Journal of Nuts 8(1):1-10, 2017
ISSN: 2383 – 319X

Factors Affecting the Development of Hazelnut Harvesting Mechanization in Guilan Province of Iran

Saeed Firouzi[*1]*, Mohammad Sadegh Allahyari*[2]*, Faramarz Hadizadeh*[2]*, Vikram Koundinya*[3]

[1] Department of Agronomy, Rasht Branch, Islamic Azad University, Rasht, Iran

[2] Department of Agricultural Management, Rasht Branch, Islamic Azad University, Rasht, Iran

[3] Environmental Resources Center, University of Wisconsin-Extension, Madison, Wisconsin, USA

Received: 18 September 2016 Accepted: 10 January 2017

Abstract

Guilan Province is the biggest hazelnut producer in Iran. Over 70% of hazelnut production cost is due to its manual harvesting. Therefore, study on all aspects of its cultivation mechanization is necessary to sustain its production. This study focused on identifying factors that affect the development of hazelnut harvesting mechanization in Guilan Province, Iran, using a three-round Delphi technique. The technical panel of the study consisted of 27 hazelnut production in Eastern Guilan. The factor "observing engineering principles in the construction of new hazelnut orchards (row planting at appropriate density)" was identified as the most important driving factor with about 99% consensus from experts. Also, the factors "devising regional and provincial macro plans for developing orchard mechanization" and "development of mechanized irrigation of orchards with convenient methods tailored to local conditions" were ranked the second and third most important driving factors, respectively, with 91.30% and 90.05% consensus of experts. The most important inhibiting factor was found to be "the slope of most hazelnut farms" with 96% consensus of experts. The second most important inhibiting factors were "lack of appropriate roads for quick and convenient access to hazelnut cultivation machinery" and "hazelnut growers' limited financial capability" with 94.75% consensus. These results indicated that it is necessary to address the modification of old gardens to oblige observing the construction principles of orchards tailored to hazelnut mechanical harvesting and to purposefully and specifically support research on the design and manufacture of small-scale implements for hazelnut harvesting tailored to local conditions of hazelnut orchards in Guilan Province.

Keywords: Delphi, Driving factors, Hazelnut harvesting, Inhibiting factors, Mechanization.

Introduction

Reduction of labor and decrease in production costs are of the major aspects of agriculture mechanization. In mechanized farming, less labor is required than in traditional farming (Rahman *et al*., 2011). Traditional farming is time-consuming and costly. Thus, it has been mechanized in most parts of the world to enhance farmers' income and make agriculture more appealing (Singh, 2006).

Iran is the seventh biggest producer of hazelnut (*Corylus avellana*) in the world after Turkey, Italy, the US, Azerbaijan, Georgia and China (FAOSTAT, 2012). In Iran, the permanent hazelnut shrubs are mostly cultivated in Eshkevar in Guilan Province, the altitudes of Qazvin, Ardabil Province and Azerbaijan Province, with Guilan Province being the biggest hazelnut producing area. Its cultivation area is about 72,000 ha in this province with annual production of 6,650 tons, which constitutes nearly 70% of hazelnut

[*]**Corresponding author**: Email: saeedfirouzi@yahoo.com

crop of Iran (Anonymous, 2012). The livelihood of most families in parts of Guilan that are under hazelnut cultivation is directly or indirectly related to this crop. Manual harvesting and weak processing industries minimize their income. Therefore, studies on the development of mechanized farming of hazelnut in Guilan Province are of crucial importance for improving hazelnut growers' income and enhancing hazelnut's sustainable production.

