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Prioritizing Effective Factors on Development of Medicinal Plants Cultivation using Analytic Hierarchy Process (Case study: North Khorasan Province, Iran)

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ABSTRACT This research conducted in order to prioritize the effective criteria on development of medicinal plants cultivation in North Khorasan Province using Analytical Hierarchy Process (AHP) and Delphi methods. For this purpose, a list of effective factors offered to delphi group. Analysis of delphi process showed that among 23 offered factors 19 factors, had greater impact on development of medicinal plants cultivation. Hierarchy tree was drawn through grouping of 19 factors into four criteria including economic, promotional-educational services, cultural-social and supportive policies factors. The pair wise comparison questionnaires were then distributed among relevant researchers and experts of the province to get their opinions about the priority of criteria and sub- criteria. The questionnaires were analyzed using Expert Choice software. The result revealed that economic criterion with respective weight of 0.406 had the most impact among four criteria affecting the development of medicinal plants cultivation. The supportive policies (respective weight of 0.275), educational-extension services (respective weight of 0.193) and cultural-social factors (respective weight of 0.125) received the maximum towards the minimum priorities, respectively. The results of synthesis process showed that among the 19 factors, the guaranteed purchase and establishing of pilot fields of medicinal plants, farmers' awareness of comparative advantage of medicinal plants, and the development of processing industries had the maximum towards minimum impacts on development of medicinal plants cultivation.

Key words: *Analytical Hierarchy Process, Iran, Medicinal plants, North Khorasan Province*

1 INTRODUCTION

Iran's economy is highly dependent on the production and export of crude oil and consequently is vulnerable to economic-policy problem. In order to solve this problem, the development of crops suggests to improve economic situation and to increase non-petroleum export (kashfibonab, 2010). Iran is a country with different climate conditions and in result rich plant flora. Beside a long history in use and production of medicinal plants, but report of the Iran medicinal plant on production and consumption is not suitable. In Iran medicinal and aromatic plants are cultivated

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today on an area of about 70,000 ha and relatively 90 species are cultivated commercially on a large scale in Iran (Sefidkon, 2008). Prioritization Factors affecting the cultivation of medicinal plants is essential, which can be helpful in macro provincial programming. The two Analytic Hierarchy Process (AHP) and Delphi method are considered as common methods in prioritization of issues (Dalkey & Helmer 1963; Saaty, 1980). The Delphi method seeks to aggregate opinions from a diverse set of experts in various fields of study such as social, economical and urban Dalkey & Helmer (1963). The objective of this method was devised in order to obtain the most reliable opinion consensus of a group of experts by subjecting them to a series of questionnaires in depth interspersed with controlled opinion feedback Powell (2003). The Delphi method is a strongly structured group communication process, in subjects on whom naturally unsure and incomplete knowledge is available are judged upon by experts.

The AHP is structured technique for dealing with complex decisions that was developed by Thomas L.Saaty in 1980. It provides a comprehensive and rational framework for structuring a decision problem for representing and quantifying its elements, for relating those elements to overall goals and for evaluating alternative solutions. The AHP as a new approach to the multi-criteria decision-making method have been widely used in agriculture (Tiwari *et al.,* 1999; Herrero *et al.,* 1999; Rozman *et al.,* 2005).

North Khorasan province is considered among areas of country that despite climatic conditions for cultivation of medicinal plants in the province was not much flourishing. According to the latest census reported 98,000 people are employed in agriculture of 800,000 people (Jihad Keshavarzi Organization North Khorasan Province, 2011). The surface area under cultivation of Rain fed and an irrigated agricultural product is 180335 and 117304 hectares respectively that the great surface area is allocated to wheat, barley, cereals, oilseeds and cotton. The main medicinal plants cultivated in the province include saffron with 313 ha and cumin with 241 ha. The surface area under cultivation of other medicinal plants is very small and does not exceed 20 hectares. Because of its special place in the Holistic Scientific Map a special position is devoted to the production of medicinal plants. In addition, no study on the application of the AHP in determining factors affecting the cultivation of medicinal plants has been carried out. Therefore this study was conducted for the first time in North Khorasan Province of Iran.

