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FACTORS AFFECTING THE ADOPTION OF SOILLESS PRODUCTION SYSTEM IN UAE

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ABSTRACT

To examine the factors that could influence the decision of growers to use hydroponic production systems in UAE, a questionnaire, was developed and completed by extension agents through direct interviews with 141 growers. Logistic regression analysis was performed to test the theoretical model. Study shows the adoption rate among those growers who receive the information about hydroponics is relatively high. More than 50% of the growers who heard about this technology package start to implement it in their farms. However, adoption also depend to some other factors which based on their importance consisted of 1) Farm income importance; 2) Education; 3) Water salinity at the farms and negative relation with conducting post-harvest. There are other factors such as 1) Agricultural loan 2) Farm income satisfaction and 3) existence of desalination unit which although have some effect but not significant. Overall, it seems that soilless production system is very suitable for UAE socio-economic and agro-ecological status. However, growers' acceptance of this new system represents one of the key issues that must be addressed to ensure the successful dissemination of the technology and sustainability of the achievements. Our study has shown that the most important factor that seems to influence growers' acceptance of soilless production system is the importance of agricultural income and education which clearly indicate the importance of appropriate organizational infrastructure, training, and technical support.

Keywords: Adoption rate, adoption model, technology transfer, farming system, protected agriculture, soilless culture, hydroponics, logistic regression.

INTRODUCTION

The Arabian Peninsula (AP) is a water-limited region with extreme aridity and limited renewable water resources. In most areas the annual precipitation is far below the potential crop water requirements. Hence, with the exception of a few areas in Yemen, all arable crop production requires irrigation. The renewable supply of water per capita is amongst the lowest in the world. (ChartsBin, 2011). In spite of the harsh environment, the economic blossom of the region has resulted to a rapid population increase which led to improving the requests for the food. It is projected that the Arabian Peninsula population will reach to above 133 million people in 2050 which shows an increase by 2 folds compared to 69 million people in 2011 (PRB, 2012). Similarly, the region countries have the highest annual population growth rate in the world.

The Population Growth Rate (PGR-The average annual percent change in the population) for the Arabian Peninsula countries is presented by Figure 1. Qatar PGR is the highest in the region and 3rd in the world.

The complexity of food security issues is exacerbated by the region harsh and dry environment. Almost 90% of the food consumed in the GCC countries is imported. It is expected that The Gulf Cooperation Council (GCC) spending on food imports will more than double from US\$24bn in 2008 to US\$49bn by 2020 (EIU, 2009). The situation is the worst in Yemen, where 43 % of people live in poverty, and 32 % of the population does not have access to enough food (Wiebelt *et al.*, 2012). Develop and improve agricultural production systems suitable with the harsh condition of the Arabian Peninsula would have a significant impact on food security of the region. Therefore, and based on the request of the AP countries National Agricultural Research Systems (NARS), the International Center for Agricultural Research in the Dry Areas (ICARDA) has started a research for development

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of program for the region called Arabian Peninsula Regional Program (APRP) since 1995. The achievements of ICARDA in the AP are demonstrated by the useful technology packages developed by APRP in rangeland rehabilitation, irrigated forages, on-farm water management, and protected agriculture including associated techniques such as soilless production

systems. In UAE same as other AP countries, the introduced and developed technologies have proven their success initially in the research station and later on, were transferred to a number of growers for extended cultivation. The technology transfer process has speed up since 2000 when the ICARDA project on technology transfer started.

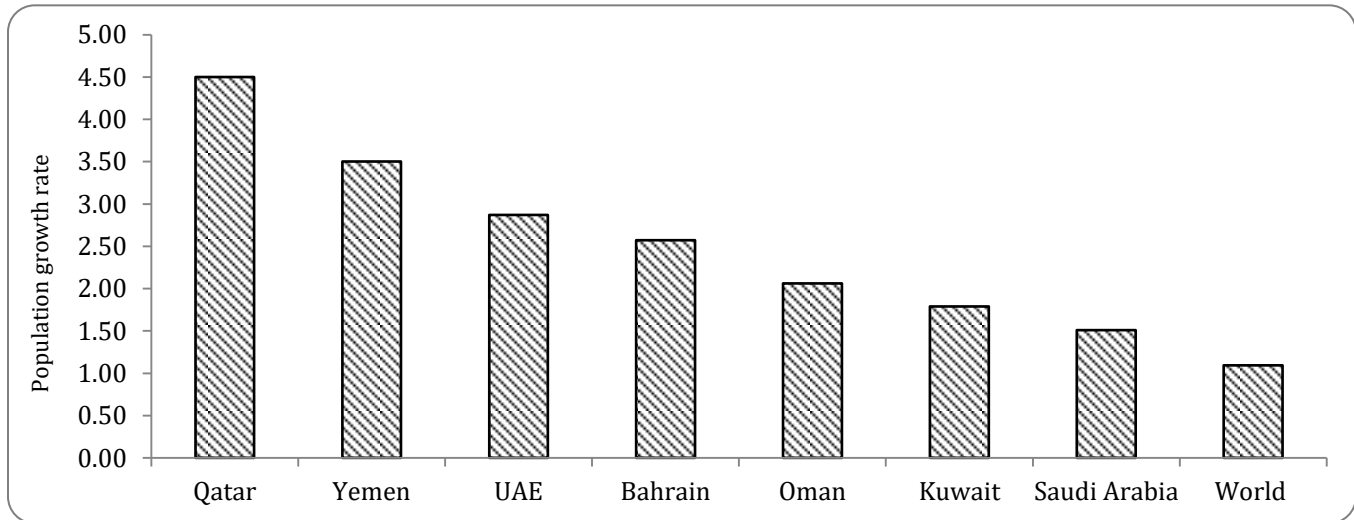


Figure 1. Population Growth Rate in the Arabian Peninsula countries (CIA, 2013).

To enhance the adoption and farther expansion of soilless production system, the present paper made an attempt to evaluate and assess the grower’s point of view (perception) on soilless production system under protected agriculture as one of the ICARDA targeted technology in the region. In addition, the focus will be on developing a model based on adoption factors permitting to predict and identify the trend of adoption of such technology by the growers based on their existing characteristics.

