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Evaluation of the income of forage products and byproducts of *Amygdalus scoparia*

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Abstract

Forage is the main product of Chenarnaz rangelands of Khatam City, and *Amygdalus scoparia* is a byproduct of this region. *Amygdalus scoparia* harvested by local people in a 30-day period in the end of the summer and is then sold in the market. In this study, some economic indicators of harvest and sale of by-products of *Amygdalus scoparia* were evaluated. Participants of the study were local farmers who grew *Amygdalus scoparia*. Results showed that the net income of forage production per family equaled 15.7 million Rials annually, and the obtained economic rent was estimated to be 202 thousand Rials per hectare annually. The average gross income of *Amygdalus scoparia* in a harvest period per household was estimated to be approximately 22.65 million Rials. Furthermore, after deduction of apparent and hidden costs, the net income per household in that period was calculated to be 14.3 million Rials. The results of the study indicated that economic rent from the exploitation of *Amygdalus scoparia* was estimated to be 706 thousand Rials per hectare annually. The expected values per hectare of rangelands were estimated to be 24 million Rials and 8.08 million Rials from harvesting byproducts, and forage, respectively. The expected total value of each hectare of rangeland relating to the production of main products and byproducts was more than 36.32 million Rials. Moreover, the contribution rate of the byproducts of *Amygdalus scoparia* to the expected total value of rangeland was calculated to be 0.78.

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Introduction

Rangeland utilization is as old as the history of mankind. Approximately, seven million years ago in Africa, the earliest human societies lived in ecosystems including: Grassland, Savanna, Spinney and Woodlands that are now called rangelands. These human societies used these lands to meet their basic needs (Grice and Hodgkinson, 2002). According to FAO (1994) and UNDP (1997), almost all rangelands have been under heavy livestock grazing or plowed for farming (FAO, 1994 and UNDP, 1997). In our country, in the not too distant past, degradation of rangelands through overgrazing and conversion of rangelands to agriculture was a common phenomenon, but today, with an increase in the understanding of knowledge among administrators and an increase in the awareness of the beneficiaries, many useful aspects of rangelands are taken into account. Therefore, it can be hypothesized that an organized planning for appropriate utilization of these resources in each region not only can reduce the degradation of rangelands, but the process also can provide preservation, restoration and an increase in the income of farmers.Thus, it becomes essential to identify and determine the actual and potential production of rangelands, in order to optimize utilization, and also to provide practical solutions for using other rangeland resources. Rangeland species have the capacity to give various products and their use should not be only restricted to forage productions. Some plant species used less as forage for livestock (Eremurus persicus and Glycyrrhiza glabra), or the species having a higher industrial and conservation value compared to forage value (*Astragalus siliqousus* species of cotton and *Amygdalus scoparia*) and or the species which could be used simultaneously for forage and medicinal and industrial purposes are harvested and sold as byproducts.

Thadani (2001) stated that from an economic, social and ecological point of view, in developing countries, the byproducts are considered as an important part of the conservation and management. Freed (2003) in his study mentioned that these products have an important role in the economy of the local residents. Shyiajan and Maythili (2003) attempted to identify the byproducts of forests and calculated the net income of each household. Monjardino *et al*., (2004) conducted a study on the income obtained from rangeland species in Australia and found that average economic rent of rangeland annually varied between 73 to 117 dollars per hectare per year. Murthy *et al*., (2005) evaluated the income earned by the local community from the collected forest byproducts in the West GATT, India. Similarly, O'Connell *et al*., (2006) reported the rangeland economic rent as 77 dollars per hectare annually in a study on "*The economic value of saltland pastures in a mixed farming system in Western Australia"*. Mahdavi (2006) identified the forest byproducts in the Kamyaran region and determined the rate of utilization by the local people and the net income of byproducts.

In Iran, little research has been conducted on the economic values of the byproducts of rangelands. The purpose of this study was to estimate the economic indicators of byproducts of *Amygdalus scoparia* harvest and sale, such as annual net income of farmers, marketing margins and the total expected value of rangeland obtained from forage production. In addition, the economic value and its role in the economy of rural households in Herat region was compared so that the value of rangelands could be investigated from other point of views other than forage production.

Materials and method

This study was conducted on rangelands of Khatam city with an area of 5062 hectares, located between longitude 53°56'25" to 54°01'14" and latitude 30°00'00" to 30°06'47", with an average annual rainfall of 332 mm. Sixty five farmers are exploiting these rangelands in the form of range management plan in a 120-day period during the spring and summer. In addition to ranching and farming, local

farmers are exploiting byproducts of rangelands. Because of having proper density per unit area, *Amygdalus scoparia* is harvested from an area of 1318 hectares of the study area by local farmers who are mostly ranchers.