2 MATERIAL AND METHODS

2.1 Delphi process

This study was conducted in 2012 in North Khorasan Province. Factors affecting the development of medicinal plants were identified using the Delphi method.

Initially a designer and analyst team consists of three professors of agricultural economics, was formed in medicinal plants. This team set out a questionnaire entitled "factors affecting the development of medicinal plants cultivation in North Khorasan Province" containing 23 agents. Delphi groups were given a questionnaire and they were asked to score the priority and the importance of each factor on a five item Likert range (too high: 5, high 4, middle: 3, Low: 2, very low: 1 point). Delphi Group in this study included 10 expert professionals that had a lot of experience in the field of education, cultivation, manufacturing, and marketing of medicinal plants. After collecting the questionnaires, the responses were analyzed and the results were made available to the group again to measure their reactions and to apply necessary changes to their responses. This process was continued until reaching a public consensus. At the end,

the factors that are rated equal or greater than the total mean score were selected and the other factors with lower points have been removed by calculating the mean scores of the group that was given to each factor. By the end of Delphi process and before running the Analytical Hierarchy Process at the experts' level of Khorasan province, the reliability of selective factors affecting the cultivation of medicinal plants was determined. For this purpose, these factors were distributed in 5-option Likert questionnaire format, at the experts' level of neighboring provinces. After collecting and analyzing data with SPSS software, Cronbach's alpha coefficient was obtained 0.91 that focuses on the internal consistency of the questionnaire and the consistency of individual responses to all questionnaire items (Sarmad *et al.*, 2006).

2.2 Hierarchical structure draw

Transforming issue or problem into a hierarchical structure is the most important part of AHP (Çimren *et al.*, 2007). Since in this section by analyzing complex and difficult issues, AHP transforms into simple forms which match the human mind and nature. In the current study, for drawing a hierarchical structure of the reliable criteria in three levels of goal, criteria and alternatives, be used by Delphi analysis. In this study, the hierarchy shows the criteria for developing medicinal plants cultivation. The top level is the selection goal which is prioritizes of effective factors on development of medicinal plant cultivation. And following this are the 4 criteria (the second level) and finally sub criteria (the third level). In analytical hierarchy process, after making hierarchy structure, comparisons are performed between pairs of elements to determine the worth of one element with another element directly above. In order to determine the important of each elements of pair wise comparison questionnaire is produced.

2.3 Pair wise comparison

In the present research, the pair wise comparison questionnaire was produced to determine the weight of the criteria/ sub criteria. Thirty medicinal expert and managers were invited to fill the pair wise comparison questionnaire to generate the weighting matrix (the proposed 9-unit scale by Saaty has been used). For this purpose, standard tables were used for pair wise comparisons of the criteria and sub criteria (Table 1). In paired comparison matrix if the comparative value of the criterion in row I_1 is equivalent 9 times of the criterion in column I_i, the comparative value of the criterion in column I_i will be equivalent to 1/9 times of the criterion in row I_1 (Table 2).

Table 1 Pair wise comparison scale (Saaty, 1996)

Verbal judgment of preferences	Numerical Rating
Extremely preferred	9
Very strongly to extremely	8
Very strongly to preferred	7
strongly to very strongly	6
Strongly preferred	5
Moderately to strongly	4
Moderately preferred	3
Equally to moderately	2
Equally preferred	1

Table 2 Pair wise comparison matrix

Criterions	I_1	...	I_i	...	I_j	...	I_n
I_1	1						
⋮		⋱					
I_i			1				
⋮				⋱			
I_j					1		
⋮						⋱	
I_n							1

The geometric mean method use to determine the final weights of criteria in the pair wise comparison matrix. In this method as Buckley (1985) explained, the weights in a pair wise comparison matrix of alternatives, A, are calculated by following formula:

$$r_{ij} = \frac{a_{ij}}{\sum_{i=1}^{m} a_{ij}} \quad (1)$$

At which a_{ij} (I,j=1..n) are the comparison ratios in the pair wise comparison matrix and n is number of alternatives.

