specific use of a species that determines the degree to which a particular species of palm is used and valued (Table 11). The higher average use value of palm species reported from Madidi, suggests these are more important for the communities in this region. At the same time, the lower values of diversity and equitability that at Madidi there are on average greater differences between the uses reported for a species. That is, some of the reported uses are used by most of the people and some by only a few. With regard to the use of the informants we found that the people in Madidi are more homogeneous with regard to the species they use and how much they use the species.

The values obtained with respect to the use consensus show that most of the species are used only by some of the informants, that is, only some of the species are recognized as being useful by all of the informants. Nevertheless the value found in Madidi reveals the presence of a greater number of species on which a greater degree of consensus in its uses is had. The consensus with respect to the use of the species is low and indicates that people use the same species for different purposes (Table 12).

At the general level a greater utility of a species is positively related both to the use diversity and to the homogeneity of each use and its contribution towards the total utility of the species and to the number of people who use it (Tabla 12). The values of informant equitability also show besides that most of the people who reported using a certain species of palms, know more or less the same number of uses. Considering our definition of what it means for a species to be important, this pattern is in fact what we would expect to obtain, that is, the palms that are used by most of people have the greater number of uses and therefore the highest values of use, diversity and equitability. Nevertheless, the only values which do not support this general pattern are the values found in Madidi, which are connected with the diversity of uses and the equitability of the species. This means that in Madidi, a greater use of the palms does not involve a greater diversification in the types of use, since the consideration of a palm as important could also be restricted to its use within one or a few categories of use. This is the case with a species such as *Iriartea deltoidea*, with numerous uses, but only restricted to two use categories. The absence of correlation between the use diversity and equitability on the one hand, and the other values of palm use on the other is also due to the widespread use of species with low use diversity in Madidi. An example is *Geonoma deversa*, which has only one use, but which is reported by almost all of the interviewed informants in Madidi. These results suggest that the differences in the socioeconomic and ecological environment that surround the communities and the individuals are exerting a certain influence on the consideration of a palm species as important. A greater use and diversification could be the result of the evolution, and the experimentation in order to satisfy basic needs (Borchsenius *et al.* 1998, Gentry 1992, Kvist and Holm-Nielsen 1987).

A loss in the diversity and a concentration on certain types of use especially, might be interpreted as a loss of the knowledge, which might be related on the one hand, to a loss of opportunities to learn (e.g. with the disappearance of certain types of vegetation and / or species) (Anyinam 1995) and on the other, with the appearance of new alternatives to the use of the natural resources such as industrially manufactured products or cash-oriented strategies of sustenance (Ladio and Lozada 2001). Nevertheless, many of these alternatives depend on factors such as the proximity to urban centers that give to access to a wide variety of products and services (Zent 1999).

Socioeconomic factors: distribution patterns

The informants know an average of nine species and ten different uses each. None of the informants uses all the registered species (Table 13). Not only are there large differences in the number of uses that a person knows, but also in the number of species they use. Furthermore, people make differential use of the palms they know, that is, a person's knowledge is concentrated on certain types of use (Table 13).

Stepwise linear regression revealed that the factors related to the knowledge of the informants with respect to the use of the palms are as follows: the residence village, level of education, age, length of time living in the community, ethnicity, place of birth and the number of crops that the individual grows (Table 14).

The variation in the knowledge of the informants on the village level is partially related to marginalization or isolation of the village, to the ecosystems or forest types available and to the ethnic origin (Table 14). The effect of the residence village on the kinds of use of palms showed that the choice of resources for certain purposes might be influenced by the cultural characteristics of the informants (i.e. ethnicity, Phillips and Gentry 1993a, Anyinam 1995), by the degree of isolation of the villages, and through this to the availability of modern services and goods (Figueiredo *et* al. 1993, Benz *et al*. 2000, Ladio and Lozada 2004).

This study reveals that there is a positive relationship between formal education and knowledge of palms (Table 14), for those informants that were interviewed in Madidi. This

may be due to the length of time in which children receive education within the community. Children who can stay in the villages while obtaining their formal education have greater and more permanent contact with their environment, and can participate in the activities both within and outside the home, which facilitates the transmission of knowledge between generations (Brodt 2002, Zarger 2002). In addition, the children are often taught by teachers from their own community, in Madidi. The positive relationship between education and palm knowledge might also reflect the fact that people who acquire a more extended formal education tend to accumulate and value traditional knowledge to a greater extent (Zent 1999).

We found a positive relationship between age and the knowledge of the informants (Table 14), that is, older informants have a greater wealth of knowledge. It has been suggested that such a pattern suggests loss of knowledge (Phillips and Gentry 1993b), with pools of knowledge that are restricted to the older generations and becoming more diluted in the young. However, the low slope with respect to the relationships found indicates the absence of older people or "experts" with much higher levels of knowledge than younger people. This suggests that a large part of the information pertinent to the use of palms acquired by the youngest informants must have come from two sources. They have the knowledge passed on to them by their elders, but they also have their own personal experiences in coming into contact with the immediate environment in order to cover the necessities that arise over their lives (Phillips and Gentry 1993b), and this can be seen reflected in the kinds of uses that are related to age (Table 14). The positive relationship with respect to the use of the palms in construction probably due to the fact that they are only important for the men since they are used in house building for families (Phillips and Gentry 1993b). However, the relationship that deals with the use of palms involving both the transmission of knowledge and learning *in situ*, by means of practical applications and in other daily activities such as in the manufacture of tools and utensils, would seem to be driven by a transmitted knowledge derived from older generations and from that which has been learned from contact and experience with the environment (Ohmagari and Berkes 1997).

The influence of the ethnic origin of the informants on the knowledge of the use of palms is only evident in the Pastaza area (Table 14), where the informants non-indigenous (i.e. settlers, farmers, peasants) have a better knowledge and make a greater use of palms than the indigenous informants. These results have been reported in other studies (Kvist and Holm-Nielsen 1987, Gentry 1992, Borchenius *et al.* 1998) which have attributed this difference to factors such as levels of access to centers of commerce, which condition the dependence of communities on external produce and, in their absence, provide a compelling incentive to utilize products derived from the resources available in the immediate environment (Byg and Balslev 2004). Furthermore, this isolation might encourage a certain contact with the indigenous communities living in the area, thus facilitating an interchange of knowledge (Atran *et al.* 2002). Similar patterns have been observed in the, so-called, neo-traditional groups that have developed successful subsistence systems that combine existing pools of knowledge with traditional elements that have been learnt from indigenous peoples (Begossi 1996).

