



Impact of medicinal plants cultivation on rural livelihoods: the case of South Khorasan Province in Iran

Mahboubeh Dalir¹ · Shahla Choobchian¹ · Enayat Abbasi¹ · Marie-Laure Fauconnier² · Thomas Dogot³ · Rando Värnik⁴ · Hossein Azadi³

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Abstract

This study aimed to investigate the effect of medicinal plants cultivation on rural livelihoods. To achieve this goal, firstly, using relevant literature and secondary sources, the data were collected, and then to determine the validity, a questionnaire was provided to a panel of subject experts, and pilot tests were used to determine the analysis tool's dependability. The alpha coefficient of Cronbach was then determined for different parts of the completed questionnaire and showed that the questionnaire has acceptable reliability. The statistical population of the study consisted of 9178 medicinal plants farmers in the South-Khorasan province of Iran in the year 2019. The sample includes 368 individuals based on Krejcie Morgan table. The results showed that there is a connection between medicinal plant cultivation and human health as well as rural livelihoods. The correlation coefficient of cultivation of medicinal plants and economic capital had the highest position and the rest are in environmental, human, social, and physical, capital. The main outcome of the cultivation of medicinal plants is increased income and savings and poverty reduction, 68% of which are affected by improved rural livelihoods through the cultivation of medicinal plants. This study concluded that economic capital has the highest priority in measuring livelihood. Providing loans and facilities in the field of medicinal plants and agricultural equipment is one of the solutions that help the government pave the way to expand planting and crops export through production incentives. Moreover, concerning the impact of different varieties of medicinal plants on improving livelihoods, poverty reduction, and increasing the income and savings of rural households, it is recommended that saffron planting be a priority, and barberry, cumin, and jujube be considered in the next priorities. It is also recommended that researchers and experts in this field try to identify and introduce quality cultivars to farmers.

Keywords Medicinal plant · Livelihoods capital · Plant cultivation · Income · Indigenous knowledge

Extended author information available on the last page of the article

1 Introduction

Medicinal plants are increasingly popular as a primary source of medicines worldwide (Dey et al., 2020; Bariotakis et al., 2019; Kandari et al., 2012). The traditional medical plant-based healthcare scheme has particular importance in ensuring the safety and health of communities (Abrokwah et al., 2017; Güler et al., 2020; Kruss et al., 2012; Torri, 2012). This part of the environmental resources has been one of the most important sources of human medicine for generations, and these plants have always had a special affinity for human beings. Medicinal plants are herbs that contain all or part of an effective substance that, beyond the manufacturing process, can have beneficial therapeutic effects on the body and help to cure diseases by regulating the activity of various body systems (WHO, 2018). Medicinal herbs, on the other hand, account for over 85% of drugs used in western health care schemes (Phondani et al., 2014; Beltreschi et al., 2019). The use of herbs and the general popularity of communities in the use of herbal remedies have increased, especially in recent years, because the superiority of medicinal plants and their medicines over chemicals has been proven (Alinia-Ahandani et al., 2019). Chemical drugs have side effects, some of which have been eliminated as hazardous drugs. The World Health Organization has announced that the target of "health for everyone" is not possible without the use of herbal medicines (Melkas, 2013; WHO, 2018; Yuan et al., 2016). According to the FAO, by 2050, the trade in medicinal plants will grow to \$ 5,000 billion. In addition, studies show that the total trade in medicinal plants rose from \$ 2.4 billion in 1996 to \$ 6.2 billion in 2013 at an annual growth rate of 5.4%. Statistics show that the growth rate of the total medicinal plants trade has grown by 10.7% over 18 years (Tripathi et al., 2017). Meanwhile, the area under the cultivation of medicinal plants in Iran in 2017 was 150,000 hectares, which exported \$ 450 million of medicinal plants abroad. Of that, \$ 230 million was for saffron, \$ 20 million for cumin, and \$ 200 million for other medicinal plants (Ministry of Agriculture Jihad, 2016).

Today, the importance of medicinal plants is growing. Millions of people are active in the field of planting and harvesting and other aspects of medicinal plants. Due to the long history and ancient origins of medicinal plants and climatic diversity in Iran, this research has been conducted to investigate the effect of medicinal plants cultivation on rural livelihoods in South Khorasan province as one of the leading provinces in the field of medicinal plants. According to the research studies conducted by researchers in the world and Iran, the role of medicinal plants in rural livelihoods has not been addressed and it can be considered as an innovative aspect of this research. In this regard, there is no comprehensive alignment between the findings of this study and other studies in the field of medicinal plants; however, it is possible to discuss the results of some aspects of livelihood capital with a number of studies in this field.

Iran has traditionally been known as a country with a long history of using plants used for therapeutic reasons (Sharafzadeh & Alizadeh, 2012). Over 8000 species of plants have been identified in Iran's flora, with 1100 of them being used in traditional Iranian medicine (Omidbaigi, 2011). Each year, over 4000 tons of medical herbs are grown, and nearly 40 million hectares of Iranian land have been set aside for medicinal herb production (Iran Daily, 2015). According to Iran's sixth national development plan, around 500,000 ha of rangelands and forests have been set aside for the cultivation of medicinal plants. Khorasan province is believed to have the highest cultivated lands and diversity of medicinal plants. It encompasses 7% of the nation's cultivated medicinal species' overall land area and 38% of this province's total land area. Acknowledging the economic significance and utilization

of medicinal plants, it is crucial to raise awareness about these plants as valuable natural resources. In fact, demand for medicinal plants is growing in developing nations, with evidence that a significant number of customers in industrialized countries are now turning to herbal treatments (Jafari, 2017). Medicinal plants' use represents a constant interest as sources of novel medicines among Iranians (Ahmadipour et al., 2016). Fruit and leaves from diverse plant species (both wild and cultivated) are crucial for resolving human health concerns and food poverty, especially in Iran (Parsaei et al., 2016).

Traditional healthcare systems for the majority of the population are based on medicinal plants. Many people in Iran are reported to seek health security from plants (Jamshidi-Kia et al., 2018). As a result of the growing human population and the frequently insufficient supply of modern medicine, the demand has been rising (Buso et al., 2020). The culturally connected traditions, community faith in traditional medicine, and the comparatively inexpensive cost of employing medicinal plants are among the main reasons why medicinal plants are in demand in south Khorasan. Today, most people in rural regions rely on medical plant products for a considerable portion of their sustenance and revenue (Azizi & Keshavarzi, 2015).