For determining weight of every alternative, arithmetic means (formula1) was a used. Vectors of the arithmetic means of the coefficients of importance were then rescaled in the manner that their sum equaled one. Then the symphonic means were calculated based on formula 2: (Buckley, 1985)

$$W = \frac{1}{N}\left[\sum_{j=1}^{N} r_{ij}\right] \quad (2)$$

Inconsistency Rate

Inconsistency rate is a mechanism through which the validity of respondent's responses was evaluated using a matrix comparison mechanism. This mechanism specified the reliability of response gained from respondent with respect to the comparison of criteria and indicator (Barzekar *et al.,* 2011). Inconsistency rate in AHP method must be less than 0.1(Tzeng *et al.,* 2002). If the inconsistency ratio is more than 0.1, the process may warrant recomputed by user (Changa *et al.,* 2007).

3 RESULTS

To draw a decision tree, it is needed to identify the factors that are involved in achieving the goals of the study. For this purpose the designer and analyst team, determined 24 factors in the development and cultivation of medicinal plants and presented it in the form of a questionnaire to Delphi group. The results of the analysis of Delphi process showed that the proposed four factors rated below total mean (3/95) (Table 3). Other remaining factors (19 factors) considered as factors affecting the cultivation of medicinal plants which were grouped in the form of four criteria of economic factors, promotional–educational services, social– cultural factors and supportive policies. Thus the hierarchical tree was developed considering the purpose of the study and criteria and sub criteria (Figure 1). In all the comparisons that follow, the inconsistency rate is between 0.01 and 0.03 which indicates high validity of responses of those surveyed in carrying out paired comparisons.

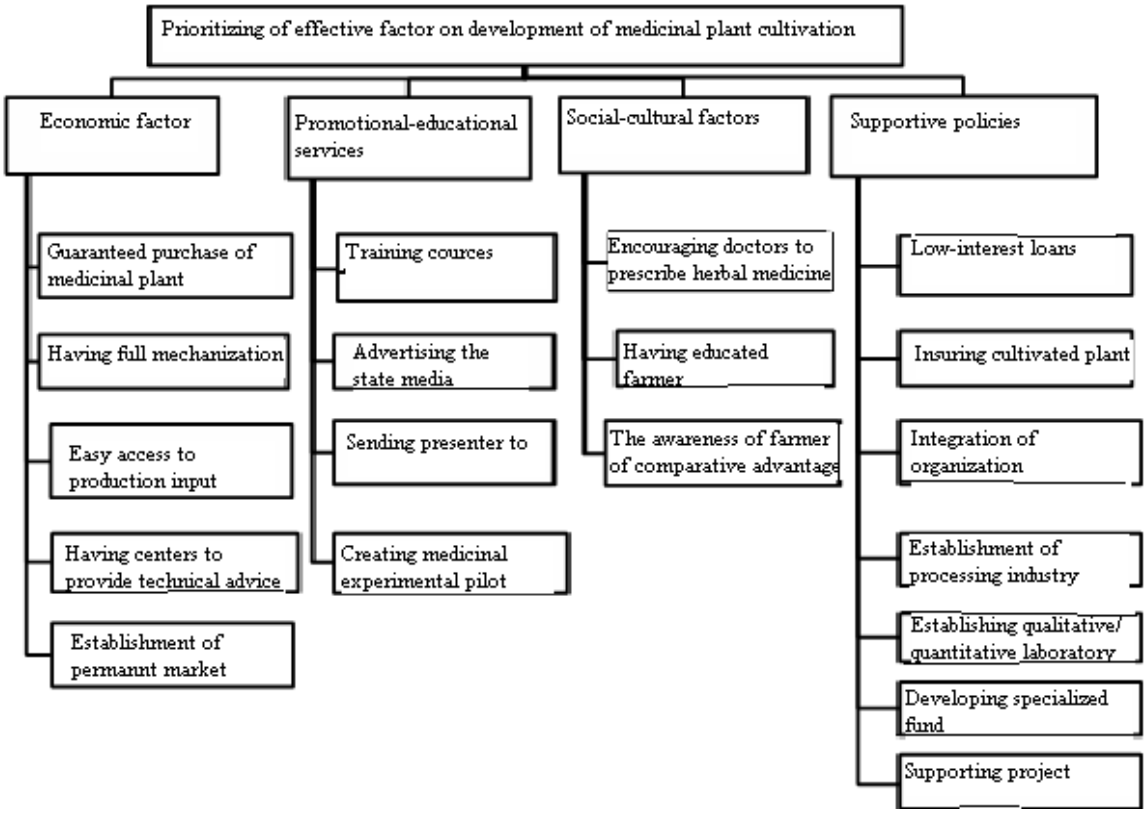

Figure 1 Hierarchy structure tree of factors affecting the cultivation of medicinal plants in North Khorasan

