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# Livelihood Gains and Ecological Costs from Household Strategies for the Management of Non-Timber Forest Products: The Case of Phnom Prich Wildlife Sanctuary, Cambodia

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## សង្ខិត្តន័យ

អនុផលព្រៃឈើមានអត្ថប្រយោជន៍ក្នុងការកាត់បន្ថយភាពក្រីក្រនៅជនបទ និងសេវាកម្មប្រព័ន្ធអេកូ ប៉ុន្តែ តួនាទីរបស់អនុផលព្រៃឈើហាក់មិនសូវបានរំលេចឱ្យបានទូលំទូលាយនោះទេ ព្រោះអ្នកធ្វើគោលនយោបាយពុំមានភ័ស្តុតាងច្បាស់លាស់។ ការបែងចែកតួនាទីនៃអនុផលព្រៃឈើមានសារសំខាន់ចំពោះការបង្ហាញសក្តានុពលក្នុងការអភិវឌ្ឍជីវភាព និងការអភិរក្ស។ អត្ថបទនេះនឹងពន្យល់ពីយុទ្ធសាស្ត្ររបស់ប្រជាជនក្នុងការគ្រប់គ្រងអនុផលព្រៃឈើ ដើម្បីបង្កើនសេដ្ឋកិច្ចជនបទក្នុងប្រទេសកម្ពុជា និងកំណត់កត្តាជះឥទ្ធិពលនានាទៅលើការសម្រេចចិត្តរបស់ប្រជាជនក្នុងការគ្រប់គ្រងអនុផលព្រៃឈើ។ ការសិក្សានេះបានប្រើប្រាស់ទិន្នន័យដែលទទួលបានពីការសម្ភាសប្រជាជននៅខេត្តមណ្ឌលគិរី ចំនួន 310 គ្រួសារ កាលពីឆ្នាំ2016 និងការសម្ភាសជនបង្គោលនៅឆ្នាំ2019។ ការសម្ភាសនេះធ្វើឡើងដោយប្រើកម្រងសំណួរ ហើយសម្ភាសប្រជាជនដោយចៃដន្យនៅក្នុងដែនជម្រកសត្វព្រៃភ្នំព្រេច។ ជាលទ្ធផលយើងអាចរកឃើញយុទ្ធសាស្ត្រគ្រប់គ្រងអនុផលព្រៃឈើរបស់ប្រជាជន ទៅតាមកម្រិតនៃការធ្វើសមាហរណកម្មអនុផលព្រៃឈើទៅក្នុងប្រាក់ចំណូល កម្រិតនៃការរួមចំណែកពីអនុផលព្រៃឈើដល់ប្រាក់ចំណូលគ្រួសារ និងកម្រិតនៃការគ្រប់គ្រងអនុផលព្រៃឈើ។ យុទ្ធសាស្ត្រទាំងនេះបានបង្ហាញពីការវិវត្តនៃការគ្រប់គ្រង ដោយចាប់ផ្តើមពីតម្រូវការត្រឹមតែដើម្បីរស់និងប្រើប្រាស់ក្នុងគ្រួសារ ហើយបន្ទាប់មក ឈានទៅបង្កើនប្រាក់ចំណូលជាលំដាប់។ ជាទូទៅ ទោះបីជាប្រជាជនប្រើប្រាស់វិធីសាស្ត្រអ្វីក៏ដោយសម្រាប់បង្កើនជីវភាពតាមរយៈអនុផលព្រៃឈើ ក៏យើងពុំឃើញមានផលប៉ះពាល់ដល់ស្ថានប្រព័ន្ធធ្ងន់ធ្ងរទេ។ ការគ្រប់គ្រងលើការដកហូតអនុផលព្រៃឈើនាពេលបច្ចុប្បន្នបានធ្វើឱ្យមានការប្រែប្រួលតិចតួចប៉ុណ្ណោះទៅលើចនាសម្ព័ន្ធព្រៃឈើ និងស្ថានប្រព័ន្ធនៃដីរចម្រុះ។ លើសពីនេះ ភាពខុសគ្នានៃការសម្រេចចិត្តរបស់ប្រជាជនទៅលើការគ្រប់គ្រងអនុផលព្រៃឈើ គឺអាស្រ័យទៅលើកត្តាកូមិសាស្ត្រ ធនធាន និងលក្ខណៈពិសេសរបស់គ្រួសារនីមួយៗ។

## ABSTRACT

Though non-timber forest products (NTFPs) have been given a high priority in addressing rural poverty and ecosystem services, policy makers tend to neglect the role of NTFPs because they lack readily available evidence. Classifying NTFPs based on their role in household livelihood strategies enables and explains the opportunities and potential of NTFPs for livelihood development and conservation. Therefore, this study emphasizes understanding NTFPs in household livelihood strategies in the rural

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economy of Cambodia and the factors that influence livelihood strategy choices. This study was carried out in Phnom Prich Wildlife Sanctuary (PPWS), Cambodia in 2016. The data was collected using structured questionnaire interviews. Random sampling was used to select 310 respondents from six communities in PPWS. Four household livelihood strategies were found according to: the level of integration of NTFPs into cash income, the level of contribution of NTFPs to household income, and the level of management of NTFPs. The identified NTFP household livelihood strategies are subsistence strategy, supplementary strategy, diversified strategy, and specialized strategy. These strategies can be considered as part of the process of evolution to an improved level of livelihood, in which rural people first seek to survive and then to increase their income over time. The management of NTFPs ensures minimum transformation of the forest structure allowing for multiple uses of the forest and maintaining relatively high biodiversity. Geographic conditions, household capital, and household characteristics were found to be the most important factors determined the choice of household livelihood strategy.

## 1. Introduction

Beginning in the early 1980s, attention paid to rural poverty and ecosystem protection has grown resulting from alarming rates of deforestation (Ruiz-Pérez et al., 2004). Forest products, especially non-timber forest products (NTFPs), were given a high priority during this time because their exploitation is more benign than timber logging (Chou, 2018; Peters et al, 1989). Conservation and development organizations have tried to promote NTFPs in various ways, especially in relation to rural poverty alleviation (Watkins et al, 2016). Recently, environmentalists have claimed that the increasing value of NTFPs provides for forest conservation because harvesting NTFPs has lower impacts on the forest ecosystem (Chou, 2018; Neumann & Hirsch, 2000). So far, the expected economic and conservation benefits of NTFPs have been evident from the diverse perspectives of researchers, international agencies, and government bodies (Chou, 2018).

Indeed, Cambodia has the largest area of forest in mainland Southeast Asia, and it supports the well-being of the local people and contributes to the country's economy. According to the Ministry of Environment of Cambodia, forest coverage in Cambodia as of 2018 was 48.86 percent of the land, making up approximately 8,510,807 ha (MoE, 2020). A recent analysis of global deforestation rates showed that Cambodia has one of the highest national deforestation rates in the World, losing 7% in the decade from 2002-2012 (Milne & Mahanty, 2015). Deforestation in Cambodia negatively affects about 80 percent of people living in protected areas who are heavily dependent on forest resources (especially NTFPs) for domestic consumption and income (FA, 2009; Milne & Mahanty, 2015; MoE, 2011).

Ecosystem benefits such as water and soil regulation, flood protection, storm protection, recreation and ecotourism opportunities are also threatened by the rapid deforestation driven by large-scale infrastructure construction, timber extraction, illegal logging, mining projects, and other resource extraction activities (Watkins et al., 2016). NTFPs are an intrinsic part of culture and traditions of forest-based and indigenous communities in Cambodia (Vantomme, Markkula, & Leslie, 2002). Forest-dependent communities traditionally collect different species of NTFPs to meet their livelihood objectives. The majority of NTFPs are collected for household consumption or informally traded within the country to meet the domestic demand (Kim, Sasaki, & Koike, 2008; Mulcahy & Boissière, 2014; Tola & McKenney, 2003; Vantomme et al., 2002).

NTFPs were also exported to neighboring countries, such as Vietnam and Thailand, but they were traded informally without any clear regulation and records (Watkins et al, 2016; Tola et al., 2010). It has been agreed that extraction of NTFPs serves the primary goals of rural livelihoods and forest conservation in Cambodia, but the economic importance of NTFPs are often overlooked by the country's ruling elite (Tola et al., 2010; Watkins et al., 2016). To lessen the deforestation rate, the Royal Government of Cambodian (RGC) has implemented various policies for forest protection and management, but the integration of an NTFPs development agenda is not sufficiently addressed (FA, 2009). Therefore,

because of a lack of consideration of the wide range of activities in which people use NTFPs in order to improve their livelihoods, the goals of forestry reforms were not achieved.

The study of De Beer and McDermott (1996) demonstrated that even though NTFPs are important for sustainable livelihood through supporting food systems and income generation at the local level, policy-makers tend to forget the role of NTFPs because they lack available evidence on the contribution of NTFPs to the national economy and daily life of rural people. The body of literature on the potential contribution to poverty alleviation and forest conservation of NTFPs has been growing, but the discussion has been limited and controversial (Adam, Pretzsch, & Pettenella, 2013; J.E. Michael Arnold & Pe´rez, 2001; Belcher, Ruiz-Perez, & Achdiawan, 2005). Nevertheless, the analyses of the processes of the current utilization and management of NTFPs have offered contrasting perspectives (Ruiz-Pérez et al., 2004).

