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Factor analysis of the challenges influencing sugar beet producers in Harsin city

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ABSTRACT

The world population increase and lack of appropriate food production force developing countries to make fundamental changes in their traditional production systems through utilizing new agronomical methods, farm management principles, and proper marketing. This study aimed to analyze factors involved in sugar beet production challenges in Harsin city, Kermanshah province. The statistical population included all sugar beet producers in Harsin city (N = 423). Based on Cochran formula, sample size was determined to 117. Data were analyzed using descriptive and inferential (regression and factor analysis) statistical methods. Factors extracted from factor analysis included problems that sugar beet producers face under the title of pest and disease, crop marketing, land preparation and seed planting, crop husbandry, and harvest. Regression analysis results showed that 73% of the dependent variable variation was explained by six variables including the rate of technology usage, access to information resources, education, access to production inputs, knowledge, and ownership of machines. Finally, facilitating access to new technology and holding educational and training courses for sugar beet producers is recommended.

Keywords: production technology, sugar beet producers.

INTRODUCTION

Agricultural development is a requirement in all countries throughout the world which is a major issue facing both economy and society of the country. Crop production should rise at a higher, or at least the same, pace of the current level in order to ensure food security. Meanwhile, agricultural education and extension are the keys as they facilitate the adoption of proper technologies and new courses of action by farmers and rural people and contribute to increasing production level (Zamanipoor, 2009).

Historical evidence shows that sugar beet has been grown in Iran from ancient times. Researchers attribute the origins of sugar beet to Anatolia and parts of Iran. The growing of sugar beet as an agronomic and industrial crop can be traced back to about 2000 years ago. In Iran, the production of this crop as an agricultural product along with industry dates back to about 150 years ago. The global acreage of sugar beet amounts to about 5.5 million ha, and its acreage in Iran is over 149,000 ha of which 8,100 ha is located in Kermanshah province and 550 ha in Harsin county (Agricultural Management of Kermanshah Province, 2014).

The significance of sugar beet lies not only in the fact that it is the raw material of sugar production, but it also booms employment and business in different agricultural service and industrial sectors. For instance, one can point to employment pertaining to loading, transportation, preparation and handling of raw material for sugar factories, production and distribution of sugar factory products, and related industries.

Kermanshah province hosts two sugar factories: Islamabad Sugar Factory (founded in 1935)

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with a capacity of 1000 tons/day, and Bisotun Sugar Factory (founded in 1962) with a capacity of 3000 tons/day (Kulyvand, 2002). Bisotun Sugar Factory in Kermanshah has been considered as an important trigger for sugar beet growing in the region. In addition, the existence of the fertile lands around the factory, relatively inexpensive labor, and appropriate climate for sugar beet growing were some other reasons that many local farmers, especially in Harsin started to plant sugar beet in the initial years after factory establishment to help the economy of their own family in the first place and the economics of the region in the second place. However, over the course of the day sugar beet production (in both acreage and production rate) not only did not improve in the region but it also started to decline. In fact, the sugar beet acreage has declined from 1,500 ha in 1995-1996 to 550 ha in 2012-2013 and its production rate has decreased from 52 t ha^{-1} to 45 t ha^{-1} at the same time. Similarly, the sugar beet delivery rate to Bisotun Sugar Factory was recorded at 132,000 tons whereas it has a capacity of 300,000 tons (Database Sugar Factory, 2012).

Given the importance of sugar beet production as the raw material for sugar extraction on the one hand and the inability to meet the demand of sugar factories with respect to their production capacity on the other hand, it is clearly imperative to address approaches to increase sugar beet production and tackle the problems of sugar beet growers in order to make this increase attainable. Indeed, the ground should be laid to have sugar beet production increased both quantitatively and qualitatively. Thus, we need to identify factors restraining the quantitative and qualitative improvement of sugar beet production and its acreage. Then, solutions can be provided to cope with them. Also, the issues and challenges facing sugar beet growers should be identified especially the ones related to their training. Next, we need to take actions to solve the problems and extend sugar beet growing.