3.1 Comparing Criteria

The results of the application of AHP method showed that in comparing criteria, Economic factors with relative weight of 0.406, have the greatest role in cultivation of medicinal plants in the province. After then, the supportive policies, extensional-educational services and cultural-social factors are being important, respectively (Figure 2).

Comparing sub criteria belonging to each main criterion among, extensional-educational services, establishing experimental medicinal plants farms for the farmers to visit were of the highest priority (Figure3).

Among economic factors, the sub criterion of the guaranteed purchase of Medicinal plants from the farmers was known as the most important economic factor (Figure4).

The local farmer's awareness of the relative advantage of the cultivation of medicinal plants was reported as the first priority of cultural factors (Figure5).

In supportive policies criterion the highest relative weight 0.244 was dedicated to establishing processing industries and processing of medicinal plants such as oil extraction, drying and packaging (Figure 6).

Table 3 Average points in Delphi Group to proposed factors affecting the cultivation of medicinal plants

Factor	Score
Guaranteed purchase of medicinal plants of the farmers	4.16
Having a full mechanization during planting to harvest medicinal plants	3.98
Easy access to production inputs such as improved seeds, cuttings, seedlings, fertilizers and pesticides	4.16
Having centers to provide technical advice services to the farmer.	3.98
The establishment of permanent or seasonal markets for buying and selling of medicinal plants in urban areas	3.98
The availability of means of transport	3.16
Training courses to acquaint farmers with the proper cultivation of medicinal plants	4.16
Advertising in the state media about the importance of cultivating medicinal plants and herbs	3.96
Special awards to top medicinal plants producers	3.5
Sending presenters to rural areas to explain the importance of the cultivation of medicinal plants	4
Establishing medicinal plants experimental farms (pilots) for a visit encouraging farmers to cultivate.	3.98
encouraging doctors to prescribe herbal medicines in urban areas	4
Having educated farmers	3.5
Manpower training in the field of medicinal plants in collaboration with Jihad-e-Agriculture	3.98
The awareness of local farmers of the comparative advantage of growing medicinal plants	4.15
Expanding groceries to establish an inclusive distribution system in the city	3.33
The integration of organizations associated with medicinal plants in the province	4.16
Supporting projects and applied researches relating to the cultivation of medicinal plants and presenting the results to the farmers	4.12
Low-interest loans for the cultivation of medicinal plants	4.16
Insuring cultivated medicinal plants	4.05
The establishment of processing industries and processing medicinal plants (extracting, drying, packaging, etc.) in the province	4.15
Establishing qualitative and quantitative laboratory of medicinal plants	3.98
Developing specialized funds and supporting the manufacturers of medicinal plants and its related products	4.30

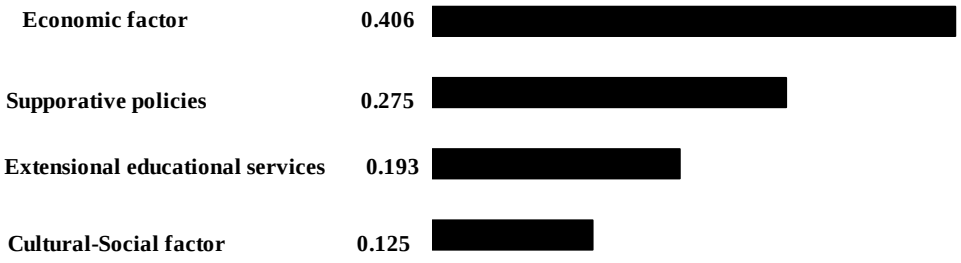

Figure 2 Relative weight of criteria related to the cultivation of medicinal plant