METHODOLOGY

Data was collected through questioners within all United Arab Emirates’ four regions which are consisted of Western, Northern, Eastern and Central regions. Based on the interviews and unpublished data from the Ministry of environment and water there are about 35,000 farms in UAE from which 80% located at western region (Abu Dhabi). To measure the reliability and validity of the questioner, an undeclared pretest (participants was not informed that they are answering pre-test) conducted for 40 growers’/farm owner (10 from each regions) whom selected randomly using farm numbers and Microsoft excel random number generator. To calculate the minimum number of sample size, a factor based on growers’ overall point of view on

protected agriculture, integrated production and protection management and soilless production system was developed from the pre-test questioners.

Standard deviation (StdDev) is used for testing and calculating the sufficient Sample Size (SS) required for this study. The SS is calculated based on the following equation (Smith, 2016):

$$SS = \frac{Z^2 \times StdDev \times (1 - StdDev)}{Margin\ of\ error^2}$$

The Z is a constant figure which for 95% confidence level is 1.96. The StdDev is calculated at 0.623. Often, an "acceptable" margin of error used by survey researchers falls between 4% and 8% at the 95% confidence level (DataStar, 2008). Considering migration of error 0.08, total required sample size calculated at 140. The Systematic sampling methods is used to select 141 farms from all UAE. Questioners were completed by extension agents whom visited farms and interviewed farm owner/farms managers. The pre-test samples were not included in to the study. From 141 farms selected randomly, 92 farms were used protected agriculture. SPSS ver. 21 was used for data processing and analysis as well as for studying and developing a model logistic regression. Logistic regression is an approach to prediction, like Ordinary Least Squares (OLS) regression.

However, with logistic regression, the researcher is predicting a dichotomous outcome (Pohlman & Leitner, 2008). In our case, the adoption of Hydroponics production system is considered as dichotomous outcomes (0=No, 1=yes).

Based on the observations in the field, data collected by questionnaires and nature of Hydroponics production systems the following indicators are selected to build the model:

- Importance of farm income for the growers (0=not important, 1=important)
- If grower use agriculture loan or government subsidies (0=No, 1=Yes)
- Growers satisfaction from agriculture income (0=not satisfied, 1=satisfied)
- If growers conducting any postharvest processing (0=No, 1=Yes)
- Salinity of water in the farm. The border for salinity is selected at 4000ppm where vegetable plants lose 50% of the yield (0=not saline, 1= saline)
- grower education level (0=illiterate and primary education, 1=above high school)
- Existence of desalination unit in the farm (0=not exist, 1=exist)

RESULTS AND DISCUSSION

Demographic description of the respondents: According to the findings mean of farm owners' age is about 55 years ranged between 25 to 80 years old. However, about 90% of the owners has 41 years old and above and 65% above 51. This could present the low interest of youth to start farm business. Farm owner education level indicated that 28% of farm owner has university degree, having 43% of farm owner illiterate or only with ability of reading and writing will negatively affect the agricultural development. The data collected from questioners show that about 70 percentages of the farm owner don't stay at the farm. As an average, the farm owners only spend 30% of their time or about 3 months per year in their farms. The routine works and farm activities are carried out by farm managers. This indicates the importance of farm managers for adapting the new technologies. The average farm sizes which are covered in this study are about 500 donom or 50ha as each donum equal to 1000m². However, from what is highlighted by Table 3 more than 50% of farms area is blow 5ha. Expect one farm which reported rented, all the farms owner ship was private. More than 96% of the farms using wells as source of irrigation water from which

90 percent are using wells inside the farm. The rest of the farms are using other source of water including treated waste water, purchased desalinated water and springs. The average salinity of well water which is reported by the growers in this study is about 7000ppt. the irrigation water in about 30% of the farms has salinity less than 1500 while in 14% of the farms this figure is between 1500 and 3000ppt. about 56% of the farms are irrigated with the water above 3000ppt which requires reverse osmosis (RO) unit. Salinity of irrigation water has negative effect on vegetable yields. Most of the vegetable crops especially tomato and cucumber lose 50% of the yield when irrigated by water with 3000 ppm and more (Grattan, 2002).

Farming systems, marketing and importance of agricultural incomes: Successful dissemination of the new technologies for enhancing the sustainability of farming system through improving agricultural production with conserving natural resources mainly water, is widely depending on a clear understanding of the present status of the target areas' farming system and its elements. Furthermore, the integration of a new practice or technology into an existing farming system generally requires careful planning and management which again requires clear understanding of the prevailing situation and circumstances (Kaine, 2004). The compatibility of the targeted technology with the present farming system will result in an overall increase of the number of growers using this new technology (Ton, 2005). In this context and to understand present farming systems in target areas, growers were questioned about their production systems. Three main groups of farms identified (figure 3): i) the group practicing open field crops (about 34%); ii) the group practicing only protected agriculture (about 29%) and iii) the group practicing the mixture of both open field and protected agriculture (about 38 %). The open field productions are mainly consisted of vegetable crops, date palm and animal fodders. The greenhouse production is focus on high value vegetables such as tomato, cucumber and lettuce.

Animal production is carried out in about 68% of the farms. Small ruminants (goats and sheep), camel and cows are the main raised animal species. Within the farms covered in this study with livestock activities, the highest numbers of animals are sheep and goats with 8397 and 6182 heads respectively. These are followed by 198 camels and 414 cows. Average numbers of animals per farms are presented by Figure 3.

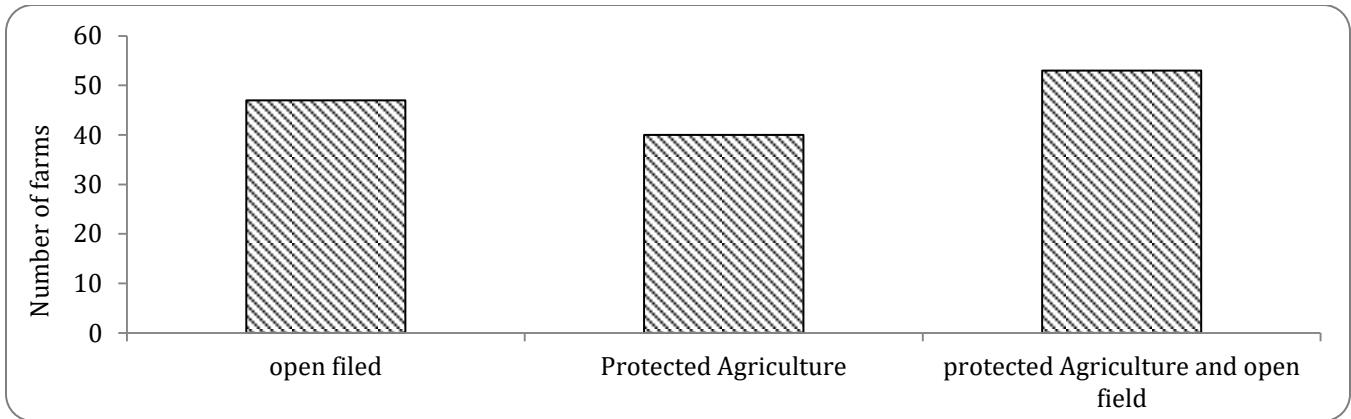


Figure 2. Number of farms with different production system in the study.