Literature shows that among different factors influencing sugar beet production, the technological, socioeconomic, demographic, and finally structural aspects seem to be more remarkable and we address them here. In a study on the source of farm information among smallholders in a Nigerian state, Erasmus et al. (1982) found that farmers mostly used promoters and other farmers as a source of information. They also explored factors influencing information sources usage including age, literacy, farm size, and participation in local organizations and found that literacy level was the most influential factor of information source selection and use. Itharat (1991) carried out a study on the adoption of sugar beet production technologies by farmers in Thailand and analyzed their socioeconomic features, personality variables, and communicational behavior. They found a positive and significant correlation between the adoption of agricultural innovations and such variables as the participation in social activities, urbanization, the use of public media, farm size, experience in farming, contact with promoters, and information sources. In a study on the marketing of agricultural products, Kohls and Richard (1992) examined the status and challenges of agricultural cooperatives including marketing. They first addressed the status quo of the agricultural sector and its problems in selling, pricing, bargaining, and the purchase of their life requirements. They reported that farmers had to sell their products for a cheaper price because of their vulnerabilities or the lack of bargaining power. Marketing cooperatives could contribute to solving these problems by collecting the products of their members' following grading, packaging, etc.

In their analysis of the technological aspects of sugar beet which influence its production, Kher (1991), Abdul and Nanda (2001), Cook and Scot (1993), and Kazaratsev (1994) listed such parameters as climate and soil, land preparation, seeding rate and type, sowing methods, irrigation method, disease and pest control, and so on. Pirayesh (1994) examined the educational needs of sugar beet workers to accomplish the maximum capacity of the Shirvan Sugar Factory and reported that the growers had a very poor knowledge of pest, disease, seeding rate, and sowing date, but they were relatively well aware of harvest stage. In addition, the work experience and literacy level of the growers were found to be directly related to their educational needs. Literacy and attending in extension courses had a positive relationship with sugar content and knowledge of cultivation too. Among the demographic factors influencing the adoption of modern agricultural technologies, Yang and Zhu (2013), Robert and Roling (1995), Rayatpanah (1996), and Itharat (1991) have pointed out personal, economic, and social characteristics, experiences, needs, information, and motives and have emphasized to care about these factors in the analysis of agricultural production problems. Technology dissemination and adoption models stress out the impact of demographic fac-

tors on the adoption or rejection of agricultural technologies.

The structural or infrastructural factors underpinning crop production are great. For example, Vasont hukumar and Sing (1990) and Laharia and Singh (1992) reported environmental conditions such as soil fertility, rainfall, etc. However, an emphasis has been placed on such issues as access to inputs, communication, and information for analyzing the problems faced by crop production. Sigal (1999) addressed the main challenges of sugar beet production in Colorado, US as the increase in planting costs, the control of weeds, the control of pests and insects, and the issue of irrigation and tillage from 1945 to 1980. He also suggested that the solution lied in enhancing the knowledge, vision, and skills of sugar beet growers about various planting, cultivation, and harvest issues via extension and education. Bob Murad (2002) focused on the extension needs of sugar beet growers in the sugar factory of Brujerd and found that familiarization with mechanization, disease and weed control, and the adoption of modern irrigation practices were among the top priorities. The lost priorities were listed as the use of different seeds, tillage schedule, and harvest method. There is a negative significant relationship between the extension needs of beet growers and the variables of attending in extension courses, educational level, and sugar beet production yield (t/ha). García et al. (2013) reported the role of innovation adoption on the improvement of land and labor productivity in the cropping systems. Technological changes in the agricultural sector will play a constructive role in meeting the ever-growing demand for crop products in future (Dietrich et al., 2014).

Overall, it can be concluded that the analysis of the problems associated with sugar beet production demands addressing the abovementioned issues. Therefore, the general objective of the present study was to perform a factor analysis on the challenges that sugar beet growers face in Harsin County, Kermanshah Province, Iran in order to suggest scientific solutions for the quantitative and qualitative development of sugar been growing. The specific objectives are to explore

- the demographic, economic, social, cultural, and communicational characteristics of sugar beet farmers,
- the problems sugar beet growers face in the context of the technical management, the extent of technology adoption, access to information and institutional resources, educational-extension programs, and marketing,
- relationship between economic, social, communicational, and cultural characteristics of growers and the extent of their problems, and
- the effect of studied variables on the extent of the problems that sugar beet growers encounter.