Amygdalus scoparia is a byproduct from Rosaceae family. It is a 6-meter shrub species with young green branches without trichome, without spines, with thin spear-shaped leaves of 40 mm length and 7 mm width, white large flowers of 25 mm diameter, ovoid fruit with a length of 20 mm and a width of 12 mm with short trichomes. This species is distributed in the highlands between Yazd and Aghda, Nodoushan, around Bafgh (Qatrom), Marvast and Herat. It is also found as single shrubs or with very low density distribution in areas in the mountain ranges with an altitude of 700 to 2700 meters above sea level (Mozaffarian, 1998). In order to determine the density of *Amygdalus scoparia*, the habitats of this species in the rangelands of the region were identified. Suitable habitats were identified on a 1:50000 scale topographic map. Then, to determine the sample size, minimal area method was used. By the use of systematic random sampling, sampling was conducted in an area of 5×5 square meter, with 40 plots along the transect lines. By collecting data from each habitat, the average number of bases in each hectare was determined and 75% of exploitable bases were considered as allowed bases. Then, from the total of percentage allowed bases, 10% were deduced for the drop due to various factors (Khosravi, Hassan and Mehrabi, 2008). In order to determine the average production of each base, the products of three bases with different canopy cover area including small (with a diameter of 8 m^2), medium (with a diameter of 12 m^2), and large (with a diameter of 20 m^2), were harvested and the average production of each base was calculated and determined to be 1.46 kg.

Method of exploitation

By mid September when the fruits begin to ripen, their soft skin starts cleaving. With the help of long wooden poles or by shaking the branches of the trees, the fruits are made to fall into a big tablecloth that is held beneath the related branch by a number of local residents. This procedure is repeatedly done until all the ripened fruits are gathered. Then, the fruits are skinned and placed in the sun for 3-4 days until they are comp letely dry.

Forage production of each plot was measured by cutting and weighing method. Finally, according to the range condition and trend and soil erosion class, the allowable use of forage was calculated (Amiri, 2009).The factors affecting the allowable use of forage are climate change, soil conditions, existing erosions in the region, grazing season, and range condition and trend (Moghadam, 2009).

Price estimation of by-products and forage

Due to the trade in the local and regional markets, the average price of byproducts can be easily estimated. The produced forage prices cannot be estimated because of the heterogeneity in terms of species type, degree of palatability, and digestibility of nutrients. Moreover, the trade of these byproducts is not common in local markets. In economics, heterogeneous goods pricing is usually conducted by Hedonic method. Therefore, in this study, the Hedonic method was used to determine the price of produced rangeland forage (HeshmatAlvaezyn, 2007). In similar studies, Hedonic method has been reported for forage pricing (Discosanzo, 1997, Laiman, 2000).

Data analysis

In the study, the obtained quantitative data were analyzed by the application of marketing margins and financial evaluation methods. For the calculation annual net income indicators per household, economic rent and the current net value to infinity or rangeland expectation value were considered.

Calculation of marketing margins

Because *Amygdalus scoparia* is traded in the markets, the estimated marketing margin of this

product can be useful in the analysis of economic exploitation. It is noteworthy that the farmers producing *Amygdalus scoparia* undertaken the costs of transportation to the market of city center and sell it with relatively high prices compared to the price at the place of production. But on typical days, the buyers purchase the product at the place of production and sell it in the local market. During the harvest period, different costs per kilogram of product are stated.

The marketing margin of this product is calculated using equation 1 (Kohpaee, 2008).

$$r = \frac{Pr-Pf}{Pr} \times 100$$

In this equation r is marketing margin, Pr is price of product in market and Pf is price of product at the place of production.

Net income and annual household benefit

After determining the amount of harvest per hectare and the average price of the product, the gross income is calculated. It is worth noting that the total harvest is not sold in local markets, and some of it, estimated as an average of 5%, is self-consumed.Thus, the total harvested product is calculated based on the rate of sale and self-consumption.Then, after the deduction of the reveals cost (transportation) and hidden cost (labor) from the gross income, the economic benefit is estimated per household.

Economic rents

The annual economic benefit obtained from a certain product per area unit, is called economic rent (Saeed, 1995). Equation 2 shows how to calculate the economic rents:

Equatoion 2.

$$ER = \frac{TR - TC}{S}$$

In above equation economic rent is ER, S is area, TR is gross income and TC is the total cost.