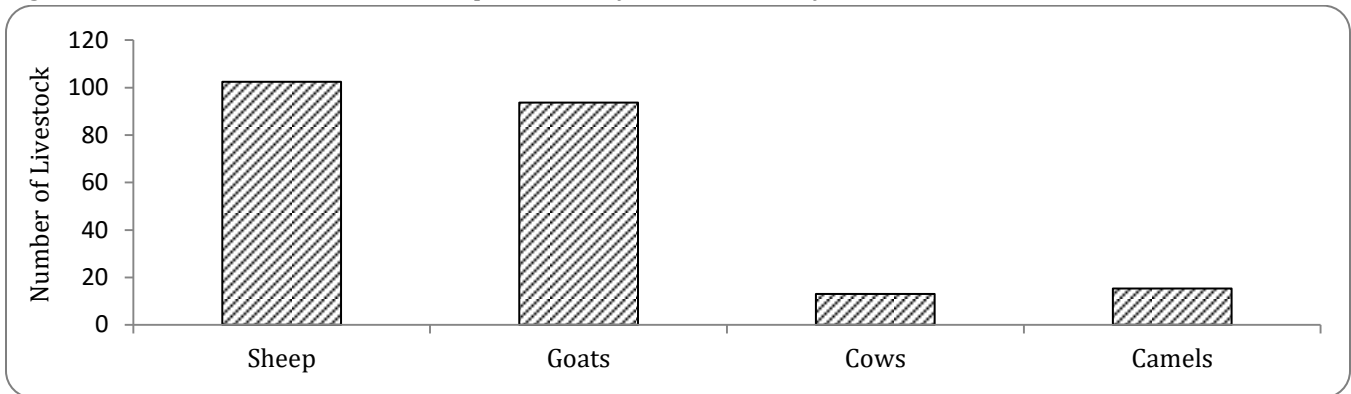


Figure 3. Average number of livestock per farms.

Direct marketing is the main channel for the UAE growers. About 42 percent of the farm owners directly send their products to the market. This is followed by the wholesale at the farm gate where about 30% of the farmers sell their products. Retailers also have a share of 11% of marketing either at the farm gates or when products delivered to them by the growers. However, about 17% of the growers produce only for self-consumption (Figure 5). The fact that only 17% of the growers in this study don't send their products to the market, shows the importance of farm income for many of the farm owners. Furthermore, the fact that most of the growers do direct marketing, which involves selling a product from the farm directly to customers shows their attentions to the market needs. In this system, farmer grows a "product" more than a crop. Farm direct marketing is closely related to the concept of "niche marketing" (Stephenson & Larry , 2015). Based on the growers' reply, only about 25% of the growers implement post-harvest process activities. However, the major proportion (75%) are sending their products to the market without any post-harvest processing. The post-harvest activities include cleaning, drying, packing,

sorting and removing infected plants. Sorting and packing are the most important post-harvest activities where 31 and 25 percent of the growers, who conduct post-harvest process, are caring out these activities respectively. The main reason for the low price and high competition in the market as expressed by growers was high volume of agricultural imports especially fresh vegetables. About 81% of the surveyed growers mentioned that they have problem in competing with imported products. This shows the importance of adopting new technologies for producing high quality products with lower price. Protected agriculture with its associated techniques such as hydroponics system would be a suitable answer as it will produce high quality vegetable crops with lower cost of production. Although, the initiation cost will be higher compare to conventional soil based systems, saving on running cost specially on water will reduce the total cost (Pilloni, 2014). The main constraints for agricultural products in UAE, which is listed and sorted by the growers who interviewed in this study, are presented in figure 7. The main constraints for marketing are low price and competition based on the growers' point of view.

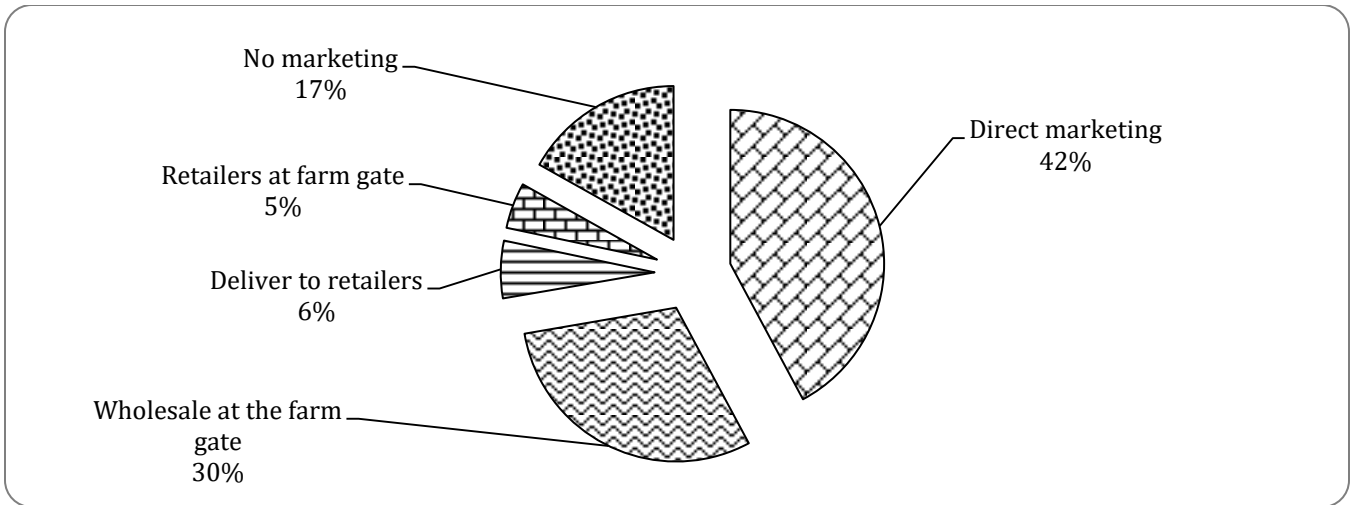


Figure 4. Distribution of percentage of farmers according to the marketing form.