The real help for the villagers is not a supportive arrest, but a change in their livelihood (Hossain et al., 2018; Kuniyal et al., 2015; Noorhosseini et al., 2020; Yu et al., 2020). Given the prevalent issues in rural communities, such as limited access to information, low skill levels, a lack of entrepreneurial culture, and ethnic and tribal disparities, it is imperative to focus on establishing infrastructure that fosters innovative approaches to organizing activities, expanding job opportunities, and optimizing resource utilization, all with a forward-thinking perspective (Hua et al., 2017; Su et al., 2019). In order to overcome these obstacles and create sustainable rural lifestyles, one must use the inherent resources of the local community. The framework for sustainable livelihoods is based on the premise that people must fulfill their livelihood goals, which require the utilization of a wide range of assets, and that no single type of asset is sufficient to meet all the needs of rural people (Daskon & McGregor, 2012; Gyawali et al., 2019; Petry et al., 2011; Veisi et al., 2014; Renaud et al., 2016). However, poor people have limited access to finance; they are looking for ways and methods to be able to combine their assets to meet their needs. The livelihood capitals, in fact, are considered the determinants of the basis of the lives of people in human settlements, especially in village zones (Bhandari, 2013; Mbiba et al., 2019; Nath et al., 2020). They include 5 categories: social capital, human capital, environmental capital, physical capital, and economic capital (Loison, 2019).

The pursuit of personal gain and well-being and the overuse of chemicals today have not only reduced food production, but also created enormous environmental, social, and economic problems (Nicolopoulou-Stamati et al., 2016). In almost every country on the planet, including Iran, the extreme use of chemicals to achieve high crop yields and compensation for resource shortages have led to the destruction of soil, water, and natural resources (Morteza et al., 2017). The severity of environmental degradation due to improper agricultural practices has attracted the attention of experts to farming systems that are environmentally sustainable (Gomiero, 2016). The production of medicinal plants is therefore one of the solutions to tackle the degradation of natural resources and producing medicinal products. These products do not harm the environment and are very beneficial to human health (Akinyemi et al., 2016). Iran also has this trend in its work plan, and South Khorasan, as mentioned earlier, is one of the poles of medicinal plants in the country. Different medicinal plants are cultivated in South Khorasan and from the studied sample, the amount of planting and harvesting of all cultivated medicinal plants per hectare was questioned. The correlation coefficient was calculated to examine the relationship between the harvest

rate of each medicinal plant and the livelihood of the villagers. The medicinal plants discussed in this review are those that have been shown to be effective in treating a variety of ailments and had a significant impact on the livelihood of the villagers. Other medicinal plants that were not related to the livelihood of the farmers were excluded from the study.

The sustainable rural livelihoods approach, which seeks to alleviate rural poverty, is one of the major issues in developed countries' approaches that try to address the problem of poverty and vulnerability of households (Philips & Potter, 2003). With the trend changes in the concepts of rural development, it can be said that the dominant issues in rural development are currently focused on reducing rural poverty, shaping the potential of indigenous knowledge, promoting the use of a collaborative approach, focusing on gender issues, etc. (Ebrahimi, 2012). In addition, increasing poverty and hunger eradication approaches is one of the Millennium Development Goals. Poverty is one of the oldest types of social damage in all societies. Since the last decades of the twentieth century, attention has been drawn to poverty alleviation and the protection of vulnerable income groups at the international level, and in most countries around the world, this has been on the agenda of governments. On the other hand, the prerequisite for development is to pay attention to the rural areas as a major part of the population because rural regions are home to the bulk of the world's poor (World Bank, 2018). Major factors affecting the poverty of the villagers are economic factors, social relations, and employment. The basis of human and economic development is livelihood. Due to the above challenges in agriculture in rural areas and the aforementioned problems at the provincial level, the issue of changing the pattern of cultivation has been considered more and more and the cultivation of medicinal plants in this area can be helpful.

The indiscriminate harvesting of medicinal and aromatic plants (MAPs) harvested from their natural environments has an impact on their availability and places these plants' survival in jeopardy. As a result, methods for encouraging cultivation must be sought in order to maintain these plants and improve livelihoods in native societies. Understanding the factors that influence MAP cultivation is crucial, particularly in developing countries, but research on the topic is scarce (Negi et al., 2018). According to a report undertaken by Saeedi-garaghani et al. (2017), their findings revealed that the cultivation of medicinal plants can help rural communities to create more working conditions. Moreover, these plants help the livelihood of villagers, and their production helps improve the pharmaceutical industry and promote livelihoods and development. Balancing economic and social well-being for local communities with the imperative of nature conservation. To address the urgent problems of rural livelihoods, infrastructure measures should be implemented that promote innovative methods to organize activities, job diversification, and resource utilization with a forward-thinking approach, because today's rural communities are frequently confronted with information poverty, low skills, poor entrepreneurship culture, and ethnic and tribal inequalities (Hua et al., 2017; Su et al., 2019). According to Sharifi et al. (2018), sustainable rural livelihood is one of the approaches that tries to solve the problem of rural poverty and vulnerability of households based on human beings. The sustainable livelihood approach helps development activities to be people-centered, accountable, participatory, multilevel, guided, dynamic, and sustainable.

Agriculture is a significant source of income for the majority of rural and urban households in developed countries; with the changes in climatic conditions and consequently the methods of production and marketing, changes must be made in the methods of rural livelihood and they should move towards sustainability. The villages would benefit most from changing their way of life rather than receiving supporting care. Infrastructure improvements should be made to create new systems of activity organization, employment variety,

and resource exploitation with a forward-looking perspective in order to lessen the immediate issues associated with living in rural regions. The severity of issues will diminish as a consequence of the factors mentioned, running concurrently with the rise in sustainable income and the improvement of villagers' livelihoods closely tied to agriculture and the utilization of medicinal plants (owing to reduced water demands and adaptability to challenging environmental conditions).

The overall goal of this research is to look into the function of cultivating medicinal plants in improving rural livelihoods. Additionally, this study aims to identify and rank the key aspects of livelihood assets and prioritize the most impactful native medicinal plant species on rural livelihoods in the area. Therefore, we present the following three hypotheses:

H₁ The government has a critical role in the development of rural livelihood by providing loans and facilities for the farmer population.

H₂ Cultivating medicinal plants has a great influence on improving livelihoods, poverty reduction, and increasing the income of rural households.

H₃ Each of the studied medicinal plants has medicinal properties that can be used traditionally or in the pharmaceutical industry.

2 Research background and conceptual framework

South Khorasan province is one of the eastern provinces of Iran. The climate of this province is dry and the difference between day and night temperatures in this province is high. Therefore—due to the special climatic characteristics of this province—the cultivation of medicinal plants such as saffron, jujube, cumin, and barberry is common in this province.