Harvesting of hazelnut is the most costly part of its production. The mechanical harvesting of hazelnut needs the garden's surface to be completely cleaned by special tools before the harvesting operation starts, because it is mechanically collected by sweeping and sucking from the garden's ground. It is impossible to use direct mechanical harvesting like that of cherries or olives in which trees are shaken and fruits are trapped by special plates because hazelnuts ripen separately for a long period of time. Different levels of mechanization of hazelnut harvesting operation are depicted in Fig. 1. They vary from simple blowers like backpack dry leaf blowers to tractor-mounted equipments and self-propelled sweepers and blowers. The harvested hazelnuts should be cleaned and dried immediately to preserve their quality during storage (Kirchmeier and Demmel, 2010). The study of different stages of harvesting and crop preparation indicated that its mechanical harvesting is much more complicated than that of olives and cherries, which has been a reason for the undeveloped condition of its mechanical harvesting in Guilan Province.

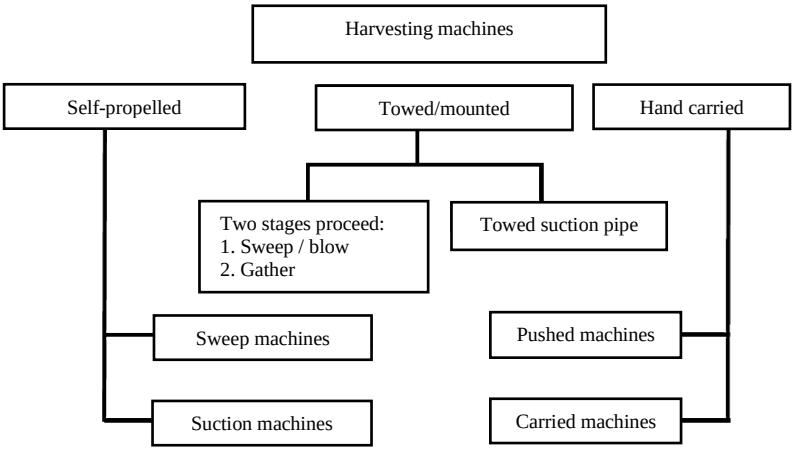

Fig. 1. Different levels of hazelnut harvesting mechanization (Kirchmeier & Demmel, 2010)

Before devising a plan for the development of agriculture mechanization, it is necessary to identify the driving forces and inhibitors of mechanical planting of a crop. Rasouli *et al*. (2010) studied the factors affecting the development of mechanized cultivation of sunflowers in Iran by adopting the Delphi Method. The small size and dispersion of sunflower fields was identified as the main inhibitors of the development of its mechanized cultivation. Zehtab Naebi *et al*. (2015) identified three factors: "devotion of specific national and provincial budgets to develop groundnut mechanization", "holding educational courses to enhance groundnut growers' technical knowledge" and "developing pilot mechanization projects" as the main driving forces for the development of mechanized planting of groundnuts in Guilan Province. Also, in a study in Burdwan district of India, Ghosh (2010) revealed that factors like "access to irrigation", "access to state funds" and "farm size" had positive influences on degree of mechanization. The study also showed that younger farmers were more interested in agriculture mechanization than older farmers. In this study, old beliefs and traditions were also mentioned as an inhibitor of agriculture mechanization development. According to Ou *et al*. (2002), agriculture

mechanization as a system engineering needs the cooperation and coordination of many other factors in addition to the quantitative and qualitative development of farm slope. These factors can be studied in the categories of economic, environmental, social and agronomical factors. In a study on the reasons for the rejection of new agricultural slope in Andika region of Khuzestan, Baldaji and Aghapour Sabbaghi (2015) concluded that "farm size", "income in recent years", "attendance in educational courses" and "ratio of irrigated to rain-fed farms" had positive impacts on the acceptance of new wheat planting slope. In contrast, "farmers' experiences" and "the dispersion of agricultural lands" had negative effects on the acceptance of new slope and equipment. Abedi *et al.* (2015) mentioned "attention to renewing the old olive orchards", "obligation to observe mechanical harvesting-consistent planting of olives", and "specific, purposeful support for research on the modifying all foreign technologies and the construction of harvesting implements tailored to the conditions of local olive orchards as the main factors for the development of mechanical harvesting of olive in Guilan Province.

