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Effective Factors in Agricultural Apple Waste in Islamic Republic of Iran: A Comparative Study

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ABSTRACT With population growth, massive pressure has been put on natural resources to produce more agricultural products, whilst million tons of agricultural products go to waste during agricultural process. The main purpose of the study was to investigate effective factors in apple waste in Zanjan Province, Iran. The population consisted of apple farmers (NF= 1000) and extension experts (NEE=78) who deal with activities about apple in Zanjan Province. A sample of 200 apple farmers and 78 extension experts were selected using stratified random sampling method. Data were collected through questionnaires. Validity of questionnaire was determined through opinions of faculty members at University of Tehran and agricultural experts in Zanjan Province. Cronbach's alpha was used to estimate the reliability. The reliability was found to be acceptable (alpha nF= 0.75, alpha nEE= 0.86). The results revealed that post harvesting problem, pre-harvesting- natural problem, infrastructure and harvesting problems were the four factors affected apple waste. These factors could totally explained 66.38 percent of variance of variables.

INTRODUCTION

For a healthy and balanced living, one has to consume basic food products, which fresh fruit and vegetables are a part of (Akpinar et al. 2009). With population growth, agriculture will need to produce enough supply of food to feed an expected more than eight milliard people by 2030 (FAO 1992) and this additional production must be achieved with productivity of production factors and decrease of agricultural waste (Hoghooghi 1998).

Advanced technologies in agriculture have been a dominant method for food production, resulting increase of agricultural products (Mutlu 2007) and increase of agricultural waste as well. Totally, agricultural waste in developing countries is about 35 percent of agricultural crop products annually (Bayat 2003), which imposes irrecoverable costs. Since agricultural waste decrease is an important way for agricultural sustainability, there is the need to understand factors influencing agricultural waste and to reduce them.

Resende (1979) stated that key factors for food losses were management experience, harvesting practices, packaging methods, and handling at the retailers.

Fehr and Romao (2001) indicated that administrative shortcomings were identified as a basic reason for agricultural waste. Also, fruit and vegetables deteriorate during the operations of handling, transport, packaging, storage, selling and consumption. Neder (1992) indicated possible relationships between physical damage and biological deterioration of fruit and vege-tables.

Tadesse (1991) found that information management and formation of talents were management procedures for reducing food losses during transportation and commercial distribution. The importance of vigilant handling and storage during transportation of fruit and vege-tables was noted by Costa and Caixeta (1996). Chaim (1999) suggested modifications to the wholesale structure to reduce losses. Polopolus (1982) advocated a standardization of packaging material for fruits and vegetables in order to reduce losses.

Bageri and Shahbazi (2003) discovered that a great number of Iranian farmers had low technical competencies at many stages of farming activities such as planting, harvesting, protecting plants, and operating agricultural machinery. They stated that about 75-82 percent of young farmers need to be trained in all latter aspects of farming.

In order to improve the safety of fresh fruits, many preservation methods are actually used in many countries, aiming at the destruction of the pathogens or inhibition of their growth. Kader and Ben-Yehoshua (2000) include refrigerated storage, controlled and modified atmosphere storage, low pressure or hypobaric storage. Certain compounds, such as calcium, silicon and borate, which directly inhibit the growth of patho-

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genic fungi, have been highly successful in controlling a number of post-harvest diseases (Qin and Tian 2005; Qin et al. 2007). The strategy of chemical control has concentrated on treatments that protect the product from infection or inhibition of the pathogen growth in incipient infections. Also, some biotechnologies, such as biological control with antagonistic yeasts (Janisiewicz and Korsten 2002) and resistance induction (Droby et al. 2002; Tian and Chan 2004), have been used to control post harvest diseases in various fruits.

