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ORIGINAL PAPER

Quantitative and financial evaluation of non-timber forest products (case study: Zemkan basin forests, West of Iran)

Sohrab Moradi[1,2] · Soleiman Mohammadi Limaei[3] · Peter Lohmander[4] · Mehrdad Khanmohammadi[5]

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Abstract Although Zagros forests in western Iran lack industrial timber value due to the severe climate and socioeconomics problems, non-timber products are of great value and importance due to their high economic potential and also their potential to improve the welfare of forest-dwelling and forest-fringe villagers. This study was done in the forests of the Zemkan basin, an important part of central Zagros forests, Iran, to recognize the non-timber forest products ($NTFP_S$), investigate their potential economic value and role in people's livelihood. Data, collected using forest cruising, participatory observations, interviews with indigenous and local persons and experts, identified wild pistachio resin, wild pistachio fruit, oak fruit and oak syrup (Shokeh manna) among the non-timber products in this basin with total potential harvestable NTFPs of 77.16, 771.602, 13248.68, and 1324.868 tons per year, respectively. The economic rent from NTFPs is 33 US$/ha/year and its total expected values with consideration of real interest rate when the exploiter invests the capital in the bank (6.4 %) and when money is borrowed from the bank to execute the incorporated projects (8.4 %) are $516/ha and $393/ha, respectively. Furthermore, families' economic share from potential profit of NTFPs is annually $601 per household. In addition wild pistachio resin has the highest share of the total potential profit of NTFPs and its equal to 51 % of the total of potential profit of NTFPs. Therefore, it is suggested that decisions be made to increase the infrastructure and strengthen the local selling market to enhance the cash income from NTFPs. Forest participatory management practices are suggested to organize and improve traditional use of the forests.

Keywords Economic rent · Household livelihood · Net present value (NPV) · Non-timber forest products (NTFPs) · Zagros forests

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✉ Sohrab Moradi
moradi_4@pnu.ac.ir

[1] Faculty of Agricultural Sciences, Payame Noor University, Tehran, Iran

[2] University of Guilan, Sowmeh Sara, Iran

[3] Department of Forestry, Faculty of Natural Resources, University of Guilan, Sowmeh Sara, Iran

[4] Department of Forest Economics, Faculty of Forest Sciences, Swedish University of Agricultural Sciences, Umea, Sweden

[5] Department of Environmental Sciences, Faculty of Natural Resources, University of Guilan, Sowmeh Sara, Iran

Introduction

Among the various land ecosystems on Earth, forests, including a host of complicated ecological processes, constantly undergo a cycle of production, contribute services that directly or indirectly play a role in economic conditions and human livelihood (Panahi et al. 2007), and provide numerous tangible and intangible benefits for human beings. In the meantime, the importance and value of non-timber forest products ($NTFP_S$) increase day to day. NTFPs include any kind of product and service that result from forests, except for lumber, including fruit, nuts, vegetables, fish, green manure, wild edible plants, thatching grasses, rattan, resins, pesticides, animal bedding,

veterinary medicines, green manure, ornamental plants, cosmetics, gums, honey, wildlife products, birds, mushrooms, medicinal plants, glue, scents, and a wide range of acrylics (Ingram et al. 2012; Sullivan 2002; FAO 1997; Krishna et al. 2009). Thus, firewood is also an NTFP (Croitoru 2007; Ingram et al. 2012; Khosravi et al. 2014).