Rangeland Expectation Value (REV)

Faustmann (1995), states that the expected value of an agricultural piece of land is directly related to the type of crop cultivated in that land. It can be literally calculated by considering the total annual net benefit in the area unit (economic rents) of a certain product ranging from a hectare of land to the infinity. In this study, the value of rangeland was estimated from *Amygdalus scoparia* products. Calculation of infinity values was done with the assumption that income and costs are consistent with fixed annual inflation rate to infinity. Therefore, the value of each hectare of the rangeland relating to the *Amygdalus scoparia* product was investigated by equation 3.

$$REV = \frac{ER}{r}$$

In this equation, REV is the value of each hectare of rangeland due to a certain product, ER is economic rent and r is the real discount rate.

Annual employment

In the region, the employment data for each person per year was obtained by dividing the number of people/farmers and laborers per day during harvest by the number of active days in a year (250 days) represented in (Equation 4).

$$E = \frac{n \times d}{250}$$

In this equation n is the average number of people employed in a day, d is employment duration (days), and E is employment.

Results

Price estimation of produced forage by Hedonic method

From an economic point of view, farmers are willing to pay more per unit of weight for one kind of forage when the amount of its digestible nutrients and therefore, the resulting livestock production is higher. Thus, there is a direct and positive relationship between the level of total digestible nutrients (TDN) and the price of forage types (Figure 1).

Agriculture, 2008) and Total Digestible Nutrient (Khaldary, 2003) is depicted. By the use of TDN, a species average existing in the region, the relationship between price and total dry matter digestibility (Equation 8), the estimated average price of forage in the region, was obtained.Thus, the price of each kilogram of rangeland dry forage was determined according to the following equation with the determination coefficient of 98% (R^2).

Table 1. The Rangeland Expected Value for forage and *Amygdalus scoparia* production based on different discount rates.

The relation between per hectare value of rangeland from harvesting *Amygdalus scoparia* and the whole rangeland	The relation between per hectare value of rangeland from harvesting *Amygdalus scoparia* and forage	The whole rangeland value from production of forage and *Amygdalus scoparia* (thousand Rials per hectare)	Rangeland value from production of forage (thousand Rials per hectare)	Rangeland value from harvesting *Amygdalus scoparia* (thousand Rials per hectare)	The real discount rate (%)
		45400	10100	35300	2
0.78	3.5	36320	8080	28240	2/5
		30266	6733	23533	3

P= 1494 TDN – 380.2

P: forage price, TDN: Total Digestible Nutrient.

Suitable species for grazing on rangelands were mainly *Stipa barbata, Astragalus podobolus, Polygonum dumosum, Scariola orientalis, Stachys inflate, Ferula ovina, Prangos ferulacea*. Accordingly, their TDN was estimated with an average of 48% per kilogram (Arzani, 2006). With the help of Equation 8, the price of each kilogram of forage in the region with the estimated TDN was calculated to be 3370 Rials. It was close to the total price determined by the Nomadic Organization ranging between 3,200 to 3,500 Rials.

The amount of exploitable forage for livestock was calculated with an average of 60 kilograms per hectare. According to the rangeland area (5062 hectares), the total net income obtained from produced forage was determined to be 3370 Rials per kilogram, (10/22 billion Rials in a year). Note that the hidden costs (labor) for forage harvesting was assumed at zero, the economic benefit in the region was estimated at 1/02 billion Rials. Therefore, by considering 65 exploiters in the investigation, the economic benefit of each household for using forage for livestock, was estimated as 15.7 millionRials per year.

Forage economic rent

The economic benefits of forage production in 5062 hectares were estimated at about 202 thousand Rials in the year.

Amygdalus scoparia marketing margins

During the season, the local middlemen consider a total average of 1,500 Rials per kg as their marketing benefit. It is obtained by adding the cost of wages and the shop rent to the quoted selling price. According to the survey results, it was found that the average cost was 3,000 Rials per kg. For example, if the price of the production at the place is 25,000 Rials, obtained by adding the local market price and the marketing prices of the product, it will increase to 29500 Rials. By using Equation 1 and considering that the *Amygdalus scoparia* price at the origin and

the local market was respectively 25,000 and 29,500 Rials, the marketing margin of the product was estimated at 84%.