The same scenario regarding the importance of agricultural waste decrease is going in Iran. Agriculture is the major sector contributes to the growth of Iran's economy (Nooripoor et al. 2008). Iran lies between 25 to 40 north latitude and between 44 and 63 east longitudes. It is located in the northern hemisphere in west Asia, and has temperate, subtropical and tropical climate conditions. With its geographical position, possibilities and soil conditions, there is a large variety of horticultural products in this country. Apple is one of the most important fruits for investing in Iran (Mahdavi and Zanjirian 2003). The total amount of apple products in 2005 was 2,661,901 tons which increased production 4 fold in 2000 (FAO 2006). Based on statistics, the total quantity of apples in Zanjan Province in 2006 was 76,290 tons and Zanjan County has the greatest contribution, with 1900 hectare, and 38000 tons (in average 20 ton/ha) but a large amount of these apples is converted to waste annually. Therefore, this study attempts to investigate factors influencing apple waste in Zanjan Province.

Purpose and Objectives

The main purpose of the study was to investigate effective factors in apple waste in Zanjan Provinces. The special objectives of the study were:

- Identifying and analyzing effective factors in apple waste;
- Comparing attitudes of farmers and extension experts toward effective factors in apple waste; and
- Comparing educational needs of farmers and extension experts.

METHODOLOGY

This study was a descriptive-correlation research, carried out in 2007 in Zanjan province. The population of the study consisted of apple farmers (NF1= 1000) and extension experts (N_{EE2}=78) who deal with activities about apple in Agricultural Extension Organizations (AOEs). A sample of 200 apple farmers and 78 extension experts were selected by using stratified random sampling method.

The survey instrument divided into three parts. Part one (28 items) were measured attitudes toward effective factors in apple waste, using a five likert-type scale (1 = "Strongly Disagree", 2 = "Disagree", 3 = "No opinion", 4 = "Agree" and 5 = "Strongly Agree"). Part two (10 items), were assessed farmers attitudes toward educational needs, and it was measured on the same five likert-type scale. Finally, the third section contained demographic data, type of labor, methods for apple supply, communication channels and so forth. Content and face validity of the instrument were obtained by a panel of experts consisting of faculty members at University of Tehran, Department of Agricultural Education and Extension and agricultural experts in Zanjan. The instrument was pilot tested using farmers and extension experts (n = 30) out of statistical population in other regions. Minor changes were made to improve the clarity and readability of the instrument. Cronbach's alpha, an internal consistency measure, was used to estimate the reliability. The reliability was found to be acceptable (alpha n_{F1}= 0.75, alpha n_{EE2}= 0.86).

Data were analyzed using Statistical Package for the Social Sciences (SPSS). Descriptive and inferential statistics were used to analyze the collected data. Descriptive statistics included frequency values and inferential statistics included t-Test, F-Test, correlation coefficient and factor analysis.

RESULTS AND DISCUSSIONS

Exploratory Factor Analysis

In this study exploratory factor analysis with data reduction approach was used. The main objective of this technique is to classify a large number of variables into a small number of factors that can adequately explain the correlations among a set of variables. Items that are grouped together are presumed to measure the same underlying construct (Kerlinger 1986).

Exploratory factor analysis is a useful tool for understanding the dimensions of a set of variables and also for isolating variables that do not represent the dimensions well. It is extremely helpful during pilot work in the development of a set of items as all loadings are free to vary.

To determine the appropriateness of data and measure the homogeneity of variables entered to the analysis, the Kaiser-Meyer-Olkin (KMO=0.705) and Bartlett's Test of Sphericity (533.78; $p < .01$) were used.

While performing the factor analysis, there are some decisions to be made: the method of factor extraction, the number of factors, and the type of factor rotation. There are several factor extraction methods. The methods used for the final solution were chosen primarily on the interpretability of the resulting factors. In this study unweighted least squares factoring was used as the extraction method. Another decision to be made when conducting factor analysis is to determine the number of factors. One rule of thumb is to use an Eigen value of one as the cut-off value. That is, all factors in a particular solution must have Eigen values greater than one. Rotation is used to reorient the factor loadings so that the factors are more interpretable. The Varimax rotation option, which tries to minimize the number of variables that load highly on a factor, was used.