The history of human use of non-timber products starts with human life (Ghanbari et al. 2011). However, these products were previously regarded as products of low importance, and as a result, they used to be called minor forest products (Arnold and Ruiz-Perez 2001). Similarly, the potential economic value of NTFPs was ignored or at least underestimated in terms of exploitation and market value (Murthy et al. 2005; Sullivan 2002). However, simultaneous with the propagation of social forestry and sustainable development concepts, NTFPs had been argued positively and significantly improving rural livelihoods (Balick and Mendelsohn 1992; Olsen 1998) and needing natural resources management (Godoy and Bawa 1993; Plotkin and Famolare 1992). Now the great importance and high economic potential of NTFPs, their contributions to the livelihoods of villagers (Newmann and Hirsch 2000; Angelsen and Wunder 2003; Sunderlin et al. 2005; Ahmadi Lashkenari et al. 2009; Ghanbari et al. 2011; Steele et al. 2015) and their role in developmental and protective purposes of forests are recognized (Saha and Sundryiyal 2012; Kasper and Carsten 2005; Arnold and Ruiz Perez 2001) and also the high economic dependence of villagers on these types of products. According to the Food Administration Organization 80 % of developing countries depend on non-timber products for their health and nutrition demands (Sadashivappa et al. 2006). It is obvious that the excessive and irregular exploitation of NTFPs, in long term, can lead to physiological weakness of trees and negative impacts on their regeneration i.e. forest degradation. Most especially, in the case that fruits are gathered in large volumes regardless of natural demands of forest ecosystems, not only regeneration of trees but also animal lives will have to endeavor the relevant threats. As a result, planned and organized exploitation of NTFPs can lead to sustainable development by increasing the villagers' income and the value of forest resources, which in turn provides a strong motivation to protect forest resources (Saha and Sundryiyal 2012; Newmann and Hirsch 2000).

A variety of studies have been conducted with regard to the financial evaluation and economic value estimation of NTFPs in different countries, primarily in the tropical forests of Latin America (Stanley et al. 2012) and recently in Africa (Heubach et al. 2011; Mutenje et al. 2010; Ambrose-Oji 2003) and Asia (Sarmah and Aruncachalam 2011; Ghanbari et al. 2011) to estimate the NTFPs value at the local and sometimes national levels.

Although the Zagros forests of Iran lack industrial timber applications, they play an undeniable role in sustaining the ecosystem and livelihood of area dwellers in terms of bioenvironmental, water and soil resources protection, wildlife shelter, and NTFP production. The Zemkan basin forests are an important part of the central Zagros forests with NTFP applications such as forest fruits, resins, manna and firewood for villagers. The lives of forest-dwelling and forest-fringe villagers vary in complexity and difficulty, and the villagers depend highly on these forests for part of their livelihood needs. Non-timber production within the Zemkan basin forests has long received attention as a source of income for forest-dwelling and forest-fringe villagers as well as for food production, medicine, and hygienic and industrial materials, which have been greatly exploited by local people from these forests and entered local, national, and sometimes international markets. Consequently, organizing the uses of the NTFPs, developing sustainable exploitation methods for these resources through the participation of local people will ensure the constancy of the products. Thus, recognizing and estimating their economic value are important measures to encourage the best management of these valuable resources. Because the potential economic value of these products often remains unknown and very few studies have considered it, the present study focused on calculating the potential economic income of NTFPs of the Zemkan basin forests and their contributions to the people's livelihoods.

Materials and methods

Study area

The Zemkan basin, one of the largest basins in Kermanshah Province, is located between 45°52′10″ and 46°35′05″ E and 34°13′45″ and 35°02′45″ N. Its area covers 2338 km^2 with a circumference of 314 km (Fig. 1). The average altitude of this basin is 1502 m asl (maximum 2547 m and minimum 514 m) (Moradi et al. 2015). It is located in a semi-humid moderate zone, and its major source of rainfall occurs in the mountains. The mean annual rainfall in basin of Zemkan has been recorded as 450 mm and mean annual temperature as 15.8 °C.

The vegetation is mostly treed (42 % the basin area), and its forest habitat includes three forest classes of closed forests (601 ha), semi closed forests (36,868 ha), and open forest (59,446 ha) that consist of tree species of oak (*Quercus* spp.), wild pistachio (*Pistacia atlantica* Desf.), Montpellier maple (*Acer monspessulanum*) (Teimouri et al. 2015), almond (*Amygdalus* spp.) and other species.