The effect of the place of birth and the length of time living in the village is only evident in those informants interviewed in Madidi (Table 14). Both the number of uses known by the informant and the diversity in the number of species used shows a significant positive relationship with the length of time a person has been living in the current place of residence. This means, that a greater the time residing in a community implies a greater the knowledge and use of palms (Table 14). The influence of the place of birth is significant only when the kinds of use are analyzed and only, when this use is commercially orientated. When this is the case, knowledge is greater among those informants that were born in the community where they are currently residing (Table 14). These results support the notion that the use of these plants in this region is a product both of the knowledge accumulated by the individual over time and that which has been transmitted from one generation to the next (Campos and Ehringhaus 2003). The data also demonstrate that both the accumulation and the modification and reevaluation of the knowledge acquired throughout a person's life are based on both their past and present experiences (Zarger 2002).

In this study we use the ownership of agricultural land as a measure of the informants' wealth (Byg and Balslev 2001, 2004). This measure was adopted since the extent to which individuals can make use of the natural resources available in the environment influences the decisions they take with respect to their agricultural activity and the investments they make in terms of capital and work (Coomes 1996, Wiersum 1997). Although, according to most traditional standards, the people who live in the forest are economically poor, inside and among the communities, the possession of certain goods such as fields of crops and the tools needed to work provide these individuals and their families with an influential local status. Agricultural bounty within this context is synonymous with wealth and is a reflection of the differences in agricultural practices of the informants. On a general level it is found that the relationship is positive, which means, the knowledge is greater when the number of crops the informant possesses is high (Table 14). Therefore, the results obtained in this study do not support the supposition that the poorest in a community (those with least access to acquiring goods) are those that are most dependent on the forest's resources and those that have greater and more extensive knowledge of the species that might provide them with useful resources (Arnold and Ruiz Pérez 2001, Byg and Balslev 2001). The general tendency with respect to the number of crops and the relationship with knowledge of palms might be interpreted as the attitude of a person toward the environment that surrounds him; if the individual is curious with respect to his environment and his outlook is experimental and businesslike, the person is more likely to have a good knowledge of both wild and domestic plants. In the long-term this knowledge might lead to a higher standard of living, especially in communities where agricultural products are not particularly diverse (Byg and Balslev 2001).

SUMMARY AND CONCLUSIONS

Both the diversity of useful palms and their uses to have been shown to be influenced by variation in the socioeconomic and ecological surroundings of the communities and individuals studied. The effect of these factors, however, is differs depending both on the species and on the type of use. Ecological factors such as diversity and the abundance of palm species affect the knowledge of palms. This is evident from the fact that the area in which there is high palm diversity is also the area in which there is the greatest diversity of useful palms. Socioeconomic factors such as remoteness, which determines the access to services, modern goods, markets, and external resources, are also elements that influence how palms are used. In contrast with other studies we do not find differences in the knowledge and use of the species related to the gender and this would seem to suggest a greater participation of women in those activities that are linked to the use of forest resources, which are frequently applied by the men. The difference in the way ethnicity affects the uses and knowledge of palm species, both on a community and an individual level, that is, the fact that the two areas studied reveal an opposing pattern, may be linked to the difference that exists with respect to the accessibility and availability of modern goods and services. This is indicated by results from other studies.

At first glance the importance and utility of palms seems to be the result of the wide variety of uses that they have. A more detailed analysis showed, however, that the importance of the used palm species is a function of their applications and potential use for certain purposes. This explanation would make sense, since the use of certain parts of the palm might be incorporating the usefulness of other parts of the same plant that need to be gathered anyway, like de palms species used in the construction. Due to their utility and potentiality these species have been proven to be important for human communities and are investigated extensively more than any other plants into different categories of use.

The differences in the levels of knowledge of the informants are just as great as the differences in terms of use and the importance of the different species of palms. The community of residence emerges as the variable that is most influential on the knowledge of palms, and the variation in the latter is related principally to the extent to which the community is marginalized, the type of forest ecosystem in which the communities are situated and their ethnic origin. The educational level achieved, age, the length of time in residence and wealth, expressed in terms of the possession of agricultural land, proved to be positively correlated to the knowledge and use of palms, but, all of these variables together with ethnicity and place of birth showed that their effect differs according to the type of use of the palms.

Therefore, this study shows that palms enter as an element in the life strategy for the inhabitants of the Western Amazon. The response that they showed with respect to the knowledge and use of palms whit regard to local differences in the social, political, economic and ecological environment that surround the inhabitants of the communities of Madidi and Pastaza, allow the study to identify their use with a subsistence strategy characterized by a tendency to depend on the use of non-timber related forest products to obtain product for the subsistence (i.e. food, material for construction, medicinal uses) and for generate economic incomes within the family.

Therefore, to preserve the traditional knowledge pool it will therefore be necessary to encourage sustainable use of palms, both species that provide subsistence and commercial products. This may also be ultimately beneficial to the preservation of forest palms as the largest threat nowadays does not seem to stem from overexploitation, but rather from habitat destruction.

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Fig. 1 A. Map showing location of the Iquitos area in Peru, and San Buena Ventura in the Madidi region in Bolivia (from Google Earth, image 2005 MDA Earth Sat); **B**: Location of the six villages where interviews were conducted in the Pastaza fan (Perú) (CDC-UNALM / WWF-OPP 2002); **C**: Location of the six villages where interviews were conducted in the Madidi region (Bolivia) (WCS-Bolivia *et al.* 2003).

Fig. 2 Number of uses report in different use categories in 12 western Amazonian villages.

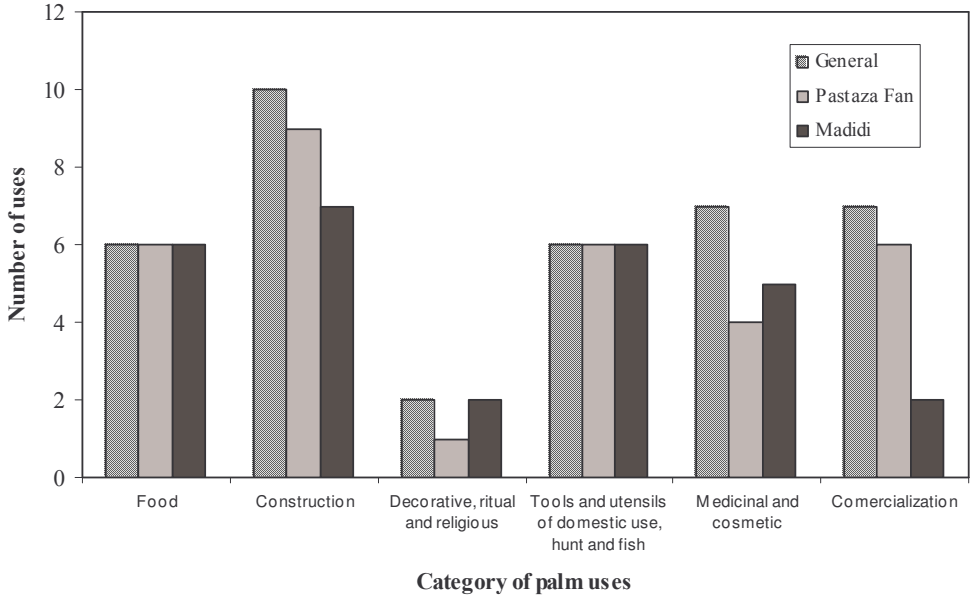

Fig. 3 Number of reports of different categories of palm uses in 12 western Amazonian villages.