Some researchers consider that extraction of NTFPs from the wild to provide for subsistence supports the long-term enhancement of livelihoods (Angelsen & Wunder, 2003; Belcher & Kusters, 2004; Ticktin, 2004). It has also been held that there is a potential for improving rural livelihoods through increased commercial exploitation of NTFPs (Belcher & Schreckenberg, 2007). Other studies suggest that increased extraction of wild NTFPs often result in overexploitation, as the process of intensified management serves to maintain or increase the supply to the markets (Belcher et al., 2005; Ruiz-Pérez et al., 2004). In general, NTFP extraction can contribute to diverse livelihood strategies to improve the standard of living, yet the empirical basis for these discussions has been weak. Therefore, attempts to classify NTFPs according to their role in supporting livelihoods is crucial for institutions to have an understanding of effective approaches to forest management in order to achieve the goals of rural economic development and forest conservation.

Typically, NTFPs were classified by phylogenetic groupings (e.g., bamboos, rattans, palms) or by functional categories (e.g., medicinal and aromatic plants, bush-meat, woodcarving). More recently, several authors have attempted to classify NTFPs based on the relation to trade and investment. To estimate Mopane worm (insect) impacts in Africa in terms of an applied livelihood strategy framework, Stack et al. (2003) used the terms: (1)'Hanging on' to describe the survival activity at the subsistence level only; (2) 'Linking in' to describe the subsistence activity with small trading activity for the accumulation of social benefits; (3) 'Stepping up' to describe the accumulation of productive resources for improving livelihoods activity and incomes; (4) 'Stepping out' to describe the increase of income flows and accumulation of capital assets. In addition to an economic perspective, Ruiz-Pérez et al. (2004) included management systems in the analysis of NTFPs in relation to livelihood strategies.

In a subsistence strategy, households harvest NTFPs from wild resources in an unmanaged manner, and NTFPs are mainly used for subsistence purposes only. In a diversified strategy, households tend to manage NTFPs to earn additional cash income. In a specialized strategy, households tend to focus on specific high-value NTFPs, and they benefit from the trade value when there is stability in the markets. Belcher et al. (2005) conducted a comparative study on NTFPs at the macro level looking at 61 cases by grouping NTFPs in terms of household economic strategies, including: (1) subsistence strategy; (2) supplementary strategy; (3) integrated strategy; (4) specialized natural strategy; and, (5) specialized cultivated strategy. They adopted the keywords from Perez et al. (2003), but they divided the 'diversified-strategy' into supplementary and integrated strategies, and 'specialized-strategy' into specialized-natural and specialized-cultivated strategies. Adam et al. (2013) modified the typology of strategies from Ruiz-Perez et al. (2004), with similar identification procedures, by classifying NTFPs use into three strategies: subsistence strategy, supplementary strategy, and specialized strategy.

Belcher et al. (2005) proposed a method for classification of NTFPs based on different household livelihood strategies, but the definitions of household livelihood strategies is still debated among other studies including Adam et al. (2013); Stack et al. (2003); and Ruiz-Pérez et al. (2004). Hence, a simpler and more useful typology is needed to classify NTFPs according to common

characteristics of usage and management. This study modifies the analysis procedure from Belcher et al. (2005) and Ruiz-Pérez et al. (2004) in order to better to classify NTFPs according to their contributions to the cash economy, to household incomes, and to management systems. The study seeks a better conception and classification of the terms of household livelihood strategies to elucidate the diverse impacts of NTFPs in the current situation. This study also looks at why, in the same forest landscape, some locals consume available NTFPs for subsistence use while others have the opportunity to specialize in NTFP consumption related to activities that offer greater income. In this regard, classifying NTFPs solely in relation to household livelihood strategies is not sufficient, as it does not take into account interrelated factors that determine a household's choice of livelihood strategy (Hegde, Suryaprakash, Achoth, & Bawa, 1996; Melaku, Ewnetu, & Teketay, 2014; Schaafsma et al., 2014).

This study aims at classifying NTFPs in relation to household livelihood strategies in the context of the Phnom Prich Wildlife Sanctuary in Cambodia. The research discusses the contribution of NTFPs in relation to the cash economy and household incomes for different types of livelihood strategies. It also compares the ecological impact from the management systems for different livelihood strategies. Another objective is an analysis of the factors influencing household decisions on the choice of livelihood strategy. This contributes to improved policy and management options for the achievement of the goals of improved rural livelihoods and sustainable forest management.

## 2. Materials and methods

Phnom Prich Wildlife Sanctuary is located in the west of Mondulkiri province, in the heart of the Eastern Plains Landscape (EPL) where there are the richest forest resources in Cambodia **(Fig.1)**. The total area of PPWS is 2,225 square kms, and it is the biggest protected area in the province (WWF, 2016). Phnom Prich Wildlife Sanctuary has been officially recognized as a protected area since 1993, following Royal Decree Number 7 on 08th November 1993 (RGC, 1993). The elevation ranges from 80 to 640 meters, and creates a rich variety of forest habitats, consisting of a mosaic of deciduous dipterocarp forest (1,027km2) and wetter semi-evergreen/mixed-deciduous forest (1,070km2) (Gray, 2011). PPWS hosts an impressive array of wildlife species including 18 endangered and critically endangered mammals, birds, and reptiles. PPWS is a rich ecosystem, and is also of great importance to local communities due to NTFP extraction (WWF, 2016).

The population in the area of the Phnom Prich Wildlife Sanctuary is diverse in terms of beliefs and ethnic groups. The majority of households are Bunong (Phnong) people who make up around 83% of the total households. Most of the households are indigneous peoples that have lived in Phnom Prich Wildlife Sanctuary for generations. Those people believe that their ancestors are represented by spirits. Bunong people also believe many things have spirits, including animals, plants, hills, stones, jars, and buildings. As a result, they traditionally have a strong link with forest ecosystems based on their beliefs (WWF, 2016). The average household size was six persons, according to a household survey of 2016 (CBD, 2016).

In general, the male head of the household makes decisions especially for the livelihood-related activities, and their average age was around 38 years old. According to Chou (2018) the illiteracy rate of the household head was high (49%) and very few entered secondary school or high school. Households had approximately three hectares of agricultural land for farming. The main occupation of households was farming (79%), with secondary occupations based on NTFP collection, hired labor, fishing, and logging. Farming activities include rainfed rice cultivation, cash crop cultivation, and vegetable cultivation in the rainy season. Raising livestock, fishing, and running small businesses were activities conducted year-round. People who were landless or owned small areas of agricultural land, decided to work for other farmers, especially in the sowing and harvesting periods of rice cultivation. To supplement supplies of food, energy, construction materials, as well as incomes, local people collect NTFPs in both seasons, depending on the type of NTFPs. For example, bamboo shoots can be collected in the

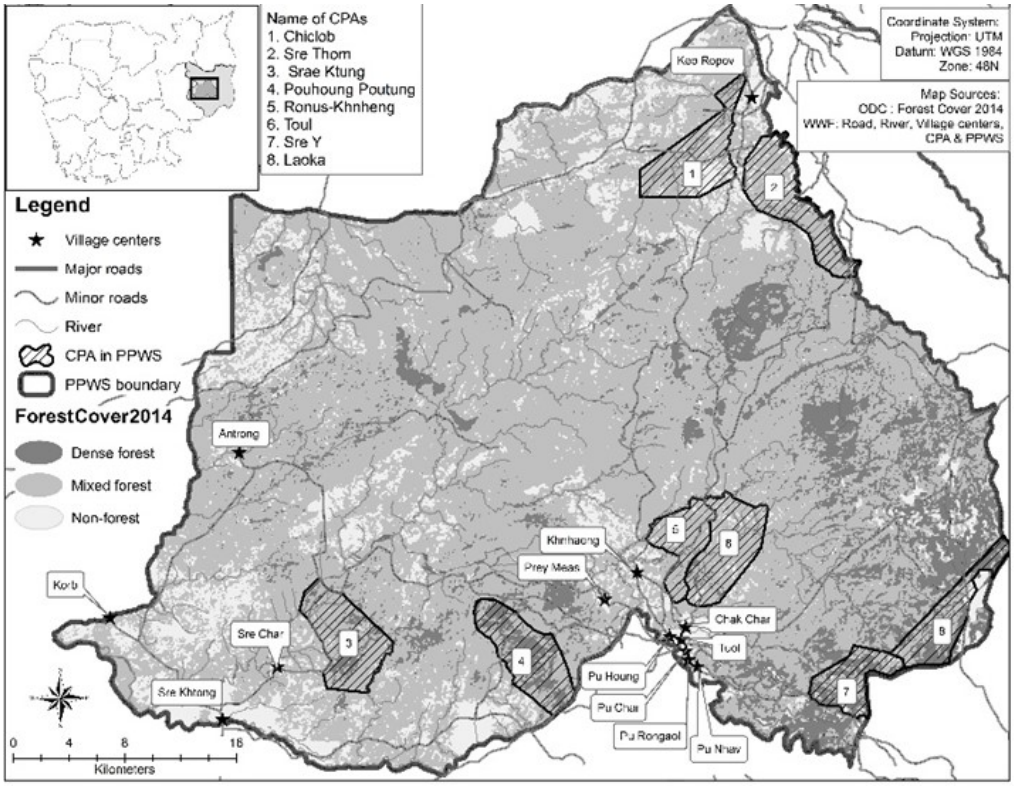


**Fig. 1.** Location of Phnom Prich Wildlife Sanctuary in Mondulkiri Province, Cambodia

rainy season, but wild honey and Prich leaf (Melientha suavis Pierre) are available only in the dry season. Indeed, local people collect the NTFPs for the market frequently, including liquid resin, solid resin, wild honey, and orchid flower in the dry season.