As per Hemmati et al. (2015), saffron (*Crocus sativus*) is recognized as a valuable medicinal plant known for its ability to lower lipid and cholesterol levels in the bloodstream. It contains essential compounds such as crocetin, crocin, various carotenoids (e.g., Beta-carotene, lycopene, and xanthin), and vitamins (e.g., Riboflavin and thiamine) that benefit the body. In addition, as stated by Sheng et al. (2006) and Moravej Aleali et al. (2019), this valuable plant is also used in traditional medicine to treat disorders such as diabetes mellitus. Rahman et al. (2018) stated that Jujube contains a high percentage of protein and carbohydrates and a significant amount of vitamin C and minerals. In addition, jujube contains large amounts of ziziphic and zizimauritic acids (Sidhu & Zafar, 2020). Hence, saffron has a notable impact on reducing blood glucose levels (Jeong & Kim, 2019), triglycerides (Shahrajabian et al., 2019), as well as LDL and cholesterol levels (Shirdel et al., 2009). As shown by Dąbrowski et al. (2018), another medicinal plant that is used for treating diabetes is barberry (*B. vulgaris*). Barberry is a rich source of the oxyacanthine and berbamine alkaloids. It is also a source of carbohydrate, malic acid, tartaric acid, and resin (Emamat et al., 2020), which may help diabetic patients lower their blood sugar levels (Alemardan et al., 2013; Rashidi et al., 2018).

As shown by Srinivasan (2018), cumin, as a medicinal plant, has an important role in strengthening the immune system and preventing diseases. In addition, Mollazadeh et al. (2017) and Ramadan (2007) have shown that cumin, with its high levels of interferon, is

a booster of the immune system that prevents cancer. Hosseini et al. (2018) conducted research to examine the *in vitro* stress-relieving properties of black cumin and its potential for cancer prevention in Sprague Dawley rats. Their results show that black cumin is more than 80% effective in controlling stress, inflammatory diseases, and carcinogenesis. Rural development theory, after the middle of the twentieth century, has moved beyond the three main intellectual bodies, namely population and technology models, agricultural development, and political economy theories, and has focused on new approaches such as sustainable living, good governance, poverty reduction, and so on. Meanwhile, the sustainable livelihood approach, as one of the new approaches to sustainable rural development, is a way of thinking and trying to achieve development that emerged in the late 1980s with the goal of progress and poverty alleviation among rural communities, and the focus on the sustainable rural livelihood approach became important for three reasons. First, it is a prerequisite for the survival of the human population. Second, it is a necessary condition for good agriculture and sustainable management, and third, it is a tool to prevent the process of urban migration from rural areas. Many studies have been conducted on rural livelihood in various regions of the world. Some of them are mentioned in Table 1.

According to the researcher's documentary studies and by reviewing different types of rural livelihood models, it became clear that in most cases, five livelihood capitals were measured and the role of the cultivation of medicinal plants in improving the rural livelihoods has not been studied so far. In this regard, the role of cultivating medicinal plants in improving rural livelihoods can be considered an innovative aspect of the current research.

In this regard, the impact of the two variables "medicinal plants cultivated areas and different varieties" on the livelihoods of rural households was investigated. In this way, rural livelihoods (status of five physicals, environmental, human, economic, and social capitals), as well as the impacts of medicinal plants cultivated areas and different varieties on the rural livelihood (increasing income and savings and reducing poverty), were measured (Fig. 1).

The five main livelihood capitals are as follows:

- (1) Social capital: Resources and wealth are referred to as social capital that individuals and communities can access in a private way through communication (Loison, 2019; Shahini et al., 2014; Zinda & Kapoor, 2019).
- (2) Human capital: Skills, fitness, and the capacity to perform are also examples of human capital to achieve the goals of livelihood for individuals and businesses (Shen, 2009).
- (3) Environmental capital: Rural environments, due to their special geographic location in the position of the land, have the highest relationship with the environment and environmental resources. The environmental environment is the main asset for the life and livelihood of villagers, and most of the economic and livelihood activities of the villagers are directly related to the environment and environmental resources. Environmental capital is a term that is used for the availability of environmental resources such as land, water resources, air quality, etc. (Kollmair & Gamper, 2002).
- (4) Physical capital: In general, physical capital is one of the most significant sources of long-term economic viability and capacity for the development (Adonteng-Kissi & Adonteng-Kissi, 2018) of the society and creates correct structures in society, especially in facilitating the process of using the existing capacities and other assets in the rural environment (Sojasi-gheidari et al., 2016).
- (5) Economic capital: Economic capital refers to economic resources (cash, bank accounts, current assets, retirement income, pensions, grants, and remittances) that are used

Table 1 Studies related to livelihood in the world

Title	Findings	References
“Livelihood sustainability in a rural tourism destination”	Improvement in the diversity of livelihoods among residents using a multifaceted strategy with cooperative communications between tourism and other sources of income will enhance the sustainable livelihood of all	Su et al. (2019)
“Promoting medicinal plant production in the Indian Himalaya as a medium for biodiversity conservation and subsistence enhancement”	Identifying economic, social, cultural, and environmental factors that affect medicinal plants’ long-term viability	Negi et al. (2018)
“The effect of local market formation on the sustainable livelihoods of rangeland farmers using numerical taxonomy”	From the point of view of the nomads, economics and economic capital, and from the viewpoint of experts, human capital had the most impact on the formation and development of local markets	Saeedi-garaghami et al. (2017)
“Assessing the importance of livelihood assets in appropriate livelihood strategies: A protocol for anti-poverty policy in China’s Eastern Tibetan Plateau”	The environmental, human, and economic assets significantly affect livelihood strategies	Hua et al. (2017)
“Investigating the status of livelihood capitals and their sustainability in rural households”	Social, human, and physical capital were in a moderate situation, and economic and environmental capital were weak	Sharifi et al. (2018)
“Measuring the level of livelihood capitals in rural areas with the sustainable livelihood approach”	The status of social capital was higher than other aspects of livelihood capitals. Then, the physical, economic, institutional, and human capitals were placed, respectively.	Sojasi gheidari et al.(2016)

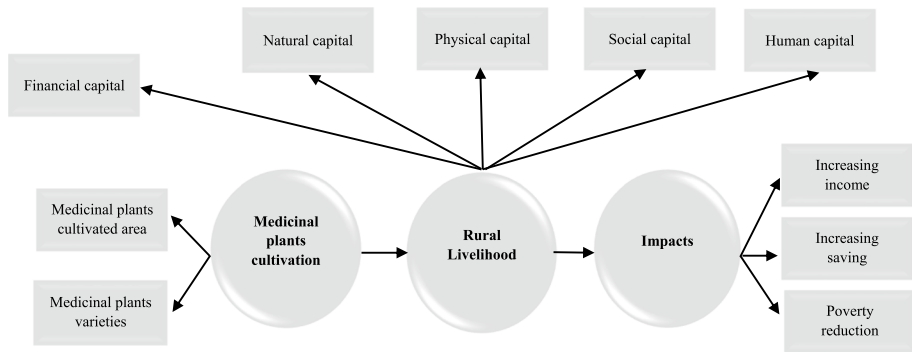


Fig. 1 Conceptual model

to maintain the present livelihood or improve the livelihoods of the people. These resources include savings, income, investment, and credit (Hou et al., 2018; Sojasi-gheidari et al., 2016).