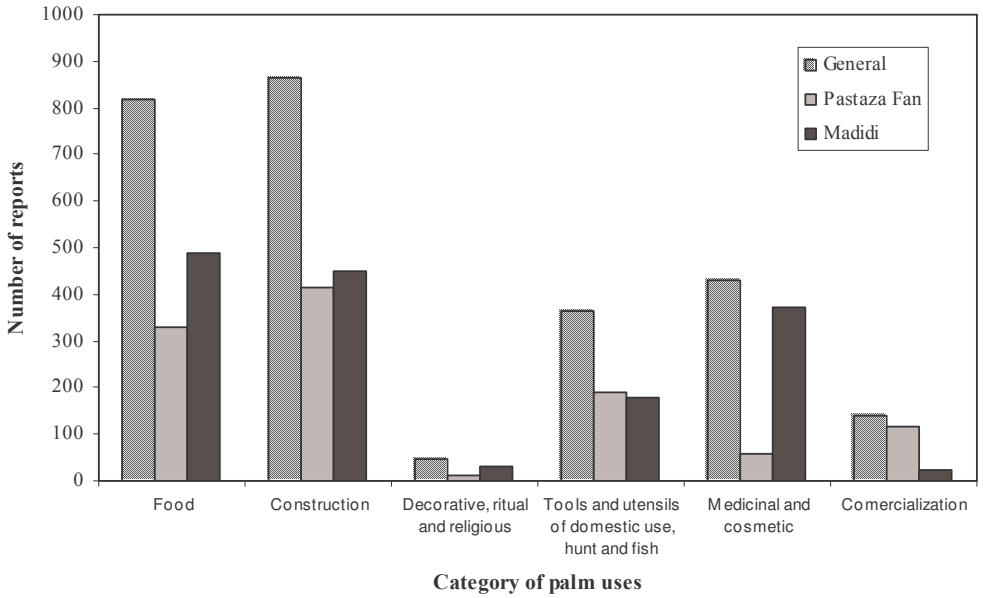

Fig.4 Distribution use and knowledge of palms among 12 western Amazonian villages indicated by the number of informants who utilize a certain number of palm species. Total number of informants was 278 and total number of palm species mentioned as being useful was 38.

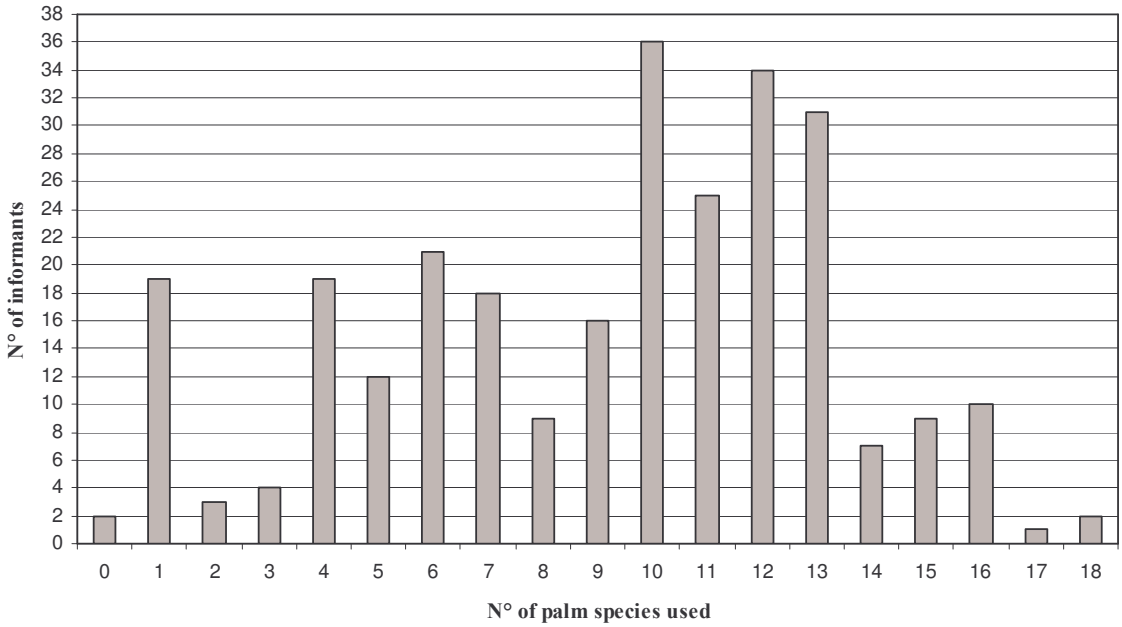

Fig. 5 Distribution of use and knowledge of useful palms reported in 12 western Amazonian communities indicated by the number of informants who utilize a certain species. Total number of informants was 278. (G) common species to both areas, (P) species reported in the area Pastaza, (M) Madidi species reported in the area Madidi.