Natural resources in PPWS are decreasing at an alarming rate, according to World Wildlife Fund (2016). Poaching and economic land concessions (ELC)/social land concessions (SLC) are the main threats to the wildlife habitats in PPWS (WWF, 2016). The demand for bush meat is continually increasing while the law enforcement against poaching and logging is inadequate. The forest and its rich biodiversity are also under tremendous pressure from commercial land clearance and agricultural expansion. The reason for selecting this site to study is because PPWS is still well endowed with NTFPs, offering a variety of opportunities for use and trade. This wildlife sanctuary consists of diverse livelihoods and employment opportunities, but these benefits have been critically threatened by rapid deforestation and insufficient forest management policy. Therefore, PPWS is a potential protected area that needs effective management to reduce the further loss of forest biodiversity.

Fieldwork was conducted in September of 2015, and March and April of 2016. Additional fieldwork was conducted to get updated information on the use of NTFPs in 2019. Focus group discussions were undertaken to gain an overview of the current livelihood activities of local people. Testing and adjustment of questionnaires were conducted prior to the survey. There are eight community protected areas (CPAs) that have been established in PPWS. This study selected six of those communities for the survey including Nglaoka, Sre Y, Chi Klab, Poutong-Pouhoung, Toul, and Srae Khtong. Structured questionnaire interviews were conducted with 310 households, which were randomly selected. Respondents had to be local people who live in these communities. Respondents were household heads and youth above 18 years old. There are more than 900 types of NTFPs listed in the declaration of the Ministry of Agriculture, Forestry and Fishery (MAFF, 2005). Results from participatory rural appraisals (PRA) and descriptive statistics from previous studies indicate the most important NTFPs in PPWS include fuelwood, bamboo shoots, prich leaves (Melientha suavis Pierre), solid resin, bamboo poles, liquid resin, wild honey, and orchid flowers because they are widely used by the local people.

DFID (1999) denotes 'livelihood strategies' as the range and combination of activities and choices that people make or undertake in order to achieve their livelihood goals. The people who live in forested areas tend to be marginalized, so they engage in diverse activities to meet basic needs based on livelihoods traditions (Belcher, Achdiawan, & Dewi, 2015). The foundation of management options to improve livelihoods and to reduce the negative impact on biodiversity can be gained from the study of preferences of different households for specific livelihood strategies (Tesfaye et al., 2011). Previous studies by other researchers focused only on commercial NTFPs, so they did not reflect the reality of roles, diversity, and trends associated with use and management of NTFPs. Therefore, this study is based on structural questionnaire interviews, so it truly reflects the current reality of the use and management of NTFPs in Cambodia.

Since our main objective was to explain livelihood strategy choice with particular focus on the households' reliance on NTFPs extraction, the level of integration into the cash economy and the share of income from NTFPs as a share of total household income, were used to classify sampled households into four groups. A household could be pursuing several livelihood strategies, so they were not classified into mutually exclusive groups. **Table 1** illustrates the four distinct groups: (1) Low integration into the cash economy in the context of low contribution to household income; (2) Low integration into the cash economy in the context of high contribution to household income; (3) High integration into the cash economy in the context of low contribution to household income; and (4) High integration into the cash economy in the context of high contribution to household income. However, there is no economic reason that a product could have low integration into the cash economy in the context of high contribution to household income. Therefore, only three classification groups were formed, (1), (3), and (4).

Also, this study set up another factor to classify NTFPs in household livelihood strategies: the management system of NTFPs. The management system is a key strategic decision for NTFPs collectors. Intensive management has the impact of disrupting ecosystems through disturbances to genes, species, and communities (Shaanker et al., 2004). The management systems of NTFPs range from wild collection to intensive cultivation (Anderson, 1992; Belcher et al., 2005), but no cases were found to indicate that NTFPs are cultivated in PPWS, Cambodia. As a result, there were three levels of management systems, including low managed systems, moderate managed systems, and strong managed systems. Low managed systems entail collection activities without any transformation of forest structure due to the extraction of NTFPs (Belcher et al., 2005). Moderate managed systems refers to extensive systems in which local people uses traditional knowledge to meet their economic needs through efficient labor and regeneration control with low impact on biodiversity (Anderson, 1992). Strong management systems, in this specific context, entail intensive management activities that local people employ to increase production through treatments such as weeding or crown opening. Forests are partially transformed, but the natural succession still occurs (Belcher et al., 2005).

**Table 1** illustrates four groups of livelihood strategies involving NTFPs. The subsistence strategy (S1) represents the households who rely on NTFPs which were collected from the wild. Those NTFPs tend to contribute little to cash income and total household income. They are primarily used for subsistence. The supplementary strategy (S2) refers to the households who are more oriented towards the cash economy. NTFPs are collected to provide supplementary income, yet the income from NTFPs as a share of total household income is relatively small. The NTFPs are collected from the wild rather than cultivated. The diversified strategy (S3) stands for households who managed NTFPs by intermediate intensive systems (moderately managed), as source of additional income. The specialized strategy (S4) relies on NTFPs as a main source of household income, and NTFPs are being managed intensively in the manner of natural regeneration.

Understanding the factors that influence people's choice of livelihood strategy is crucial to reinforce the positive aspects and mitigate the constraints and negative outcomes. It enables improving the livelihood outcomes in a manner that is responsive to the people's needs (DFID, 1999).

**Table 1.** Characteristics of NTFPs in household livelihood strategy

| 1. Integration into the cash economy | | 2. Contribution to household income | | 3. Management system of NTFPs | | | NTFPs in household livelihood strategy |
|---|---|---|---|---|---|---|---|
| <50% | >50% | <50% | >50% | Low | Moderate | Strong | |
| Sell <50% of amount of collected a NTFP | | Share <50% of HH income | | Collect from the Wild with low management | | | (S1) Subsistence strategy |
| Sell >50% of amount of collected a NTFP | | Share <50% of HH income | | Low management | | | (S2) Supplementary strategy |
| Sell >50% of amount of collected a NTFP | | Share <50% of HH income | | Moderate or Strong management | | | (S3) Diversified strategy |
| Sell >50% of amount of collected a NTFP | | Share >50% of HH income | | Strong management | | | (S4) Specialized strategy |

However, this study suspects that in the same forest landscape, some local people use available NTFPs for subsistence, while others have the opportunity to specialize in NTFPs that offer greater income. The level of reliance on NTFPs for supporting local livelihoods differs across households. Adam et al. (2013) claimed that NTFPs in household livelihood strategies are influenced by a variety of interrelated factors. Therefore, identifying the factors influencing the decision of local people to collect NTFPs in various livelihood strategies helps policy-makers design management systems which benefit both peoples' livelihoods and forest conservation.

In theories of allocation, people make all allocation decisions independently based on what they want, and what they want is revealed by the choices they make (Gowdy & Erickson, 2005). A household can have economic opportunities by improving quantity, quality or timing of collection of income generating resources through more intensive management (Belcher et al., 2005). Related studies have demonstrated that household production models explain the choice of livelihood strategy for natural resource extraction, including capital, labor, and land (Belcher et al., 2005; Lopez, 2011; López-Feldman & Taylor, 2006; Schaafsma et al., 2014). Some studies found that household characteristics determine the decision on how much local people collect NTFPs. For example, nativity to the area and age of the household head were found to be factors that influenced to the extraction of NTFPs (Kar & Jacobson, 2012; Melaku et al., 2014). Schaafsma et al. (2014) also found that higher education of the household head is likely to correlate with increased extraction of NTFPs, because the household head has alternative livelihood activities.

Another study identified that community participation also strongly influences NTFP management and trading options. Some community members received technical training from government and development agencies, and they were found to be more likely to collect larger amounts of NTFPs to improve their income (Melaku et al., 2014). According to a comparative study which focused on the macro level, livelihood strategy choice may also be influenced by market accessibility. A studied by Belcher et al. (2015) found that where forest resources are available, people use them to meet subsistence needs, and where market conditions permit, they will trade forest resources to generate cash income. However, this study hypothesized that the ability to pursue different livelihood strategies depends on factors such as the possession of household production inputs, community participation, household characteristics, and geographic

conditions.