In addition to offsetting labor shortage, reducing work hardiness and allowing on-time operations, the development of hazelnut harvesting mechanization can cut crop production costs and increase motivation to produce this crop. In spite of the importance of the development of hazelnut harvesting mechanization, evidence shows that this fruit is unfortunately produced almost exclusively by traditional practices mostly in the Guilan Province. Therefore, it is necessary to examine factors affecting the development of hazelnut harvesting mechanization in Guilan Province. This study focused on the driving and inhibiting factors of the development of hazelnut mechanical harvesting in this province.

Materials and Methods

This study was carried out in Guilan Province located on northern Iran in 2014. Delphi technique was applied at three rounds to identify the driving and inhibiting factors of the development of hazelnut harvesting mechanization in this province. The Delphi technique is a group communication process whose final target is to lead a panel of experts to a final consensus on a technical issue (Hsu & Sandford, 2007). Unlike other methods, the validity of the results of Delphi research depends not on the number of respondents but on the respondents' validity and expertise (Hsu & Sandford, 2007; Luduig, 2005). The sample size in Delphi studies is less than 50 people (Witkin and Altschuld, 1995). After consulting with the academic professors of Guilan, 27 informed experts of hazelnut production from the agriculture offices in eastern Guilan (including agriculture management offices of Rudsar, Langarud, Amlash and Kelachay) as well as the experts in hazelnut research stations in eastern Guilan were selected. The details and objectives of the study were explained to them, and they were asked to cooperate in three rounds of the research. At the first round of three-round Delphi, two open-ended questions were asked and the respondents were requested to mention specific cases in their answers:

a. What are the most important driving factors of the development of hazelnut harvesting mechanization in Guilan Province?

b. What are the most important inhibiting factors of the development of hazelnut harvesting mechanization in Guilan Province?

The questionnaires were personally administered to the selected people and after the deadline, they were collected, and the results were gathered and summarized. According to the analysis of the content from the first round, 19 driving factors and 19 inhibiting factors were identified. At this round, multiple response analysis by SPSS Software Package was used to statistically analyze the open-ended questions. At the second round of the Delphi study, all technical questions were designed by five-point Likert type scale (from very high to very low). Then, all opinions were presented to all selected people and

their extents of agreement were studied. After collecting the second round questionnaire, the results were prioritized by SPSS Software Package according to the importance and normalized score. The degree of importance of each question was estimated by dividing the sum of experts' opinions (after applying the equivalence coefficients of the responses) by the number of questions. The normalized weight score for the questions was estimated by dividing the degree of importance of that question by total sum of importance degrees of all questions. Then, Kendall's W test confirmed the fulfillment of the third round of the Delphi technique (Heiko, 2012). Ten higher priorities of inhibiting factors and 10 higher priorities of driving factors were put in question in the third round of the Delphi technique as a questionnaire. Since the number of questions was fewer, it was possible to compare items and express the percentage of agreement with each question more precisely. The final opinions were expressed as respondents' agreement percentage listed in a descending order. According to the final consensus, all factors with over 90% agreement were selected as the most important factors (Zehtab Naebi *et al*., 2015). At the end of each round of Delphi technique, the results were tabulated as driving and inhibiting factors.

Results

Driving Factors

According to the frequency of responses to the first open-ended question of the first round of the Delphi technique (the most important driving factors of the development of hazelnut harvesting mechanization), 19 expertise opinions were identified as the driving factors in Guilan Province (Table 1). Respondents most frequently mentioned "observing engineering principles in the construction of new hazelnut orchards (row planting at appropriate density)", "devising regional and provincial macro plans for developing orchard mechanization" and "enhancing hazelnut growers' technical knowledge with appropriate extension programs" with the frequencies of 13, 13 and 12, respectively.