3 Material and methodology

3.1 Study area

Iran, with 11 of the world's 13 ecosystems, 300 sunshine days a year, and a temperature differential of 40 to 50 degrees Celsius between the coldest and warmest points in the region, has created ideal conditions for the development of a unique ecosystem; these conditions have provided the basis for medicinal plants in Iran so that there are more than 90% of the world's plant species in Iran, making Iran one of the most susceptible countries in the world for medicinal plants. Various crops are produced in different climates of Iran. Iran has over 10,000 species in terms of plant diversity in the world, which is equivalent to the plant species in the European region. Out of 8000 species of medicinal plants in the world, up to 2300 species of medicinal plants have been identified in Iran.

South Khorasan province in Iran is one of the provinces with high possibilities for medicinal plant production. The average rainfall is 133 mm per year; regular winds with an average speed of more than 4 m/s on 223 days per year and sunny skies over 300 days per year are the climatic features of this province. These conditions have made the province prone to the cultivation of a large number of medicinal plants; as the figures show, South Khorasan province has high plant diversity and has 1200 known plant species. South Khorasan province accounts for about 10% of Iran's plant diversity, and out of about 150,000 hectares of agricultural and horticultural land, about one-third of it (5,000 hectares) is devoted to medicinal plant cultivation. In the province, there is a lot of medicinal plant production, adding saffron, reaching 131,000 hectares (Fig. 2).

Despite the high potential in South Khorasan, due to the arid climate, rainstorms, occasional rain, prolonged periods of heat, intermittent droughts, and groundwater depletion in the province, agriculture faces many challenges such as increasing the unemployment rate, increasing disparities in urban and rural income levels, migration,

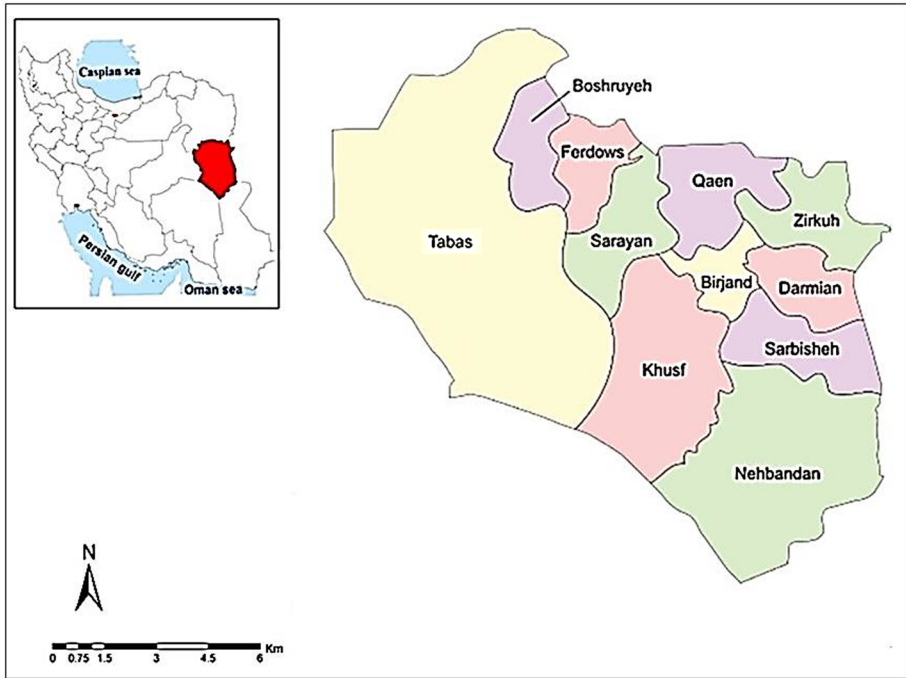


Fig. 2 South Khorasan province

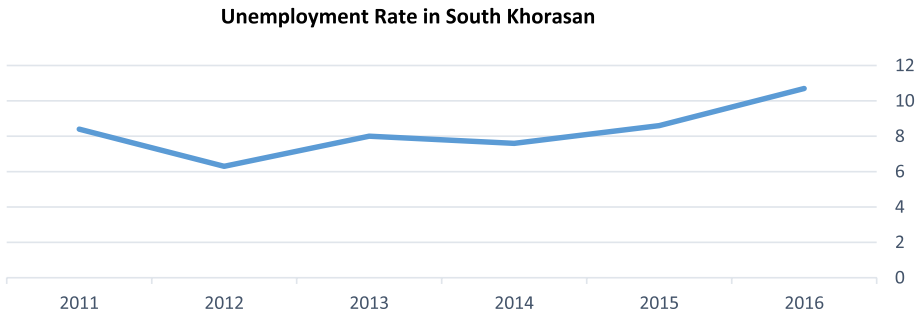


Fig. 3 Unemployment trend in South Khorasan province. (Reference: Iran Statistical Center (2016))

and the spread of false jobs. Figure 3 shows the rising rate of unemployment in South Khorasan province during 2011–2016.

Figure 4 shows the downward trend of employment share of the agricultural sector in South Khorasan province which shows the relative decline in the share of the agricultural sector from the total employment that has fallen from 37.5% in 2012 to 32.9% in 2016.

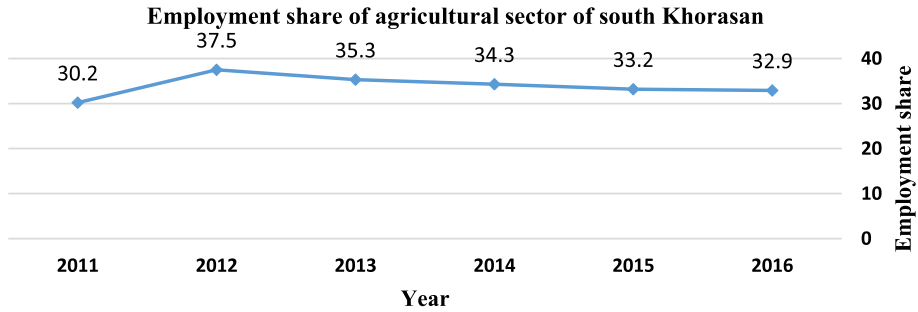


Fig. 4 Employment rate share of the agricultural sector of South Khorasan province. Reference: (Iran Statistical Center (2016))

4 Research method

The statistical population of the research includes 9178 medicinal plant farmers of South Khorasan province in the year 2019. The sample size, according to the Krejcie and Morgan table, was determined to be 368. A questionnaire was used to gather data for this analysis. The content and face validity of the test instrument were checked and updated in this analysis based on the views of a panel of experts. 30 copies of the designed questionnaire were distributed to farmers in Sarayan as part of a pilot test to determine its reliability. Using SPSS, the Cronbach alpha coefficient for these completed questionnaires was determined and the results were presented in Table 2.

The questionnaire was found to have high reliability based on the obtained coefficients, as the Cronbach alpha coefficient for all sections of the questionnaire was 0.7 or higher. In addition, because of the problems with the Cronbach alpha method, which includes considering the same value for all questions of a construct, the composite reliability method was used in this study and its coefficients were listed in Table 2. A construct with a CR value greater than 0.6 is considered reliable (Bagozzi & Yi, 1998). The closer this value is to one, the more trustworthy it is. Furthermore, the diagnostic validity was determined by determining the average variance extracted (AVE) index, in addition to determining the method of content and face validity.