Also, sugar beet production problems" are categorized into different factors as done for sugar beet growers' in awareness of sugar beet production process. The results can shed light on solutions for the main problems of sugar beet growers in order to improve their production and income and reduce the need for food import resulting in exchange saving. This can be, in turn, used to finance the development programs and alleviate the migration from villages.

MATERIALS AND METHODS

The present work is an applied study in terms of objective, a descriptive survey in terms of data collection methodology, and a comparative-causal study since it explains the causal relationships of the variables. The statistical population is composed of all rural sugar beet growers in Harsin County who has contract with Sugar Factory. They amount to 423 person within three rural districts of Cham Jamal, Shizar, and Homeh of the county according to the data provided by the Bisotun Sugar Factory. The sample size was determined to be 117 by Cochran's formula (1, Sarmad et al., 2005) in which n represents sample size, N represents population size, d is the approximation in estimating population parameters assumed to be 0.071, and t-student was assumed to be 1.96. Also, p and q are the likelihood to have or lack the desired trait and they were assumed to be 0.5. The sample size was distributed across the studied sites by stratified sampling with proportionate allocation so that eight villages (with a population of 80 people) were selected from Cham Jamal, three villages (with a population of 25 people) were selected from Shizar, and two villages (with a population of 12 people) were selected from Homeh, all randomly.

$$n = t^2 pqN / d^2(N) + t^2 pq \quad (1)$$

The main research tool was a questionnaire designed in six sections: demographic characteristics, economic characteristics of production, the

Table 1. Cronbach's alpha for multi-item variables of the questionnaire

Variable	Number of items	Cronbach's alpha
Produced economic characteristics	7	85%
Adoption of production technology	15	78%
Structural dimension	19	96%
Extent of problems and challenges in different stage of sugar beet production	23	81%
Extent of awareness of the activities pertaining to sowing, cultivation, and harvesting phases	31	79%

extent of production technology adoption, structural dimension, problems and challenges, and the extent of awareness. The instrument validity was checked by content validity in which the questionnaire was provided to the members of the Faculty of Agriculture Extension and Education, Tehran University and to the experts of the Office of Extension Management and Public Participation Studies of Kermanshah province. Then, their comments were applied and the final version of the questionnaire was derived. The reliability of the research instrument was estimated by Cronbach's alpha, for which 30 questionnaires were used in a pre-test. Results are presented in Table 1.

Data were described with descriptive statistics (frequency, mean, standard deviation, median, and mode) and inferential statistics (coefficient of correlation, regression, and factor analysis). The dependent variable of sugar beet growers' challenges at different sugar beet production stage was hypothesized to have a significant relationship with the independent variables including grower's age, educational level, second job, number of years working in sugar beet growing, land ownership, sugar beet acreage, production of the prior year, income per ha sugar beet in the prior year, animal holding, machinery holding, the extent of the use of sugar beet production technologies, access to information sources, access to production input, access to communication media, number of attendance in training courses of sugar beet growing, access to transportation, and awareness.

The present study evaluates the strength of the relationship of these 17 independent variables with the dependent variable (total challenges at different sugar beet production stage measured with 23 items). The Pearson coefficient of correlation was used to examine these relationships for independent variables with the interval or relative scale, and the Spearman coefficient of correlation is used for the independent variables with the ordinal scale. Since the coefficient of correlation does not enable one to forecast a variable by another variable, other methods like regression analysis should be employed for more advanced analyses and the prediction of the change in a dependent variable with the change in the independent variable(s). The results of the regression in the present study is a linear equation that provides the best forecast of the dependent variable from several independent variables.

Here, we used a stepwise regression analysis because of several independent variables to show their impact on the dependent variable. In other words, it was aimed to answer the question as to which variable out of the independent variables can best forecast the dependent variable, how the shares of the variables are ranked in the order of importance, and how much the variables altogether can forecast the dependent variable. Also, exploratory factor analysis is applied to identify and categorize "the challenges of the growers" and "the awareness of sugar beet growers" and to find out to what extent the factors can account for the variance. In factor analysis, Varimax rotation is applied to find the significant factors, and the number of factors is determined by eigenvalue (greater than 1). The placement of the variables is, also, reported depositing the placement of the variables in the factor load of greater than 0.5.