Table 1. Results of the first and second round of the Delphi study: the driving factors of the development of mechanization of hazelnut orchards in Guilan Province

Driving factors	First round			Second round	
	Frequency	Percentage	Priority	Normalized weight score	Priority
Observing engineering principles in the construction of new hazelnut orchards (row planting at appropriate density)	13	48.15	1	5.76	2
Devising regional and provincial macro plans for developing orchard mechanization	13	48.15	2	6.31	1
Enhancing hazelnut growers' technical knowledge with appropriate extension programs	12	44.44	3	5.46	4
Mechanized irrigation of orchards with convenient methods	10	37.04	4	5.61	3
Development of regional processing and packaging industries to enhancing the hazelnut growers' income	7	25.93	5	5.36	6
Backing the design and construction of specific machinery for hazelnut harvesting tailored to local conditions	7	25.93	6	5.56	4
Governmental support for domestic and foreign marketing of hazelnut	5	18.52	7	5.06	9
Governmental support for the import of specific hazelnut cultivation and harvesting machinery	4	14.81	8	4.81	13
Devotion of fertile, well-sloped lands to hazelnut production	4	14.81	9	4.76	14
Timely pruning of hazelnut trees and the removal of suckers	4	14.81	10	4.96	12
Uniformity of hazelnut trees	3	11.11	11	5.01	11
Educating technical people for hazelnut mechanization by specific trainings	3	11.11	12	5.21	7
Supporting pioneering orchard owners of leading orchards	3	11.11	13	5.21	6
Scientific visit of leading mechanized orchards inside and outside the country	3	11.11	14	5.41	5
Exploitation of the experiences of leading countries in the production and processing of hazelnut	2	7.41	15	5.16	8
Specific governmental support for maintaining the sustainability of hazelnut production through deterring its import	2	7.41	16	5.46	5
Encouraging educated native people in hazelnut production areas to contribute to the production of this crop	1	3.70	17	5.11	8
Linking industrial sector to agricultural sector	1	3.70	18	5.06	10
On-time harvesting of hazelnut fruits	1	3.70	19	4.71	15
Total	98	362.96		100	

According to the findings of the second round of the Delphi technique, among factors affecting the development of hazelnut harvesting mechanization in Guilan Province (Table 1), the factor "devising regional and provincial macro plans for developing orchard mechanization" was ranked the first driving factor with normalized weight score of 6.31. The second factor was found to be "observing engineering principles in the construction of new hazelnut orchards" with a normalized weight score of 5.76, and the third factor was "mechanized irrigation of orchards with convenient methods" with a normalized weight score of 5.61. "Backing the design and construction of specific slope for hazelnut harvesting tailored to local conditions" was ranked the fourth driving factor of the mechanization of hazelnut harvesting with normalized weight score of 5.56.

Table 2 shows 10 final driving forces of the development of hazelnut harvesting mechanization in Guilan Province. "Observing engineering principles in the construction of new hazelnut orchards (row planting at appropriate density)" was ranked the first effective factor with 98.80% of experts' agreement. This was the second promoter of mechanization of hazelnut harvesting in Guilan Province with normalized score of 5.76 at the second round of Delphi study.

According to experts' opinions, 91.30% of them agreed that "devising regional and provincial macro plans for developing orchard mechanization" was the second most important driving factor of the development of hazelnut mechanization in Guilan Province. This factor has also been as the first driver of mechanical harvesting the hazelnut in Guilan Province with normalized score of 6.31 at the second round of Delphi study.

Table 2. Results of the third round of the Delphi study: Driving factors of the development of mechanization of hazelnut orchards in Guilan Province

No.	Driving factors	Consensus (%)	Priority
1	Observing engineering principles in the construction of new hazelnut orchards (row planting at appropriate density)	98.80	1
2	Devising regional and provincial macro plans for developing orchard mechanization	91.30	2
3	Mechanized irrigation of orchards with convenient methods	90.05	3
4	Enhancing hazelnut growers' technical knowledge with appropriate extension programs	85.05	4
5	Supporting pioneering orchard owners of leading orchards	83.80	5
6	Educating technical people for hazelnut mechanization by specific trainings	81.30	6
7	Specific governmental support for maintaining the sustainability of hazelnut production through deterring its import	78.80	7
8	Scientific visit of leading mechanized orchards inside and outside the country	78.80	8
9	Development of regional processing and packaging industries	78.80	9
10	Backing the design and construction of specific machineries for hazelnut harvesting tailored to local conditions	76.30	10

The factor "mechanized irrigation of orchards with convenient methods" was ranked the third most important driving factor of the development of hazelnut production mechanization, as 90.05% of experts agreed. This factor has been also ranked as the third promoter of mechanized harvest of the hazelnut in Guilan Province with normalized score of 5.61 at the second phase of Delphi study.