Fig. 1 Map to show location of study area in Iran

Table 1 Data collection and examinations in different sections

Working section	Data collection method
Recognizing, forest-dwelling and forest-fringe villages	District survey and using of satellite images
Recognizing the NTFPs	Interview and observation
Recognizing the methods, exploitation time and instruments	Interview (recording data from questionnaires) and observation
Determining the prices in local markets	Interview

Method

The method used in this research was based on participatory observation and field studies. In this study, the researcher involved himself in the lives of the intended dwellers as an observer and used available facilities by participating in different public gatherings, meetings, and places, and also visiting and interviewing the society agents and informants. Table 1 presents the way the data was collected for this research study.

To locate the forest-dwelling and forest-fringe villages, we used a land-use map that was derived using IRS-P_6 satellite images—LissIII and LissIV sensors—in 2008, acquired from Organizations of Geography of Armed Forces and Aerospace of Iran, and field study methods to survey all villages in the study area.

To determine the NTFPs, 358 families were selected from among 5345 forest-dwelling and forest- fringes families, in 126 villages (statistical population) that had forests based on the population of each village as the sample on the basis of Morgan table and on the questionnaires completed by interviewing the families in person. In the questionnaires, three issues were particularly emphasized: the type of NTFPs used by families, the production cost, and the income from NTFPs.

To calculate the total production cost of the NTFPs harvested in Zemkan basin, first it is necessary all of NTFPs for each product had to be calculated separately; the exploiters that entered the forest were assumed to be occupied only in exploiting the NTFPs. Therefore, in this study, the number of oak and wild pistachio trees per hectare in closed, semi closed and open forests in the Zemkan basin were estimated using a transect method with fixed trees (five trees) for oak and fixed length (140 m) for wild pistachio. In the next stage, the total number of harvestable trees was calculated by multiplying the area of each type of forest (closed, semi closed, and open forests) to the mean number per hectare of each species (oak and wild pistachio).

A gain in annual economic benefit from a specific product in surface unit is called economic rent (Saeed 2009) calculated as:

$$E_R = \frac{T_P}{S} \quad (1)$$

where E_R is economic rent; S is surface area; T_P is total profit. Faustmann (1995) contended that the present total of annual pure benefits in surface unit (economic rent) of a 1 ha of land until infinity from production of a specific product shows the expected value of the land. In this study, the forest value was estimated based on its leading non-timber products. The value until infinity is calculated with the presumption that costs and incomes continue constantly based on the annual fixed real interest rate. Therefore, value of a hectare of Zemkan basin forests is calculated based on formula 2.

$$N_{PV} = \frac{E_R}{r} \quad (2)$$

where N_{PV} is the net present value of NTFPs and r is the interest rate. Two values for the interest rate are needed: first, when the exploiter invests his capital in the bank and second when he borrows money from the bank to execute incorporative projects.

Results

NTFPs of the Zemkan basin

Wild pistachio resin (saqez)

The resin or latex of wild pistachio (*Pistacia atlantica* Desf.), called saqez, is used for a variety of industrial and

