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Farmers' acceptance of a micro-irrigation system: A focus group study

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Abstract. Despite water scarcity and the numerous benefits offered by micro-irrigation systems, the implementation of these systems on potato crops in the Bekaa Valley of Lebanon is notably low. This could be related to the local farmers' acceptance to use this technique. The objective of this study is to investigate the factors that may or may not affect the adoption and investment in a new micro-irrigation system. For this purpose, the unified theory of acceptance and use of technology (UTAUT) served as the conceptual framework. A qualitative approach using focus group discussion was applied. A total of six focus groups with 34 farmers were conducted in the three main districts of the Bekaa Valley. From the analysis, performance expectancy, effort expectancy and facilitating conditions emerged as the three most prominent factors which influenced the farmers' acceptance and adoption of micro-irrigation systems. According to the results of the focus groups, potato farmers are willing to adopt a new micro-irrigation system if they are assured that it will result in gains and reduce the amount of time and effort required for farming Barriers included lack of knowledge about the system, financial capabilities and extension services. Participants were enthusiastic about the idea of adopting a micro-irrigation system, but hindered by the unstable socio-economic conditions in Lebanon and the financial situation. It was concluded that age, experience and voluntariness of use exert an effect on the related major determinants. This study will provide recommendations that can be considered while drafting agricultural policies.

Keywords: UTAUT model, Focus group, climate change, Micro-irrigation, Technology acceptance.
JEL codes: Q01, Q2, Q3.

1. INTRODUCTION

Climate change is having a huge detrimental impact on freshwater availability on a worldwide scale, affecting water resources quantitively and qualitatively (Field & Barros, 2014). Water scarcity is one of the most dangerous threats which has already resulted in catastrophic losses, notably in the arid regions. High temperatures, increased evaporation and fluctuations in precipi-

tation are altering water availability and reducing crop yields (Arbuckle et al., 2013; Niles & Mueller, 2016). These factors affect the management of farms, especially in arid and semi-arid regions (Scoville-Simonds et al., 2020). Moreover, climate change is endangering the agricultural sector presenting risks for developed and developing countries (Field & Barros, 2014; Niles & Mueller, 2016).

Lebanon is a small mountainous country on the Mediterranean Sea's eastern coast, covering a total area of 10,452 Km². From a climatic point, Lebanon is characterised by a Mediterranean climate with a cold rainy winter and a semi-hot dry summer. According to the Lebanese Ministry of Agriculture (MoA), Lebanon experiences water shortages during the dry season which goes from July through October, with about 60 percent of the country's territory undermined by desertification (MoA, 2003). This condition is expected to worsen in the future as a result of the effects of climate change. (Bank, 2014). According to the Lebanese Agricultural Research Institute (LARI), water scarcity more than land resources is actually the constraining factor in the country's expansion of agricultural production (LARI, 2019). In Lebanon, groundwater sources are increasingly stressed by climate change as well by the increased demand from agriculture, the inadequate utilisation of underground water, the population growth and the industrial development (UNDP & UNHCR, 2021). Further, recent results (Halwani & Halwani, 2022) showed that from 1930 to 2019, the average temperature in Lebanon increased between 1 to 3 °C and a recent report from USAID (USAID, 2018) expects a 4–11% decrease in precipitation by 2100. Thus, various conditions threatening water balance make adaptation to climate change more difficult in Lebanon. In this situation, the enhancement of irrigation water usage efficiency and the conservation of water resources are turning into strategic priorities. For this to happen, adequate institutional arrangements are required to complement technical interventions in order to achieve effective water usage (Speelman & Veettil, 2013).

According to the Lebanese Ministry of Economy (MoE) and the UNDP, the Bekaa valley of Lebanon, which represents 42% of Lebanon's area, is a very fertile valley in which 60% of Lebanon's agricultural production is concentrated including cereals, potatoes, vegetables and grapevine (MoE & UNDP, 2011; MoE et al., 2015). The production of potatoes typically ranks first among the top 10 commodities produced in Lebanon each year, with a total production of 390,000 tonnes in 2017 (FAOSTAT, 2017). Two-thirds of Lebanon's potato production comes from the Bekaa Plain, which is entirely irrigated (MoA & LARI, 2008). The Bekaa valley is divided into three main zones: North Bekaa, Central Bekaa and West Bekaa. The valley is confronting the consequences of drought and reduced water availability that menace the yield and quality of irrigated crops (Karam & Karaa, 2000; MoE et al., 2015; Jaafar et al., 2016) . This is the case of potato crops which is one of the most sensitive crops to soil moisture stress and requires a systematic irrigation schedule (Ayas, 2013).