RESULTS AND DISCUSSION

Data showed that growers were on average 44.27 years old, and the studied population was mostly in their adulthood age. In the sample, 91.5% (107 people) were married and the remaining 8.5% (15 people) were single. Most participants (50.4%, or 50 people) were illiterate or lowly literate. The main job of 96.6% (113 people) was farming, and the remaining 3.4% (4 people) were self-employed. Also, none of the participants was an animal farmer. 31.6% (37 people) had no second job, for 41% (48 people) the second job was animal farming, and 25.6% (30 people) had some self-employed second job. On average, participants had been working on sugar beet growing for 19.37 years, showing their long experience in sugar beet growing. The average irrigated land size of the studied population was 5.5 ha, and

Table 2. Coefficient of correlation between independent variables and total challenges (function value) at different sugar beet production stages

Independent variables	Scale	Dependent variable	Coefficient of correlation (r)	Significance level
Age	Ratio	Total number of challenges at different production stages	0.330*	0.017
Educational level	Ordinal	Total number of challenges at different production stages	-0.503**	0.007
Second job	Nominal	Total number of challenges at different production stages	0.513**	0.000
Job experience	Relative	Total number of challenges at different production stages	0.187	0.000
Yield	Ratio	Total number of challenges at different production stages	-0.638**	0.000
Land ownership	Ratio	Total number of challenges at different production stages	0.057	0.000
Sugar beet acreage	Ratio	Total number of challenges at different production stages	0.122	0.203
Income	Ratio	Total number of challenges at different production stages	-0.660**	0.000
Number of owned animals	Ratio	Total number of challenges at different production stages	0.206	0.000
Owned machinery	Interval	Total number of challenges at different production stages	-0.743**	0.000
Extent of technology adoption	Interval	Total number of challenges at different production stages	-0.705**	0.000
Access to production inputs	Interval	Total number of challenges at different production stages	-0.469**	0.007
Access to information sources	Interval	Total number of challenges at different production stages	-0.468**	0.007
Access to communication media	Interval	Total number of challenges at different production stages	-0.363**	0.005
Number of attended training courses	Ordinal	Total number of challenges at different production stages	-0.566**	0.000
Access to transportation facilities	Interval	Total number of challenges at different production stages	-0.677**	0.000
Awareness of sowing, husbandry, and harvest stages	Interval	Total number of challenges at different production stages	-0.560**	0.000

*: significant at the $p < 0.05$ level; **: significant at the $p < 0.01$ level.

67.5% (79 people) had an irrigated land size of smaller than 5 ha. The studied participants had, on average, 4.6 ha rainfed farm, and the rainfed farm size of 50.4%of the participants (59 people) was less than 5 ha. The average sugar beet acreage was 1.9 ha so that 37.6% (44 people) of participant allocated <1 ha of their lands to sugar beet growing whilst this was 1-2 ha for 37.6% (44 people) of them and > 3 ha for 17.9% (21 people) of participants. So, it can be concluded that studied people assigned a small part of their lands to sugar beet growing and they did not produce sugar beet commercially. Average sugar beet yield was 45 t ha^{-1} in 2012-13 growing season showing its poor status.