Inhibiting factors

According to the frequency of answers to the open-ended question of the first round of the Delphi study, 19 factors were identified to hinder the development of hazelnut harvesting mechanization in Guilan Province (Table 3).

Table 3. Results of the first and second round of the Delphi study: the inhibiting factors of the development of mechanization of hazelnut orchards in Guilan Province

Inhibiting factors	First round			Second round	
	Frequency	Percentage	Priority	Normalized weight score	Priority
The slope of most hazelnut orchards	16	59.26	1	5.81	2
Smallness of most hazelnut orchards and smallholder system	13	48.15	2	5.71	3
Inadequacy of support by granting specific funds to hazelnut production	13	48.15	3	5.06	11
Limited water resources or lack of access to reliable water resources in some regions	13	48.15	4	5.51	5
Lack of governmental support for guaranteed purchase of hazelnut fruits	10	37.04	5	4.76	16
Hazelnut growers' limited financial capability	8	29.63	6	5.26	9
Inappropriate conditions for receiving grants for agriculture mechanization (general facilities for mechanization)	6	22.22	7	5.36	7
Disorganized planting of hazelnut trees in most orchards of Guilan Province	6	22.22	8	5.31	8
Inappropriate conditions of hazelnut crop insurance	5	18.52	9	5.26	9
lack of appropriate roads for quick and convenient access to hazelnut cultivation machinery	5	18.52	10	5.61	4
Farmers' traditional beliefs about accepting modern farming practices	4	14.81	11	5.41	6
Complexity of hazelnut farming system (ea. uneven ripping time of fruits)	1	3.70	12	5.86	1
Lack of trade unions of hazelnut growers and production cooperatives	1	3.70	13	4.96	13
Lack of specific mechanization service firms for hazelnut in Guilan Province	1	3.70	14	4.91	14
Low level of knowledge and technical skill among craft people of Guilan Province in the field of specific hazelnut harvesting machinery	1	3.70	15	4.86	15
Low attention to the hazelnut mechanized cultivation researches	1	3.70	16	5.16	10
Dispersion of hazelnut orchards	1	3.70	17	4.71	17
Old age of hazelnut growers and the immigration of youths to urban areas	1	3.70	18	5.01	12
The increased problem of unemployment as the result of hazelnut production mechanization	1	3.70	19	4.01	18
Total	107	396.30		100	

The slope of most hazelnut farms" was ranked the first most important factor hindering the development of hazelnut harvesting mechanization in Guilan Province with the response frequency of 16 and 59.26% consensus. The second most important inhibiting factors were found to be "smallness of most hazelnut orchards and smallholder system", "inadequacy of support by granting specific funds to hazelnut production", and "limited water resources or lack of access to reliable water resources in some regions" with the frequency of 13 and 48.15% cases percent. The results presented in Table 3 were used for performing the second round of the Delphi technique. Table 3 shows the percentage of agriculture mechanization experts' consensus with the factors identified at the first round of the study on inhibitors of the development of hazelnut harvesting mechanization.

According to these results, the factor "specificity of hazelnut harvesting slope" was ranked the first inhibitor of the development of hazelnut harvesting mechanization in Guilan Province with normalized weight score of 5.86. It should be noted that at the first round of the Delphi study, this factor was ranked as the first inhibitor with case percentage of 3.70. "The slope of most hazelnut gardens" and "smallness of most hazelnut orchards and smallholder system" were ranked as the second and third most important hindering factors respectively with normalized weights of 5.81 and 5.71, respectively.