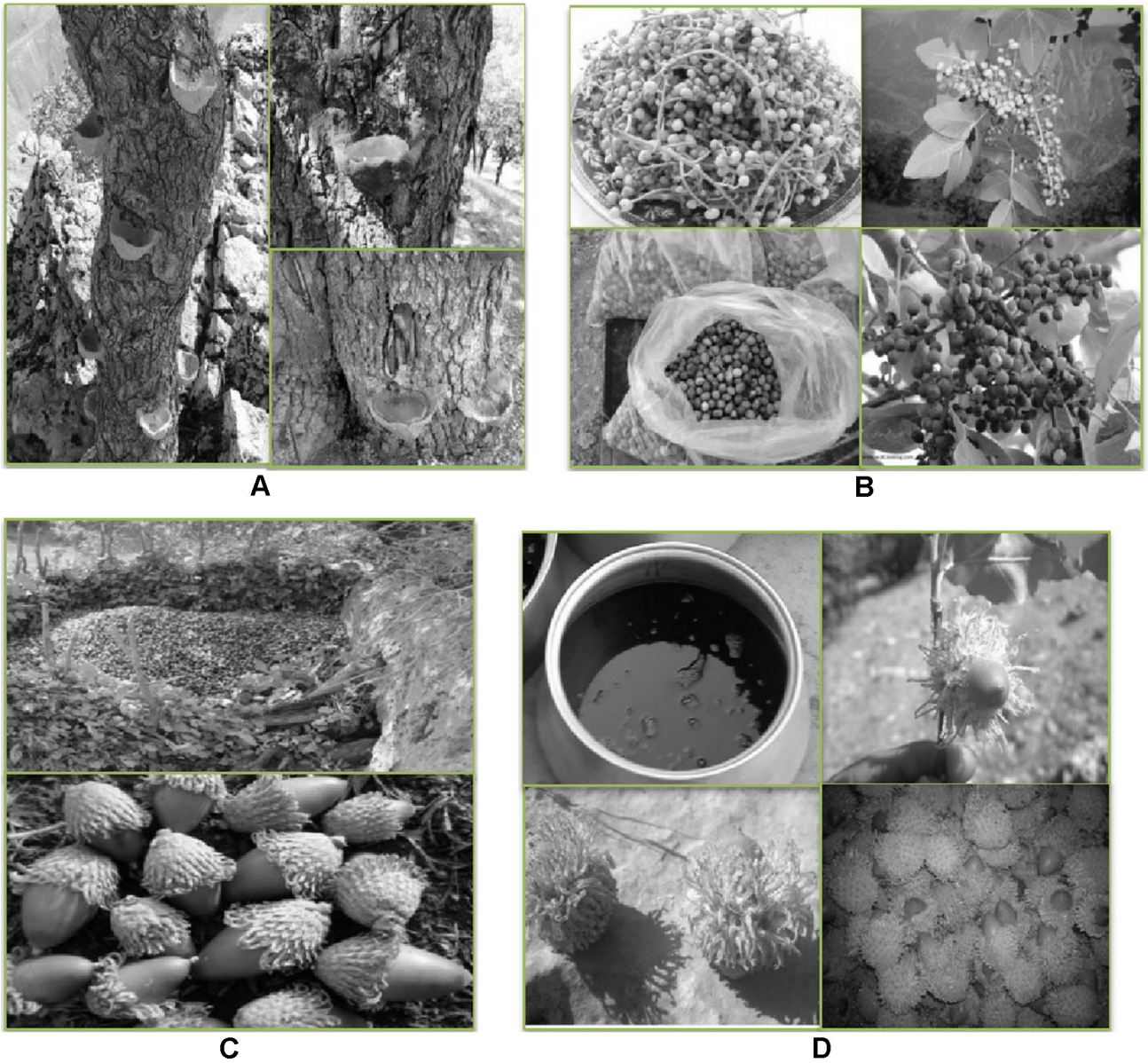

Fig. 2 The most important $NTFP_S$ of the Zemkan basin. **a** Saqez harvesting by the traditional method. **b** Wild pistachio fruit. **c** Oak seeds to feed domesticated animals. **d** Oak syrup (shokeh manna) in different forms

traditional uses, including food and medicine (Pourreza et al. 2008). Saqez is a semi-dense, sticky, fluid resin that exudes from the trees during the growing season and hardens during the cold seasons and become soft and melts when warmed. The raw saqez extract has a bitter, spicy flavor and involves abundant turpentine. Therefore, it cannot be chewed. However, if it is boiled in water and its impurities removed, its spicy flavor diminishes, and this product is sold as typical saqez in the market (Moradi 2011).

The traditional exploitation of saqez starts in mid-June; the exploitation group (at least three persons) uses axes to make wounds on the trees trunk by axes. These wounds have no special direction and are totally disorderly in traditional method. Between 10 and 50 wounds are usually cut, depending on tree lushness, extract abundance, and diameter and height of trunk. In the next stage, someone makes a small clay bowl to place under the wound (Fig. 2a). After about 20 days of placing the bowls under the wounds, the harvesting and production stage starts and finally the produced saqez is sold in local, national, and sometimes international markets. Generally ending in mid-September, the entire exploitation process of saqez from wild pistachio trees lasts about 3 months.