Since potato crops are sensitive to water stress, water use efficiency such as water-saving technologies are becoming of high importance. Until now, in the Bekaa region, the high majority of potato farmers are still using the ordinary sprinkler irrigation (MoA & LARI, 2008). Micro-irrigation, particularly mini-sprinklers, could be a solution to the above-mentioned climate-change related problems (Houston et al., 2018). Mini-sprinklers are small sized static sprinklers with a flow varying between 150 and 300 L per hour and a pressure of 1.5 bars inducing a water cooling canopy (Deligios et al., 2019). Micro-irrigation can induce an even application of water resulting in an improved crop quality and yields, in water savings and which also leads to energy and fertilizer savings compared with other irrigation methods (Varma & Namara, 2006; Shah, 2011). Further, micro-irrigation systems allow for a high level of control of chemical applications and weed and disease reduction due to limited wetted area. Previous research executed in the Middle East and North Africa (MENA) region, in Lebanon and beyond indicated that the use of micro-irrigation in potato cultivation could have promoting results in terms of water savings of up to 40% (Darwish et al., 2003; Darwish et al., 2006), and allow for energy savings associated with higher crop quality and yields (Karam & Karaa, 2000; Varma & Namara, 2006; Shah, 2011; Rouzaneh et al., 2021). In this context, it should also be noted that the improvement of the diffusion of innovations such as water saving techniques is a crucial strategy for promoting economic development (Lopolito et al., 2022).

Given the lack of information available on the performances of innovative technologies, farmers may evaluate these new systems through their experience and knowledge. This study aims to analyse the indirect non observed factors such as farmers' motivations, attitudes and socioeconomic factors which may influence the farmers' perceptions and behaviours in their investment in and adoption of a new micro-irrigation system. By disentangling these factors, effective strategies, and support systems for promoting the use of micro-irrigation systems in the area could be designed. To this end, the Unified Theory of Acceptance and Use of Technology (UTAUT) model (Venkatesh et al., 2003) was adopted. The UTAUT model (Venkatesh et al., 2003)

is a tool that was mainly used to analyse the acceptance and diffusion of information systems and technology by evaluating the influencing factors. Nowadays, the UTAUT model is commonly used to study individual intention and behaviour to adopt any type of technology (Rippo & Cerroni, 2023). Previous studies utilised the UTAUT model to investigate factors affecting the adoption of pressurised irrigation technology among olive farmer (Nejadrezaei et al., 2018), the acceptance of e-agriculture (Eweoya et al., 2021), farmers' use of communication technologies (Mahamood et al., 2016), the acceptance of water saving technologies (Sabbagh & Gutierrez, 2022) as well as farmers' participation in the apple-Income Stabilisation Tool (IST) (Rippo & Cerroni, 2023).The UTAUT model integrates behavioural factors such as system ease of use, experience, and facilitating conditions , which give valuable insights into individuals' decisions to innovate. Understanding the impact of behavioural variables in innovation adoption could increase the efficacy and success of policies such as agricultural ones (Cerroni, 2020; Streletskaya et al., 2020). This is what makes UTAUT useful to analyse the adoption of other types of technologies other than information systems and technology.

A qualitative study that utilised a focus group discussion (FGD) approach was employed. In this study, FGD could be an appropriate tool because it can allow for drawing upon the respondent's knowledge, views, and experiences about the specific topic of introducing micro-irrigation systems. To the best of our knowledge, this is the first study to use the UTAUT model combined with a Focus Group Discussion approach to shed light on the impact and importance of socio-economic, psychological and behavioural factors in influencing the adoption and use of a micro-irrigation system. Several researchers found that these three factors work simultaneously to understand and obtain a more complete vision of the intention to adopt a new investment (Heller et al., 1988; Konana & Balasubramanian, 2005). To this end, the scope of this paper is to enlarge the literature on technology investment analysing the impacts of socio-economic, psychological and behavioural factors that may affect the intention to adopt and invest in a micro-irrigation system by the potato farmers in the Bekaa Valley of Lebanon.

The remainder of this paper is organised as follows. Section two briefly analyses the UTAUT model. Section three explains the methodological approach employed in this study to explore the acceptance of a new micro-irrigation system. Section four presents the results of focus groups conducted with potato farmers in three main districts of the Bekaa valley. Section five discusses the main findings providing insights about policies that the government could implement to encourage potato farmers to adopt a micro-irrigation system. In section 6, the main conclusions are presented.