The determinants of the different livelihood strategies were analyzed using binary logistic regression and multinomial logistic regression. The binary logistic model was applied to assess the relation between two livelihood strategies. In practice, we found five NTFPs, which the sample showed households to have two choices of livelihood strategies. Those NTFPs were liquid resin, solid resin, bamboo poles, bamboo shoots, and prich leaves. Equation (1) describes the empirical results of the binary logistic analysis. The results were interpreted in terms of level of significance and the level of coefficient and odd-ratio. Since wild honey was the only NTFP for which sampled households had three choices of livelihood strategies, multinomial logistic regression was applied as this model can predict more than two outcomes from response variables, as shown in equation (2). The sampled households had only one choice of livelihood strategy for fuelwood and orchid flower, so both NTFPs were not included in the statistical analysis.

For reliability prediction analysis, the following diagnostic procedures were undertaken. First, Chi-square test and One-Way ANOVA test were used with all concerned explanatory variables **(Appendix 1)**. Only significant variables from this analysis were included in the final model **(Appendix 2)**. Second, a multicollinearity test was used to avoid the problem of high correlation among the predicted variables. The results from tolerance & VIF (variance inflation factor) can illuminate problems in case they occur. Third, Omnibus tests of model coefficients were used to check whether the predicted variables fit or not. They test whether the explained variance in a set of data is significantly greater than the unexplained variance. Fourth, Hosmer-Lemeshow test was used to check how well the model predicts the outcomes. Finally, a classification table was employed to see how good the model was at predicting the actual outcomes. As such, the percentage of correct value must be greater than the null hypothesis.

For reliability prediction analysis in multinomial logistic regression, the final model checked whether the P-value is significant or not.

$$Binary\ logit(Y_i = 1/0) = \alpha + \sum_{j=1}^{n} \beta_j I_j + \sum_{j=1}^{n} \beta_j S_j + \sum_{j=1}^{n} \beta_j H_j + \sum_{j=1}^{n} \beta_j X_j + \varepsilon_j \quad (1)$$

Where Yi is outcome of binary choices of household economic strategy

$$Multinomial\ logit(Y_k) = \alpha + \sum_{j=1}^{n} \beta_j I_j + \sum_{j=1}^{n} \beta_j S_j + \sum_{j=1}^{n} \beta_j H_j + \sum_{j=1}^{n} \beta_j X_j + \varepsilon_j \quad (2)$$

Where Yk is outcome of probability of category of household economic strategy

Explanatory Variables:

I: Household production factors (household labor, land ownership, and capital)

S: Community support (membership, received market information, and technical training received)

H: Household characteristics

X: Geographic conditions

ε: The error term

β: The function of coefficient

The strength of fit in both Pearson and Deviance were tested. Pseudo R-Square values, which explain the proportional value of total variance were also estimated. The likelihood ratio tests were also checked through Chi-Square analysis.

## 3. Results and discussion

### 3.1 Household Strategies for NTFPs Management

It is generally understood that many NTFPs are just minor by-products contributing little to the

economy or household income. There has been some speculation that commercially traded NTFPs play a crucial role as primary income sources for households living in protected areas. The results of this study indicate that the integration into the cash economy from trade of NTFPs varies across products. Solid resin, orchid flower, liquid resin, and wild honey are the NTFPs with the highest proportion of commercialization: 100%, 100%, 99%, and 98%, respectively. The sampled households collected these NTFPs primarily for selling to the local markets and middlemen based on the availability of transportation. Most of the local people prefer not to travel far distances, so they were happy to sell NTFPs through middlemen. Additionally, prich leaves, bamboo shoots, and bamboo poles were sold to the market in small amounts for supplementary sources of cash income.

Furthermore, fuelwood is only the product, which was not found to be sold in this study. Regarding the contribution level of NTFPs to household income, liquid resin, wild honey, fuelwood, solid resin, bamboo poles, orchid flowers, prich leaves, and bamboo shoot made up about 26%, 24%, 15%, 11%, 7%, 5%, 4%, and 2%, respectively. Bamboo poles, orchid flowers and prich leaves were mostly collected on a small scale seasonally. Therefore, their contribution to household income was less. Regarding, the issue of management systems, the extraction of NTFPs entails a direct and indirect impact on the forest ecosystem. The level of management system is associated with the ecological cost because it represents the level of human disturbance to specific species as well as to forest biodiversity.

This study found three levels of the management system of NTFPs such as wild collection, intermediate intensive management, and intensive management. In most cases, fuelwood, prich leaves, orchid flowers, bamboo shoots, bamboo poles, and solid resin were gathered extensively with little management. Furthermore, since harvesting wild honey remains a predominantly opportunistic activity, the management system of NTFPs varies across wild collection to wild intensive management. As an extreme case, liquid resin in PPWS is regularly harvested with intense management. Local people who own liquid resin trees collect their products regularly, taping the trees every three to four days. Local people use a combination of indigenous techniques and new methods introduced by local NGOs.

Using the integration of income from NTFPs into the cash economy, the share of income from NTFPs of household income, and the management systems of NTFPs, four distinct household livelihood strategies can be identified. The sampled households consumed fuelwood, bamboo shoots, bamboo poles, and prich leaves as a 'subsistence strategy', as shown in **Fig. 1**. All sampled households consumed fuelwood as a subsistence strategy, serving for energy consumption. 91% of the sampled households consumed bamboo shoots and 86% consumed prich leaves as a subsistence strategy. Rural households collected bamboo shoots and prich leaves for food consumption. Nevertheless, the remaining 9% of the sampled households traded bamboo shoots and 14 % traded prich leaves as a 'supplementary strategy', which is more oriented towards earning cash income. 90.50% of the sampled households harvested bamboo poles as a subsistence strategy, but the remaining 9.50% harvested them as a diversified strategy. Bamboo poles are mostly used for construction, but a few households traded to the local markets for cash earning by investing some input in management.

Orchid flowers and solid resin were largely used as part of a 'supplementary strategy', resulting in additional financial security. All amounts collected of orchid flowers and solid resin were completely sold to middlemen and local markets for earning cash income. Both of the NTFPs were extracted in a supplementary strategy because they were more oriented toward earning cash income on a small scale, but their contributions to household income were still low. NTFPs in this supplementary strategy were collected from the wild without any management. As **Fig. 2** shows, all of the sampled households traded orchid flowers as a supplementary strategy. Notably, 76.50% of the sampled households traded solid resin as a supplementary strategy, but the remaining 23.50% traded it as a as a diversified strategy. Since communities received some technical training on collection techniques of solid

resin, some sampled households have started to manage solid resin for better production as well as for a better price at the market.

Liquid resin and wild honey were commonly traded and managed as part of a diversified strategy. The diversified strategy and supplementary strategy are distinguished from one another by whether or not NTFPs are moderately managed or collected from the wild. Fig. 2 shows that 94% and 73% of the sampled households traded and managed liquid resin as a diversified strategy and 73% did so with wild honey. However, 5.6% of households traded liquid resin and 8% traded wild honey as a specialized strategy. Few households tend to rely on both NTFPs as main sources of cash income. They invested their labor and time more intensively to harvest liquid resin and wild honey regularly with higher productivity and quality. The management level of both products was strong, yet they did not reach the levels of cultivation of monoculture. Local people still used indigenous knowledge and management techniques from NGOs (World Wild Fund for Nature, Mondulkiri Forest Venture, and Wildlife Conservation Society). However, the specialized strategy allows for accumulation of financial capital by households, but there are some constraints on resource access and some risk of overexploitation.

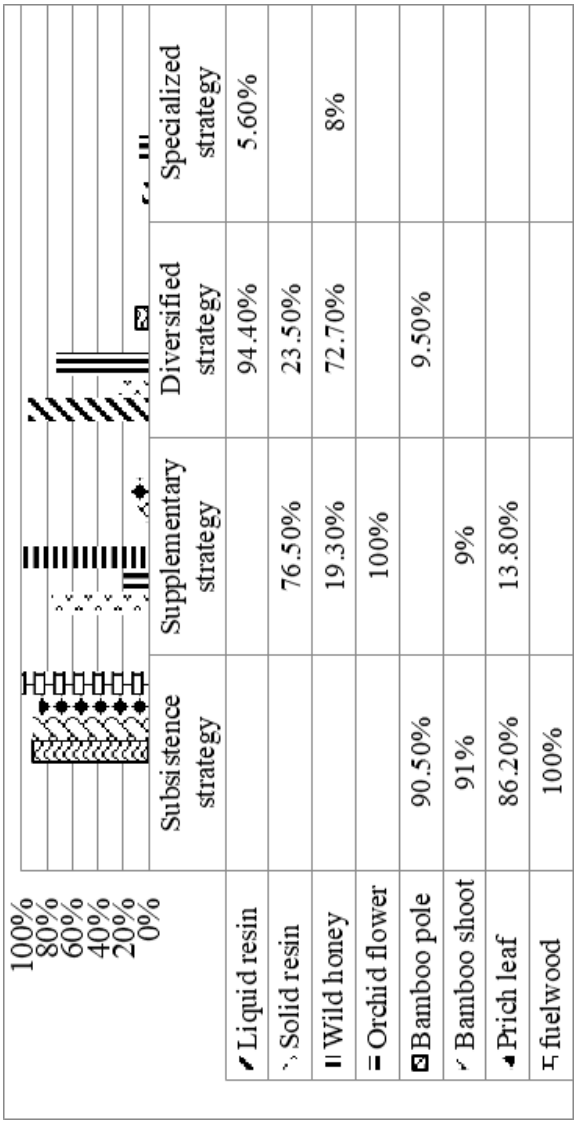


Fig. 2. Household Strategies for NTFP Management at PPWS

## 3.2 Factors Influencing the Decision on Household Strategy for NTFP Management

This section analyses the factors that influence the choice of household livelihood strategy. Some households collected NTFPs for subsistence purposes only, while others attempted to increase cash income through trading. Some households even managed NTFPs intensively, increasing production to meet the demand of the market. Thus, this study examines why in the same protected area with the same NTFPs, the households have different livelihood strategies.