Wild pistachio fruit

After 10 years of growth, wild pistachio trees produce clusters of abundant tiny drupe fruits in the spring. Young bark is white and soft; part of the bark is red and gradually turns green as it the bark hardens (Fig. 2b). Some of the uses of wild pistachio fruits in Zemkan basin villages are as follows: making juice, scenting doogh (a yogurt drink) and flavoring rice. It can be used as a component in halva (a sweet paste), pickles, and sweet. One can also eat it as a nut and finally some local people use it in making chaplet. Wild pistachio fruits are exploited two times a year by local people: when its clusters are soft and not very hard (in May and June), and when the fruits are completely hard (in October, November and December). Thus, the wild pistachio fruit are used for 5 months.

Oak fruit

Generally, oaks (*Quercus* spp.) belong to the class Cupuliferae class that produce fruits called a gland in a calyx called a cupule (Mozaffarian 2004). Long ago, poor forest dwellers in the Zemkan basin lacked enough cereals and grains and started to collect seed of different types of oak to make local breads (Tabatabaie and Ghasriani 1992). In the present villages of the Zemkan basin that have forests, seeds from the oak fruits are collected and fed to domesticated animals (Fig. 2c) when the weather is too cold and wintery to take the animals to the forests. Oak fruit gathering starts at the beginning of June and lasts until the end of October (5 months).

Oak syrup (shokeh manna)

Manna, a NTFP of forests and pastures, results from the three-way interaction of specific environmental conditions, an insect on a specific host plant or plant reaction against some mechanical factors such as making rifts on the trunk or branches of trees, and environmental warmth (Takavar and Mohammadi 2008; Razavi 2010), and has therapeutic properties. Manna is expelled from the end of the unknown productive insect in the form of juice, and after contact with air, it hardens into a sugar-like substance. The oak syrup, which is locally referred to as shokeh, before exploitation is in the form of small or large nectar-like, sweet seeds that form on the calyx and fruit of Persian oak (Fig. 2d). The extracted product is almost dense, sweet dark-brown nectar locally called produced shokeh. According to indigenous people and our experience, it is effective for stomach aches. Although it lacks high nutritional value, it is mostly used as a breakfast food by local people. Producing this extract is traditionally done by villagers, starting by picking fruits with a cupule and cutting branches and head branches of oak from mid-August through mid-November (3 months).

Exploitation of NTFPs

Given the type of product, needed forces for exploitation, and type of exploitation, different tools and instruments are used. The most important tools that are used in the district for exploiting non-timber products are the blade making hack for using Saqez and ax. These tools are made and sold by blacksmiths of the area. The number of persons also differs from one to some people depending on the type of exploitation, the intended tree physical features, and difficulty of work. Table 2 shows the type of used tools for each product and exploitation amount of products in a day. After visiting the study area, the exploitation costs of non-timber products were divided into two categories of working man costs and tools costs. Daily cost of specific tools such as blade (hack) of Saqez extraction was calculated after determining the working days in a year and the time period for their depreciation.

Daily tools cost = Tools purchase price/usable day's number.

Financial evaluation of NTFPs

To calculate the total cost of NTFPs harvest in Zemkan basin, first it is necessary to calculate all of harvestable non-timber products for each product separately. Therefore, in this study, first Number of oak and wild pistachio trees per hectare in Closed, Semi-Closed, and

Table 2 Exploited products and tools used

Product	Tools	Minimum labor needed for harvest	Quantity (kg/day)	Quantity (kg/labor day)	Income (US$/labor day)	Tool cost (US$/day)	Total costs (US$/labor day)
Wild pistachio resin	Ax and clay pots	3	9	3	10	1	11
Wild pistachio fruit	Stick and sack	1	25	25	8	0.4	8.4
Oak fruit	Stick and sack	1	150	150	8	0.4	8.4
Oak syrup	Stick and sack	1	3	3	8	0.4	8.4

