Factor analysis of agricultural mechanization challenges in Iran

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Abstract: A descriptive survey research was undertaken in order to assess challenges facing agricultural mechanization development in Iran. The research population included agricultural mechanization experts, managers and specialists in private and governmental sections. Using proportional stratified sampling, a sample of 119 was constituted out of a total population of 809 based on the Cochran formula. Data were collected using questionnaire on which the statements were collected after literature review of research and interviews with mechanization specialists. The questionnaire was validated by a panel of experts and its reliability index was established by a Cronbach's coefficient. A pilot study was conducted with 30 questionnaires (not included in the sample population) to determine the reliability of the questionnaire. Computed Cronbach's alpha score was 75%, which indicated that the questionnaire was highly reliable. All survey data were analyzed using the Statistical Package for Social Sciences (SPSS 16.0). The results of factor analysis indicated that 69% of the variances of the challenges could be classified in seven groups, namely: programming, technical, infrastructural, managerial, economical, research and extension, and content area. From each group the most important challenges facing agricultural mechanization development in Iran include: inefficiency of subside payment methods for buying agricultural machinery, large number of time-worn agricultural machinery, incomplete collection of agricultural equipments for power generator machinery (tractor), slow trend of beneficiaries in accepting new technologies, financial weakness of agricultural beneficiaries, inefficiency of agricultural extension and education methods, and weakness of agricultural machinery producers and operators in protecting their guild benefits.

Keywords: agricultural mechanization, challenge, extension, factor analysis, Iran

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1 Introduction

Agriculture continues to play an important role in the economies of most developing countries. A 1% growth in per capita agricultural gross domestic product (GDP) leads to 1.61% increase in per capita income of the bottom quintile of the population, whereas a similar 1% growth in industrial GDP increases the income of the poor by 1.16% (Norton, 2004). Commercialization is essential for agricultural development, which, amongst other things, entails mechanization of agriculture to reduce the cost of production and to increase the yield of crops. Due to the ever-increasing agricultural labour scarcity in developing countries, an extensive scale agricultural commercialization may not be possible without mechanization (Nepal and Thapa, 2009).

Tools, implements, and powered machinery are essential and major inputs to agriculture. The term mechanization is generally used as an overall description of the application of these inputs. The level, appropriate choice and subsequent proper use of mechanized inputs into agriculture has a direct and significant effect on achievable levels of land, labour productivity, profitability of farming, sustainability, environment and quality of people's life engaged in agriculture (Olaoye and Rotimi, 2010). Agricultural mechanization constitutes the centre stage power source for boasting agricultural production. The application of machines in agricultural production minimizes the burdens and drudgery of manual farm labour, and increases farmers' income (Kepner et al.,

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2003). Among the recent trends in development of agricultural mechanization, there are an increase in power and energy capacity of agricultural machinery and equipments, an increase in their reliability and decrease in exploitation expenses and labour consumption (Bagheri and Moazzen, 2009; Yadav et al., 2010).

Numerous attempts were carried out by different countries for development of mechanization and determination of its challenges. Aderoba (1987) investigated major problems of using modern machinery in small farms. The author suggested a model for development of mechanization in small farms. A simple procedure to assist such decision-making is reported in the work.

Pawlak et al. (2002) showed that having an appropriate mechanization is an extremely wide-ranging problem, which requires deep technical analysis and a holistic approach. To solve this problem, mechanization needs to be considered not just in technical terms, but also as a component in a system where development relies upon establishing a series of essential "collateral" activities within various countries. These concern networks of applied research and testing centres, extension services, after-sales services, contracting companies, education and training schools, etc.

Fernando et al. (2005) exhibited technology transfer strategies for small size farm mechanization in the Philippines. The results showed that, the most important challenges for agricultural mechanization were: lack of information technology, farmers with limited-resource, small size of farm, lack of appropriate machinery, lack of agricultural mechanization experts, political interference and institutional weaknesses.