Reliability testing and detailed item analysis were undertaken to refine the factor measures associated with waste management. Nunnally (1978) developed a widely adopted method to evaluate the assignment of items to scales. This approach considers the correlation of each item with each scale. Specifically, the item score to scale score correlations are used to determine if an item belongs to a dimension as assigned by the factor analysis, or if it should be consider within another dimension or dropped altogether. The general approach taken was to evaluate each measurement item with respect to its reliability contribution to the scale. If through the analysis any item reduced the reliability of a factor, it was subsequently discarded. Factors were deleted in cases where the coefficient alpha was below 0.70 (save only one factor) - as recommended by Nunnally (1978), and a new solution derived in efforts to improve the reliability of the study. Others suggest that it is not unusual in exploratory studies to consider alphas less than 0.70 (i.e. between 0.50 and 0.70) (Katabe 1990; Kohli 1989). In this study, given the objective to optimize the highest level of internal consistency of the factor items, 0.70 was maintained as the threshold.

Eigen values, variance percentage and the cumulative variance percentage of extracted determinants are presented in table1.

Accordingly, four factors were extracted (Table 1). Factors were examined and given a descriptive title that represented the characteristics of the constructs. The first factor was post harvesting problem which explained 24.18 percent of variance. Other factors were pre-harvesting-natural problem, infrastructure and harvesting problem, which explained 16.28, 14.93, and 10.97 percent of the total variance respectively. These factors accounted for a total of 63.38 percent of the total variance. The four factors that were extracted are as follows:

- *Factor 1:* The first factor accounted for 24.18 percent of the total variance and 4 variables loading significantly (Loadings range from 0.72 to 0.78). These variables were packaging problems, harvesting in traditional persuader, transportation problem, and grading. So, this factor was termed "post harvesting problem".
- *Factor 2:* The second factor accounted for 16.28 percent of the total variance and 3 variables loading significantly (Loadings range from 0.68 to 0.75). These variables were inappropriate time of irrigation, excessive (unrestricted) use of pesticides, and hailstone. So, this factor was termed "pre-harvesting-natural problem".
- *Factor 3:* The third factor accounted for 14.93 percent of the total variance and 2 variables loading significantly (Loadings range from 0.75 to 0.77). These variables were inappropriateness of infrastructures (springhouse, storehouse and…), and glutting. So, this factor was termed "infrastructure".

Table 1: Eigen values, variance percentage and the cumulative variance percentage of extracted determinants.

Waste causes	*Eigen value*	*The variance percentage*	*Cumulative variance percentage*
Post harvesting problem	2.41	24.18	24.18
Pre-harvesting-natural problem	1.62	16.28	40.47
Infrastructure	1.49	14.93	55.4
Harvesting problem	1.09	10.97	66.38

- *Factor 4:* The last factor accounted for 10.97 percent of the total variance and this is single-item variable loading significantly (Loadings range from 0.85). This variable was harvesting out of/ sooner time and named "harvesting problem" (Table 2).

Correlation Analysis between the Amount of Waste and Demographic Variables

Correlation analysis was used to describe the probabilistic relationship between the amount of waste and demographic variables of respondents. The results showed that there were significant relationship between the amount of waste in year ago and horticulture income [r=0.348, p=0.000] and income of nonagricultural activity [r=0.198, p=0.001]. Also, there was significant relationship between the amount of waste in 5 years ago and horticulture income [r=0.16, p=0.023].

Comparison between the Amount of Waste and Educational Levels and Type of Labor (F- Test)

The F-test (ANOVA) for probabilistic differences between the amount of waste and farmers' educational levels was used. The results showed significant differences (F=1.29, p<0.000) between the amount of the waste (in 5 years ago) of apple farmers who had high level of education and those with intermediate and low level of education. According to the results, apple farmers who had low and intermediate level of education had more apple wastes rather than farmers who had high level of education.