With respect to the ownership of machinery and mechanized implements, most studied people (65.8%, or 77 people) had no tractors, 88% (103 people) did not possess any seeders, and 94% (100 people) did not own any harvester. On the other hand, 57.3% (67 people) had no fertilizer distributor and 62.4% (73 people) had no herbicide sprayer. Almost all participants (99.1%, or 116 people) used developed seeds, and 83.8% (98 people) sown seeds mechanically. Most growers took care of weeding, thinning, irrigation, pest control, and agronomic rotation operations in a timely manner. It should be noted that the application of manure was not popular, and only a few used it. Most participants acknowledged that they had an easy access to all production inputs. They generally had more access to communication media than to promoters and agriculture experts of Agriculture Services. Also, results on growers access to different communication media revealed that 20.5% (24 people) had most access to training courses, 12% (14 people) to radio broadcasts, 8% (10 people) to television broadcasts, 3.4% (4 people) to agriculture journals, 7.7% (9 people) to agriculture magazines, and 5.1% (6 people) to newspaper. Results on attending educational-extension training courses indicated that 12% (14 people) were attended in these courses once, 29.9% (35 people) twice, 14.5% (17 people) three times, and 22.2% (26 people) more than three times. As far as transportation vehicles were concerned, 31.6% (37 people) had a very high access, 22.2% (26 people) had a moderate access, 40.2% (47 people) had a low access, and 6% (7 people) had no access. According to the findings, only 12% (14 people) had knowledge as how to store and handle sugar beet root. 36.8% (43 people) had moderate knowledge, and another 36.8% (43 people) were lowly aware. The remaining 14.5% (17 people) lacked this knowledge. Results of hypothesis testing showed that 13 independent variables had a significant ($p < 0.01$ or $p < 0.05$) relationship with the dependent variable and four hypotheses were refuted (Table 2).

Out of the 13 variables included in the regression, six variables were entered into the linear regression equation. Results of stepwise regression are presented in Tables 3 and 4. The variable of 'the application of production technology' alone accounted for 50% of the variance of the dependent variable, so it was the most important

Table 3. Results of stepwise regression

Step	Variable	B	SE	Beta	t	Sig. level	Collinearity statistic	
							Tolerance	VIF
1	Constant	4.05	2.98	-	64.17	0.000		
	Technology application	-2.27	0.27	-0.71	-7.37	0.000	1.000	1.000
2	Constant	4.25	2.66	-	68.97	0.000		
	Technology application	-1.60	0.26	-0.50	-6.01	0.000	0.838	1.193
	Access to information sources	-1.80	0.33	-0.44	-4.29	0.000	0.838	1.193
3	Constant	3.97	2.72	-	71.13	0.000		
	Technology application	-1.40	0.26	-0.44	-6.65	0.000	0.838	1.193
	Access to information sources	-1.75	0.32	-0.43	-4.84	0.000	0.528	1.895
	Educational level	-1.74	0.70	-0.18	-4.51	0.016	0.590	1.696
4	Constant	3.70	6.73	-	58.61	0.000		
	Technology application	-1.01	0.32	-0.31	-7.82	0.000	0.830	1.205
	Access to information sources	-1.76	0.31	-0.43	-6.62	0.000	0.524	1.907
	Educational level	-2.18	0.72	-0.23	-4.59	0.004	0.590	1.696
	Access to inputs	-0.914	0.45	-0.18	-2.37	0.047	0.970	1.031
5	Constant	3.89	7.01	-	53.86	0.000		
	Technology application	-1.50	0.40	-0.46	-7.95	0.000	0.729	1.372
	Access to information sources	-1.86	0.31	-0.45	-7.89	0.000	0.395	1.532
	Educational level	-2.41	0.72	-0.25	-6.40	0.001	0.588	1.700
	Access to inputs	-1.10	0.45	-0.21	-2.35	0.018	0.912	1.096
	Awareness	-0.15	0.07	-0.23	-2.02	0.050	0.636	1.573
6	Constant	3.97	7.53	-	47.51	0.000		
	Technology application	-1.68	0.39	-0.46	-7.17	0.000	0.711	1.407
	Access to information sources	-1.61	0.33	-0.40	-6.84	0.000	0.395	2.532
	Educational level	-2.11	0.72	-0.22	-7.18	0.005	0.520	1.923
	Access to inputs	-1.15	0.44	-0.22	-5.01	0.011	0.896	1.116
	Awareness	-0.16	0.07	-0.26	-2.96	0.029	0.577	1.734
	Machinery ownership	1.45	0.72	0.16	-2.23	0.047	0.769	1.301

Table 4. The variance of the variable 'challenges in different agronomic stages' captured by the independent variables

Step	Variable included in the equation	R	R^2	Adjusted R^2	Durbin-Watson
1	Extent of production technology application (X1)	0.71	0.50	0.49	
2	Access to information sources (X2)	0.81	0.65	0.64	
3	Educational level (X3)	0.82	0.68	0.66	1.71
4	Access to inputs (X4)	0.83	0.70	0.68	
5	Awareness (X5)	0.84	0.72	0.69	
6	Machinery ownership (X6)	0.85	0.73	0.70	

predictor variable. The variable of 'access to information sources' was the second most important variable included in the equation that captured 15% of the variance. The next important variables were 'educational level', 'access to inputs', 'awareness', and 'the quantity of the owned machinery'. They, altogether, accounted for 73% of the variance of the dependent variable.