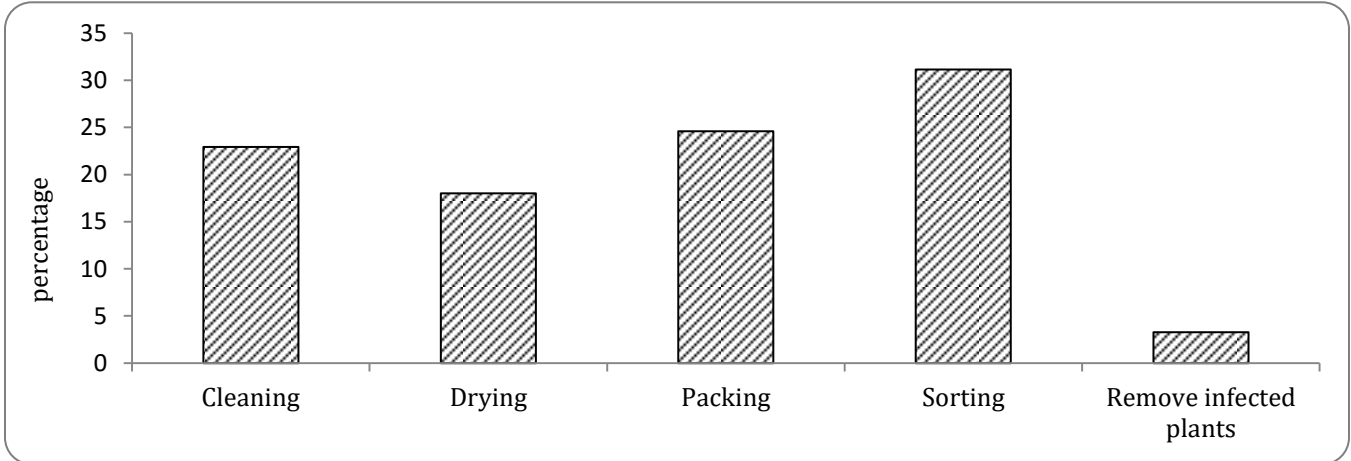


Figure 5. Percentage of different post-harvest process used by those growers who conduct some form of post-harvest activities in their farms.

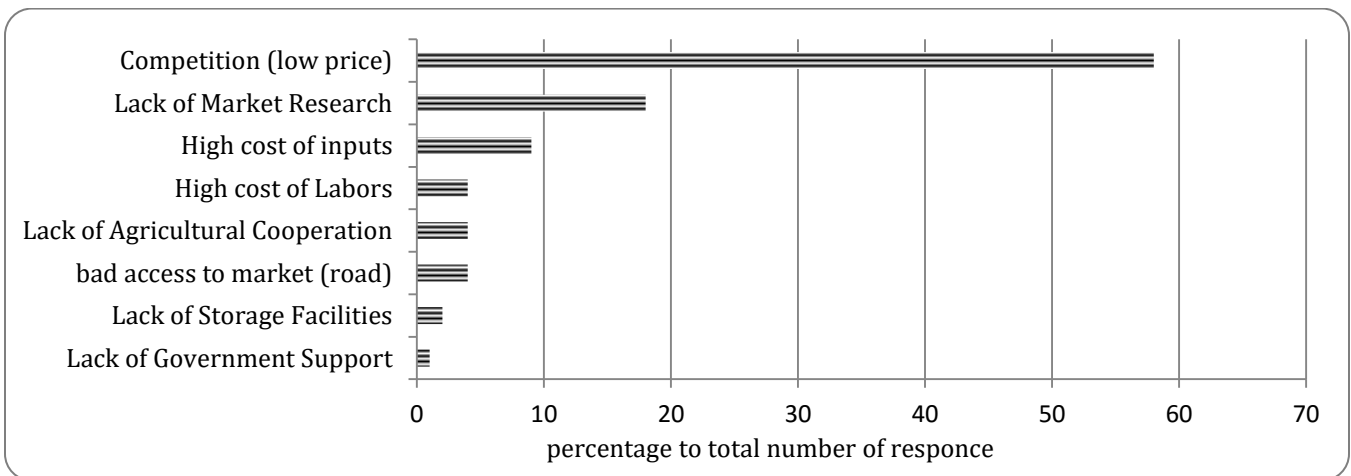


Figure 6. UAE growers' main constraints for marketing.

The best crops, in term of marketing, listed and sorted by the growers are presented in figure 8. A total of 36 out of 63 growers who replied to this question

mentioned that cucumber is the best crop in term of marketing in UAE which is followed by tomato and date palm.