Net income and annual economic benefit of households

On average, each farmer exploits 30 *Amygdalus scoparia* bases per day. The production rate of each base was calculated at 1/460 kg by taking the average of the three bases: with small crown (0.700 kg), medium crown (1.200 kg) and large crown (2.500 pounds), respectively. Therefore, the harvest rate per farmer per day was calculated at 43/8kg. Assuming that the density of the *Amygdalus scoparia* base was 30 per hectare, in a 1318-hectare rangeland exploitable for *Amygdalus scoparia*, the rate of total production amounted to 57,728 kg. Thus, it is inevitable that when the product is less the price rise is witnessed up to 30,000 Rials and when the product is easily accessible the price falls to 22,000 Rials.

The findings of this study showed that the amount of total harvest was estimated to be 57,728 kg per year. It was obtained by the addition of the amount of consumption (2886 kg) and the amount of products sold in the market (54,842 kg). For all the farmer households, the total financial cost of the product was estimated at 1,472 million Rials, and the gross income of the product was estimated equal to be 22/65 million for each farmer household on the basis of the average original price of 25,500 Rials per kilogram of *Amygdalus scoparia*.

The net income of the harvested product of each household is calculated after deducing the labor charges from net income, which is mainly undertaken by the members of the household (hidden costs). Hidden costs of production included a 30 minute time period for each *Amygdalus scoparia* base (in order to collect, peel and dry the product). The whole procedure took 3608 working days for the complete area under study with a daily wage of 150,000 Rials for the labors.

After deducing the labor charges, the net income of total product was 930/8 million Rials. The net income of harvested product of *Amygdalus scoparia* for each farmer household was calculated to be 14/3 million Rials per year. In this study, there was no shipping cost. Therefore, a total of 541/2 million Rials per year was estimated.

Economic rent of Amygdalus scoparia

According to equation (2), economic benefits derived from the exploitation of *Amygdalus scoparia* per hectare (economic rents) was estimated at 706 thousand Rials annually.

Annual employment caused by Amygdalus scoparia harvest

Considering the number of users (65 farmers) in a 30-day period, attempting to harvest *Amygdalus scorpia* (1950 persons a day), the employment rate in the region was estimated about8 persons per year using Equation 4.

Economic rent of Amygdalus scoparia and forage

According to Equation 4, the economic benefit derived from forage was calculated at 202 thousand Rials per hectare per year. Similarly, the economic benefit from harvesting the byproduct (*Amygdalus scoparia*) or economic rent was estimated to be 706 thousand Rials per hectare. Thus, the total economic rent is more than 908 thousand Rials per hectare per year.

Rangeland Expected Value related to the forage and Amygdalus scoparia production

Using Equations 5 and 6, the expected value of per hectare of rangeland from the harvested byproduct and forage, and also the total expected value of rangeland from both harvested products, with real discount rates of 2% to 3% was calculated and is demonstrated in Table 1.

Rangeland Expected Value achieved from harvesting *Amygdalus scoparia* with a real discount rate of 2/5 percent, was calculated to be about 28/24 million

Rials per hectare and the expected value of rangeland achieved from forage production was calculated at 8/08 million Rials per hectare. Therefore, the total expected value of rangeland from *Amygdalus scoparia* and forage production with a real discount rate of 2/5 percent reached 36/32 million Rials. The ratio between the values of harvesting *Amygdalus scoparia* to the produced forage was equal to 3/5 and the ratio between the values of the harvested product to the total value of rangeland was estimated equal to 0.78.

Annual employment of Amygdalus scoparia and forage

Considering the number of forage exploiters (65 households), the average employment of each household (two persons) and 120 days of the exploitation of rangeland in spring and summer seasons, the employment rate in the area with 5062 hectares, was calculated equal to 62 persons by using equation 4. Similarly, according to the total number of people (65 people) in one period (30 days), attempting to harvest *Amygdalus scoparia*, the employment rate in the region with an area of 1318 hectares, was estimated as 8 people, by using equation 4. Thus, the contribution of byproduct to employment creationwas about 11 percent.

Discussion and conclusion

Multipurpose use of rangelands is the objective of sustainable development of natural resources. Herbal and medicinal plants are not only income-generating, but can also help in the generation of productive jobs in various sectors. By introducing the arid and semi arid rangelands as one of the most benefitable sectors of the economy in the growth of medicinal plants, they also help to preserve and aid in the survival of these valuable species as well.

According to the calculations, the net income of each household from harvesting forage to feeding livestock was estimated at 15/7 million Rials per year, which makes about 17/8 percent of the average annual income of the rural household.