The questionnaire consisted of 3 different parts: 1) Medicinal plant cultivation, 2) Livelihood, and 3) Impact.

Medicinal plant cultivation: it consisted of saffron, barberry, cumin, and jujube production per hectare. Livelihood was the mediator variable measured using a total of five economic, environmental, social, physical, and human capitals. Multiple items were used to measure each capital, and every object was graded on a Likert scale (1=extremely low, 2=low, 3=medium, 4=high, 5=extremely high). The variables of economic, environmental, physical, social, and human capital included 12, 7, 7, 11, and 9 items, respectively (Table 2). The impacts (increased income, reduction in poverty, and increased savings) were also calculated as a composite index of items “after medicinal plants cultivation” using dividing by mean method for the elimination of scale bias (Table 3).

Table 2 The livelihood capitals

Variables	Items	References
Economic ($\alpha = 0.87$, $AVE = 0.50$, $CR = 0.82$)	Access to credit and loan facilities to cultivate medicinal plants	Asghari Sarskanroud et al. (2016), Sojasi Gheidari et al. (2016), Abdollahzadeh et al. (2015)
	Amount of income from the cultivation of medicinal plants and related occupations	Sharifi et al. (2018), Noroozi & Hayati (2015), Abdollahzadeh et al. (2015), Shen (2009), Tian et al. (2016), Keshavarz et al. (2017), Su et al. (2019), Njole (2011) Sharifi et al. (2018)
	Ability to repay the loan	Sojasi Gheidari et al. (2016)
	Access to capital	Sojasi Gheidari et al. (2016)
	Access to production resources (fertilizer, seed, etc.)	Sojasi Gheidari et al. (2016)
	Ability to have savings	Ali Beigi & Mehdizade (2016), Abdollahzadeh et al. (2015)
	Satisfaction with savings	Ali Beigi & Mehdizade (2016)
	Providing suitable job opportunities for youth and other people in the village	Sojasi Gheidari et al. (2016)
	Improved income status	Abdollahzadeh et al. (2015)
	Occupational safety due to the planting of medicinal plants (occupational and retirement insurance)	Abdollahzadeh et al. (2015)
Environmental ($\alpha = 0.72$, $AVE = 0.52$, $CR = 0.82$)	Hope for future career and career development	Abdollahzadeh et al. (2015)
	Total household savings	Ellis (2000)
	Increasing the variety of agricultural products	Eftekhari et al. (2014)
	Increasing vegetation in the area	Quandt (2018), Sharifi et al. (2018)
	Reduction of soil erosion in arable lands	Quandt (2018)
	Maintaining rangelands to collect medicinal plants	Sharifi et al. (2018)
	Improving farm soil fertility	Sharifi et al. (2018), Sojasi Gheidari et al. (2016), Noroozi & Hayati (2015), Abdollahzadeh et al. (2015), Asghari Sarskanroud et al. (2016)
	Improvement of the growth rate of the plant	Abdollahzadeh et al. (2015)
	Sufficient water for the irrigation of fields and gardens	Abdollahzadeh et al. (2015), Noroozi & Hayati (2015), Sojasi Gheidari et al. (2016)

Table 2 (continued)

Variables	Items	References
	($\alpha = 0.75$, AVE = 0.50, CR = 0.79)	
Physical	Reducing product transportation problems compared to other agricultural products (corruption, etc.)	Sojasi Gheidari et al. (2016), Abdollahzadeh et al. (2015), Quandt (2018)
	Convenient transportation facilities for marketing	Noroozi & Hayati (2015)
	Access to agricultural machinery and equipment for planting and maintaining medicinal plants	Sharifi et al. (2018), Sojasi Gheidari et al. (2016), Abdollahzadeh et al. (2015)
	Easier marketing and access to market	Noroozi & Hayati (2015), Sojasi Gheidari et al. (2016)
	Less energy needs on the farm	Ali Beigi & Mehdizade (2016), Sharifi et al. (2018)
	Proximity of the workplace to the living environment	Sojasi Gheidari et al. (2016)
	Development of complementary agricultural industries in the field of medicinal plants	Savari et al. (2022)
	($\alpha = 0.82$, AVE = 0.52, CR = 0.92)	
Social	Ali Beigi & Mehdizade (2016), Asghari Sarskamroud et al. (2016), Sojasi Gheidari et al. (2016)	Ali Beigi & Mehdizade (2016), Sojasi Gheidari et al. (2016)
	Njole (2011)	Njole (2011)
	Ali Beigi & Mehdizade (2016)	Ali Beigi & Mehdizade (2016)
	Ali Beigi & Mehdizade (2016)	Ali Beigi & Mehdizade (2016)
	Ali Beigi & Mehdizade (2016), Sojasi Gheidari et al. (2016)	Ali Beigi & Mehdizade (2016), Sojasi Gheidari et al. (2016)
	Sojasi Gheidari et al. (2016)	Sojasi Gheidari et al. (2016)
	Noroozi & Hayati (2015), Keshavarz et al. (2017)	Noroozi & Hayati (2015), Keshavarz et al. (2017)
	Sojasi Gheidari et al. (2016)	Sojasi Gheidari et al. (2016)
	Ali Beigi & Mehdizade (2016), Motiee Langroudi et al. (2011)	Ali Beigi & Mehdizade (2016)
	Sojasi Gheidari et al. (2016), Yang et al. (2018)	Sojasi Gheidari et al. (2016), Yang et al. (2018)
	Noroozi & Hayati (2015), Sojasi Gheidari et al. (2016), Abdollahzade et al. (2015)	Noroozi & Hayati (2015), Sojasi Gheidari et al. (2016), Abdollahzade et al. (2015)

Table 2 (continued)

Variables	Items	References
	($\alpha = 0.77$, AVE = 0.50, CR = 0.83)	
Human	Asghari Sarskanroud et al. (2016)	Asghari Sarskanroud et al. (2016)
	Ali Beigi & Mehdizade (2016)	Ali Beigi & Mehdizade (2016)
	Ali Beigi & Mehdizade (2016), Sharifi et al. (2018)	Ali Beigi & Mehdizade (2016), Sharifi et al. (2018)
	Ali Beigi & Mehdizade (2016)	Ali Beigi & Mehdizade (2016)
	Sharifi et al. (2018), Abdollahzade et al. (2015)	Ali Beigi & Mehdizade (2016), Sharifi et al. (2018), Abdollahzade et al. (2015)
	Ali Beigi & Mehdizade (2016)	Ali Beigi & Mehdizade (2016)
	Ali Beigi & Mehdizade (2016)	Ali Beigi & Mehdizade (2016)
	Ali Beigi & Mehdizade (2016), Asghari sarskanroud et al. (2016)	Ali Beigi & Mehdizade (2016), Asghari sarskanroud et al. (2016)
	Ali Beigi & Mehdizade (2016)	Ali Beigi & Mehdizade (2016)

5 Results

According to the results, out of the 368 medicinal plant farmers, 263 (71.5%) and 105 (28.5%) were male and female, respectively. Most of them (318 (86.4%)) were 16 years old and less experienced. Considering the education level of farmers, the maximum number was related to bachelor's and higher degrees (123 subjects (33.4%)), showing that most of the medicinal farmers are educated. The maximum frequency of the yearly profit from medicinal plant cultivation is around 1000 USD. Furthermore, according to the results of medicinal plant farmers, 239 (64.9%) farmers had less than 0.5 hectares of saffron cultivation, 248 farmers (67.4%) had less than 0.5 hectares of barberry cultivation, 305 people (82.9%) had a cumin cultivated area of less than 0.5 hectares, and 327 medicinal plant farmers (88.9%) had a jujube cultivated area of less than 0.5 hectares (Table 4).