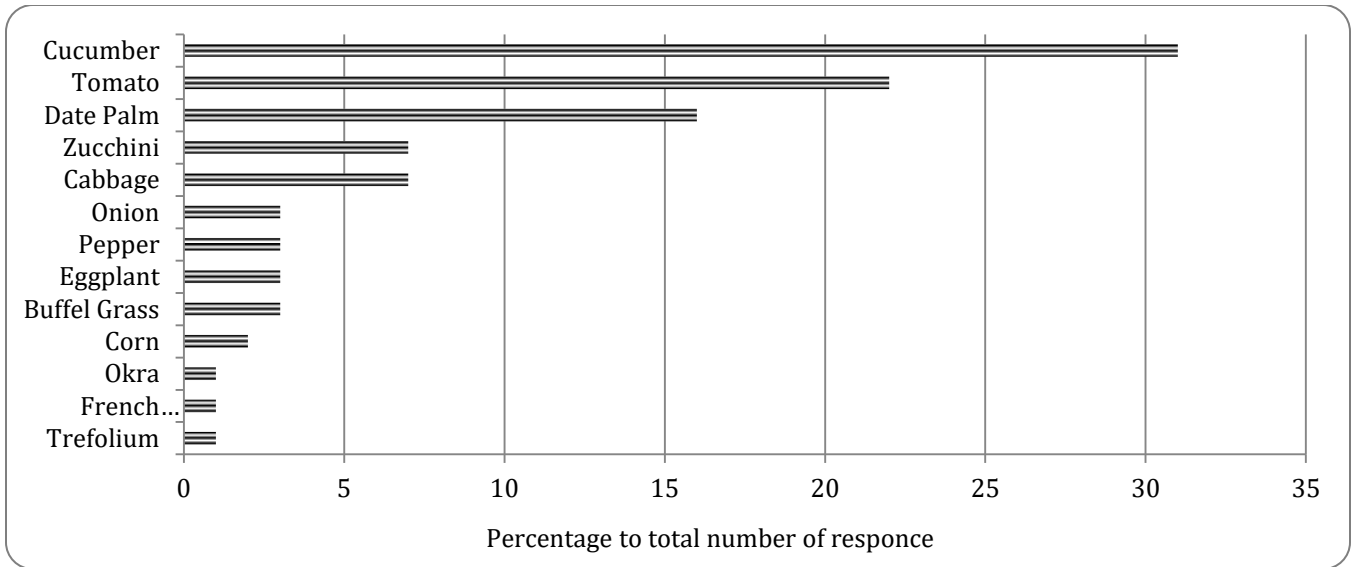


Figure 7. Best crops in UAE in terms of marketing as perceived by the growers.

Agriculture and farm income for about 50% of growers participated in this study was important or very important while for the other 50% the money generated from the farm is just acceptable or not important (Figure 9). For this group the farming activities are not the main source of income. However, as illustrated in figure 10, the agricultural income for about 70% of growers is satisfactory.

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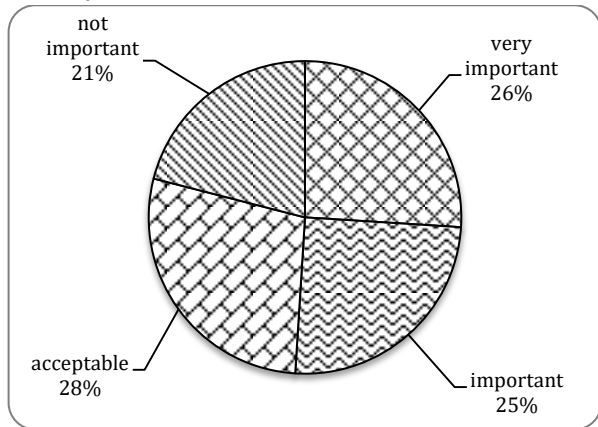


Figure 8. Importance of farm income for the grower.

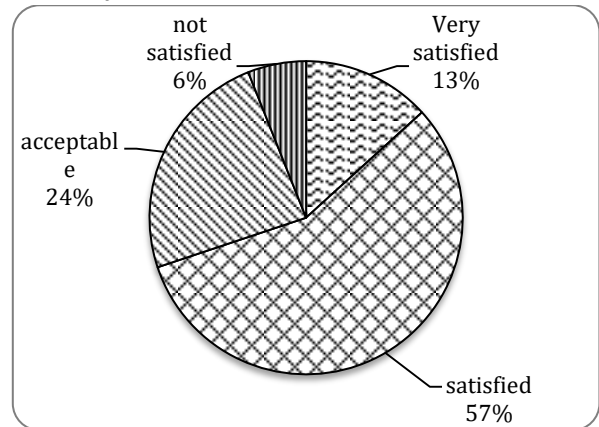


Figure 9. Level of satisfaction of growers from agricultural income.

Economic indicators: Economic feasibility and benefit is a very strong motivation for adopting the new technology by growers (Mishra *et al.*, 2010). In our case and based on growers' reply, adoption of soilless production system improves their annual income by 10US\$/m² of the greenhouse. Hydroponics production systems in general have a good economic feasibility which is mostly due to high yield and therefore income and the high water productivity (Jensen, 2015). For

instance, in 2012, ICARDA reported that in Oman the production of cucumber reached a record of 17.3 kg/m² for a single crop. In UAE, water productivity for tomato reached 48 kg/m³ under soilless culture as compared to 7 kg/m³ under traditional soil system. In Saudi Arabia the average water productivity for tomato crops reached about 40 kg/m³ under soilless culture versus only about 9 kg/m³ under soil system (ICARDA-APRP, 2013). It is reported by number of different resources that,

Hydroponics/soilless culture can be a great way to contribute to better energy conservation, practice a sustainable lifestyle, and protect the environment from some of the worst problems facing our future (Save the Environment with Hydroponics , 2013). Water is our most precious resource. Hydroponics uses 70%-90% less water as compared to conventional vegetable production systems. The second greatest ecological benefit is that no fertilizer runoff escapes into aquifers. These two items alone, water conservation and the non-pollution of aquifers, are major environmental plus values (Symply Hydro, 2008). In UAE, the soilless production systems (hydroponics) are receiving very good attention by the growers. More than 62% of total growers involved in this study have heard about the soilless culture from which about 51% also adopted the technology (Figure 10). The likelihood that farmers will adopt a technology depends on how well the technology is adapted to the local conditions. These local conditions

can be classified into three categories (Kirway *et al.*, 2003): 1) Production environment (i.e. the biophysical conditions); 2) farmer categories of the recommendation domain and; 3) Production goals of the farmers. The high rate of adoption among the growers who received some information on soilless production in UAE shows the good level of adaptability of this technology to the local conditions. Figure 10 shows also importance of the extension and research activities in technology transfer. The high initial costs and lack of skilled labors are the main issues affecting the speed of adoption among growers. Figure 12 showing growers' point of view about soilless (Hydroponics) production systems revealed that about 76% of the growers evaluated this technology package under very good and good category. However, 12% of the growers classified this technology unacceptable and rejected which mainly due to inadequate technical support or high cost of establishments.