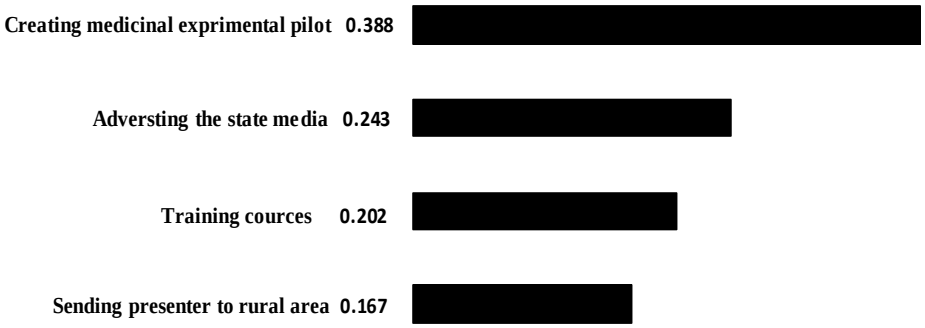

Figure 3 Relative weight of sub criteria related to extensional-educational service

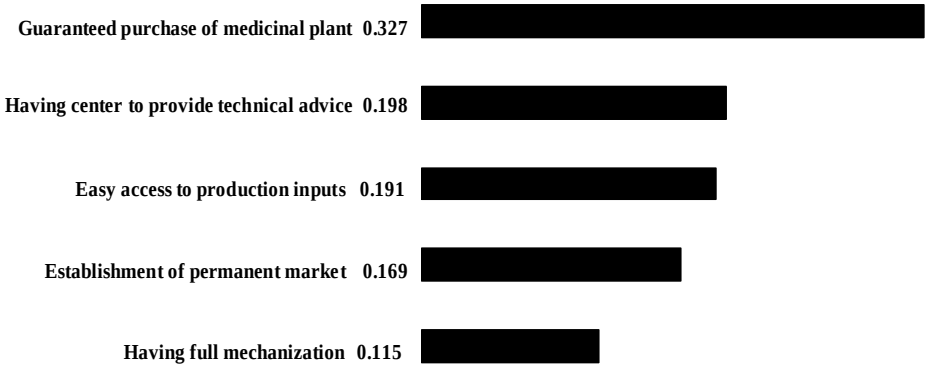

Figure 4 Relative weight of sub criteria related to economical factor

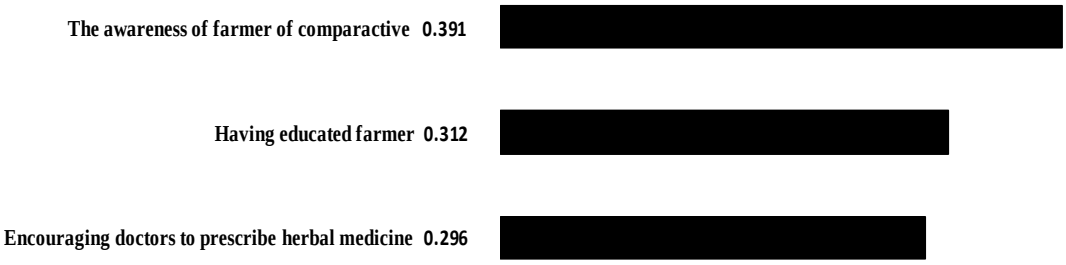

Figure 5 Relative weight of sub criteria related to social – cultural factors

3.2 Comparing the total sub criteria

The final weight of sub criteria showed that the sub criteria of the guaranteed purchase of plants of the farmers, the construction of processing industries and processing of medicinal plants and having centers to provide technical advice are considered the first three priorities in the development of medicinal plants in North Khorasan (Figure 7).