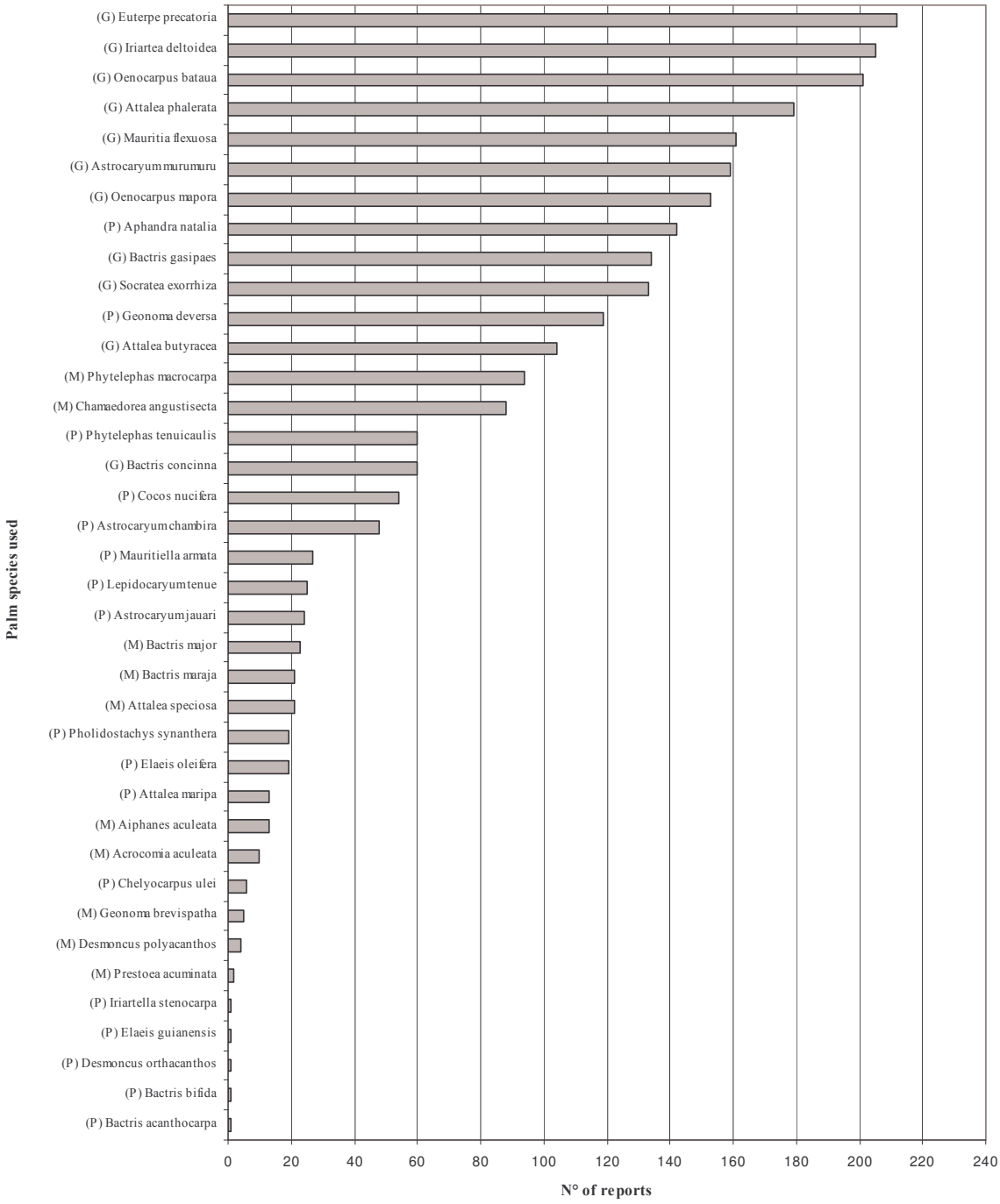

Table 1. Characteristic of 12 villages interviewed in the area of the Pastaza fan (department of Loreto, Peru); and in the northwest of the Madidi region (department of La Paz, Bolivia). The coordinates were taken with a GPS and the number of houses and information about social services, building material, etc. was observed during our visit to the villages. The distance to Iquitos was measured on a map, and the distance to San Buenaventura was taken in field. Data concerning the informants is from the interview survey. (*) Indigenous of the region.

	PASTAZA FAN						MADIDI					
Village	**Porvenir**	**San José**	**Velasco**	**Reforma**	**Guineal**	**Sungachi**	**San Isidro**	**Buena Vista**	**25 de Mayo**	**San Silvestre**	**Sta. Rosa de Maravilla**	**Alto Satariapo**
South latitude	03°48'40,3''	03°48'37,4''	04°44'5,1''	04°31'59,0''	04°22'0,5''	03°45'25,7''	14°23'54.5"	14°22'11.6"	14°12'27.7"	14°05'14.9"	13°57'06.2"	13°47'08.3"
West longitude	75°08'31,9''	75°09'43,5''	75°38'23,8''	75°42'45,4''	75°49'01,2''	76°25'56,1''	67°36'56.7"	67°33'56.8"	67°47'25.7"	67°52'15.3"	68°00'32.4"	68°14'32.4"
Main acces	River	River	River	River	River	River	Road	Road	Road	Road	Road	Road
Name river/road	Corrientes			Urituyaco		Pastaza	San Buenaventura-Ixiamas					
Greater town closest/distance (km)	Iquitos/500	Iquitos/510	Iquitos/440	Iquitos/467	Iquitos/489	Iquitos/667	San Buenaventura/11	San Buenaventura/16	San Buenaventura/35	San Buenaventura/52	San Buenaventura/65	San Buenaventura/105
Type of forest	Terrace forest Floodplain forest	Terrace forest Floodplain forest	Terrace forest Floodplain forest	Terrace forest Floodplain forest	Terrace forest Floodplain forest	Terrace forest Floodplain forest	Bosque de serranía y bosque de llanura	Bosque de llanura	Bosque de serranía	Bosque de llanura	Bosque se serranía y bosque de llanura	Bosque de serranía
Ethnicity	Indigenous	Indigenous	Peasants	Peasants	Indigenous	Indigenous	Peasants	Indigenous	Peasants	Indigenous	Indigenous	Peasants
Physical structure												
Number of houses	31	16	29	46	20	32	25	43	29	17	9	7
Rustic buildind materials	+	+	+	+	+	+	+	+	+	+	+	+
Processed	+	+		++	(+)		+	+	++	+	+	+
Social services												
School	+	+	+	+	+	+	+	+	+	+	+	
Church			+	+							+	
Shops				+				+	+		+	
Health care Centre				+				+	+			
Informants												
Number of interviews	34	22	22	17	26	28	18	36	23	29	12	11
Ethnicity	Urarina* (32), Mestizo (2)	Urarina* (17), Mestizo (5)	Mestizo	Mestizo	Urarina* (14), Mestizo (12)	Quechua	Tacana* (9), Quechua (4), Mestizo (5)	Tacana* (22), Mestizo (14)	Aymara (2), Mestizo (21)	Tacana* (26), Mestizo (3)	Tacana* (8), Mestizo (4)	Aymara (5), Quechua (3), Mestizo (3)
Gender (Male, Female)	17-17	20-2	11-11	10-7	18-8	11-17	11-7	21-15	15-8	17-12	5-7	7-4
Age (min-max)	17-70	16-54	16-23	21-55	16-77	17-86	25-80	29-85	20-68	18-58	21-77	20-66
Years school (min-max)	0-15	0-6	0-8	2-13	0-6	0-13	2-9	0-12	0-12	0-12	2-12	0-12
Place of born (inside, outside the village)	24-10	4-18	6-16	2-15	6-20	8-20	0-18	14-22	1-22	11-18	0-12	0-11
Time living in the village	0,1-58	0,3-40	5-63	5-31	0,3-65	0,1-86	5-45	2-74	2-28	5-58	2-23	1-33

Table 2. Description of the use categories used for the interviews on knowledge and use of palms in 12 western Amazonian villages.