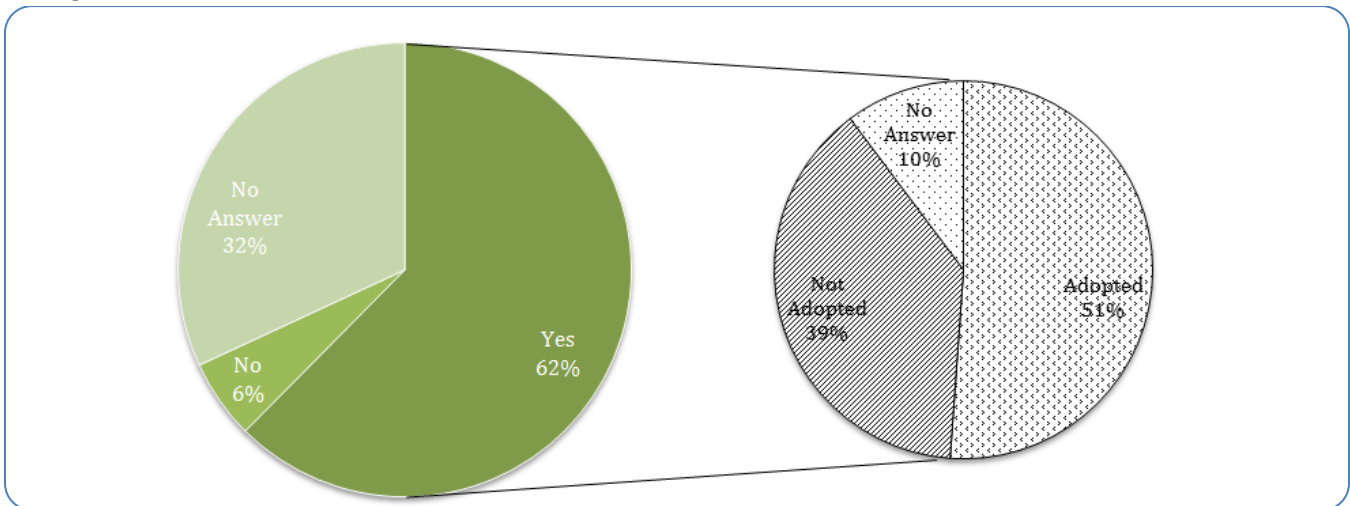


Figure 10. Percentage of growers adopted the soilless culture production system (right) after heard about the technology (left).

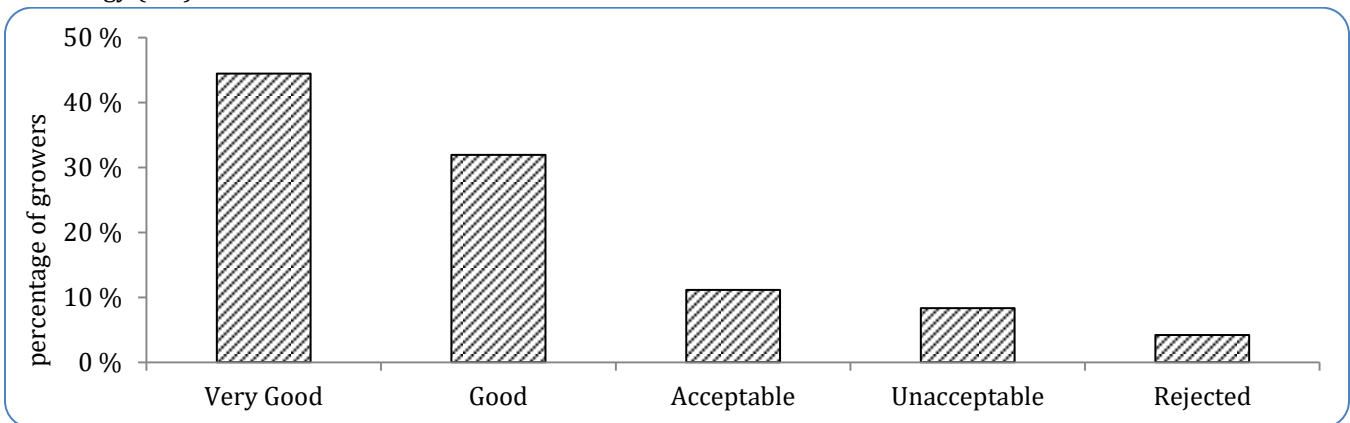


Figure 11. Growers' point of view on Hydroponics Production Systems.

Table 1. Correlation between adoption of Hydroponics and some other indicators.

		have you adopted Hydroponics	
		1) No	2) Yes
farm production system 1) protected agriculture and open field; 2) Protected Agriculture only; 3) Open field Only	Pearson Correlation	.325*	
	Sig. (2-tailed)	.010	
	N	62	
the farm owner education1) illiterate2) only reading and writing3) primarily4) high school5) university degree	Pearson Correlation	.281*	
	Sig. (2-tailed)	.027	
	N	62	
the importance of farm income in total family income1)Not Important 2) Acceptable 3) Important 4) Very important	Pearson Correlation	.301*	
	Sig. (2-tailed)	.021	
	N	59	
single Spam GH, Areas of normal cooled GH	Pearson Correlation	.487*	
	Sig. (2-tailed)	.034	
	N	19	

Develop model for adoption probability for soilless production system: Based on the data collected in this study, adoption of hydroponics by the growers has positive correlation with farmers’ production systems and Greenhouse areas, production for the market and importance of farm income and arm owner education (Table 5). However, predicting the adoption of the technology by the growers depends on different factors which as a group they also affecting each other. To study and developing a model logistic regression are used where the adoption of Hydroponics production system is considered as dichotomous outcomes (0=No, 1=yes). Table 2. Tests of Model Coefficients.

		Chi-square	d.f.	Sig.
Step 1	Step	18.390	7	.010
	Block	18.390	7	.010
	Model	18.390	7	.010

Chi-square and Sig. - This is the chi-square statistic and its significance level. The statistics for the Step, Model and Block are the same because we have not used stepwise logistic regression or blocking. The value given in the Sig. column is the probability of obtaining the chi-square statistic given that the null hypothesis is true. In other words, this is the probability of obtaining this chi-square statistic (18.390) if there is in fact no effect of the independent variables, taken together, on the dependent variable.

This is, of course, the p-value, which is compared to a critical value or significance level such as .05 or .01 to determine if the overall model is statistically significant. In this case, the model is statistically

The model is run by SPSS package. Out of 141 cases 93 farms are selected where protected agriculture are used as part of production system. No cases are dropped by the system from these 93 observation (missing cases=0). The modeling is done in two main steps. The difference between the steps is the predictors that are included. Step 0- . The first step, called Step 0, which includes no predictors and just the intercept. Often, this model is not interesting to researchers therefore we move to next step. Step 1 - This is the step (or model) with predictors in it (Table 6).

highly significant because the p-value is less than 0.010.

Table 3 shows how many cases are correctly predicted based on the full logistic regression model. Thirty-five (35) cases are observed to be “0” and are correctly predicted to be “0”; while 34 cases are observed to be “1” and are correctly predicted to be “1”. On the other hand table also shows how many cases are not correctly predicted. Thirteen (13) cases are observed to be 0 but are predicted to be 1; and 21 cases are observed to be 1 but are predicted to be 0. This gives the overall percent of cases that are correctly predicted by the model. Overall 74.2 percentage of cases predict correctly by the full model.