Amount of oak syrup is considered after production from oak fruit

open forests in Zemkan basin was estimated by using transect method with fixed trees (five trees) for oak and fixed length (140 m) for wild pistachio. In the next stage, the total number of harvestable trees was calculated by multiplying the area of each type of forest (Closed, Semi-Closed, and open forests) –which has been calculated via land use map and ArcGIS10.1 software—to the mean of number in hectare of each species (oak and wild pistachio). Then, considering the mean amount of harvestable product for each tree and harvest alternation, we calculated the total harvestable product in 1 year for each product separately (Table 3). Profit from NTFPs was calculated by subtracting the total cost from the total income (Table 4). Note, however, that the calculated profit in this study means potential profit of forest to produce these products; it does not mean the profit that resulted from actual NTFPs by local villagers based on a cost–benefit analysis (Table 5).

According to official statistics of the Central Bank of the Islamic Republic of Iran in 2014, the average rate of inflation, the interest rate of 1-year invested trusts in the majority of state banks and the expected interest rate of facilities in the form of participatory projects was 15.6, 22 and 24 %, respectively. Accordingly, the real interest rate can be calculated for investing when the exploiter invests his capital in the bank as $22 - 15.6 = 6.4$ % and for borrowing when the exploiter borrows money from the bank to execute participatory projects as $24 - 15.6 = 8.4$ %. Via the second equation, the expected values per hectare of forest from NTFPS at a real interest rate for investing and borrowing were calculated separately in Table 6.

Table 3 Calculation of harvestable product and cost of NTFPs in Zemkan basin forests

Land use	Area (ha)	Mean number of trees/ha		Total harvestable NTFPs[a] (kg)				Total cost of harvestable NTFPs[b] (US$)			
		Wild pistachio	Oak	Wild pistachio resin	Wild pistachio fruit	Oak fruit	Oak syrup	Wild pistachio resin	Wild pistachio fruit	Oak fruit	Oak syrup
Closed forests	601	9	104	1352	13,522	156,260	15,626	4957	4543	8751	43753
Semi-closed forest	36,868	5	84	46,085	460,850	7,742,280	774,228	168,978	154,846	433,568	2,167,838
Open forest	59,446	2	36	29,723	297,230	5,350,140	535,014	108,984	99,869	299,608	1,498,039

[a] According to interviews with local and indigenous people, consultations with experts and prices in local markets, the price of 1 kg of wild pistachio resin and fruit, oak fruit, and oak syrup was determined to be $US 25, 0.625, 0.125, and 3.125

[b] Profit of harvestable NTFPs was calculated by subtracting total cost from total income

Table 4 Calculation of sale price and profit of harvestable NTFPs in Zemkan basin forests

Land use	Area (ha)	Mean number of trees/ha		Total income from harvestable NTFPs[a] (US$)				Profit from harvestable NTFPs[b] (US$)			
		Wild pistachio	Oak	Wild pistachio resin	Wild pistachio fruit	Oak fruit	Oak syrup	Wild pistachio resin	Wild pistachio fruit	Oak fruit	Oak syrup
Closed forests	601	9	104	33,800	8451	19,532	48,831	28,843	3908	10,781	5078
Semi-closed forest	36,868	5	84	1,152,125	288,031	967,785	2,419,463	983,147	133,185	534,217	251,625
Open forest	59,446	2	36	743,075	185,769	668,768	1,671,919	634,091	85,900	369,160	173,880

[a] According to interviews with local and indigenous people, consultations with experts and prices in local markets, the price of 1 kg of wild pistachio resin and fruit, oak fruit, and oak syrup was determined to be $US 25, 0.625, 0.125, and 3.125

[b] Profit of harvestable NTFPs was calculated by subtracting total cost from total income

Table 5 Calculation of economic rent of NTFPs of Zemkan basin forests

Land use	Area (ha)	Profit (US$)	Economic rent (US$/ha)
Closed forests	601	48,610	81
Semi-closed forest	36,868	1,902,174	52
Open forest	59,446	1,263,031	21
Total		3,213,815	33