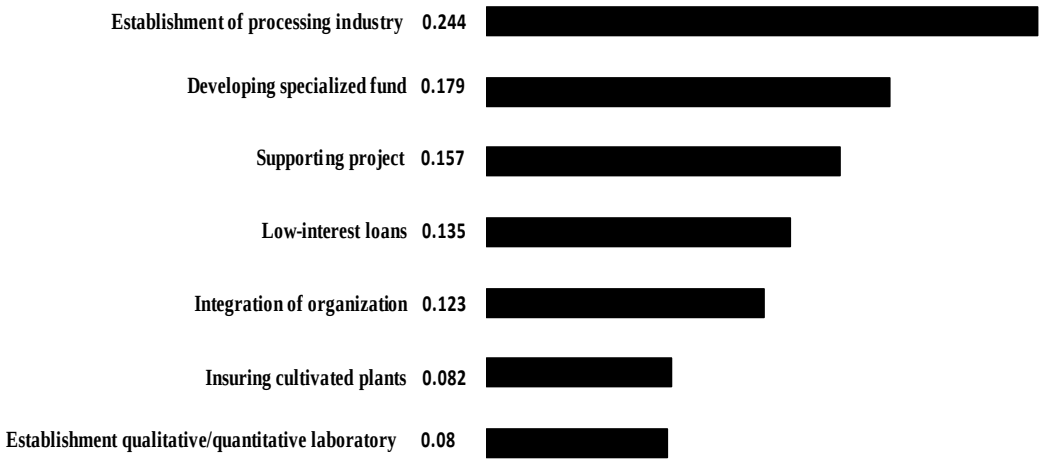

Figure 7 Relative weights of sub criteria related to supportive policies

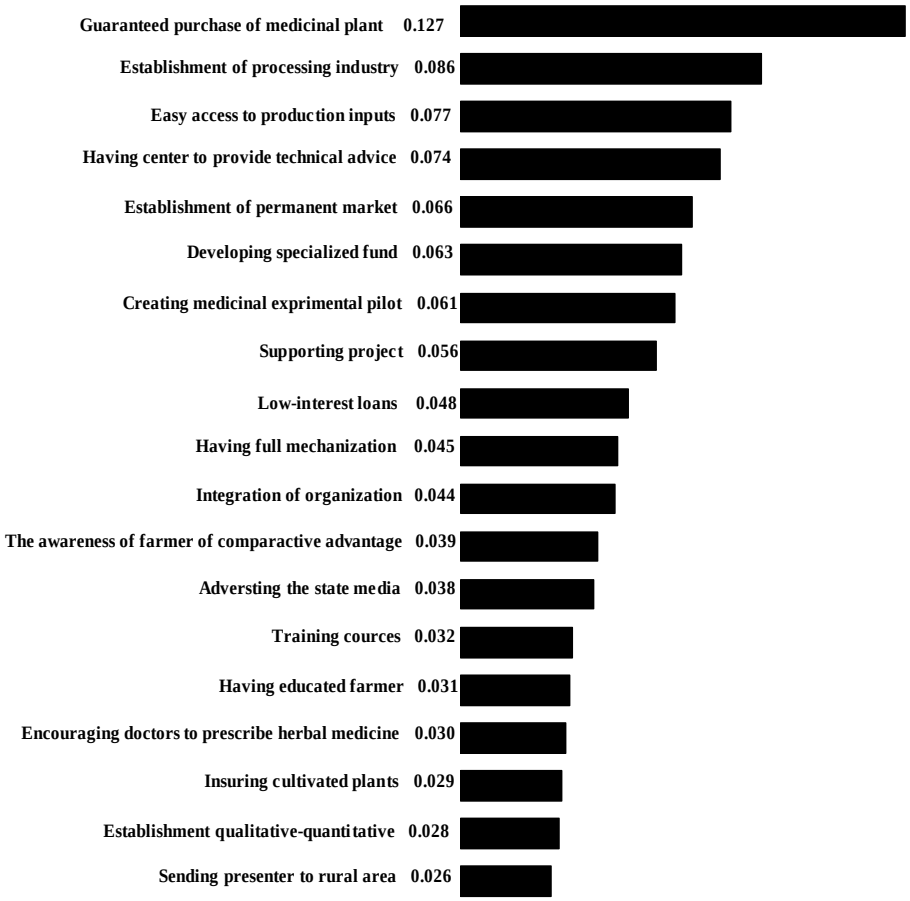

Figure 7 The final weights of sub criteria related to the cultivation of medicinal plant