Table 3. Classification of the growers in observed and predicted adopters in relation to the model outputs.

Observed			Predicted		Percentage Correct
			Adoption1		
			Non-Adopter	Adopter	
Step 1	Adoption1	Non-Adopter	35	13	72.9
		Adopter	11	34	75.5
	Overall Percentage				74.2

a. The cut value is .500

Table 4 shows the values for the logistic regression equation for predicting the dependent variable from the independent variable. They are in log-odds units. Similar to OLS regression, the prediction equation is:

$$\log(p/1-p) = b_0 + b_1*x_1 + b_2*x_2 + b_3*x_3 + b_3*x_3+b_4*x_4+...+b_7*x_7 \text{ "or"}$$

$$\text{Prob} (y=1) = 1/(1+e-(b_0 + b_1*x_1 + b_2*x_2 + b_3*x_3 + b_3*x_3+b_4*x_4+...+b_7*x_7))$$

Where p is the probability of being in Adopt the soilless production system. Expressed in terms of the variables used in this study, the logistic regression equation is

$$\log(p/1-p) = -1.282 + 1.008FII + 0.365AGL + 0.54*FIS - 1.448CPH + 0.662WAS + 0.932EDU + 0.270DES$$

Table 4. Variables in the Equation.

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1a	Farm income importance	1.008	.505	3.979	1	.046	2.741
	Agriculture Loan	.365	.966	.143	1	.706	1.441
	Farm income satisfaction	.054	.241	.050	1	.823	1.055
	Conduct post-harvest	-1.448	.537	7.275	1	.007	.235
	Water salinity	.662	.582	1.296	1	.255	1.939
	Education	.932	.496	3.522	1	.061	2.539
	Desalination unit	.270	.519	.271	1	.603	1.311
	Constant	-1.282	.948	1.830	1	.176	.277

Table 5 shows the effect of each predictors while considering other predictors constant with their value equal to 1. The highest effect in the model is belong to importance of farm income followed by growers' education level. Increasing the salinity of irrigation

Where: Farm income importance (FII), Agricultural loan (AGL), Farm income satisfaction (FIS), Conduct post-harvest (CPH), Water salinity (WAS), Education (EDU), Desalination unit (DES).

These estimates, describe the relationship between the independent variables and the dependent variable (Adoption of soilless production system), where the dependent variable is on the logit scale. These estimates reveal the amount of increase or decrease in the predicted log odds of adoption = 1 that would be predicted by a 1-unit increase (or decrease) in the predictor, holding all other predictors constant.

water also is an important factor for adoption of this technology. Conducting post-harvest has negative effect in the model which needs further studies why growers who adopted this technology not interested in post-harvest methods.

Table 5. Effect of each predictor while considering other predictors constant with their value equal to "1".

	B	All		FII		AGL		FIS		CPH		WAS		EDU		DES	
		X	BX	X	BX	X	BX	X	BX	X	BX	X	BX	X	BX	X	BX
Farm income importance	1.008	1	1.008	0	0	1	1.008	1	1.008	1	1.008	1	1.008	1	1.008	1	1.008
Agriculture Loan	0.365	1	0.365	1	0.365	0	0	1	0.365	1	0.365	1	0.365	1	0.365	1	0.365
Farm income satisfaction	0.054	1	0.054	1	0.054	1	0.054	0	0	1	0.054	1	0.054	1	0.054	1	0.054
Conduct post-harvest	-1.448	1	-1.448	1	-1.448	1	-1.448	1	-1.448	0	0	1	-1.448	1	-1.448	1	-1.448

Water salinity	0.662	1	0.662	1	0.662	1	0.662	1	0.662	1	0.662	0	0	1	0.662	1	0.662
Education	0.932	1	0.932	1	0.932	1	0.932	1	0.932	1	0.932	1	0.932	0	0	1	0.932
Desalination unit	0.270	1	0.27	1	0.27	1	0.27	1	0.27	1	0.27	1	0.27	1	0.27	0	0
Constant	-1.282		-1.282		-1.282		-1.282		-1.282		-1.282		-1.282		-1.282		-1.282
Prob (y=1)			63.67		39.01		54.88		62.41		88.17		47.48		40.83		57.22
effect					24.66		8.78		1.26		-24.51		16.19		22.84		6.44

These are in line with the growers' responses to the questions about the main advantages of soilless production systems compared to conventional production systems under protected agriculture (Figure 12).

The advantages are named by growers as "using less water" and "higher yield" where 36 and 28 percent of growers respectively mentioned these two factors as the main advantages. These are followed by "better quality" which is important for those producing for the market.

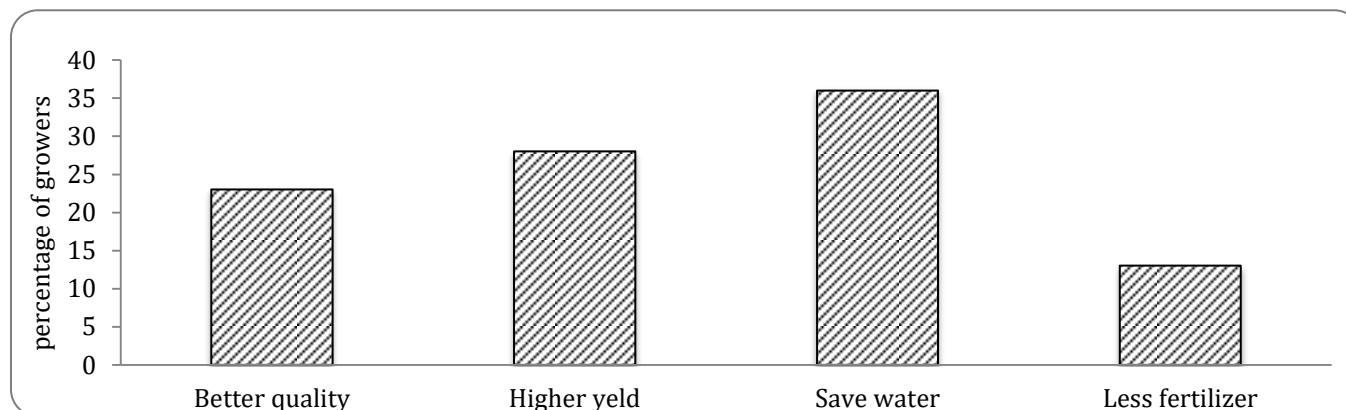


Figure 12. Advantage of soilless culture over conventional production system from growers' point of view.