Table 6 Expected value of forest from NTFPS with real interest rates for investing and borrowing

Land use	Area (ha)	Investing real interest rate (%)	Borrowing real interest rate (%)	Investing NPV (US$/ha)	Borrowing NPV (US$/ha)
Closed forests	601	6.4	8.4	964	1266
Semi closed forest	36,868	6.4	8.4	619	813
Open forest	59,446	6.4	8.4	250	328
Total		6.4	8.4	393	516

Investing when exploiter invests his capital in bank, Borrowing when exploiter borrows money from bank for projects

Table 7 Potential profit and annual portion from NTFPs per family

NTFP	Profit (US$)	Annual portion of families (US$)	Portion of total profit (%)
Wild pistachio resin	166,081	308	51
Wild pistachio fruit	222,993	42	7
Oak fruit	914,158	171	29
Oak syrup	430,583	80	13

Role of NTFPs in families' income

From the 207 villages in Zemkan basin, 126 villages, with 5345 families, are among the forest-dwelling or forest-fringe villages that make use of NTFP-related incomes. From among the introduced NTFPs in the current study, wild pistachio resin contributes the most to incomes (51 %). From 5345 forest-dwelling and forest-fringe families in 126 sampled villages, each family annually averaged potential profit of US$308 from wild pistachio resin. Other NTFPs such as oak fruit, oak syrup, and wild pistachio fruit also had important roles in their incomes (29, 13, and 7 %, respectively, of total potential profit from NTFPs) (Table 7).

Conclusion

In this study, we tried to comprehensively estimate the potential economic value of NTFPs by identifying the leading NTFPs of the Zemkan basin forests in the Zagros area of Iran. Because determining the potential value of NTFPs can enhance the motivation to protect and restore the most profitable species for local and forest-dwelling people. Wild pistachio resin and fruit, oak fruit and syrup (shokeh manna) were among the most profitable NTFPs of these forests. In the related studies, wild pistachio resin in Zagros forests has been introduced as an industrial product, and wild pistachio fruit was offered as a noncommercial product having food value (Karamshahi et al. 2005; Bordbar et al. 2006; Pourreza et al. 2008). However, no studies have been published on oak fruit or syrup as a non-timber product in Zagros forests.

Our results also indicated that exploitation and use of NTFPs could be one of the most important livelihood strategies for forest-dwelling and forest-fringe villagers (Khosravi et al. 2014; Mahdavi et al. 2011) as evidenced by the importance of the NTFP contributions to families' incomes. That is, families' economic portion from NTFPs potential profit in the study area would be US$601 per family per year, with wild pistachio resin contributing the most (51 % of the total potential profit from NTFPs). This study is compatible with the researches carried out by (Nakazono et al. 2004) in Amazon forests, (Ahmadi Lashkenari et al. 2009) in northern Zagros forests and (Murthy et al. 2005) in Uttara Canada district such that the economic incomes of villagers from NTFPs has been emphasized. It is also worth mentioning that the people benefiting these forests tend to preserve them willingly.

The findings of the mean annual economic rent of US$33/ha from NTFPs and total expected values with consideration of interest real rate in two conditions (6.4 % when investing capital, 8.4 % when borrowing for US$516/ha and US$393/ha, respectively). These findings uncovered that harvesting NTFPs might play a highly positive impact on the families' economy. Hence, in the management of $NTFP_S$ by the respective organizations, the following should be considered: For optimal exploitation define exploitation plans and determine the minimum harvestable level of NTFPs, determine the usable species in the forests and the permissible amount of exploitation for each of these species. Additionally, we suggest that decisions be made with regard to improving infrastructures and strengthening local selling markets to increase cash income of NTFPs. Running participatory management programs for forests to organize and improve traditional exploitation should protect natural resources and increase the cash income of villagers to sustain the Zemkan basin forests and thus the livelihood of dependent villagers.

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