The Pearson correlation test revealed that there is a strong and meaningful association between the two variables social, physical, economic, environmental, human capital and medicinal plants cultivation at 99% level. Furthermore, there is a strong and constructive connection between the farmers' total livelihood and cultivation of saffron, barberry, cumin, and jujube at 99% level (Table 5).

There was a strong and constructive connection between the two medicinal plants cultivation, increasing the savings and income of farmers, and poverty reduction after cultivating medicinal plants at 99% level. The results of Wilcoxon test showed that 188 people had lower poverty after cultivating medicinal plants (Table 6).

5.1 Models fit

The AMOS₂₂ software was used to confirm the models of the research. In this section, the measurement model of the livelihood and the general model of the research were tested. Given that the measurement model and general model of the research diagnostic validity and composite reliability were also strong, indicators such as the model's goodness of fit were assessed using the Chi-square to Degree of Freedom ratio (CMIN/DF), Goodness of Fit Index (GFI), Normal Fit Index (NFI), Tucker-Lewis Index (TLI), and Comparative Fit Index (CFI). However, the model's relative indices such as CFI and GFI were greater than 0.9. Finally, the models were well-suited in terms of the RMSEA (Root Mean Square Error of Approximation) index (Table 7) (Figs. 5, 6).

5.2 Total effects of the research models

In the measurement model, the maximum effect was related to the economic capital (0.777), environmental capital (0.768), human capital (0.714), social capital (0.712), and physical capital (0.642). It shows that the cultivation of medicinal plants has improved the economic and environmental capital more than other aspects. Saffron cultivation, with a standardized coefficient of 0.56, barberry cultivation, with a standardized coefficient of 0.47, cumin cultivation, with a standardized coefficient of 0.27, and jujube cultivation, with a standardized coefficient of 0.12, were rated 1 to 4 in the final model, showing the relative importance of each to the livelihood of medicinal plants farmers. The cultivation of these herbal plants explains 48% of the variance of the livelihood of medicinal plants farmers, and economic, environmental, human, social, and physical capitals (with standardized coefficients equal to 0.80, 0.78, 0.73, 0.70, and 0.64) had the most relative importance to

Table 3 Items of the impacts

Variable	Dimensions	References
Impacts	Income (\$)	Abdollahzadeh et al. (2015)
	Saving (\$)	Ali Beigi & Mehdizade (2016), Abdollahzadeh et al. (2015)
Multi dimensional poverty	Poverty	UNDP 201
	None of the household members have completed 5 years of schooling (Y/N)	
	None of the school-age children attend school (Y/N)	
	A child has died in the family (Y/N)	
	The household has no electricity (Y/N)	
	Family members do not have health insurance (Y/N)	
	Malnutrition of an adult or child in the family (Y/N)	
	Lack of access to municipal wastewater (Y/N)	
	Using firewood, charcoal, animal fuel, and coal for cooking (Y/N)	
	The family does not own a television, telephone, refrigerator, motor, car, or truck (Y/N)	
Lack of residential ownership (Y/N)		

Table 4 Descriptive statistics

Variable	Category	Frequency	Percentage	Mode	Mean
Gender	Male	263	71.5	Male	–
	Female	105	28.5		
Educational degree	Under diploma	78	21.2	Diploma	–
	Bachelor and higher	123	33.4		
		168	45.4		
Experience	$X \leq 16$	318	86.4	5	8.59
Max = 50	$X < 34 < 16$	37	10.1		
Min = 1	$34 X >$	13	3.5		
Yearly Profit \$	$X \leq 1000$	351	95.4	500	550
Max = 3000	$1000 < X \geq 2000$	13	3.5		
Min = 10	$2000 X >$	4	1		
Saffron cultivation (ha)	$X \leq 0.5$	239	64.9	0.5	0.61
Max = 3.8	$0.5 < X \geq 1$	79	21.5		
Min = 0	$1 X >$	50	13.6		
Barberry cultivation (ha)	$X \leq 0.5$	248	67.4	0.5	0.78
Max = 3	$0.5 < X \geq 1$	22	6.00		
Min = 0	$X > 1$	98	26.6		
Cumin cultivation (ha)	$X \leq 0.5$	305	82.9	0.1	0.28
Max = 5	$0.5 < X \geq 1$	46	12.5		
Min = 0	$X > 1$	17	4.6		
Jujube cultivation (ha)	$X \leq 0.5$	327	88.9	0.1	0.18
Max = 5	$0.5 < X \geq 1$	35	9.5		
Min = 0	$X > 1$	6	1.6		

Table 5 The results of Pearson correlations between the variables of the research

Variables 1	Variable2	r	Sig
Social capital	Medicinal plants cultivation	0.371**	0.00
Physical capital	Medicinal plants cultivation	0.364**	0.00
Economic capital	Medicinal plants cultivation	0.536**	0.00
Environmental capital	Medicinal plants cultivation	0.521**	0.00
Human capital	Medicinal plants cultivation	0.497**	0.00
Livelihood	Saffron cultivation	0.541**	0.00
Livelihood	Barberry cultivation	0.440**	0.00
Livelihood	Cumin cultivation	0.207**	0.00
Livelihood	Jujube cultivation	0.106**	0.00
Medicinal plants cultivation	Income	0.578**	0.00
Medicinal plants cultivation	Saving	0.497**	0.00
Medicinal plants cultivation	Poverty reduction	0.248**	0.00

** Significantly at 1% error level

the livelihood impacts. The results showed that by cultivating medicinal plants and improving farmers' livelihoods, 68% of the livelihood impacts will be explained. The relative importance of this improvement will be for income, savings increase, and poverty reduction with standardized coefficients of 0.82, 0.65, and 0.48.