Also, the F-test result for probabilistic differences between the amount of waste (in 5 years ago) and type of labor (constant, pro-visional, and mixed) was significance (F=3.65, p<0.028). The result revealed that there were differences between the amount of waste of farmers who applied constant labors and the amount of waste of farmers who applied provisional and mixed labor.

Comparison between Attitudes of Farmers and Extension Experts Toward Effective Factors in Apple Waste (t- Test)

The results of t-test for probabilistic differences between the attitudes of farmers and extension experts toward effective factors in apple waste are shown in table 3.

It can be seen that the two groups showed significant differences for 23 variables (out of the 27 variables). According to the results, there were no significant differences between farmers and extension experts about malapropos of fertilizers, excessive (unrestricted) use of pesticides, inappropriate time of irrigation, and premature harvesting. The results of Leven-test revealed that variant distribution of variables were the same in two groups.

Comparison between Educational Needs of Farmers and Extension Experts (t- Test)

The results of t-test for probabilistic differences between educational needs of farmers and extension experts showed that there were differences in storing methods (t=3.27, sig. =0.01), harvesting time (t=5.53, sig. =0.000), grading (t=2.9, sig. =0.012), labors (t=10.18, sig. =0.000), and teamster/ transformers (t=5.37, sig. =0.000).

CONCLUSIONS AND RECOMMENDATIONS

Iran is one of the top ten horticultural producers. However, harvest losses in Iran are

Table 2: Effective factors on apple waste

Factor name	*Variable*	*Factor load*
Post Harvesting problem	Packaging problems	0.782
	Harvesting in traditional persuader	0.78
	Transportation problem	0.731
	Grading	0.729
Pre-harvesting- natural problem	Inappropriate time of irrigation	0.753
	Excessive (Unrestricted) use of pesticides	0.712
	Hailstone	0.682
Infrastructure	Inappropriateness of infrastructures (springhouse, storehouse and…)	0.774
	Glutting	0.758
Harvesting problem	Harvesting out of/ sooner time	0.854

Table 3: Comparison between attitudes of farmers and extension experts toward effective factors in apple waste.

Factors	*Groups*	*Mean*	*t-test*	*Sig*	*df*
Hailstone	F	3.96	-5.523 **	0.000	148.4
	EE	4.72			
Nipping	F	4.89	8.84 **	0.000	143.15
	EE	3.92			
Cyclone	F	4.34	8.15 **	0.000	137.7
	EE	3.26			
Pests and diseases	F	4.12	-3.95 **	0.000	153.8
	EE	4.58			
Malapropos of fertilizers	F	3.29	1.62 ns	0.100	125.5
	EE	3.06			
Abuse of pesticides	F	2.93	-3.99 **	0.000	127.9
	EE	3.59			
Excessive (Unrestricted) use of pesticides	F	2.88	0.209 ns	0.835	168.27
	EE	2.85			
Inappropriate time of irrigation	F	2.82	-1.147 ns	0.140	157.21
	EE	3.03			
Harvesting out of/ sooner time	F	4.14	-0.98 ns	0.324	138.23
	EE	4.28			
Lack of skills in labors	F	3.99	5.82 **	0.000	142.12
	EE	3.12			
Lack of number of labor in harvesting time	F	3.45	3.36 **	0.001	173.73
	EE	2.94			
Harvesting in traditional persuader	F	4.11	8.92 **	0.000	176.01
	EE	2.92			
Inappropriate packaging	F	4.67	4.6 **	0.000	119.58
	EE	4.01			
Using of inappropriate transportation methods	F	4.43	7.68 **	0.000	150.00
	EE	3.47			
Un grading of harvested Apple	F	4.22	4.73 **	0.000	136.00
	EE	3.56			
Distance between harvesting and storing	F	4.35	4.34 **	0.000	137.44
	EE	3.78			
Over storing of Apples in fridge	F	4.64	4.67 **	0.000	128.5
	EE	4.03			
Lack of infrastructure	F	4.63	10.82 **	0.000	124.95
	EE	3.18			
Inappropriateness of storehouse and fridge	F	3.44	7.37 **	0.000	134.17
	EE	2.33			
High distance between production centers and supply centers	F	4.25	7.22 **	0.000	177.96
	EE	3.29			
Lack of processing infrastructure	F	4.9	6.5 **	0.000	123.99
	EE	4.03			
Superabundant supply in markets	F	3.96	9.84 **	0.000	151.59
	EE	2.47			
Low information of farmers about markets	F	4.44	9.86 **	0.000	134.14
	EE	3.12			
Inconsistent prices	F	5.07	9.14 **	0.000	133.3
	EE	3.95			
Lack of human resource	F	5.2	9.27 **	0.000	130.00
	EE	4.04			
Ineffective public organization for marketing	F	5.21	7.04 **	0.000	138.05
	EE	4.37			
Ineffective private organization for marketing	F	4.03	14.59 **	0.000	156.6
	EE	2.15			