A look at the collinearity statistics including tolerance and variance inflation factor (VIF) in Table 3 shows that the estimated values and the actual values of the standardized regression coefficients do not differ significantly. When all independent variables of the model have no linear dependence on one another, the coefficient of determination will be 1 for all of them, so VIF will be 1 for all independent variables. This statistic was found to be between 1 and 2 for most independent variables of the study. Thus, the calculations were feasible. The VIF values of greater than 10 imply strong collinearity between the independent variables, which is a serious problem. Another assumption in regression is the independence of the error (i.e. the difference between the actual values and the values predicted by the regression equation) with respect to one another. If the hypothesis of error independence is refuted and the errors are found to be correlated, it will not be feasible to employ regression. The error independence in regression was examined by the Durbin-Watson Test. This statistic varies between 0 and 4, and the values in the range of 1.5-2.5 imply that the errors are independent. According to Table 4, the Durbin-Watson statistic was 1.71 for our regression model, proving the independence of the residuals.

The overall form of the linear regression equation derived from this analysis on the basis of the beta coefficients are as below:

$y = 3.97 - 0.46x_1 - 040x_2 - 0.22x_3 - 0.22x_4 - 0.26x_5 + 0.16x_6$

Table 5. Results of factor analysis for the variable of 'challenges and problems of sugar beet growers' (factors, factor loads, and eigenvalues derived from the rotation matrix)

Factor	Variables	Factor load	Eigenvalue	Percent variance of eigenvalue
The control of pests and diseases	Bothynoderes *obliquefasciatus*	0.928	5.87	25.52
	Chaetocnema tibialis	0.912		
	Spodoptera exigua (Hübner)	0.841		
	Powdery mildew	0.837		
	Stem borer	0.820		
	Root rot	0.806		
Crop marketing problems	Low crop price	0.809	4.67	20.30
	Delayed payments to farmers	0.772		
	Delayed purchase of crop by factory	0.688		
	Long interval between crop harvest and transportation to factory	0.598		
	Transportation facilities	0.547		
	Crop storage facilities	0.538		
Problems in land preparation and sowing stage	Winter plow	0.910	3.92	13.70
	Seed disinfection	0.905		
	Autumn plow	0.845		
	Mechanized sowing	0.809		
	Purchase of improved seeds	0.782		
Challenges in plant husbandry stage	On-time thinning	0.760	2.83	12.31
	On-time weeding	0.714		
	On-time fertilization at correct rate	0.662		
	On-time irrigation at correct rate	0.657		
Challenges in crop harvesting stage	On-time harvest	0.849	1.86	8.10
	Mechanized harvest	0.825		

The results of exploratory factor analysis to recognize and categorize 'the problems and challenges of sugar beet 'growers and 'the awareness of sugar beet growers and to determine the variance captured by each individual factor are tabulated in Tables 5 and 6. The significance ($p < 0.01$) of Bartlett's test for 'the challenges of sugar beet growers and 'the awareness of sugar beet growers' (1840.209 and 2522.209, respectively) and the values of KMO (0.89 and 0.70, respectively) implied that data were appropriate for factor analysis. To find out the validity of the factors, data were halved randomly, and factor analysis was performed on the two halves separately. Results showed that over 90% of the items had similar distribution across two groups. Data adequacy statistic for factor analysis in the two groups is as below:

Group 1: KMO = 0.617 Bartlett's test (chi-square = 1061.968, sig. = 0.000)

Group 2: KMO = 0.608 Bartlett's test (chi-square = 788.68, sig. = 0.000)

According to Table 5, five factors were derived from the assessment of sugar beet growers' challenges that altogether accounted for 78.92% of the variance. They were named 'pests and diseases', 'crop marketing issues', 'land preparation and sowing challenges', 'crop husbandry challenges', and 'crop harvesting challenges'. Furthermore, factor analysis for sugar beet growers awareness led the derivation of five factors namely 'awareness of agronomic activities at plant husbandry stage', 'awareness of pre-sowing activities', 'awareness of sowing activities', 'awareness of harvesting activities', and 'awareness of post-harvest activities'. They captured 71.41% of the variance.