Among participating experts, 96.00% had consensus on the fact that "the slope of most hazelnut orchards in Guilan Province" was the most important inhibiting factor (Table 4).

Table 4. Results of the third round of the Delphi study: inhibiting factors of the development of mechanization of hazelnut orchards in Guilan Province

No.	Inhibiting factors	Consensus (%)	Priority
1	The slope of most hazelnut farms	96.00	1
2	Lack of appropriate roads for quick and convenient access to cultivation machinery	94.75	2
3	Hazelnut growers' limited financial capability	94.75	3
4	Farmers' traditional beliefs about accepting modern farming practices	93.50	4
5	Smallness of most hazelnut orchards and smallholder system	93.50	5
6	Disorganized planting of hazelnut trees in most orchards of Guilan Province	93.50	6
7	Limited water resources or lack of access to reliable water resources in some regions	88.50	7
8	Complexity of hazelnut farming system (e.g. uneven ripping time of fruits)	81.00	8
9	Inappropriate conditions for receiving grants for agriculture mechanization (general facilities for mechanization)	79.75	9
10	Inappropriate conditions of hazelnut crop insurance	79.75	10

This factor has been also identified as the second obstacle for mechanical harvesting the hazelnut with normalized score of 5.81 at the second round of Delphi study.

The second most important limiting factor of the development of hazelnut harvesting mechanization in Guilan Province was mentioned as "lack of appropriate roads for quick and convenient access to hazelnut cultivation machinery" and "hazelnut growers' limited financial capability" with 94.75% consensus of the experts. This factor also ranked as the forth priority at the second round of the Delphi study with normalized score of 5.61.

Three factors were together ranked as the third most important inhibiting factor with 93.50% consensus of experts: "Farmers' traditional beliefs about accepting modern farming practices", "the smallness of most hazelnut orchards and smallholder system", and "disorganized planting of hazelnut trees in most orchards of Guilan Province. These factors also ranked as the sixth, third, and eighth barriers for mechanical harvest of hazelnut in Guilan Province with acquiring the normalized scores of 5.41, 5.71, and 5.31, respectively, at the second phase of the Delphi study.

Discussion

Driving factors

According to the results, "observing engineering principles in the construction of new hazelnut orchards" has been identified as the first promoter factor of mechanized harvest of hazelnut in Guilan Province. Given the importance of infrastructure required for the application of mechanized implements of hazelnut harvesting, it is necessary to take actions to transfer the technical knowledge to orchard owners who are contemplating to establish new orchards. Traditional orchards are possible to be improved by row planting of seedlings between old hazelnut trees and simultaneously removing suckers and pruning the main trees.

"Devising regional and provincial macro plans for developing orchard mechanization" has been recognized as the second most important promoting factor of the mechanized hazelnut harvest in Guilan Province. In Abedi (2015), 92.87% of participated experts agreed that "the lack or defect of planning for the development of olive harvesting mechanization" was the second most important inhibiting factor of olive mechanical harvesting in Guilan Province. Zehtab *et al*. (2015) stated that 90.38% of participants believed "lack of national and regional insight towards the development of groundnut culture mechanization" was one of the main problems of the mechanization of this crop in Guilan Province. It should be noted that most driving measures for the mechanical harvesting of hazelnut requires specific budgets and macro plans. Therefore, the active support by state officials is of crucial importance for

the development of hazelnut harvesting mechanization.

"Development of mechanized irrigation of orchards with methods tailored to local conditions of Guilan Province" considered as the third most important driving factor of the mechanical harvesting of hazelnut harvest in Guilan Province. Since hazelnut is cultivated as rain-fed in Guilan Province, the decrease in precipitation and climate changes in Iran seriously threaten the sustainable production of this crop. Thus, it is necessary to develop mechanized irrigation of hazelnut in order to keep the sustainability of this crop production on the one hand and to improve hazelnut growers' income on the other hand. This important issue must be particularly considered in the plans of the development of hazelnut orchards at regional level. In a study in Burdwan district of India, Ghosh (2010) demonstrated that access to irrigation positively influenced mechanization level. Baldaji and Aghapour Sabbaghi (2015) also found that the ratio of irrigated to rain-fed lands was an important factor in the rejection of new farming slope in Andika region of Khuzestan.