Of all explanatory variables hypothesized, some variables were excluded from the final model because the results from Chi-square test and One-Way ANOVA showed no significant variation from one group to another (Appendix 2). Table 2 indicates that the sampled households extracted bamboo shoots as part of two household livelihood strategies, subsistence strategy (S1) and supplementary strategy (S2). The fitted model correctly predicted 93% of the observed values. There was no multicollinearity problem that occurred with the predicted variables. Omnibus test and Hosmer and Lemeshow test were also fitted (see note "a"). The result of binary logistic shows that distance to market had a negative and statistically significant ($p$<0.001) influence on the decision to extract NTFPs as part of a supplementary strategy rather than subsistence strategy.

Prich leaves were used and managed as part of two household livelihood strategies, subsistence strategy (S1) and supplementary strategy (S2). Of the 13 variables, age of household head, number of occupations per household, and distance to market were found to be significantly different between the two strategies. The fitted model correctly predicted 90% of the observed values. There was

**Table 2.** Determinant factors influencing household decisions on livelihood strategy for extraction of bamboo shoots, prich leaves, bamboo poles, solid resin, and liquid resin.

| Variables | | Bamboo shoots (S1-S2)[a] | | Prich Leaves (S1-S2)[b] | | Bamboo poles (S1-S3)[c] | | Solid resin (S2-S3)[d] | | Liquid resin (S3-S4)[e] | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | B | Exp(B) | B | Exp(B) | B | Exp(B) | B | Exp(B) | B | Exp(B) |
| Household production factors | HH labor | | | | | | | | | | |
| | HH land owner | | | | | .243 | 1.275 | | | -.441 | .643 |
| | HH capital (motor) | | | | | | | | | | |
| Community participation | Member of CPA | | | | | -.914 | .401 | -.370 | .691 | .417 | 1.518 |
| | Received NTFP market information | | | | | -2.160 | .115 | | | | |
| | Received technical training | | | | | 1.266 | 3.547 | | | .760 | 2.138 |
| Household characteristics | Living period in current location | | | | | -.069 | .934 | | | | |
| | Age of household head | | | -.039* | .962 | .046 | 1.047 | | | | |
| | Occupations/ HH | | | -.568** | .566 | | | | | | |
| | Ability to read | | | | | | | | | | |
| | Number of NTFPs collected/HH | | | | | | | .636*** | 1.889 | -.900** | .406 |
| Geographic conditions | Distance to NTFPs (km) | | | | | | | .024 | 1.024 | .109 | 1.115 |
| | Distance to market (km) | -1.111*** | .329 | -.532** | .587 | -1.288*** | .276 | -.225*** | .798 | | |

Source: Author's structured interviews (2016).

*Note: a Omnibus tests of model coefficient=0.000***; Hosmer and Lemeshow test=.310; Correctly predicted percent=93%*

***b** Omnibus tests of model coefficient=0.000***; Hosmer and Lemeshow test=.011; Correctly predicted percent=90%*

***c** Omnibus tests of model coefficient=0.000***; Hosmer and Lemeshow test=.771; Correctly predicted percent=96.2%*

***d** Omnibus tests of model coefficient=0.000***; Hosmer and Lemeshow test=.878; Correctly predicted percent=77.8%*

***e** Omnibus tests of model coefficient=0.006***; Hosmer and Lemeshow test=.001; Correctly predicted percent=94.4%*

no multicollinearity problem that occurred in the predicted variables. Omnibus test was also fitted, sees in the note "b". The result shows that age of household head, number of occupations per household, and distance to market, significantly and negatively influence the selection of supplementary strategy (S2) rather than subsistence strategy (S1). Bamboo poles were mostly harvested as part of a subsistence strategy, but a few households decided to manage this product moderately as part of a diversified strategy. After Chi-square test and One-Way ANOVA test were conducted, seven variables were included in the final model: household land ownership, membership in a CPA, receiving NTFP market information, receiving technical training,

time living in the current location, age of the household head, and distance to the market. The fitted model correctly predicted 97.5% of the observed values. There was no multicollinearity problem that occurred among the predicted variables. The Omnibus test was significant for the coefficient-fit of predicted variables (see in the note "c"). The result from the model shows that market access significantly and negatively influences the collection of bamboo poles as a part of a diversified strategy (S3) rather than a subsistence strategy (S1).

Solid resin was collected towards cash income, but some sampled households decided to manage it moderately as part of a diversified strategy (S3) while in many of sampled households it remained as part of a supplementary strategy (S2). Four explanatory variables were included in the final model including: membership in a CPA, number of NTFPs collected per household, distance to collect NTFPs, and distance to market. The fitted model correctly predicted 77.8% of the observed values. There was no multicollinearity problem that occurred among the predicted variables. Omnibus test and Hosmer and Lemeshow test were also conducted (see note 'd'). **Table 3** shows the result that distance to market significantly and negatively influenced the choice of diversified strategy (S3) rather than supplementary strategy (S2). Number of NTFPs collected per household significantly and positively influenced to the preference of a diversified strategy (S3) relative to a supplementary strategy (S2).

Liquid resin was commonly traded and managed as part of a diversified strategy (S3), but a few sampled households decided to manage it intensively as part of a specialized strategy (S4) in order to increase production. Five explanatory variables were included in the final model such as household land ownership, membership in a CPA, receiving technical training, number of NTFPs collected per household, and distance to collect NTFPs. The fitted model correctly predicted 94.4% of the observed values. There was no multicollinearity problem that occurred among the predicted variables. An omnibus test was also conducted (see the note 'e'). **Table 3** shows the result that the numbers of NTFPs collected per household significantly and negatively influences the choice of S4 rather than S3.

**Table 3.** Determinant factors influencing household decisions on livelihood strategies from extraction of wild honey

| Wild honey in HH livelihood strategy | | B | Std. Error | Wald | df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|---|
| Supplementary strategy | Intercept | -3.004 | 1.375 | 4.776 | 1 | .029 | |
| | HH capital (motor) | 1.382** | .632 | 4.772 | 1 | .029 | 3.981 |
| | [Cannot read =0] | 3.257** | 1.274 | 6.531 | 1 | .011 | 25.967 |
| | [Can read =1] | 0[b] | . | . | 0 | . | . |
| Diversified strategy | Intercept | 1.308 | .920 | 2.020 | 1 | .155 | |
| | HH capital (motor) | .132 | .549 | .058 | 1 | .810 | 1.141 |
| | [Cannot read =0] | 2.126* | 1.112 | 3.652 | 1 | .056 | 8.381 |
| | [Can read =1] | 0[b] | . | . | 0 | . | . |
| a. The reference category is: Specialized strategy | | | | | | | |

Source: Author's structured interviews (2016).
Note: Number of Observations (n=88), Final model (P=0.001), Goodness of fit: Pearson, (P=0.942), Deviance (P=.893), Pseudo R-Square = 0.259.

Linking NTFPs to household livelihood strategies allows us to consider the roles of NTFPs for improving livelihoods within the sampled households. This study suggests four household livelihood strategies, considering the reality from the field survey in Phnom Prich Wildlife Sanctuary, Cambodia. Each livelihood strategy was identified according to three characteristics such as (1) integration into the cash economy, (2) contribution to household income, and (3) management system of NTFPs. Data was obtained from structured questionnaire interviews. The identified livelihood strategies are subsistence strategy, supplementary strategy, diversified strategy, and specialized strategy. However, different livelihood strategies may play different roles in terms of livelihood gains and ecological costs.