Overall, results show that the older the sugar beet growers are, more challenges they face in all sugar beet production stages. This can be attributed to the lower educational level of these growers as we found a significant ($P<0.01$) negative relationship between the educational level of sugar beet growers s and their challenges in all stages of sugar beet production. In other words, older people with lower educational level are faced with more problems. Results of Bub Murad (2002) confirm this finding. Furthermore, it was found that as the higher yield (production per ha) was achieved by the individuals, their challenges were fewer. This is also buttressed with the significant negative relationship between income and growers' challenges in all stages of sugar beet production because higher yields mean higher income and this higher income is important for

dealing with many challenges like the procurement of production technology and inputs. The

Table 6. Results of factor analysis for the variable of 'the awareness of growers' (factors, factor loads, and eigenvalues derived from the rotation matrix)

Factor	Variables	Factor load	Eigenvalue	Percent variance of eigenvalue
Farmers' awareness of agronomic practices during plant husbandry stage	Awareness of weeding and thinning principles	0.943	13.31	42.95
	Awareness of the rate of heading fertilizer	0.881		
	Awareness of cultivator effect on sugar beet yield	0.817		
	Awareness of the effect of excessive fertilizer use	0.808		
	Awareness of pre-harvest leaf cutting effect	0.747		
	Awareness of the relationship between root size and sugar content	0.741		
	Awareness of the rate of micronutrient use	0.705		
	Awareness of the best time to fertilizer the farm	0.668		
	Awareness of how to control the pests	0.667		
	Awareness of ways to increase root yield	0.632		
	Awareness of thinning effect on crop yield	0.617		
	Awareness of irrigation frequency	0.614		
	Awareness of ways to increase root sugar content	0.609		
	Awareness of crop rotation	0.607		
	Awareness of appropriate time interval between irrigations	0.600		
	Recognition of sugar beet disease symptoms	0.583		
	Awareness of how to control diseases	0.569		
	Recognition of sugar beet pests	0.539		
Farmers' awareness of pre-sowing activities	Recognition of suitable soils	0.828	3.47	11.20
	Awareness of root fertilizer use rate	0.790		
	Awareness of how to disinfect sugar beet seeds	0.749		
	Awareness of pre-sowing plow frequency and timing	0.712		
	Recognition of ecological conditions for sugar beet sowing	0.696		
	Awareness of the required seeding rate per ha	0.511		
Farmers' awareness of sowing activities	Awareness of mechanized sowing	0.725	2.06	6.66
	Awareness of sowing depth	0.673		
	Awareness of sowing row spacing	0.574		
	Awareness of appropriate sowing date	0.545		
Farmers' awareness of harvest activities	Awareness of sugar beet harvest time	0.826	1.74	5.60
	Awareness of the correct way of crown cutting	0.675		
Farmers' awareness of post-harvest activities	Awareness of how to store sugar beets	0.696	1.55	5.00

significant negative relationship of the agricultural machinery ownership and technology adoption with the problems that sugar beet growers are faced during sugar beet production also suggests that the higher the number of the owned agricultural machinery and the adoption of technology are, the fewer the challenges and problems that the sugar beet growers will face during the production of this crop. Rayat Panah (1996), Laharia and Singh (1992), and Kher (1991) reported similar findings. A significant ($p < 0.01$) negative correlation was found between access to production inputs and information sources and challenges of sugar beet growers. This is supported by Laharia and Singh (1992), Kher (1991), and Itharat (1991). Also, it was figured out that as access to communication media is enhanced, sugar beet growers were faced with fewer challenges during crop production. Itharat (1991) reported a similar finding. Attending educational-promotional courses can contribute to alleviating the problems of sugar beet growers because their awareness about different agronomic stages of sugar beet is improved and this helps the process of production. The evidence is the significant negative relationship between the awareness level of growers and their challenges. Pirayesh (1994) accomplished similar results. Also, we found that the more the access of growers to transportation facilities, the fewer their problems. This is in agreement with Pirayesh (1994) results. To summarize and determine the number of factors related to the variables of 'extent of problems and challenges' and 'the awareness of sugar beet growers', we employed factor analysis. Eventually, five factors were derived for the former variable and five factors were derived for the latter variable. The factors pertaining to the problems and challenges were named 'pests