Use category	Description
Food	Species that offer dietary products, that can be consumed directly or after some processing. It also includes species that are used for the extraction of oil, and others that are indirect source of food, as the case of the trunks of some species where edible larvae develop..
Construction	Species that are sources of material used in the construction of permanent or temporary houses.
Tools and utensils of domestic use, hunting and fishing	Species from which raw materials for the manufacture of tools used in hunting and fishing (blow guns, darts), basket-making (fans, baskets, rush mat) and utensils used in the home and/or the agricultural activities are obtained.
Medicinal and cosmetic	Species used directly or as ingredients (extracts, oils) in the preparation of remedies and for cosmetic use (creams, soaps, etc.).
Decorative, ritual and religious	Species used in ceremonial or religious activities (perfums, decoration) and others related to cultural aspects (magic species).
Commercialization	Species that are a source of raw material for the manufacture of products that are commercialized, and/or species which are commercialized directly (without processing).

Table 3. Measures of palm use calculated to determine how many palm species were used and how evenly different palm species contributed to the total use of palm in 12 western Amazonian villages (Byg and Balslev 2001).

Measure	Calculation	Description
Total species diversity (SD_{tot})	$SD_{tot} = -\sum P_s \ln P_s$ P_s = contribution of species *s* to the total use of palm in the study communities (= number of times species *s* was mentioned divided by the total number of reports of palm uses)	Measures how many species are used and how evenly they contribute to total palm use. Values range between 0 and *n*.
Total species equitability (SE_{tot})	$SE_{tot} = SD_{tot} / SD_{max} = SD_{tot} / \ln \boldsymbol{n}$ $\boldsymbol{n}$ = number of species used	Measures how evenly different palm species contribute to total palm use, independently of the number of species used. Values range between 0 and 1.

Table 4. Measures of importance and use of palm species calculated to determine which aspects of palm use contribute to the importance accorded to palms by local people in 12 western Amazonian villages (Byg and Balslev 2001). UV*s* is modified from Phillips and Gentry (1993a).

Measure	Calculation	Description
Use value (UV_s)	$UVs = \sum UV_{is}/n$ UV_{is} = number of uses informant i knows for species *s*	Measures the average number of uses informants know for a species.
Use diversity value (UD_s)	$UDs = -\sum Pc * \ln Pc$ Pc = contribution of use category c to the total utility of a species *s* (=number of times species *s* was mentioned within each use category, divided by the total number of reports of use of species s across all use categories)	Measures for how many use categories a species is used and how evenly these contribute to its total use. Values range between 0 and number of use categories for which it is used.
Use equitability value (UE_s)	$UE_s = UD_s/(\ln UD_s\ max)$ $UD_s\ max$ = maximum possible use diversity value for a species *s* with uses occurring in a given number of categories	Measures how evenly the different uses contribute to the total use of a species independently of the number of use categories. Values range between 0 and 1.
Informant diversity value (ID_s)	$ID_s = -\sum Pi * \ln Pi$ Pi = contribution of informant *i* to the total knowledge pool of species s (number of reports of use of species s by informant *i* divided by the total number of reports of use of species s)	Measures how many informants use a species and how its use is distributed among them. Values range between 0 and the number of informants using it.
Informant equitability value (IE_s)	$IE_s = ID_s/(\ln ID_s\ max)$ $ID_s\ max$ = maximum informant diversity value for a species *s* which is known by a given number of informants	Measures how the use of a species is distributed among informants independently of the number of informants using it. Values range between 0 and 1.
Use consensus value (UC_s)	$UC_s = 2n_s / (n - 1)$ n_s = number of people using a species *s*	Measures how large is the degree of consensus is between informants concerning whether species are considered as useful or not. Values range between -1 and +1.
Purpose consensus value (PC_s)	$PC_s = \sum P_u^2 / S$ P_u = proportional contribution of use *u* to the total utility of a species s (= number of times use *u* was reported for species *s* divided by the total number of reports of use of species *s*); *S*= number of types of uses of species s.	Measures how large is degree of consensus among informants using a certain species concerning what purposes they use it for. Values range between 0 and 1.

Table 5. Measures of informants palm knowledge calculated to investigate how homogeneous knowledge was distributed in 12 western Amazonian villages and whether knowledge differences were related to socio-economic factors (Byg and Balslev 2001).

Measure	Calculation	Description
Relative use value (RUV*i*)	RUV*i* = [(∑UV*is*/ UV*s*)]/*n* UV*is* = number of uses that informant i knows for species s; UVs = use value of species s (= average number of uses that informants know for species s); *n* = number of useful species	Measures how many palm uses an informant knows relative to the average knowledge among all informants (Phillips and Gentry 1993a)
Species diversity value (SD*i*)	SD*i* = $1/\sum Ps^2$ P*s* = contribution of a species *s* to informant *i´*s total use of palms (=number of times species *s* was mentioned by informants *i* divided by the total number of informant *i´*s answers)	Measures how many species an informant uses and how evenly his uses are distributed among the species. Values range between 0 and the number of species used by the informant.
Species equitability value (SE*i*)	SE*i* = SD*i*/ SDi_{max} SDi_{max} = maximum possible species diversity value for an informant *i* who uses a given number of species.	Measures how evenly an informant makes use of the palms he knows, independently of the number of palms used. Values range between 0 and 1.

Table 6. Description of the socioeconomic variables used as independent variables in the analyses.

Independent variable	Description
Village	Nominal variable (12 levels): 1 = Porvenir; 2 = San José; 3 = Velasco; 4 = Reforma; 5 = Guineal; 6 = Sungachi; 7 = San Isidro; 8 = Buena Vista; 9 = 25 de Mayo; 10 = San Silvestre; 11 = Santa Rosa de Maravilla; 12 = Alto Satariapo
Distance	Nominal variable (6 levels): In relation to proximity to San Buenaventura: 1 = San Isidro; 2 = Buena Vista; 3 = 25 de Mayo; 4 = San Silvestre; 5 = Santa Rosa de M.; 6 = Alto Satariapo. In relation to proximity to Iquitos: 1 = Porvenir; 2 = San José; 3 = Velasco; 4 = Reforma; 5 = Guineal; 6 = Sungachi
Ethnicity	Nominal variable (2 levels): 1 = indigenous (of the area); 2 = Non indigenous (colonist, peasant, settler of ethnic mixed origin)
Gender	Nominal variable (2 levels): 1 = male; 2 = female
Age	Continuous variable (number of years)
Civil state	Nominal variable (2 levels): 1 = single; 2 = married
Place of birth	Nominal variable (2 levels): 1 = inside the village; 2 = outside the village
Time living in the community	Continuous variable (number of years)
Education	Continuous variable (number of years)
N° people living in the household	Continuos variable
N° of crops	Continuos variable

Table 7. The 38 species of useful palms reported in 12 western Amazonian communities.