Inhibiting factors

It was concluded that "the slope of most hazelnut orchards in Guilan Province" was the most important barriers of mechanized hazelnut harvest in Guilan Province. This factor has been mentioned as one of the most important limiting factors of the application of olive harvesting slope in Guilan Province and in Italy as well (Antognozzi *et al*., 1990; Abedi, 2015). The slope of hazelnut farms in Guilan region makes it impossible to use flail mower and tractor-mounted and self-propelled sweepers in most hazelnut farms. Therefore, design and fabrication of appropriate small equipment such as lightweight weed cutters, hand-held shakers, and knapsack hazelnut fruit sweepers must be considered by those responsible for mechanization of hazelnut harvesting in Guilan Province. Procuring all appropriate foreign technologies and adapting them to local conditions may help in achieving this aim.

The factor "lack of appropriate roads for quick and convenient access to cultivation machinery" was the second most important hindrance to mechanical harvest of hazelnut in Guilan Province. There is no doubt that the provision of any mechanization service, especially for those provided by the local agricultural mechanization cooperatives depends on existence of proper connecting ways.

"Farmers' traditional beliefs about accepting modern farming practices" has been considered as the third obstacle for mechanizing the hazelnut harvest. This finding is in accordance with the result of Ghosh, (2010) who reported that the farmers' old traditional beliefs were as an inhibitor for mechanized farming operation in Burdwan district of India. Therefore, enhancing the level of farmers' knowledge may be helpful to develop mechanized hazelnut cultivation in Guilan Province, Iran.

The factor "the smallness of most hazelnut orchards and smallholder system" has been also ranked as the third important barrier for mechanical hazelnut harvest in Guilan Province. Due to high variable and fixed costs of farm equipment, their purchase can be justified only in large orchards (Almassi *et al*., 2006). Providing the required equipment by supportive cooperatives may be a solution to overcome their high purchase and maintenance costs. Rasouli *et al*. (2010), Zehtab *et al*, (2015) Yousefzadeh (2015) and Abedi *et al.* (2015) also mentioned this factor as the hindering factor of the mechanization development of grain corn in Iran and groundnut, rice and olive in Guilan Province, respectively. Therefore, it is crucial to have national plans for integrating small hazelnut farms.

The disorganized planting of hazelnut trees in most orchards of Guilan Province has been also recognized as the third barriers for mechanical harvesting of hazelnut in Guilan Province. As stated in the explanation of driving factors of the development of hazelnut mechanical harvesting in Guilan Province, multi-stemmed state of hazelnut

trees in the studied region can be modified by row planting of seedlings between old hazelnut trees and simultaneously removing suckers and pruning the main trees for providing appropriate conditions for mechanical harvesting of hazelnut. Not many reported studies are available on mechanized hazelnut harvesting in hazelnut orchards with multi-stemmed and planted in brushes (Yildiz and Tekgüler, 2014).

Conclusions

This study found that various factors play a role in the development of hazelnut harvesting mechanization in Guilan Province, among which "observing engineering principles in the construction of new hazelnut orchards (row planting at appropriate density)" and "the slope of most hazelnut farms" were the most important factors. Therefore, it is necessary to take actions to transfer the technical knowledge to orchard owners who are contemplating to establish new orchards or to improve their old orchards in order to develop hazelnut harvesting mechanization and consequently and to sustainably develop the production of this crop in Guilan Province and Iran. As well, an in-depth study of small-scale machineries specific to hazelnut harvesting in the world and backing their improvement along with financial support for the design and manufacture of machineries tailored to regional conditions should be taken into consideration by the Ministry of Agriculture and the Organization of Agriculture of Guilan Province.

Acknowledgements

Financial support by Rasht Branch, Islamic Azad University Grant No. 4.5830 is acknowledged.