## 3.3 Roles of NTFPs for livelihoods

Looking at the four livelihood strategies allows an understanding of four important patterns of NTFPs in relation to livelihoods through contribution to cash income and household income. A first important pattern is to survive as usual. **Fig. 2** illustrates that most of the sampled households used fuelwood, prich leaves, bamboo shoots, and bamboo poles as part of a subsistence strategy. Those NTFPs contributed less than 50% of the total cash income, while their contribution to the household income was also little. This finding reflects that NTFPs collected from the wild serve local people in relation to basic needs for survival through food security, energy, and construction materials. Such subsistence use of NTFPs allows households to save their meager cash income for goods and services that cannot be obtained locally. Therefore, NTFPs undoubtedly contribute to the livelihood security and welfare of the rural people. Nevertheless, in a subsistence economy, most of the economic value of NTFPs is hidden when households consumed them without any transaction in the market (Angelsen & Wunder, 2003; J.E. Michael Arnold & Pe´rez, 2001; Ruiz-Pérez et al., 2004). Since many of the non-commercial NTFPs were not recorded in the national economy, the government or the public has not recognized their value (Beer & McDermott, 1996). In fact, NTFPs have significant economic value by preventing the need for cash expenditure and readily providing sources of energy and construction materials. As Shackleton et al. (2011) and (IIED, 1995) contend, it is reasonable to collect NTFPs from the forests to serve their needs rather than going to town to purchase them.

The second important pattern is income generation as usual. **Fig 3** shows that solid resin and orchid flowers were traded as part of a supplementary strategy. A small proportion of households collected wild honey, bamboo shoots, and prich leaves as part of a supplementary strategy to earn cash income as well **(Fig. 3)**. Households using this strategy are more oriented towards the cash economy, although they gathered NTFPs from the wild. Even though these NTFPs were integrated into the cash economy at a rate of more than 50%, a large portion of household income was derived from farm and non-farm sources other than NTFPs. The cash income from NTFPs for those following this strategy is very important for the rural households to cover expenses for basic needs (Cavendish, 2002; Godoy, Lubowski, & Markandya, 1993). The households seek ways of trading NTFPs to supplement other sources of income and stabilize or 'smooth out' their earnings throughout the year. Shackleton et al. (2011) mentioned "income smoothing" as a benefit of NTFPs which contribute to reducing livelihood risks because the cash income from NTFPs can complement a range of other livelihood activities.

Third, NTFPs are important for livelihood diversification. **Fig. 3** shows that the sampled households used and managed liquid resin and wild honey as part of a diversified strategy. Some of the sampled households harvested bamboo poles as part of a diversified strategy instead of a subsistence strategy **(Fig. 3)**. NTFPs collectors with this strategy tend to use more intensive labor and techniques to extract NTFPs in order to earn the majority of their cash income. This diversification strategy also allows households to balance seasonal labor requirements (Belcher et al., 2005). For instance, household labor was intensively used in farming activities during the rainy season, and they actively managed liquid resin, wild honey, and bamboo poles for trade during the dry season. When this livelihood diversification was undertaken, it secured the use of NTFPs as a way to accumulate 'savings' or provide 'insurance' for emergency spending, especially during difficult times (Adam et al., 2013; Ruiz-Pérez et al., 2004; Stack et al., 2003).

Fourth, NTFPs serve as a regular primary source of income. Figure 3 shows that few of the sampled households tend to manage NTFPs intensively. Only liquid resin and wild honey have been harvested as part of a specialized strategy. The sampled households undertaking this strategy traded liquid resin and wild honey as their primary source of income, resulting in high levels of specialization. The households used their labor and time more intensively to regularly collect specific NTFPs. Those households have managed NTFPs to get higher income. There is usually stability in the NTFP markets, so household incomes can be secured. Even households that expect to get a higher income from NTFPs, must understand that

those products are gathered from the natural systems which obligate adherence to customary rules and regeneration processes of the target species. In such cases, the high level of management of NTFPs pays off in increased production of relatively high-value products. There is a niche opportunity for high reward products (Belcher et al., 2005). However, Shackleton et al. (2011) highlighted the concern that if more households find themselves in this specialized strategy, then the danger exists that NTFPs will be exhausted after a few years, or the trade may be captured by elites rather than local communities.

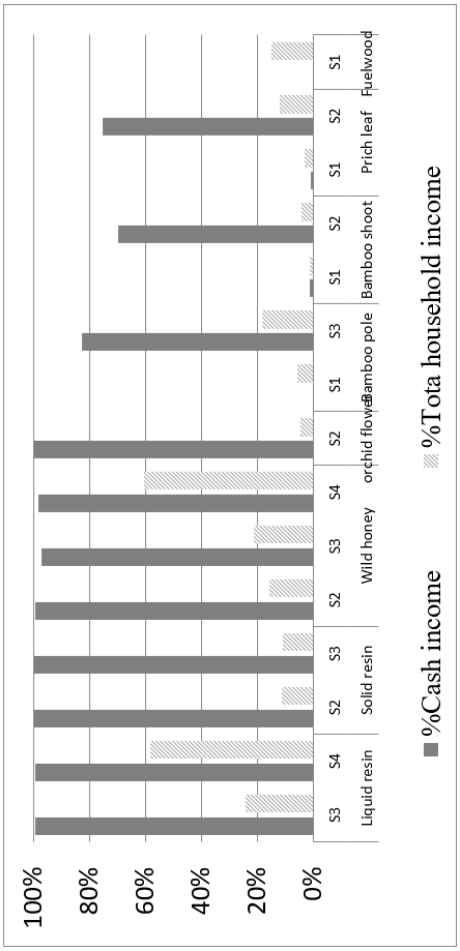


**Fig. 3.** Role of NTFPs in supporting livelihoods

Note: S1=Subsistence strategy; S2=Supplementary strategy; S3=Diversified strategy; S4=Specialized strategy.

## 3.4 Ecological costs from management systems of NTFPs

Management systems reflect key strategic decisions by NTFP collectors. The concept of management systems has gained support because it can illustrate the potential range of land-use options, as well as some of the trade-offs involved when resource use is intensified (Anderson, 1992). The collection of NTFPs has often been considered to have less impact on biodiversity than timber extraction or agriculture, but the impact depends on the management systems that is practiced (Belcher et al., 2005). The livelihood gains from NTFPs result in ecological costs, ranging from small transformations of the forest structure to changes in the population dynamics and demography of harvested species and the entire ecosystem (Shaanker et al., 2004). Wild collection systems are the traditional extraction systems in the areas with low population densities, poor access to markets, credit, and other facilities (Anderson, 1992). This is a non-intensive system, which this study categorizes as a minimally managed system (S). Such system can have a low impact on the ecology at the local and landscape scale (Belcher et al., 2005). The second management system discussed in this paper is an extensive system, which this study categorizes as a moderately managed system (S). An extensive system is a form of management that can produce rapid and substantial returns. This system involves selective thinning to promote the regeneration and growth of target species. The third management system examined in this study is an intermediately intensive system, which this study characterizes as a highly managed system (S). This system falls between extensive management and intensive management. This study did not find any cases in which NTFPs are deliberately planted as seeds or seedlings. Instead, local people invest their labor intensively in conventional management practices such as weeding or crown opening. Therefore, this study used the terminology suggested by Belcher et al. (2005) and characterizes them as intermediately intensive systems. This study examines the ecological costs from the choices of these three management systems according to the livelihood strategies.

NTFPs, which are harvested as part of subsistence and supplementary strategies, are gathered from the wild without any management or with minimal management. **Fig. 4** shows that in most cases, the sampled households did not manage fuelwood, prich leaves, orchid flowers, bamboo shoots, bamboo poles, and solid resin. According to findings of fieldwork carried out, the local people collected those NTFPs from the wild in a way which resulted in low impact on the forest structure. This 'wild collection' is entails the traditional forest extraction practices of the Bunong people that have been living in the area of

the Phnom Prich Wildlife Sanctuary for centuries. On the other hand, the NTFPs were collected in the areas with low population density and poor access to markets. Local people used their minimal levels of labor and financial inputs to collect these NTFPs. Due to highly extensive extraction, these NTFPs were reported to show neither significant decline in resources nor critical impact on ecology and biodiversity. This study supports the claim that NTFPs gathered from the wild result in little transformation of the forest structure (Belcher et al., 2005). As a result, the regeneration of those species and their ecosystems, particularly forest structure, can be maintained (Neumann & Hirsch, 2000; Mirjam A.F Ros-Tonen & Wiersum, 2005).

An extensive system or moderately managed system was used in the harvesting of bamboo poles, wild honey, solid resin, and liquid resin. **Fig. 4** shows that these NTFPs are collected in the forest with little transformation of the forest structure. According to key informant interviews, the local people use indigenous knowledge together with customary rules to manage resources of solid resin, wild honey, bamboo poles, and liquid resin. The collection methods mostly take into account the regeneration process, allowing for multiple uses of forest resources and substantially maintaining biodiversity. Mondulkiri Forest Vulture, World Wildlife Fund for Nature-Cambodia, Wildlife Conservative Society-Cambodia provided training to most of the community protected areas (CPAs) including Nglaoka, Chi Klab, and Poutong-Pouhoung, on collection techniques for collection of liquid resin, wild honey, and bamboo poles, to improve production and quality. After having received training and support, some households decided to manage NTFPs in order to earn higher returns. In addition, wild honey is a high-value product, and the intensity of collection and management varies from low to high levels. The impact on ecology and forest structure was low and wild honey was reported to have a slightly declining resource base, according to the key informants interviewed. Thus, this study supports Belcher et al. (2005) and Shaanker et al. (2004) who contend that when forest structure slightly transformed through an extensive management system, the target NTFPs can still be regenerated naturally together with relatively high biodiversity.