Species of palms reported	Pastaza Fan						Madidi						Total number of reports	Total number of uses reported
	Porvenir	San José	Velasco	Reforma	Guineal	Sungachi	San Isidro	Buena Vista	25 de Mayo	San Silvestre	Santa Rosa de M.	A. Satariapo		
Acrocomia aculeata							2	5	2		1		10	5
Aiphanes aculeata							4	2		7			13	5
Aphandra natalia	32	19	21	17	25	28							142	18
Astrocaryum chambira	10	8	2	1	6	21							48	15
Astrocaryum jauari	1		6	2	7	8							24	12
Astrocaryum murumuru	6	6	7	6	13	20	18	35	14	26	8		159	18
Attalea butyracea	7	8	21	16	21	27		4					104	15
Attalea maripa	3		1			9							13	9
Attalea phalerata	1	6	10	8	8	23	18	36	20	28	12	9	179	20
Attalea speciosa								14		4	3		21	6
Bactris acanthocarpa			1										1	2
Bactris bifida	1												1	1
Bactris concinna			2	1		5	17	35					60	8
Bactris gasipaes	4		12	17	14	13	14	27	4	19	1	9	134	21
Bactris major								1	10	12			23	4
Bactris maraja							9	10		2			21	3
Chamaedorea angustisecta							12	33	4	28	10	1	88	3
Chelyocarpus ulei	1	5											6	2
Cocos nucifera			16	16	16	6							54	7
Desmoncus orthacanthos		1											1	1
Desmoncus polyacanthos										4			4	1
Elaeis guianensis			1										1	1
Elaeis oleifera			3	7		9							19	9
Euterpe precatoria	14	11	18	14	13	16	18	36	23	28	12	9	212	23
Geonoma brevispatha										4		1	5	1
Geonoma deversa							16	36	23	28	11	5	119	1
Iriartea deltoidea	9	6	12	14	25	15	18	36	22	28	11	9	205	18
Iriartella stenocarpa					1								1	1
Lepidocaryum tenue	1		4	3	1	16							25	4
Mauritia flexuosa	16	16	15	10	14	25	10	25	5	15	8	2	161	22
Mauritiella armata	5		6		2	14							27	11
Oenocarpus bataua	11	10	6	12	13	24	18	36	22	28	12	9	201	23
Oenocarpus mapora	7	2	7	7	6	14	18	32	14	28	9	9	153	17
Pholidostachys synanthera			2			17							19	4
Phytelephas macrocarpa							17	36	6	28	7		94	8
Phytelephas tenuicaulis	6		13	11	7	23							60	12
Prestoea acuminata							2						2	2
Socratea exorrhiza	2		11	8	4	15	13	34	13	22	8	3	133	17
Total number	**19**	**12**	**23**	**18**	**18**	**21**	**17**	**19**	**14**	**18**	**14**	**11**	**2543**	**38**

Table 8. Different types of use reported for 38 species of palms in 12 western Amazonian villages.

Use category	Use description	Part of the palm used	Frequency for village in Pastaza Fan	Frequency for village in Madidi	Total reports	Total reports in Pastaza Fan	Total reports in Madidi
Food	Palm heart	Leaves	6	6	216	105	111
	Mesocarp edible	Fruits	6	6	246	126	120
	Preparation of drinks	Fruits	4	6	136	30	106
	Edible (raw or cooked)	Seeds	5	5	62	28	34
	Harvesting of larvae	Stem, seeds	4	2	42	36	6
	Extraction of oils	Fruits, seeds	2	6	116	3	113
Construction	Wood for walls	Stem	6	6	159	64	95
	Wood for floors	Stem	5	1	42	38	4
	Posts for to fence	Stem	4	4	73	21	52
	Posts for houses	Stem	6	5	159	57	102
	Support (beam) for floors	Stem	4		54	54	0
	Support (beam) for roofs	Stem	4	4	22	17	5
	Edge, top for roofs	Leaves	4	6	85	17	68
	Roof of house	Leaves	6	6	231	107	124
	Roof of temporary house	Leaves	6		31	31	0
	Roof of kitchen	Leaves	3		9	9	0
Decorative, ritual and religious	Ceremonial/ritual	Leaves	2	1	14	13	1
	Decorative	Flowers		5	31	0	31
Tools and utensils of domestic use, hunt and fish	Use the stem	Stem	2	5	25	4	21
	Basket-making (fans, mats, baskets, hats, ,hammocks, bedspreads, bags)	Leaves	6	6	117	66	51
	Broom	Leaves	1	4	56	1	55
	Fibers	Leaves	6	1	85	83	2
	Utensils for hunt and fish	Stem, leaves	3	3	44	14	30
	Utensils of domestic use	Stem, roots, leaves, seeds	4	4	39	21	18
Medicinal and cosmetic	Extract	Root	5	6	129	41	88
	Cosmetic use	Root	1		1	1	0
	Palm hearth	Leaves	2		10	10	0
	Cooking (drink)	Flowers, fruits	4	6	80	6	74
	Powder	Seeds		1	4	0	4
	Cosmetic use (oil)	Seeds		6	91	0	91
	Medicinal use (oil)	Seeds, fruits		6	115	0	115
Commercialization	Handicrafts	Stem, seeds		4	18	0	18
	Baskets, fans, bags, etc.	Leaves	1		2	2	0
	Fiber	Leaves	6		103	103	0
	Palm hearth	Leaves	1		2	2	0
	Fruits	Fruits	3	2	12	5	7
	Oil (extract from fruits and/or seeds)	Seeds	1		1	1	0
	Seeds	Seeds	3		5	5	0
		N° total uses	**33**	**28**	**2667**	**1121**	**1546**

Table 9. Number of uses by use category for 38 species of useful palms reported in 12 western Amazonian communities. The species are arranged in according to the total number of reported uses. (*) Species reported in both places.