4 DISCUSSION

Economical factors had the greatest role in the development of plants cultivation in the province. Relative advantage is an important economic factor to plan the production, import, export and means the ability of a region to produce goods at lower costs. In other words, each region, according to the abundance of natural talent and levels of productivity of production factors, relatively has an advantage in production of a specific group of products (Omidbaigi, 2009; Sefidkon, 2008). Sub criterion of the guaranteed purchase of plants from the farmers was known as the most important economic factor. From the perspective of agricultural economics each farm acts as an economic unit. The farmer as the farm manager is seeking to maximize the profit from the product and proceeds to decide on the choice of cropping patterns with taking into account different economic agents (Roozbehan 1992). Considering this view has also been effective in the view of experts so that they have referred to the profitability factors of cultivation of medicinal plants as the first priority in the development of their cultivation in comparing economic sub criteria. Guaranteed purchase of pharmaceutical products while establishing incentive, raising revenue and also increasing rural employment is effective in increase of success in the economic resistance.

Supporting the farmers by providing them support packages such as seed and other inputs in order to promote and introduced species and supporting consultant firms to provide technical and scientific training necessary for farmers are other factors that lead to growth and development of planting medicinal plants. Assadi *et al.* (2009) identified no guaranteed purchase of greenhouse products as one of the barriers to development of greenhouse cultivation. These researchers such as Healy (1991) introduced the access to counseling services as an important factor in the development of greenhouse products. In the present study the centers available to provide technical advice is known as the second economic priority in the development of cultivation of medicinal plants.

Difficulty in access, lack of inputs and lack of funds prevented increase in cultivation of medicinal plants and supports by the Ministry of Agriculture through the provision of technical advice and easy access to inputs increases the willingness of farmers to plant herbs (Omidbaigi, 2009).

Although the ultimate goal of all training sub criteria is to introduce various aspects of cultivation and production of medicinal plants. However, in view of experts this introduction is achieved by direct observation and visiting cultivated medicinal plants. So that establishing an experimental medicinal plants farm for the farmers to visit had the highest priority in the extension- training services. Shafiei (2007) reported in examining the development causes of olive cultivation in Kerman province, Iran that Olive farmers have participated in training courses more than visiting the Olive Garden in the North. This difference in attitude may be due to differences in the statistical population that were replaced with the farmers in the experts' present study. Furthermore, the cultivation of medicinal plants doesn't have a long history, thus experimental fields' observation before mass cultivation can be helpful in selecting plants by the farmers. Create a test field to deliver promotional-educational services for welcoming more producers are essential. Experimental farms contribute to the development of planting by presenting model fit of medicinal plants (Omidbaigi, 2009).

Executing necessary conferences and advertising to farmers through increasing awareness of the advantages of cultivation of medicinal plants, helps to promote planting medical herbs and establishing jobs.

The local farmers' awareness of the comparative advantage of medicinal plants cultivation was introduced as the first priority of social-cultural factors. Maximizing social benefit is an important purpose of agriculture. This profitability is significant only when the products are of great advantage. Medicinal plants have certain eco-physiological characteristics which cause them to be economically justified compared to other crops in the same regional conditions. For example, there are some medicinal plants such as thyme, mint, pepper and fennel that don't need to cost land preparation and buying seeds again with once spent at the time of planting for 3-4 years. Many medicinal plants are of plants that don't need much water and food that allows them to grow in environments with low interest rate lands and environments with water limitations (Omidbaigi, 2009). Those surveyed believing the above criteria compared with social-cultural sub criteria have stated that if local farmers be aware of the relative merits of medicinal plants, they start to enter the plants in their cropping pattern.

Establishment of processing and packaging industries alongside cultivation of this product causes the development planting. processing industries as the bridge between industry and agriculture is an important factor in processing in one hand, increase value added to products and in the other put products on the market that are obtained by processing (Sefidkon, 2008).

The establishment of processing industries, processing medicinal plants and establishing community support funds were introduced as two priority support policies. The industry's role in the development of the agricultural sector has been highlighted in various ways. Establishing job opportunities, increasing the added value of primary products, optimum use of resources, better marketing, reducing regional disparities and reducing waste products are considered among the key advantages of establishing processing industries (Omidbaigi, 2009).