Singh (2006) estimated mechanization index and investigated its impact on production and economic factors in India. Analysis revealed that the human labour cost was the largest component in the cost of cultivation in the wheat crop in India. Results also revealed that the states having higher mechanization indices incurred a lower cost of cultivation of the wheat crop on quintal basis due to increased yield.

Balasubramanian et al. (2007) described the most important challenges and opportunities for rice production in Sub-Saharan Africa. Nepal and Thapa (2009) analyzed effective factors on agricultural mechanization in Nepal. Information was collected through a questionnaire survey, covering 120 farm households, and group discussion and key informant interviews. In both instances of farm mechanization, the degree of commercialization is the most influential factor, indicating the significant role of mechanization in agricultural commercialization. The major policy implications of the findings of the study are outlined (Anonymous, 1995; 2003).

Bagheri and Moazzen (2009) investigated agricultural mechanization challenges in Iran. They found that an important part of challenges belonged to human resources. Therefore, development of human resources is the most effective way to solve many challenges.

To improve the situation of agricultural mechanization in Iran, government carries out many attempts. Nevertheless, current situation of agricultural mechanization is not acceptable. Previous researches indicated that some challenges hinder the development of mechanization in Iran (Bagheri and Moazzen, 2009) and it is necessary to be known. So, the main objective of this research is to find out and then prioritize agricultural mechanization challenges in national level.

2 Materials and methods

The methodology used in this study involved a combination of descriptive and analytical method. In order to achieve information, interviews were conducted with agricultural mechanization specialists. Information collected from different points of view; studies which applied in other countries, papers presented in international congresses, and so on. The research population included agricultural mechanization experts, managers and specialists of agricultural engineering in private and governmental sections and farmers with different farm holdings (mostly small farms). Using proportional stratified sampling, a sample of 119 was constituted out of a total population of 809 by using Cochran formula. A questionnaire was developed based on relevant literature to be the main and basic method of information gathering to achieve goals. The

questionnaire included fixed choice questions on which the statements were collected after literature review of researches and interviews with specialists. To prioritize challenges, 24 statements were used and asked from respondents to determine their opinions about them.

A five-point Likert scale was used to measure the perception of respondents. The respondents were asked to indicate their agreements with statements by marking their response on a five point Likert-type scale. Content and face validity were established by a panel of experts consisting of faculty members at universities. Minor wording and structuring of the instrument were carried out based on recommendation of the expert panel. A pilot study was conducted with 30 persons (not included in the sample population), to determine the reliability of the questionnaire. Computed Cronbach's alpha score were 75%, which indicated that the questionnaire was highly reliable.

All survey data were analyzed using the Statistical Package for Social Sciences (SPSS 16.0). According to diversity of challenges, factor analysis was used to prioritize and reduce number of variables to fewer factors and determine the portion of each factor in the experts view about challenges of mechanization in Iran. Regarding the Kaiser criterion, seven factors with more than one eigenvalue were extracted. So, studied variables were divided into seven factors after factor rotation by the Varimax method.

3 Results

Prioritized challenges of agricultural mechanization in Iran are shown in Table 1. As shown in this table, among challenges, the highest priorities refer to small size of farms and traditional forms of gardens, severe and long process to pay credit loans, financial weakness of agricultural beneficiaries, weakness of agricultural mechanization programs because of their low feasibility and adaptability and slow trend of beneficiaries in accepting new technologies. While the least important challenges were low quality of country-made agricultural machinery, inefficiency of subside payment methods for buying agricultural machinery, large number of time-worn agricultural machinery, and lack of suitable services for agricultural machinery.