The intermediately intensive system is the most intensive form of management strategy currently practiced in Phnom Prich Wildlife Sanctuary. **Fig. 3** shows that only high-value NTFPs including liquid resin and wild honey were found to be intensively managed. The community protected areas and commune councils control the resin tapping techniques to prevent forest fires and illegal logging. In addition, owners of liquid resin trees took some action such as weeding to encourage the growth of preferred species and prevent forest fires, which partially transformed forest structure at the local level. This management practice did not impact the biodiversity at the landscape level, according to interviewed with WWF officers. The intermediately intensive system on liquid resin and wild honey lead to high production and returns, and this system did not critically impact the forest structure. As Belcher et al. (2005) claimed, even if the NTFPs are traded in larger markets as part of a specialized strategy, there is still a good possibility for high rewards with such products if they are cultivated by being collected from the wild. In contrast, if this system continues to be practiced by larger populations, it may lead to erosion of biodiversity as forest structures are transformed (Anderson, 1992; Shaanker et al., 2004).

It is clear that the low intensity of collection/management of NTFPs from a natural forest can occur without a significant impact on forest biodiversity at a landscape scale, and even at the species scale. The consequences of this wild collection system are low yield and returns, which makes them constantly threatened with substitution by more intensive systems (Anderson, 1992). By maintaining the native forest through extensive management systems, labor requirements are minimized, but by manipulating forest structure and composition through indigenous knowledge, yields of economic species are greater than in a wild collection system (Anderson, 1992). If the intensity of collection and management increase, the negative outcomes on the ecosystem are more likely to occur. However, in the current situation in Phnom Prich wildlife sanctuary, an intermediate intensive system is a promising management option because it provides the better economic outcomes than the other two

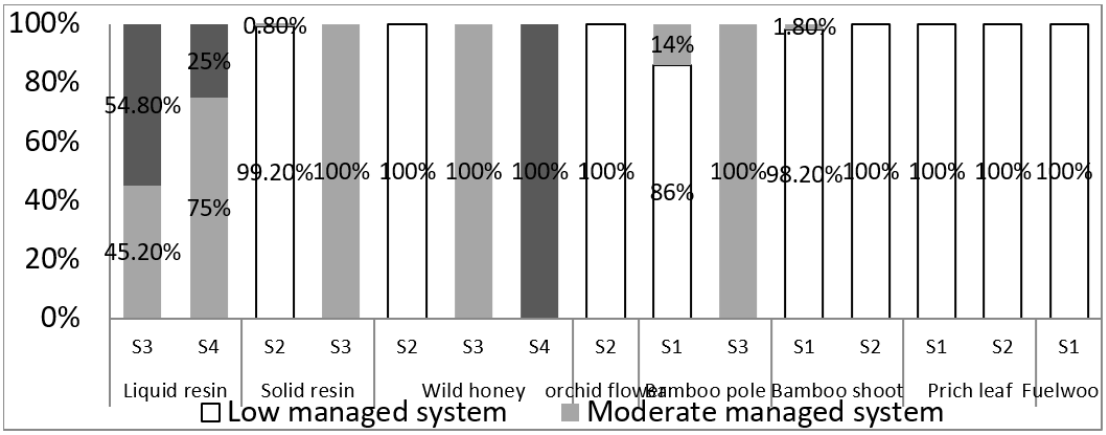


**Fig. 4.** The impact of management systems of NTFPs categorized by livelihood strategy

Note: S1=Subsistence strategy; S2=Supplementary strategy; S3=Diversified strategy; S4=Specialized strategy

systems while the biodiversity impact remains low. For forest management in the long-term, if NTFPs extraction can be managed sustainably, the forest structure continue to provide ecosystem benefits such as carbon storage, nutrient cycling, erosion control, and watershed protection (J.E. Michael Arnold & Pérez, 2001; Myers, 1988).

### 3.5 Factors influencing household decisions on the use of NTFPs in household livelihood strategy

Theoretically, all NTFPs can be harvested and traded for increasing cash income, but it is not true in practice because each NTFP has different functions in the economy and the ecosystem. In reality, even for the same NTFP, local people applied different livelihood strategies according to different determining factors.

Geographic conditions, specifically the distance from the place of residence to the market, strongly determined the choice of rural households to manage and trade NTFPs for greater economic benefits. Analyzed results show that distance from residence to the market place strongly and negatively affected the choice of livelihood strategies related to bamboo shoots, bamboo poles, prich leaves, and solid resin. Sampled households living far from the market places were less likely to choose livelihood strategies which are more oriented towards the cash economy. For instance, sampled households were less likely to collect bamboo shoots and prich leaves as part of a supplementary strategy rather than subsistence strategy when their houses were located further from the marketplace. Similarly, sampled households living far from the market place were less likely to manage bamboo poles and solid resin as part of a diversified strategy instead of a subsistence strategy and supplementary strategy, respectively. It reflects that where the market is sufficiently attractive, NTFPs will be sufficiently valuable, and people are more likely to invest in managing NTFPs in order to increase income from NTFPs (Belcher et al., 2005). Moreover, negative effects of distance to the marketplace on the strategy for managing NTFPs were expected because the cost of transportation increases as the distance to the marketplace increases (Belcher et al., 2015). Direct observation revealed that households in Phnom Prich Wildlife Sanctuary lack organization and cooperation for trading NTFPs. Most of them are living in remote areas, so they were not willing to take the risk of transporting their goods to the market with uncertain demand and prices. It can be argued that, local people are still relying on NTFPs for subsistence, unless they can access markets with low cost and low risk. The enhancement of information on potential markets and marketing channels may provide incentives to local people to boost incomes through more intensive commercial extraction of NTFPs. Otherwise, traditional NTFP-extraction based livelihoods will tend to be supplemented by alternative forms of employment.

Household capital significantly and positively influenced the choice of collection of wild honey as part of a supplementary strategy

rather than a specialized strategy. This finding goes against predicted outcomes of the theory of random utility maximization (Lopez, 2011; López-Feldman & Taylor, 2006). According to the theory, maximizing yields through the choice of strategy is a function of household production inputs including capital, labor, and land. This theory is recognized as the appropriate model especially in the agricultural sector and in NTFPs management systems (Tesfaye et al., 2011). However, against this, in this particular study, the sampled households who owned a motorbike (a form of capital) were less likely to invest more in management of wild honey as a specialized strategy. This is due to the fact that most of wild honey collectors preferred a traditional collection system even though they owned a motorbike which enabled them to travel further. The households who could not afford a motorbike, decided to manage wild honey extensively in the forest nearby because they were unable to travel longer distances. Likewise, household capital is still believed to be the primary investment input for intensive management. Further investigation should be done with another proxy, especially household savings.

The number of NTFPs collected per household is significantly and positively associated with the choice of collecting NTFPs as part of a diversified strategy rather than a supplementary strategy. This is due to the fact that most solid resin collectors tend to collect multiple NTFPs to supplement income and smooth out their earning throughout the year. Since local people cannot increase the supplies of solid resin, they need to extract other NTFPs to meet their livelihood needs. On the other hand, rural households will concentrate their management efforts on collecting fewer NTFPs, focusing on those that have relatively large markets and high value (Belcher et al., 2005). For instance, the number of NTFPs collected per household is significantly and negatively associated with the choice of collecting liquid resin as part of a specialized strategy when compared with a diversified strategy. This clearly illustrates that local people who already own liquid resin trees spent more time focused on this product rather than diversifying to collect numerous NTFPs. However, not all NTFPs can be intensively managed to yield a higher value and greater benefits to local people. To specialize in the collection of NTFPs with high returns, rural household are required to select only a few products so as to improve production in order to meet market demand.

For wild honey collection, the ability to read is strongly significantly and positively related to choosing a specialized management strategy rather than a supplementary management strategy or diversified management strategy. It reflects the fact that rural heads of household that can read tend to invest more in intermediate intensive management to scale up their production and returns. They were able to read marketing information and techniques for wild honey collection and processing. Escobal and Aldana (2003) claimed that education (measured as number of years of schooling) increases the investment in intensive management for sustainable income-generating activities including NTFP extraction. On other hand, interventions aimed at increasing the number of school years for members of rural households are costly and time consuming. The results support the conclusion that improving reading ability is the more effective way to improve NTFP management techniques for rural households in remote areas.

Age of household head was found to negatively and significantly affect the choice of collection of NTFPs as part of a supplementary strategy rather than a subsistence strategy. For instance, the higher the age of the household head was linked to collecting prich leaves for subsistence use only. Older heads of household suffered were unable to climb bigger trees to collect the leaves. Even when older heads of household had longer experience collecting prich leaves, their physical capacity was a primary impediment. This agrees with findings of Melaku et al. (2014) who claimed that the younger people are more likely to participate in NTFP collection because their physical health is sufficient to collect higher levels of NTFPs.