References

Abedi H (2015) Factors affecting the development of mechanization of olive production in Guilan Province. MSc. Thesis, Islamic Azad University, Rasht branch, College of Agriculture, Department of Agricultural Management, Rasht, Iran. pp. 65. [In Persian].

Almassi M, Loveimi N, Kiani S (2006) Farm machinery management. First edition, Ferdowsi University of Mashhad Press, Mashhad, Iran, Spring 2008, pp. 282. [In Persian].

Anonymous (2012) Trade promotion organization of Iran (TPO). Available from: http://fa.tpo.ir

Antognozzi E, Cartechini A, Tombesi A, Paliotti A (1990) La trasmissione della vibrazione e l'efficienza di raccolta in *olivi della* cv. Moraiolo. Genio Rurale. 53(5), 75-77.

Baladji U, Aghapour Sabbaghi M (2015) Investigating the reasons for non-acceptance of new machines by wheat growers in Andica County. Journal of Scientific Research and Development. 2(1), 62-66.

FAOSTAT. 2012. FAO, www.fao.org

Ghosh BK (2010) Determinants of farm mechanization in modern agriculture: A case study of Burdwan districts of west Bengal. International Journal of Agricultural Research. 5(12), 1107-1115.

Heiko A (2012) Consensus measurement in Delphi studies: review and implications for future quality assurance Technological Forecasting and Social Change. 79(8), 1525-1536.

Hsu C, Sandford BA (2007) The Delphi Technique: Making Sense of Consensus, Practical Assessment, Research and Evaluation. 12(10), 1-8. Available from http: // pareonline. net / pdf / v12n10.pdf [Accessed 28 September 2010].

Kirchmeier H, Demmel M (2010) Mechanization of hazelnut production in Germany. Landtechnik. 65(4), 290-292.

Ludwig B (1997) Predicting the future: Have you considered using the Delphi methodology? Journal of Extension. 35 (5), 1-4. Retrieved November 6, 2005 from http: // www. joe. org / joe /1997october/tt2.html

Ou Y, Yang D, Yu P, Wang Y, Li B, Zhang Y (2002) Experience and Analysis on Sugarcane

Mechanization at a state farm in China. 2002 ASAE Annual International Meeting/ CIGR 15th World Congress Sponsored by ASAE CIGR, Hyatt Regency Chicago, Illinois, USA July 28- 31.

Rahman MS, Monayem Miah MA, Moniruzzaman & Hossain S (2011) Impact of farm mechanization on labor use for wheat cultivation in Northern Bangladesh. The Journal of Animal and Plant Sciences. 21(3), 589-594.

Rasouli F, Sadighi H, Minaei S (2010) Factors Affecting Agricultural Mechanization: A Case Study on Sunflower Seed Farms in Iran. Journal of Agricultural Science Technology. 11, 39-48.

Singh G (2006) Estimation of a mechanization index and its impact on production and economic factors—a case studies in India. Biosystems Engineering. 93(1), 99–106.

Witkin BR, Altschuld JW (1995) Planning and conducting needs assessment: A practical guide. Thousand Oaks, CA: Sage Publications, Inc.

Yildiz T, Tekgüler A (2014) The effects of different maturity times of fruit ripening and limb connection heights on the percentages of fruit removal in mechanical harvesting of hazelnut (Cv. *Yomra*). Tarim Bilimleri Dergisi. Journal of Agricultural Sciences. 20, 38–47.

Yousefzadeh S (2015) Factors affecting development of mechanization of rice cultivation in Guilan Province. MSc. Thesis, Islamic Azad University, Rasht branch, College of Agriculture, Department of Agricultural Management, Rasht, Iran. pp. 65. [In Persian].

Zehtab Naebi R, Firouzi S, Ebrahimzadeh MR (2015) Promoters and Deterrents of Developing Mechanization of Peanut Cultivation in North of Iran. International Journal of Agricultural Management and Development. 5(1), 1-8.