Table 1 Prioritized challenges of agricultural mechanization in Iran

Challenges	Mean	SD	C.V	Priority
Small size of farms and traditional forms of gardens	4.3	0.72	0.167	1
Severe and long process to pay credit loans	3.93	0.72	0.183	2
Financial weakness of agricultural beneficiaries	4.02	0.74	0.184	3
Weakness of agricultural mechanization programs because of their low feasibility and adaptability	4.40	0.91	0.206	4
Slow trend of beneficiaries in accepting new technologies	3.95	0.83	0.210	5
Incomplete collection of agricultural equipments for power generator machinery (tractor)	3.81	0.81	0.212	6
Lack of effective supervision and delay in application of suitable feedback to agricultural mechanization evolutions	4.05	0.89	0.219	7
Low skill of operators in correct application of agricultural machinery and equipments	3.57	0.80	0.224	8
Inefficiency of agricultural extension and education methods	3.57	0.80	0.224	8
Old technology of country-made agricultural machinery	3.62	0.82	0.226	9
Weakness of agricultural machinery producers and operators in protecting their guild benefits	3.47	0.79	0.227	10
Low skill and technical information of graduate students in agricultural machinery majors	3.81	0.88	0.230	11
Weakness of information technology in agricultural sector mechanization area	3.97	0.96	0.241	12
Deficiency of applied research in agricultural mechanization field	4.00	0.99	0.247	13
Lack of necessary law in agricultural mechanization area	3.76	0.98	0.260	14
Inattention of agricultural mechanization managers to rural development and environment considerations	3.76	0.98	0.260	14
Slowness of agricultural machinery test centre in testing machinery	3.63	0.98	0.269	15
Financial weakness of mechanized services companies	3.30	0.90	0.272	16
Lack of consensus about definition and domain of agricultural mechanization	3.44	0.94	0.273	17
Financial weakness of agricultural machinery producers	3.35	0.93	0.277	18
Nonobservance of financial considerations in establishment of mechanized services companies	3.54	0.99	0.279	19
Low social position of agricultural and rural jobs	3.33	0.93	0.279	20
Lack of suitable services for agricultural machinery	3.94	1.18	0.299	21
large number of time-worn agricultural machinery	3.79	1.14	0.300	22
Inefficiency of subside payment methods for buying agricultural machinery	3.92	1.24	0.316	23
Low quality of country-made agricultural machinery	3.94	1.30	0.329	24

According to diversity of challenges, factor analysis was used to prioritize and reduce number of variables to fewer factors and determine portion of each factor in the experts view about challenges of mechanization development in Iran. Calculations indicated that the internal consistency of data was suitable (KMO=0.70) and Bartlett statistic was significant at 1% level. Regarding the Kaiser criterion, seven factors with more than one eigenvalue were extracted (Table 2 and Table 3). Studied variables were divided seven factors after factor rotation by the Varimax method, namely, programming, technical, infrastructural, managerial, research and extension, economical and content factors.

Table 2 Extracted factors with Eigenvalue after rotation

Factor	Eigenvalue	Variance %	Cumulative %
First	2.89	11.13	11.13
Second	2.88	11.08	22.21
Third	2.66	10.23	32.44
Fourth	2.56	9.88	42.32
Fifth	2.46	9.48	51.81
Sixth	2.34	9.02	60.83
Seventh	2.14	8.24	69.08

Table 3 Constituting variables for each factor

Factor	Variable	Factor loading
Programming	Inefficiency of subside payment methods for buying agricultural machinery	0.53
	Lack of effective supervision and delay in application of suitable feedback to agricultural mechanization evolutions	0.87
	Inattention of agricultural mechanization managers to rural development and environment considerations	0.84
	Lack of necessary law in agricultural mechanization area	0.72
	Weakness of agricultural mechanization programs because of their low feasibility and adaptability	0.57
Technical	large number of time-worn agricultural machinery	0.67
	Low quality of country-made agricultural machinery	0.53
	Lack of suitable services for agricultural machinery	0.61
	Old technology of country-made agricultural machinery	0.84
	Low skill and technical information of graduate students in agricultural machinery majors	0.65
Infrastructural	Incomplete collection of agricultural equipments for power generator machinery (tractor)	0.58
	Low social position of agricultural and rural jobs	0.69
	Slowness of agricultural machinery test centre in testing machinery	0.84
Managerial	Slow trend of beneficiaries in accepting new technologies	0.7
	Lack of consensus about definition and domain of agricultural mechanization	0.76
Economical	Financial weakness of agricultural beneficiaries	0.77
	Financial weakness of agricultural machinery producers	0.65
	Financial weakness of mechanized services companies	0.74
	Small size of farms and traditional forms of gardens	0.85
Research and extension	Inefficiency of agricultural extension and education methods	0.81
	Weakness of information technology in agricultural sector and mechanization area	0.7
	Deficiency of applied research in agricultural mechanization field	0.8
Content	Weakness of agricultural machinery producers and operators in protecting their guild benefits	0.61
	Nonobservance of financial considerations in establishment of mechanized services companies	0.81
	Severe and long process to pay credit loans	0.67