and diseases', 'crop marketing challenges', 'preparation and sowing stage challenges', 'crop husbandry challenges', and 'harvest stage challenges'. These factors altogether accounted for 78.92% of the variance of growers' problems. The factors related to sugar beet growers' awareness were named awareness of crop husbandry, pre-sowing, sowing, harvest, and post-harvest stages. They all captured 71.41% of the variance of awareness variable. To determine the educational priorities of the growers, average of their awareness of different crop production stages were ranked and accordingly, their educational priorities were specified. Finally, 'how to control diseases' was found to be the top priority and 'knowledge of seeding rate per ha' was found to be the least important educational need. Also, the factor 'crop husbandry activities' was identified as the most important factor for education. According to the results, the following recommendations can be drawn:

- According to the results about identifying the challenges of farmers in the category of 'pests and diseases' including dealing with *Bothynoderes obliquefasciatus*, *Chaetocnema tibialis*, *Spodoptera exigua* (Hübner), powdery mildew, stem borer, and root rot, it is recommended that Bisotun Sugar Factory distribute foreign cultivars (such as German Latina and French Dorohea) which are resistant to these diseases among sugar beet growers. It is, also, recommended to the Jihad-e Agriculture Organization of Bisotun to hold educational courses on how to deal with sugar beet pests and to introduce new type of herbicides in order to help farmers cope with these problems.
- Results revealed that a major problem of most growers was crop marketing which included six variables of low crop price, delayed payment to sugar beet growers, delayed purchase of crop by factories, long time distance between crop harvest and its transportation to the factory, transportation as well as storage facilities. It is suggested to the sugar factories to take the following actions:
    - Sugar factory officials should comply with their obligations under the contract and should make payments to the sugar beet growers immediately crop purchase.
    - They should bear the whole cost of sugar beet transportation to the factory.
    - They should purchase crop for a higher price.
    - Growers can be motivated to deliver their crop to a certain factory by giving bonuses like free sugar.
    - Sugar beet should be taken from the growers immediately after crop harvest.
- Given the positive effect of access to production inputs on the alleviation of growers' problems, Jihad-e Agriculture Organization is recommended to cooperate with Bisotun Sugar Factory to facilitate access to production inputs like seeds, fertilizers, pesticides, and machinery. The fees can be paid by farmers after crop harvest when payments are made to them.
- As application of production technology plays a vital role in reducing growers' challenges, Jihad-e Agriculture Organization is recommended to promote application of new technologies among growers such as mounted machinery and implements in order to mechanize sowing, cultivation and harvest stages. Also, actions can be taken to extend the use of foreign seeds which are resistant to pests and diseases, micronutrient and biological fertilizers, preharvest leaf cutters and so on to help crop protection. To this end, the pioneering growers can be very helpful in promoting the use of these innovations.
- Stepwise regression analysis for the dependent variable of the challenges of growers in all agronomic stages showed that the variables of 'technology use', 'access to information sources', 'educational level', 'access to inputs', 'awareness level', and 'extent of machinery ownership' were significantly effective. So, it is recommended to the relevant organizations (Bisotun Sugar Factory and Jihad-e Agriculture Organization of Bisotun) to supply technologies, information resources, inputs, and machinery and to hold educational-promotional training courses.
- Given the positive effect of access to information resources and the use of communication media on alleviating sugar beet growers' challenges, it is recommended to increase their knowledge, attitude, and skills about the technological aspects of crop production by holding educational-promotional training courses. With respect to these courses, it is imperative to have a precise and sound planning to accomplish course objectives, i.e. improvement of crop production. These courses should be provided to these growers in various ways, especially group training and mass training so that sugar beet yield can be escalated in coming years..

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