Table 6 Wilcoxon test

Categories	N	Mean rank	Sig.
Negative ranks	188	91.08	0.00
Poverty after planting < Poverty before planting			
Positive ranks	3	56.17	
Poverty after planting > Poverty before planting			
Ties	177		
Total	368		

Table 7 The results of the compliance of the measurement and structural model with fit indices

Fit Indices	Recommended criteria*	Results for structural model**	Results for measurement model**
CMIN/DF	Smaller than 3	2.171	1.936
GFI	Larger than or equal to 0.90	0.951	0.989
NFI	Larger than or equal to 0.90	0.921	0.932
CFI	Larger than or equal to 0.90	0.913	0.965
TLI	Larger than or equal to 0.90	0.944	0.929
RMSEA	Smaller than or equal to 0.08	0.056	0.050

* Maccallam, 1996; Joreskog & Sorbom, 1989

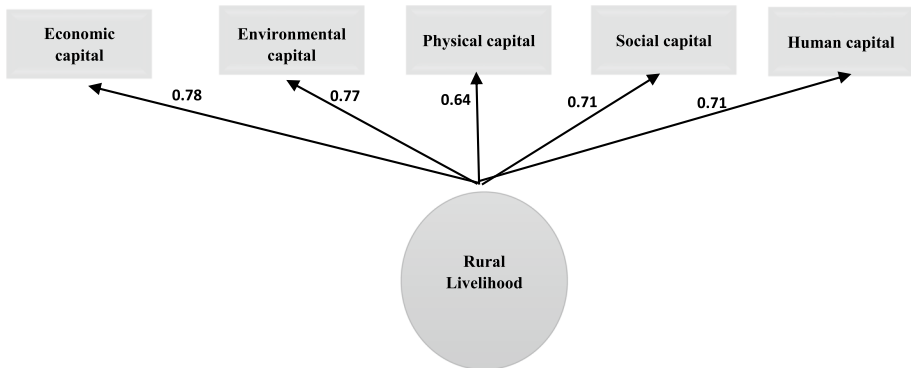


Fig. 5 Measurement model

In the following formula, all of the variables that directly affect the livelihood of medicinal plants farmers are depicted.

Medicinal plants farmers' livelihood = $(0.575) \times \text{Saffron cultivation} + (0.265) \times \text{Cumin cultivation} + (0.471) \times \text{Barberry cultivation} + (0.125) \times \text{Jujube cultivation}$ (Table 8).

The total impact of medicinal plants cultivation is calculated as follows:

The total impact of medicinal plants cultivation = $(0.861) \times \text{total medicinal plants cultivation} + (0.528) \times \text{medicinal plants farmers' livelihood}$.

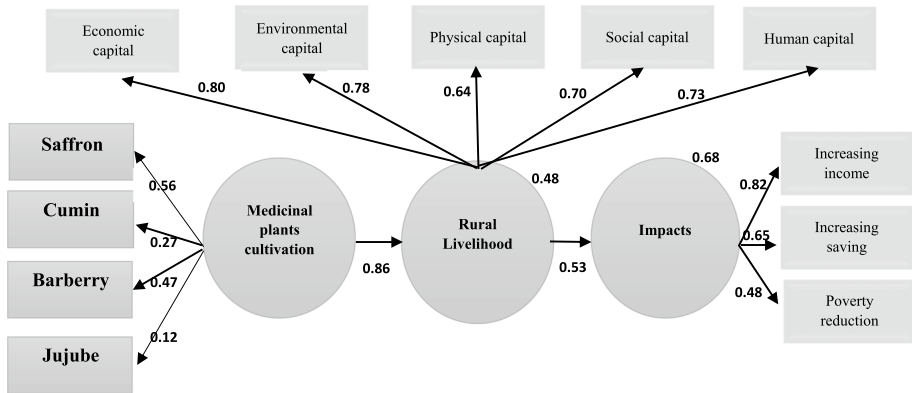


Fig. 6 Structural model

Table 8 The results of the total effect of variables

Independent variables	Dependent variable	Total effect
Saffron cultivation	Medicinal plants farmers' livelihood	0.575
Cumin cultivation	Medicinal plants farmers' livelihood	0.265
Barberry cultivation	Medicinal plants farmers' livelihood	0.471
Jujube	Medicinal plants farmers' livelihood	0.125
Medicinal plants farmers' livelihood	Impact	0.528

6 Discussion

The results of descriptive statistics showed that most of the medicinal plant farmers had a high level of education. Although Andriamparany et al. (2016) found that traditional knowledge had a tremendous impact on the acceptance and planting of medicinal plants, and these people often had the lowest level of education, in the current study, these educated people have been attracted to this sustainable market and this provides a new research area.

In addition, in confirming the measurement model of medicinal farmers' livelihood, cultivating medicinal plants in the region had the greatest impact on improving the economic and environmental capital of the region, which is a very noteworthy finding for planning and policy-making in this field.

Furthermore, based on the proposed regression model, it was shown that planting saffron and barberry significantly improves the livelihood of farmers, and based on this finding, holding training and extension classes and farm days can lead to attracting traditional farmers to this new market.

According to the results, the influence of livelihood capitals on the livelihood impacts is in decreasing order from economic, environmental, human, social to physical capital. This finding is very interesting and noteworthy, and the status of physical capital (the last rank) is in line with the findings of Huiqin et al. (2020). They studied the role of tourism in improving the livelihoods of households, in which physical capital (housing assets,

urable properties, and livestock worth) was ranked the lowest, and human capital (workforce, staff education, cognitive capability, and proficiency training period) was ranked the highest. This shows that such activities have not been effective in improving physical capital, and depending on the philosophy of the approach, tourism is more focused on the human capital aspect, and the cultivation of medicinal plants is more focused on the economic and environmental aspects. This finding shows that medicinal plants farmers still have problems with convenient transportation facilities for marketing, access to agricultural machinery and equipment to cultivate and maintain medicinal plants, and easier marketing and access to the marketplace.

Furthermore, this first place of economic capital improvement is inconsistent with the findings of Sharifi and Nooripoor (2018) and Omrani and Farajzadeh (2016). According to their findings, economic capital had the worst situation, indicating the profound effect of medicinal plants cultivation on improving livelihoods and its outcomes.

Furthermore, medicinal plant production and the enhancement of subsistence capitals are included for 68% of the variance of impacts but do not have the same effect on various aspects of livelihood outcomes. The cultivation of medicinal plants has increased income and savings and has had relatively smaller effects on multi-dimensional poverty reduction. Although Wilcoxon's results show that multi-dimensional poverty has improved significantly since the cultivation of medicinal plants, it is still far from the ideal state, requiring special attention to future policies. In addition, the results showed that based on standardized coefficients among different medicinal plants under this study, saffron and barberry cultivation should be a priority in planning and promoting. Regarding the positive effect of saffron cultivation on household livelihood, this observation is in line with Azimy et al.'s findings (2020). However, the effective role of barberry cultivation has been less discussed.

6.1 The livelihood and therapeutic effect of medicinal plants in this study

Saffron: Findings showed that the cultivation and production of saffron, along with creating and increasing a sense of satisfaction with saffron cultivation in farmers, have been able to increase social participation, sense of spatial belonging, or permanence of the population. Moreover, the increasing support from government agencies and organizations has increased the scope of social relations and interactions (Siddiqui et al., 2018).