1 = "Strongly Disagree", 2 = "Disagree", 3 = "No opinion", 4 = "Agree" and 5 = "Strongly Agree"

several times greater than the world's average loss. Even after establishing an Agricultural Extension Service, Iran still experiences great problems in reducing post-harvest losses.

The main purpose of this study was to investigate effective factors in apple waste in Iran. The results showed that four effective factors in apple wastes were post harvesting problem, pre-harvesting-natural problem, infrastructure, and harvesting problem. The factors direct us to the activities which should be taken into consideration. While challenging the harvesting problems could be expected from Agricultural Waste Management Extension Education (AWMEE), providing the infrastructure is initially not the nature of such an extension work. In other words, AWMEE can start training the gardeners to decrease the wastes in all the three stages of pre, interim, and post harvesting. It can afford the infrastructures for them. Also, the AWMEE can start designing an educational package which includes preliminary, interim and post harvesting steps. The package could also include waste management materials which can lead to decreasing of waste.

The results showed significant differences between the amount of the waste (in 5 years ago) of apple farmers who had high level of education and those with intermediate and low level of education. The result showed that apple farmers who had low and intermediate level of education had more apple wastes rather than farmers who had high level of education. Therefore, AWMEE is a necessary part to help farmers to make the most appropriate decisions, rather than influencing or intervening in their decisions about increasing farming efficiency and/or making decisions for them. (Malek Mohammadi 2006). AWMEE deals with almost all aspects of agriculture and natural resources demanding knowledge and understanding. In any aspect of human resources development and human resources capital development, Extension has an active and determinant role to play.

The result of F-test for probabilistic differences between the amount of waste (in 5 years ago) and type of labor (constant, provisional, and mixed) were significant. The result revealed that there were differences between the amount of waste of farmers who applied constant labors and the amount of waste of farmers who applied provisional and mixed labor. Since constant labors are more experienced, it is recommended that farmers use constant labors in different stage of cultivation.

REFERENCES

Akpinar MG, Aykin SM, Sayin C, Ozkan B 2009. The role of demographic variables in purchasing decisions on fresh fruit and vegetables. *Journal of Food, Agriculture and Environment*, 7(3&4): 106-110.

Bageri A, Shahbazi E 2003. Determining factors for educational needs of rural youth in sustainable exploitation of rice farms, a case study in Amol Township in The Province of Mazandaran. *Iranian Journal of Agricultural Sciences*, 34(3): 303-320. (In Farsi).

Bayat F 2003. Effective factors in agricultural losses, and Ways to combat it. *Paper presented in the first conference in prevention methods of natural resources*, 19-21 Jan. Farhangestan Olom, Tehran. (In Farsi).

Chaim NA 1999. *Modifications to the Supply Chain of Fruits and Vegetables and the Role of Supermarkets* (in Portuguese). M.Sc. Dissertation. Federal University, Uberl ândia.