In this research, seven factors were extracted and named based on the nature of agricultural mechanization challenges. The first factor was programming factor. In regarding the highest eigenvalue of this factor (Eigenvalue 2.89 and variance % 11.13), challenges related to programming factor are the most important challenges for agricultural mechanization development. These challenges include: inefficiency of subside payment methods for buying agricultural machinery, lack of effective supervision and delay in application of suitable, feedback to agricultural mechanization evolutions, inattention of agricultural mechanization managers to rural development and environmental considerations, lack of necessary law in agricultural mechanization area, and weakness of agricultural mechanization programs because of their low feasibility and adaptability.

Because of the nature of constituting variables of the second factor, this factor is named as a technical factor. This factor explained 11.08% of the challenges (eigenvalue 2.88). Technical mechanization challenges are: large number of time-worn agricultural machinery, low quality of domestically produced agricultural machinery, lack of suitable services for agricultural machinery, old technology of domestically produced

agricultural machinery, and low skill and technical information of graduate students in agricultural machinery majors.

According to the constituting variables of third factor, it named as infrastructural factor that explained 10.23% of the challenges. Infrastructural challenges include: incomplete collection of agricultural equipments for power generator machinery (tractor), low social position of agricultural and rural jobs, and slowness of agricultural machinery test centre in testing machinery. So, the fourth factor, named managerial factor determined 9.88% of the challenges. Agricultural mechanization challenges in managerial fields were slow trend of beneficiaries in accepting new technologies, and lack of consensus about definition and domain of agricultural mechanization. Also, the fifth factor was economical factor that explained 9.48% of the challenges include: financial weakness of agricultural beneficiaries, financial weakness of agricultural machinery producers, financial weakness of mechanized services companies, and small size of farms and traditional forms of gardens. The sixth factor was named research and extension that explained 9.02% of the challenges. These challenges are: inefficiency of agricultural extension and education methods, weakness of information technology in agricultural sector and mechanization area, and deficiency of applied research in agricultural mechanization field. Finally, regarding to the nature of variables, the seventh factor named content factor that covers 8.24% of the mechanization challenges include; weakness of agricultural machinery producers and operators in protecting their guild benefits, non observance of financial considerations in establishment of mechanized services companies, and severe and long process to pay credit loans. Totally, as it is illustrated in Table 2, the seven mentioned factors explained about 69.1% of challenges and the other was related to factors which were not predicted in this study.

4 Discussion and conclusions

The results of this study indicated that the small size of farms and traditional forms of gardens, severe and long process for paying credit loans, financial weakness of agricultural beneficiaries, weakness of agricultural mechanization programs because of their low feasibility and adaptability and slow trend of beneficiaries in accepting new technologies were determined as the most important challenges facing agricultural mechanization development in Iran.

The results of factor analysis indicated that 69.1 % of the variances in the challenges of agricultural mechanization could be classified in seven groups of programming, technical, infrastructural, managerial, economical, research and extension, and content area. It is necessary to mention that the most important challenges include: inefficiency of subside payment methods for buying agricultural machinery, large number of time-worn agricultural machinery, incomplete collection of agricultural equipments for power generator machinery (tractor), slow trend of beneficiaries in accepting new technologies, financial weakness of agricultural beneficiaries, inefficiency of agricultural extension and education methods, and weakness of agricultural machinery producers and operators in protecting their guild benefits. It is believed that these findings are partially consistent with studies by Aderoba (1987); Asoegwu and Asoegwu (2007).

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