		USE CATEGORY							
	Species	Food	Construction	Tools and utensils of domestic use, hunt and fish	Medicinal and cosmetic	Decorative, ritual and religious	Commercialization	Total number uses	Total number use category
PASTAZA FAN	*Oenocarpus bataua**	5	7	4	4			20	4
	*Mauritia flexuosa**	4	8	4			3	19	4
	Aphandra natalia	4	7	5			2	18	4
	*Bactris gasipaes**	5	7	2	1	1	2	18	6
	*Euterpe precatoria**	5	8	1	2	1	1	18	6
	Astrocaryum chambira	5	3	3	3		1	15	5
	*Astrocaryum murumuru**	5	6	1	2	1		15	5
	*Attalea butyracea**	6	5	3	1			15	4
	*Iriartea deltoidea**	4	7	2	1	1		15	5
	*Socratea exorrhiza**	4	8	1	2			15	4
	Astrocaryum jauari	4	3	4	1			12	4
	Phytelephas tenuicaulis	4	6		1		1	12	4
	*Attalea phalerata**	4	2	3	1	1		11	5
	Mauritiella armata	3	7	1				11	3
	*Oenocarpus mapora**	2	5	1	2			10	4
	Attalea maripa	3	2	3	1			9	4
	Elaeis oleifera	3	5		1			9	3
	Cocos nucifera	2	3		1		1	7	4
	*Bactris concinna**	1	4	1				6	3
	Lepidocaryum tenue	2	2					4	2
	Pholidostachys synanthera	2	2					4	2
	Bactris acanthocarpa		2					2	1
	Chelyocarpus ulei	1		1				2	2
	Bactris bifida	1						1	1
	Desmoncus orthacanthos			1				1	1
	Elaeis guianensis	1						1	1
	Iriartella stenocarpa		1					1	1
	Number of species	24/11*	23/11*	18/11*	15/9*	5/5*	7/2*		
MADIDI	*Attalea phalerata**	6	2	3	4		1	16	5
	*Euterpe precatoria**	3	5	2	4			14	4
	*Oenocarpus bataua**	3	1	3	3		1	11	5
	*Oenocarpus mapora**	2	5	1	2			10	4
	*Astrocaryum murumuru**	2	4	2			1	9	4
	*Bactris gasipaes**	3	1	2	2		1	9	5
	*Iriartea deltoidea**	1	7	1				9	3
	*Socratea exorrhiza**		5	2	1		1	9	4
	*Mauritia flexuosa**	3	1	2	2			8	4
	Phytelephas macrocarpa	3	3	1			1	8	4
	Attalea speciosa	2	1	1	2			6	4
	Acrocomia aculeata	2			3			5	2
	Aiphanes aculeata	3	1				1	5	3
	Bactris major	4						4	1
	*Bactris concinna**	1		1			1	3	3
	Bactris maraja	2	1					3	2
	Chamaedorea angustisecta				1	2		3	2
	Prestoea acuminata		2					2	1
	*Attalea butyracea**		1					1	1
	Geonoma brevispatha		1					1	1
	Desmoncus polyacanthos			1				1	1
	Geonoma deversa		1					1	1
	Number of species	15/9*	17/10*	13/10*	10/7*	1/0*	8/5*		
	Total number of species	29	29	21	19	6	12		

Table 10. Total species diversity (DS_{tot}) and Total species equitability (ES_{tot}) calculated for the use of palms in 12 western Amazonian villages. The calculations and the content of the different measurements are described in Table 3. A T-test was carried out on the number of palms species known ($\alpha = 0,05$).

	GENERAL	PLACE		GENDER						VILLAGE ETHNICITY						INFORMANT ETHNICITY					
				General		Madidi		Pastaza Fan		General		Madidi		Pastaza Fan		General		Madidi		Pastaza Fan	
		Madidi	Pastaza Fan	Male	Female	Male	Female	Male	Female	Indigenous	Non indigenous	Indigenous	Non indigenous	Indigenous	Non indigenous	Indigenous	Non indigenous	Indigenous	Non indigenous	Indigenous	Non indigenous
DS_{tot}	2,89	2,45	2,37	3,13	3,20	2,44	2,46	2,87	3,00	3,09	3,02	2,49	2,33	2,67	2,81	2,88	2,89	2,48	2,39	2,06	2,38
ES_{tot}	0,80	0,79	0,72	0,87	0,92	0,79	0,8	0,88	0,97	0,88	0,87	0,82	0,79	0,85	0,91	0,82	0,81	0,8	0,79	0,86	0,74
Number of useful palm species	38	22	27	37	33	22	22	26	22	33	32	21	19	22	23	33	35	22	21	21	25
T Test significance value		< 0,0001		0,5944		0,6810		0,7467		0,0003		< 0,0001		< 0,0001		0,0002		< 0,0001		< 0,0001	

Table 11. Summary of quantitative measures of different aspects of use and importance calculated for palm species used by local people in 12 western Amazonian villages. The table gives average values for all species, standard deviations to indicate the spread in values for different species, and minimum and maximum values (in parentheses) recorded. Calculation and content of the different measures are explained in Table 4.

	GENERAL		**MADIDI**		**PASTAZA FAN**	
	Mean value (min; max)	Standard deviation	Mean value (min; max)	Standard deviation	Mean value (min; max)	Standard deviation
Number of uses	9,21 (1; 23)	7,50	6,27 (1; 16)	4,34	9,63 (1; 19)	6,07
Use value	0,56 (0,004; 3,60)	0,8	1,26 (0,023; 6,81)	1,63	0,35 (0,0067; 2,77)	0,53
Use diversity	0,49 (0,69; 1)	0,36	0,49 (0,64; 0,95)	0,37	0,77 (0,33; 1,69)	0,49
Use equitability	0,49 (0,58; 1)	0,35	0,49 (0,64; 0,95)	0,37	0,56 (0,47; 1,05)	0,33
Informant diversity	3,04 (1,99; 5,07)	1,66	3,50 (0,64; 4,78)	1,35	2,86 (1,99; 4,87)	1,57
Informant equitability	0,54 (0,35; 0,9)	0,30	0,72 (0,13; 0,98)	0,28	0,57 (0,40; 0,97)	0,31
Use consensus	-0,52 (-0,99; +0.53)	0,5	-0,015 (-0,97; +0,95)	0,75	-0,43 (-0,99; +0,91)	0,50
Purpose consensus	0,26 (0,006; 1)	0,39	0,25 (0,007; 1)	0,37	0,20 (0,0093; 1)	0,35

Table 12. Correlations between the importance accorded to a palm and different aspects of its use. Calculation and content of the different measures are explained in Table 4. Directions of the correlations are indicated by "+" and "-"signifying positive and negative correlations, respectively. Significance levels of the correlation are indicated by asterisks in the following way: *: 0,05<P≤0,07; **: 0,01<P≤0,05; ***: 0,001<P≤0,01; ****: 0,0001<P≤0,001; *****: P≤0,0001; NS: Not significant.

	GENERAL						MADIDI						PASTAZA FAN					
	Use value	Use diversity	Use equitability	Informant diversity	Informant equitability	Use consensus	Use value	Use diversity	Use equitability	Informant diversity	Informant equitability	Use consensus	Use value	Use diversity	Use equitability	Informant diversity	Informant equitability	Use consensus
Use diversity	+***						NS						+****					
Use equitability	+***	+*****					NS	+*****					+*	+*****				
Informant diversity	+*****	+*	+*				+*****	NS	NS				+*****	+***	+*			
Informant equitability	+*****	+*	+*	+*****			+*****	NS	NS	+*****			+*****	+***	+*	+*****		
Use consensus	+*****	+**	+**	+*****	+*****		+*****	NS	NS	+*****	+*****		+*****	+***	+*	+*****	+*****	
Purpose consensus	-**	-***	-***	-*	-*	-*	-*****	-***	-***	-***	-***	-****	-*****	-****	-**	-*****	-*****	-*****

Table 13. Summary of different quantitative measures of informants' knowledge of palm uses. Calculation and content of the different measures are described in Table 5. The table gives average values for all informants, standard deviations to indicate the spread in informants' knowledge, and minimum and maximum values (in parentheses) recorded.