The relatively high share of households' income from harvesting the forage is due to the fact that households do not pay any ownership interest for the exploitation of forage to the owner of the national rangeland, the government, so the harvested product is obtained free. However, the low revenue of traditional husbandry and the low number of livestock units per household, and therefore, the low rate of household annual income are reasons to justify the high share of income derived from forage from the total household's income. Since rangeland's free forages make a big part of the household income and the added value in traditional farming is low, any ownership interest can be uneconomical to produce such product.

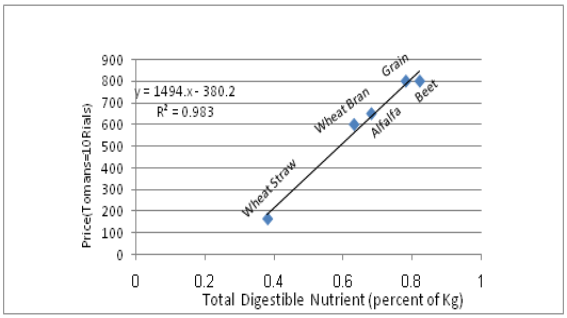

Fig. 1. The relationship between price and Total Digestible Nutrient.

However, in Herat region, harvesting forage as the major product of rangeland plays an important role in the rural economy. Rural utilization of rangeland is not limited to forage, but rests on harvesting byproducts, particularly *Amygdalus scoparia*. Net income per household from harvesting *Amygdalus scoparia* is 14/3 million Rials a year which is equal to 16/2% of the total rural household income.

The research indicated that economic rents obtained from the utilization of forage and *Amygdalus scoparia* was 908 thousand Rials per hectare per year, or about 74 dollars per hectare per year. The research also showed that the total expected value of rangeland from *Amygdalus scoparia* production and forage including the real discount rate of 2/5 percent exceeded to 36.32 million Rials per hectare a year, or about 2,962 dollars per hectare.

A research conducted by Monjardino *et al.* (2004) in Australia, accounted for an average economic rent changes of rangeland between 73 to 117 dollars per hectare per year. Likewise, O'Connell *et al.* (2006) estimated the economic rent of a rangeland in Western Australia amounting to 77 dollars. Using a real discount rate of 2/5%, the expected value of the rangeland in the research conducted by Monjardino *et al.* (2004) and also O'Connell *et al.* (2006) in Australia, exceeds to at least $ 2920.

The economic value of forage and *Amygdalus scoparia* is not only related to the annual net income but also to the employment level. The share of *Amygdalus scoparia* in employment is (11%) (8 people) and in household annual income is about 13 percent. In comparison with the share of forage in employment 89% (62 people) and in annual household income 45%, it provides a considerable employment rate in contrast to the obtained income. It is because the harvest of *Amygdalus scoparia* is done by farmers manually, but forage utilization is done by livestock that does not need much workforce. Farmers mainly handle the husbandry and supervise their work.

Marketing margin rates of *Amygdalus scoparia* is at 84 percent. The high marketing margin rate is due to the distance of the major consumer markets, particularly, the province centre and neighboring provinces, and the high costs of transportation. Its seasonal harvesting increases the attraction of the product marketing for the exploiters, especially, the middlemen. The various applications of this product in the food industry, pharmaceutical, medical and cosmetic industry as well as in traditional and domestic use are the reasons for its marketing attraction and result in the rise of its share in household income.

Since *Amygdalus scoparia* brings business, it should not be studied without considering the probable destructive effects associated with an excessive invasion of farmers into the rangelands. Yet, despite the harvesting of this product over the past several decades, not much of the destructive effects have been observed in the lands.

Amygdalus scoparia should be harvested based on principles and should be predicted in a rangeland management plans and be considered as lateral income for the rural habitants. By applying a developmental approach to improve the areas covered by this species in the region, we can prevent the probable destructive effects of the use, destructive effects of climate change and successive drought. Moreover, in order to increase the product benefitability and more job creation in the area it is suggested to get government's and banks' financial support for farmers to launch processing centers for the production and processing of *Amygdalus scoparia* in the farm place.

Considering the fact that the operation of rangeland is not only to provide forage for livestock and byproducts, such as *Amygdalus scoparia*, but also to control soil erosion, water reservation and ground water recharge and for the wildlife protection. So, in the considerations and discussions related to the rangeland, not only the forage and byproducts, but also a range of other values of rangeland should be taken into consideration. The Rangeland Expected Value calculated in this study was just related to *Amygdalus scoparia* product. By considering all of its environmental and non-market services and products, the real value of rangeland would provide a much greater expected value and will result in the rangeland management be introduced as a job with sufficient income and a benefitable economic activity along other jobs related to the natural resources.

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