Maximum adoption rate for Hydroponics in UAE:

Based on the characteristics of target group it is possible to calculate and predict the maximum adoption rate of a technology before any action is undertaken to test or diffuse it. This priority estimation needs a good understanding of the farmers population and the production environments for which the technology is meant to be. Calculation of the maximum adoption rate facilitates priority setting of research and extension. It reveals that, in many cases, one-dimensional or blanket recommendations have low maximum adoption rates, and that flexible recommendations are needed to obtain more satisfactory rates of adoption (Kirway ed, *et al.*, 2003). Based on the finding from the model of adoption probability, and without considering the growers Table 10. Maximum adoption rate for hydroponics in UAE.

education level, the maximum adoption rate would be a function of two indicators of having greenhouse and producing for the market to see the importance of farm income. Although it is expected that the farm owners' education have some effects on accepting the technology, as most of the farm owner in UAE are more inventors than growers the higher economic value of the hydroponics will attract them. Therefore, the maximum adoption rate is a two-dimension function:

$$MAR = C f(1,n) \times G f(1,n) / 100$$

MAR = Maximum Adoption Rate (%)

Cf(1,n)=Frequency of farmer production system categories

Gf(1,n) = Frequency of production goals (market or not market)

C1=GH Production system = 62%		C2=Open field system = 35%	
G1=Market= 86%	G2=Not Market=14%	G1=Market=84%	G2=Not Market=16%
C1G1= 53.32%	C1G2=8.68%	C1G1=29.4	C1G2=5.6%

While, the 141 growers participated in this study covered the sufficient number of samples for representing the whole growers population in UAE, it can be stated that maximum adoption rate for the

Hydroponics production system in UAE will be about 53.32% of the growers. Therefore, to cover such a large number of growers, the hydroponics production system should be considered as a high priority for research and

extension system in UAE.

DISCUSSION

The results and finding of this study reveal that soilless production system is a suitable technology package for more than 50% of the farms in the UAE. These are the farms which produce for market and using greenhouse production systems. The most common farming system in UAE includes protected agriculture (greenhouses) either alone or accompanied with other production systems such as open field and animal production. Soilless production systems are specifically suitable for the production of high value vegetable crops such as tomato, cucumber and lettuce which from other hand are the best and marketable crops in UAE based on the growers and farm owners' point of view which collected in this study. Based on the growers reply, only about 25% of the growers implement post-harvest process activities. However the major proportion (75%) are sending their products to the market without any post-harvest processing. Some of resources reported that soilless production system provides exact required nutrition for a better cell structure in the plant which resulted in a longer shelf life after harvest (PureHydroponics, 2016). This might explain the negative impact of post-harvest activities on adoption of soilless production system. It seems the crops produced in soilless production system required less post-harvest treatment. However, there is a need for a specific study to confirm this. Although might have required higher capital cost, significant increase in yield and quality accompanied with better water and fertilizer efficiency not only reduce the cost of production but also improve total growers net income.

The above mentioned factors would provide growers with more comparative advantage to compete with imported vegetable crops and low price of products in the market which are the main constraints facing growers in UAE for marketing their products. Adoption rate among those growers who receive the information about hydroponics is relatively high. As mentioned before more than 50% of the growers who heard about this technology package start to implement it in their farms. However, adoption is also depends on some other important issues such as: 1) Farm income importance; 2) Education; 3) Water salinity at the farms and negative relation with conducting post-harvest. There are other factors such as 1) Agricultural loan 2) Farm income

satisfaction and 3) existence of desalination unit which although have some effects but not significant.

Study Limitations: The results of our study should be interpreted in light of some limitations. First, despite the fact that an acceptable response rate was achieved, it was not reflecting the variation between the numbers of farms in different regions. Second, the questionnaire was completed with different extension agents in different region which could bring some biases to the study. Finally, some of the findings need more investigation to be analysed. These includes the negative correlation between post-harvest activities and adoption of soilless production systems.

CONCLUSION AND RECOMMENDATIONS

As the food security becoming a major issue in the region and UAE, soilless production system is increasingly seen as an efficient and cost-effective mean for producing high value vegetable crops. However, it is important to acknowledge the fact that adoption of this technology package requires technical support from National Agricultural Research and Extension Systems (NARES). Large portion of the growers who don't accept the system or reject it after the adoption raised lack of knowledge and technical support as main reason for their choice. This is clearly indicating the importance of enhancing the capacity of NARES for improving adoption rate. Study shows that the adoption rate among those growers who receive the information on hydroponics is relatively high. More than 50% of the growers who heard about this technology package start to implement it in their farms. From the finding of this study it can be stated that soilless production systems have a great potential to be adopted by at least 50% of the farms in UAE where produce high value vegetable crops market under protected agriculture. The advantages of the soilless production systems over conventional soil bed production under protected agriculture are listed by growers as use less water, higher yield, better quality and using less fertilizers. Review the model which is developed in this study, shows that the following factors (listed by their importance) has positive effect on growers' decision for adopting soilless production systems:

- Importance of farm income
- Education
- Salinity of water source
- Availability of agricultural loan
- Availability of desalination unit
- Farm income satisfaction

Importance of high water salinity, and availability of desalination unit clearly indicate the suitability of soilless production techniques for high water scarcity region such as Arabian Peninsula. Overall, it seems that soilless production system is very suitable for UAE socio-economic and agro-ecological status. However, growers' acceptance of this system represents one of the key issues that must be addressed to ensure the successful dissemination of the technology and sustainability of the achievements. Our study has shown that the most important factor that seems to influence growers' acceptance of soilless production system is the importance of agricultural income and education which clearly indicate the importance of appropriate organizational infrastructure, training, and technical support. However, the initial capital cost which include desalination unit and greenhouse production system is also very important for accepting this production technique and farther expansion in UAE. The experience of subsidizing 50% of the cost for installation of greenhouse with soilless production system was very successful in UAE to increase number of farms accepting this production technique. Better marketing and increasing farm income also are very important factors for accepting the soilless production systems by growers and farm owners. In general, and based on this study findings, to farther expansion of soilless production techniques in UAE, the following activities are recommended:

- Enhance the agricultural extension system to provide technical backstopping and know-how to the growers;
- Financial support to cover the initial coat of establishment of the production system and desalination units if required;
- Enhance marketing systems for improving farms incomes;
- Further technical research to improve productivity and efficiency of soilless production system;

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