These benefits are not just limited to the common agricultural products but also can be realized about medicinal plants. Processing industries in the areas of plants cultivation, causes the plants to be able to sell its products at agreed prices which results in reducing the risk of production. Establishing support funds through their role in financing agriculture has been considered is one of the most important strategies to expand investment in the agriculture sector. The establishment of such funds in the Medicinal plants section can contribute to encourage farmers to cultivate Medicinal plants due to the credit services that they provide (Omidbaigi, 2009).

5 CONCLUSION

Due to the wild harvesting of medicinal plants during the last few decades, the natural resources have considerably decreased in Iran. Therefore, the natural resources are not able to supply of medicinal plants and, development program in cultivation could conserve natural resources in Iran. In addition, the successful establishment of medicinal plant sector may help in increasing rural employment, boost commerce and contribute to the health of peoples in North Khorasan, Iran. There are many parameters attached to medicinal plant sector and the success of medicinal plant mainly depends on the guaranteed purchase of medicinal plants, establishment of processing industry, having center to provide technical advice, developing specialized fund and supporting, establishing an experimental pilot for visit farmer, supporting project and applied research. In summary, we state that medicinal plant cultivation is a sustainable option and major factors preventing the development of the medicinal plant cultivation in North Khorasan, Iran are the lack of information on the economic benefits and low information the medicinal plant cultivation. It is therefore necessary to establish processing industry in

order to assure farmers of the sale and having educated farmer by agriculture seminars greatly enhance the growth of medicinal plant cultivation. This research produced valuable information about the relative importance of the factors that were evaluated and could be a useful precedent for future studies about the development of medicinal plants cultivation.

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چکیده تحقیق حاضر با هدف اولویت‌بندی عوامل موثر بر توسعه کشت گیاهان دارویی در استان خراسان شمالی با استفاده از روش دلفی و تحلیل سلسله مراتبی (AHP) به انجام رسید. برای این منظور فهرستی از عوامل موثر به گروه دلفی پیشنهاد شد. تجزیه و تحلیل رهیافت دلفی نشان داد که بین ۲۳ عامل پیشنهادی ۱۹ عامل در توسعه کشت گیاهان دارویی نقش موثرتری دارند. با قرار گرفتن ۱۹ عامل در قالب چهار معیار عوامل اقتصادی، خدمات ترویجی- آموزشی، عوامل فرهنگی- اجتماعی و سیاست‌های حمایتی درخت سلسله مراتبی ترسیم گردید. سپس پرسشنامه مقایسات زوجی در بین کارشناسان و خبرگان استان توزیع گردید تا نظر آنها نسبت به ارجحیت و اولویت معیارها و زیرمعیارها اخذ گردد. پرسشنامه‌های جمع‌آوری شده با استفاده از نرم‌افزار Expert Choice آنالیز شدند. نتایج نشان داد که بین معیارهای چهارگانه موثر بر توسعه کشت گیاهان دارویی، بیشترین تاثیر را معیار اقتصادی با ضریب اهمیت ۰/۴۰۶ دارا می‌باشد. سیاست‌های حمایتی (۰/۲۷۵)، خدمات ترویجی- آموزشی (۰/۱۹۳) و عوامل فرهنگی- اجتماعی (۰/۱۲۵) اولویت‌های بعدی را شامل شدند. در عوامل اقتصادی زیرمعیار خرید تضمینی گیاهان دارویی، در خدمات ترویجی- آموزشی عامل ایجاد مزارع آزمایشی، در عوامل فرهنگی- اجتماعی عامل آگاهی کشاورزان از مزیت نسبی کشت و در بین سیاست‌های حمایتی عامل راه‌اندازی صنایع تبدیلی و فرآوری گیاهان دارویی از حداکثر اهمیت برخوردار بودند. نتایج عمل تلفیق نیز نشان داد که در مجموع بین ۱۹ عامل لحاظ شده، عامل خرید تضمینی، راه‌اندازی صنایع تبدیلی و فرآوری و مراکزی برای ارائه مشاوره فنی به تولیدکنندگان بیشترین تاثیر را در توسعه کشت گیاهان دارویی استان دارا هستند.

کلمات کلیدی: استان خراسان شمالی، فرآیند تحلیل سلسله مراتبی، گیاهان دارویی