Costa FG, Caixeta JVF 1996. Loss analysis of tomato marketing, a case study (in Portuguese). *Informac¸ õesconômicas* (São Paulo), 26(13): 9-24.

Droby S, Vinokur V, Weiss B, Cohen L, Daus A, Goldschmidt EE, Porat R 2002. Induction of resistance to Penicillium digitatum in grapefruit by the yeast bio control agent Candida oleophila. *Phytopathology*, 92: 393-399.

FAO 1992. *A Commodity System Assessment Methodology.* FAO Study. Rome: FAO.

Fehr M, Romao DC. 2001. Measurement of fruit and vegetable losses in Brazil: A case study. *Environment, Development and Sustainability*, 3: 253-263.

Hoghooghi M 1998. Food security. *Water and Development*, 2&3: 47-57.

Janisiewicz WJ, Korsten L 2002. Biological control of postharvest diseases of fruits. *Annual Review of Physiopathology*, 40: 411-441.

Kader AA, Ben-Yehoshua S 2000. Effects of super atmospheric oxygen levels on postharvest physiology and quality of fresh fruits and vegetables. *Postharvest Biology and Technology*, 20: 1-13.

Katabe M 1990. Corporate product policy and innovative behavior of European and Japanese multinationals. *Journal of Marketing*, 54(2): 19-33.

Kerlinger FN 1986. *Foundations of Behavioral Research.* New York, NY: Holt, Rinehart and Winston.

Kohli AK 1989. Effects of supervisory behavior: The role of individual differences among salespeople. *Journal of Marketing*, 53: 40-50.

Mahdavi H, Zanjirian A 2003. Feasibility Study and retrieval and production of valuable materials from agricultural wastes and related processing industries. *The First Conference in Prevention Methods of Natural Resources, 19-21 Juanary Farhangestan Olom, Tehran.* (In Farsi).

Malek Mohammadi I 2006. Agricultural Waste Management Extension Education (AWMEE). The Ultimate Need for Intellectual Productivity. *American Journal of Environmental Sciences*, 2(1): 10-14.

Mutlu N 2007. *Consumer Attitude and Behavior Towards Organic Food: Cross-cultural Study of Turkey and Germany.* Master Thesis. Institute for Agricultural Policy and Market, Stuttgart-Hohenheim.

Neder RN 1992. *Microbiology and the Deterioration of Fruits and Vegetables* (in Portuguese). Microbiologia de Alimentos. Piracicaba.University ESALQ Press.

Nooripoor M, Shahvali M, Zarafshani K. 2008. Integration of Communication Media For Horticultural Sustainability: The Application of Multiple Criteria Decision Making (MCDM). *American-Eurasian J Agric Environ Sci*, 3(1): 137-147.

Nunnally JC 1978. *Psychometric Theory.* 2nd Edition. New York: McGraw-Hill Book Company.

Polopolus L 1982. Agricultural economics beyond the farm gate. American Journal of *Agricultural Economics*, 64(5): 803-81.

Qin GZ, Tian SP 2005. Enhancement of biological control activity by silicon and the possible mechanisms involved. *Phyto Pathology*, 95: 69-75.

Qin QZ, Tian SP, Chan ZL, Li BQ 2007. Crucial role of antioxidant proteins and hydrolytic enzymes in pathogen city of Penicillium expansum: Analysis based on proteomic approach. *Molecular and Cellular Proteomics*, 6, in press.

Resende LMA 1979. *Causes and Effects of Losses in Vegetable Marketing* (in Portuguese). M.Sc. Dissertation. Federal University, Viçosa.

Tadesse F 1991. Post-harvest losses of fruits and vegetables in horticultural farms. *Acta Horticulture*, No. 270, pp. 261-270.

Tian SP, Chan ZL 2004. Potential of induced resistance in postharvest disease control of fruits and vegetables. *Acta Psychopathological Sinica*, 34: 385-394.