	GENERAL		**MADIDI**		**PASTAZA FAN**	
	Mean value (min; max)	Standard deviation	Mean value (min; max)	Standard deviation	Mean value (min; max)	Standard deviation
Number of informants	278	-	129	-	149	-
Number of uses	9,83 (1; 20)	4,77	12,52 (2; 20)	4,04	7,47 (1; 20)	4,07
Number of species	8,79 (1; 19)	4,06	9,99 (3; 15)	3,11	7,76 (1; 19)	4,49
Relative use value	0,24 (0,03; 0,47)	0,11	0,49 (0,05; 0,73)	0,14	0,29 (0,04; 0,67)	0,16
Species diversity	0,36 (0,02; 1)	0,20	0,79 (0,04; 1,21)	0,27	0,44 (0,03; 1,49)	0,33
Species equitability	0,10 (0,01; 0,27)	0,05	0,25 (0,01; 0,39)	0,09	0,13 (0,01; 0,45)	0,10

Table 14. Relationship between informants' knowledge of palm uses and socio-economic factors. The relationships were determined by means of stepwise linear regression of different quantitative measures of informants' knowledge about palms onto socio-economic variables. The table includes only those variables which were statistically significant, the order of the factors reflect their significance values. Transformations of independent variables are indicated in the table. The numbers of the **villages** refer to the following: 1=Porvenir; 2=San José; 3=Velasco; 4=Reforma; 5=Guineal; 6=Sungachi; 7=San Isidro; 8=Buena Vista; 9=25 de Mayo; 10=San Silvestre; 11=Santa Rosa de M.; 12=Alto Satariapo (more detalis to see Table 2); the variable **Ethnicity** has two levels: 1= indigenous; 2= non indigenous; the variable **Place of birth** has two levels: 1= Inside the village; 2= Outside the village.

					KNOWLEDGE FOR USE CATEGORY					
	Number of uses	Total number of species used	Relative use value	Species diversity value	Food	Construction	Tools and utensils	Medicinal and cosmetic	Decorative, ritual and religious	Comercialization
GENERAL	Village (1,3,12,5,9<4,6,11,10,7,8) (1,2<3,12,5,9) (4,6,11<10,7,8) Education (+) Log N° crops (+) Time living in the village (+) R^2=0,63 p<.0001	Village (1,2,12,9,5,11<4,10,8,7,6) (1,2<12,9,5,11) (3,4,10<7,8,6) Education (+) R^2=0,55 p<.0001	Village (1,2,12,5,9,11,3<4,10,7,6,8) (1,2<12,5,9,11,3) (4<10,7,6,8) Education (+) R^2=0,59 p<.0001	Village (1,5,9,3,12,4<11,10,7,8,6) (1,2<5,9,3,12,4) (11,10<7,8,6) (5,9,3,12<4) Log N° crops (+) Education (+) Time living in the village (+) R^2=0,69 p<.0001	Village (1,2,3,5,6,4<9,11,10,12,7,8) (9,11,10,12<7,8) (1,2<3,5,6,4) (3,5<6,4) (1<2) Education (+) Time living in the village (+) R^2=0,58 p<.0001	Village (1,2,12<11,9,5,10,3,7,4,8,6) (11,9,5,10,3<7,4,8,6) (1,2<12) (7,4<8,6) (8<6) Log n° crops (+) Time living in the village (+) Education (+) R^2=0,57 p<.0001	Village (12,9,1,2,5,3,11<7,8,4,6,10) (12,9,1<2,5,3,11) (7,8<4,6,10) Age (+) Village*Age R^2=0,33 p<.0001	Village (1,25,3,4,6,9,12<11,7,10,8) (1,2,5,3,4<6,9,12) (6<9,12) Time living in the village (+) Education (+) R^2=0,78 p<.0001	Village (5,10,7,8<11,9,6,1,3,4,2,12) (11,9<6,1,3,4,2,12) (11,9<6,1,3,4,2,12) R^2=0,29 p<.0001	Village (4,5,3,1,2,12<6,10,11,8,7,9) (6,10,11<8,7,9) Place of born (1>2) R^2=0,285 p=0.0466
PASTAZA FAN	Village (1,2<3,5,4,6) (3,5<4,6) Sq Age (+) R^2=0,53 p<.0001	Ethnicity (1>2) Village (1,2,5,3,4<6) R^2=0,49 p<.0001	Ethnicity (2>1) N° crops (+) R^2=0,42 p<.0001	Village (2,1,5,3,4<6) Ethnicity (2>1) N° crops (-) Sq Age (+) R^2=0,60 p<.0001	Village (1,3,5<2,6,4) R^2=0,14 p<.0001	Village (1,2<5,3,4,6) (5,3<4,6) Sq Age (+) R^2=0,55 p<.0001	Village (2,1,5,3<6,4) Sq Age (+) R^2=0,30 p<.0001	Village (1,2,3,5<4,6) N° crops (+) Sq Age(+) R^2=0,31 p<.0001	Village (5<6,1,4,2,3) Ethnicity (1>2) R^2=0,55 p<.0001	Village (1,4,5,3<2,6) R^2=0,58 p=0.0012
MADIDI	Village (12,9<11,10,7,8) (11,10<7,8) Education (+) Time living in the village (+) Village*Education R^2=0,46 p<.0001	Village (12,9,11<10,7,8) (10<7,8) Education (+) R^2=0,55 p<.0001	Village (12,9,11<10,7,8) (10,7<8) (12,9<11) Education (+) R^2=0,57 p<.0001	Village (9,12,11<10,7,8) (10<7,8) (9,12<11) Education (+) Time living in the village (+) Village*Education R^2=0,64 p<.0001	Village (9,11,10,12<7,8) Education (+) Time living in the village (+) R^2=0,29 p<.0001	Village (12,9,11,10<7,8) (12<9,11,10) Education (+) Time living in the village (+) Ethnicity (1>2) R^2=0,41 p<.0001	Village (12,9<11,7,8,10) (11,7,8<10) Age (+) Village*Age R^2=0,38 p<.0001	Village (9,12<7,11,10,8) Time living in the village (+) R^2=0,38 p<.0001	Village (10,7,8<11,9,12) R^2=0,16 p=0.0007	Village (12<10,11,8,7,9) Place of born (1>2) R^2=0,14 p=0.0001