The average number of occupations per household was found to be significantly and negatively correlated with the choice to collect NTFPs as part of a supplementary strategy rather than a subsistence strategy. As Lopez (2011)

claimed, people will concentrate on NTFP collection when they lack alternative livelihoods. Extraction of NTFP as part of a subsistence strategy can more easily be substituted by other employment activities when local people have more livelihood choices. Therefore, the collection of NTFPs as part of a subsistence strategy continues for those who have minimal labor or financial inputs because it is crucial for their survival.

In this regard, the choice of collecting of NTFPs, in accordance with different livelihood strategies, depends on geographic features, household characteristics, and household production factors. The results reveal that such decisions on collecting NTFPs as part of a livelihood strategy ultimately result in economic outcomes. This evidence is relevant for decision makers and relevant development agencies for making more effective interventions aimed at improving both economic and environmental objectives.

## 4. Conclusion

The four different household livelihood strategies of NTFPs can be considered as part of a dynamic process of economic outcomes, through which local people first seek to survive, then to get a safety-net, and finally to earn a high cash income. This exploratory analysis emphasizes the approach for classification of NTFPs based on household livelihood strategies. In this regard, we are able to understand the level of use and the degree of management activities undertaken to achieve economic and environmental objectives from harvesting NTFPs. The different NTFPs in household livelihood strategies entail different roles and indicate the need for different kinds of intervention in order to improve rural livelihoods and to maintain forest ecology.

This study reveals a variety of aims for rural households, ranging from securing necessary subsistence to contributing cash income and total income to household livelihoods. Thus, it is not accurate to make the general claim that NTFPs often do not successfully improve livelihoods. NTFP collection as part of a subsistence strategy may limit the NTFP yields and related income for rural households, but it has a low impact on forest ecology. In this study, fuelwood, bamboo shoots, bamboo poles, and prich leaves were mostly consumed as part of a subsistence strategy. These NTFPs serve households for food supply, construction, and energy. Unfortunately, in remote areas, with the threat of economic land concessions, logging, and forest encroachment there is a tendency for resource degradation. So, this subsistence strategy is constantly faced with pressure for substitution by other forms of employment. Some households collected NTFPs as part of supplementary strategy because they could earn extra cash income to support household expenditures. Orchid flowers and solid resin were mostly traded to supplement cash income of the sampled households in PPWS. For NTFPs with larger markets, the diversified strategy and specialized strategy are good options to have higher cash incomes. For instance, wild honey and liquid resin have a high potential for strategies oriented towards cash income . There are also niche opportunities to get higher economic returns when rural households have managed NTFPs to get higher income. Also, the extensive management and intermediate intensive management of wild honey and liquid resin NTFPs did not significantly negatively impact forest ecology. Therefore, the research supports the conclusion that the collection NTFPs as part of a subsistence strategy is not viable over the long-term. While low-level management systems assure environmental conservation, they fail to meet the basic economic needs of current rural households and their future descendants. On the basis of economic, environment, and political reasons, management systems of NTFPs must necessarily intensify.

This study argues that the ability of households to pursue the more remunerative livelihood strategies have faced many constraints that limited their choices. Geographic constraint limit opportunities for increasing income through trade of NTFPs. Households living far from the markets faced difficulties in accessing the markets

because of high travel costs and unstable demand. This constraint can be overcome by building organizational capacity through assisting NTFP collectors and traders to better organize. That would enable them to negotiate with different stakeholders regarding their needs, such as communicating with itinerant traders for purchasing NTFPs at farms and negotiating prices. This organizational management may require a coordinator such as international NGOs or academic institution to facilitate or to lobby on behalf of local people since they lack sufficient knowledge and skills. Also, improving market information access related to the demand and price of NTFPs is required for effective NTFP commercialization. When market information is sufficiently provided, collectors are more likely to manage NTFPs for the purpose of increasing cash income. Other constraints such as household capital, physical health, ability to read, alternative employment, and number of NTFPs collected, were related to household awareness and preferences. Therefore, providing rural households with capacity-building and increased awareness through technical training and assistance could foment skills for sustainable use of NTFPs and better entrepreneurial practices. Second, community involvement must be enhanced to manage NTFPs for sustainable use. Third, relevant ministries (the Ministry of Environment, the Ministry of Agriculture, Forestry, and Fisheries, and the Ministry of Commerce) and international organizations should consider providing more incentives, including providing fiscal incentives, such as price support for NTFPs that are collected from the wild with less disturbance to ecosystems services. These NTFPs are wild honey, liquid resin, and bamboo poles. As well, the RGC and IOs could promote commodities agreements between NTFP collectors and buyers. Technical assistance should be provided to local people to enhance the capacity of intensive management in producing commercial NTFPs, and encourage new species. However, to some extent NTFPs can contribute to household livelihoods with little ecological impact. Investments in NTFPs may be a good opportunity for income earnings for local people, and this process can be done with intensive NTFPs management and improving market access.

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## Declaration of competing interest

The author declare that he has no competing interests.

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# Appendix

**Appendix 1: Table A1.** Explanatory variables. Source: Author (2016).

| Explanatory variables | Assumptions | Expected sign | Sources |
|---|---|---|---|
| **Household production factors** | | | |
| HH labor | Households with more laborers are more likely to collect more NTFPs for cash income and household income | + | Lopez (2011); Schaafsma et al. (2014) |
| HH land owned | Households with large land are less likely to collect more NTFPs for their livelihoods | - | Lopez (2011) |
| HH capital | Households with more capital are more likely to collect more NTFPs to improve livelihoods (Motor as proxy) | + | |
| **Community participation** | | | |
| Member of CPA | Members of community protected area are more likely to collect more NTFPs to improve livelihoods | + | Melaku et al. (2014) |
| Received NTFP market information | Households that received marketing information on NTFPs from CPAs are more likely to collect NTFPs | + | |
| Received technical training | Households that received technical training from CPAs are more likely to collect NTFPs | + | |
| **Households' characteristics** | | | |
| Living period in the area | HH living in longer in area are more likely to collect more NTFPs | + | Kar and Jacobson (2012) |
| Gender of household head | Male household heads are more likely to choose a more intensive livelihood strategy | + | |
| Age of household head | The older the household head the more likely to collect more NTFPs due to his/her experience | + | |
| Number of Occupations | HH with more occupations are less likely to collect more NTFPs | - | Added by author |
| Education level | HH that have a higher level of education are less likely to collect more NTFPs because they have alternative livelihood supports | - | Schaafsma et al. (2014); Escobal and Aldana (2003) |
| Ability to read | HH that can read are more likely to increase production and returns from NTFPs | + | Added by author |
| Number of NTFPs collected/HH | HH collecting multiple NTFPs are less likely to invest more on a specific NTFP for increasing income | - | |
| **Geographic conditions** | | | |
| NTFP access (km) | HH willing to travel further distances are more likely to collect more NTFPs | + | Adam et al. (2013) |
| Market access (km) | HH with less distance from residence to the market are more likely to integrate NTFPs into cash income | - | Added by author |

**Appendix 2: Table A2.** Significant associations of explanatory variables of NTFP use in household economic strategies. Source: Author's structured interviews (2016).

| Variables | | Bamboo shoots (S1-S2) | Prich Leaves (S1-S2) | Bamboo poles (S1-S3) | Solid resin (S2-S3) | Wild honey (S2-S3-S4) | Liquid resin (S3-S4) |
|---|---|---|---|---|---|---|---|
| | | P-value | P-value | P-value | P-value | P-value | P-value |
| Household production factors | HH labor | .529 | .877 | .190 | .244 | .166 | .365 |
| | HH land owned | .992 | .890 | .001*** | .749 | .759 | .069* |
| | HH capital (moto) | .827 | .664 | .159 | .271 | .003*** | .611 |
| Community participation | Member of CPA | .961 | .447 | .035** | .045** | .543 | .059* |
| | Received NTFP market information | .389 | .902 | .001*** | .190 | .236 | .101 |
| | Received technical training | .806 | .286 | .057* | .576 | .513 | .063* |
| Household characteristics | Living period in current location | .508 | .742 | .035** | .776 | .360 | .861 |
| | Gender | .500 | .498 | .148 | .582 | .852 | .635 |
| | Age of household head | .192 | .025** | .089* | .991 | .327 | .820 |
| | Number of occupations of HH | .442 | .007*** | .784 | .956 | .772 | .292 |
| | Education level | .314 | .304 | .887 | .451 | .109 | .669 |
| | Ability to read | .303 | .783 | .369 | .655 | .039** | .467 |
| | Number of NTFPs collected HH | .134 | .536 | .935 | .000*** | .437 | .005*** |
| Geographic conditions | Distance to collect NTFP (km) | .447 | .560 | .312 | .097* | .914 | .056* |
| | Distance to the market place (km) | .000*** | .000*** | .000*** | .002*** | .273 | .443 |