Furthermore, the research conducted in the study area shows that saffron can cause social changes and mobilize the rural economy and it can be a good source of income for the poor and vulnerable rural groups. Therefore, it seems that according to the results, this product can be an effective step towards sustainable agriculture and rural development. Some of the health benefits of saffron include improving respiratory health, strengthening the digestive system, relieving pain, improving sleep habits, reducing bleeding, strengthening heart health, increasing blood circulation, preventing diabetes, strengthening bones, and improving the immune system (Gohari et al., 2013).

Barberry: Barberry is one of the unique products that is widely cultivated in South Khorasan province and from an economic point of view, it has a vital role in creating added value and employment in the livelihood of people in rural areas. This plant also has several healing properties, the most important of which are preventing chronic bleeding and reducing mucous secretions and blood pressure (Tatari et al., 2019). The advantages of barberry include preventing ischemia-induced ventricular tachyarrhythmia, improving heart contractility, and lowering peripheral vascular resistance and blood pressure (an active constituent

of barberry). Many studies have shown that a variety of medicinal plants can help to reduce the symptoms of metabolic syndrome, such as dyslipidemia and hypertension (Imensahidi & Hosseinzadeh, 2019; Kalmarzi et al., 2019).

Cumin: Cumin is a valuable plant in terms of medicinal properties. One of the main goals and motivations of farmers in choosing medicinal plants as cultivation activity is their high profitability compared to different types of other crops. In particular, some of these plants can be grown and produced in unfavorable and restrictive conditions. Some of its medicinal properties are being a disinfectant, being a gastrointestinal strengthener, and treating nervous weakness and bronchitis (Hosseini et al., 2019).

Cumin extracts protect against a variety of biomolecular damage types that affect peroxynitrite-induced damage to proteins, lipids, and DNA is especially dangerous (Ho et al., 2008). Cumin and other spices were studied for their effects on bile secretion rates and bile acid content by Dimitrijevi et al. (2018). The spices were given either as a single oral dose or as a dietary supplement. The findings revealed that dietary intake had a significant impact on bile secretion rate and single-dose intake has only a slight effect on bile acid content.

The seeds were used for a variety of purposes, including aromatic, thermogenic, diuretic, expectorant, purgative, stimulant, sudoriferous, sedative, and carminative. Skin infections, jaundice, bowel issues, anorexia, conjunctivitis, dyspepsia, rheumatism, diabetes, amenorrhea, anorexia, asthma, cough, bronchitis, headache, fever, pneumonia, and eczema are among the more common ailments that have been treated with cumin seeds in traditional Arabic herbal medicine (Dehaghi & Mollifilabi, 2011; Sayeed et al., 2014).

Jujube: Jujube plays a significant role in the villagers' economy and profits, especially in South Khorasan, because it is one of the major horticultural products in the region. This medicinal plant has a large share in the economy of this region because the income of thousands of rural households depends on the production of jujube and the development of jujube cultivation, as a plant resistant to water shortages can have a significant impact on reducing unemployment. Jujube purifies the blood, removes toxins from the body, and prevents heart problems (Rajaei et al., 2020). Furthermore, the fruit of Jujube has gained wide attention in folk herbal medicine for the treatment of a wide range of disorders. Anti-diabetes, anti-cancer, anti-inflammatory, anti-obesity, immunostimulating, antioxidant, hepatoprotective, and gastrointestinal defense properties, as well as the suppression of macrophage foam cell forming, have been demonstrated in jujube fruit phytochemical studies (Alizadeh et al., 2017).

7 Conclusion

Considering the importance of planting herbs to rural livelihoods and their positive role in compatibility with climate change and weather conditions and according to the results of this research, the following points are recommended:

Given that economic capital has the highest priority in livelihood measurement in this research, providing loans and facilities in the field of medicinal plants and agricultural equipment is one of the solutions that help the government pave the way to expand the planting and export of these crops through production incentives. Establishing rural credit funds or rural banks can also be useful to facilitate planting and equipping medicinal plants farms. Given the second-order impact of environmental capital on rural livelihoods in this study, formulating crop products and promoting crop yields by creating added value and

preventing raw crop sales provide a better opportunity for potential crop markets and a better return for farmers. Aside from the region's high potential for medicinal plant production, planting these crops in waste and marginal lands as part of a participatory management action plan will strengthen the livelihoods of disadvantaged farmers, which should be a priority for planners. In this context, Poly pits, which can be termed the "poor man's growth chamber", are the best solution for planting medicinal plants and protecting them from climate change. These Poly pits are made of recycled plastic and offer a wide range of applications, installation, and commissioning; Poly pits provide the plant with proper conditions for growth and protect the plant against environmental stresses. This solution will have a great impact on protecting environmental capital and improving physical capital. According to the third rank of human capital impact on livelihood, in order to familiarize farmers with innovative and different methods in the field of medicinal plants, the status of knowledge management components should be a research priority, and knowledge and information in this field must be recorded, stored, expanded, and shared throughout the world. Membership and participation in cooperatives should be one of the priorities for policymakers, and the associated co-operatives and NGOs in the region should have sufficient mobility. Through high bargaining power, it will be possible to attract credits, incentives, and exemptions. Concerning the impact of different varieties of medicinal plants on improving livelihoods, poverty reduction, and increasing the income and savings of rural households, it is recommended that saffron planting needs to be the first priority, and barberry, cumin, and jujube need to be considered as the next priorities. It is also recommended that researchers and experts in this field try to identify and introduce quality cultivars to farmers.

In order to improve the field of medicinal plants, it seems necessary to pay attention to the following issues: Consideration should be given to creating coherent and continuous cooperation between the organizations and institutions related to the medicinal plant sector; making maximum use of the power; benefiting from and using the local and advanced infrastructure; reviewing and updating the relevant laws, regulations, and standards; organizing the management of resources; and protecting basic resources.

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Availability of data and material We confirm that the data, models, or methodology used in the research are proprietary and the derived data supporting the findings of this study are available from the first author on request.

Declarations

Conflicts of Interest The authors have no conflicts of interest.

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Authors and Affiliations

Mahboubeh Dalir¹ · Shahla Choobchian¹  · Enayat Abbasi¹ · Marie-Laure Fauconnier² · Thomas Dogot³ · Rando Värnik⁴ · Hossein Azadi³ 

✉ Shahla Choobchian
shchoobchian@modares.ac.ir

¹ Department of Agricultural Extension and Education, College of Agriculture, Tarbiat Modares University (TMU), Tehran, Iran

² Department of Chemistry for Sustainable Food and Environmental Systems (CSFES), Gembloux Agro-Bio Tech, University of Liège, Gembloux, Belgium

³ Department of Economics and Rural Development, Gembloux Agro-Bio Tech, University

of Liège, Gembloux, Belgium

⁴ Institute of Agricultural and Environmental Sciences, Chair of Rural Economics, Estonian University of Life Sciences, Tartu, Estonia

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