2. RESEARCH BEHAVIOURAL MODEL AND RESEARCH QUESTIONS

A number of theories have been put forward to explain an individual's behavioural intention to introduce a new technology. The current study employed the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) as a technology adoption model, which integrated previous technology acceptance models. Thus, UTAUT is basically a synthesis through unifying at least eight existing technology acceptance and use models and specifically i) the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975); ii) the Theory of Planned Behaviour (TPB) (Ajzen, 1985); iii) the Technology Acceptance Model (TAM) (Venkatesh & Davis, 2000); iv) the Combined TAM and TPB (C-TAM-TPB) (S. Taylor & P. A. Todd, 1995); v) the Innovation Diffusion Theory (IDT) (Moore & Benbasat, 1991); vi) the Motivation Model (MM) (Davis et al., 1992); vii) the Social Cognitive Theory (SCT) (Bandura, 1994; Compeau & Higgins, 1995; Compeau et al., 1999) and finally viii) the Model of PC Utilization (MPCU) (Thompson et al., 1991). According to UTAUT, an individual's views on technology impact his or her behavioural intent to use and actual use of the technology. Based on the integration of the eight models, UTAUT suggests four major determinants that have an effect on a person's "use behaviour" to adopt a technology: performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC). The first three constructs influence use behaviour through a behavioural intention variable, while the fourth construct directly impacts the use behaviour. These constructs can be affected by four moderators a) age, b) gender, c) experience with similar technology, and d) voluntariness of use. Fig. 1 presents the model.

The Performance Expectancy (PE) represents the user's level of belief in how advantageous a system usage will be and how it will help to attain benefits (Venkatesh et al., 2003). PE aggregated all job performance related aspects, like usefulness (adapted from TAM/TAM2 and C-TAM-TBP) (S. Taylor & P. Todd, 1995; Venkatesh & Davis, 2000), job fit (from MPCU) (Thompson et al., 1991), relative advantage (from IDT) (Moore & Benbasat, 1991), extrinsic motivation (from

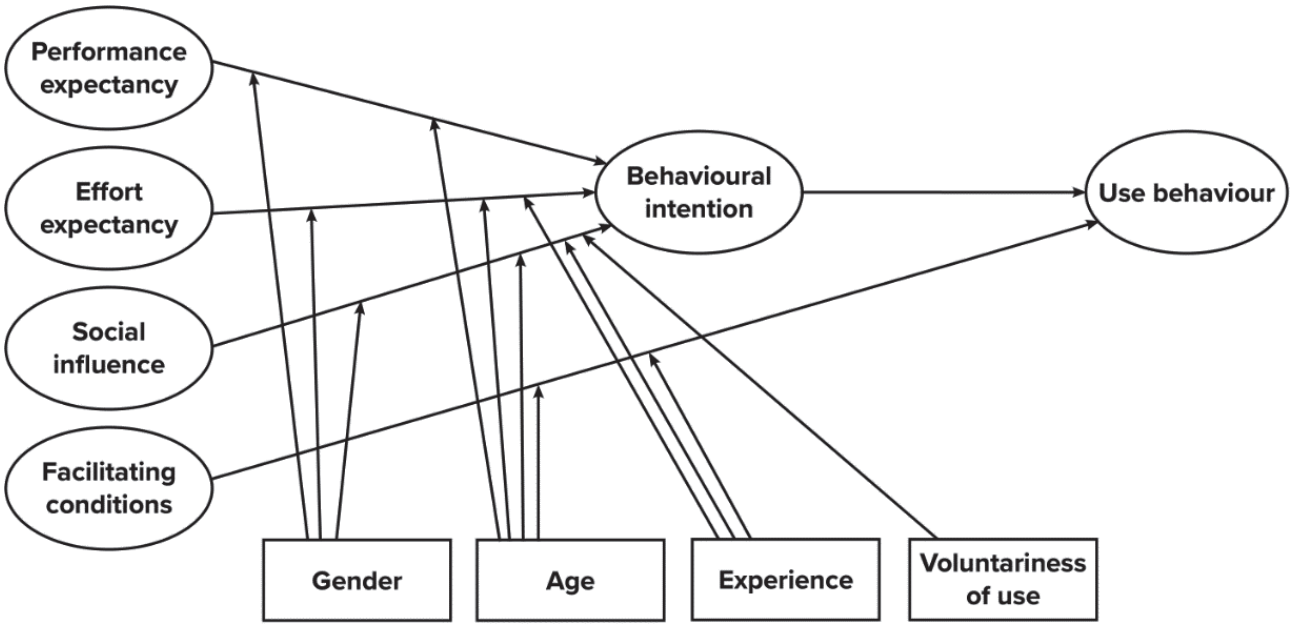

Figure 1. Unified theory of acceptance and use of technology model (UTAUT) (Venkatesh et al., 2003); Adapted with permission from Viswanath Venkatesh, *MIS Quarterly*, 2003. The figure employs terminology, with ovals identifying latent variables and rectangles identifying moderator variables.

MM) (Davis et al., 1992) and outcome expectations which are related to the consequences of the behaviour (from SCT) (Bandura, 1994; Compeau & Higgins, 1995; Compeau et al., 1999). Based on previous findings, PE will significantly and positively influence behavioural intention and technology acceptance (Venkatesh et al., 2003; AbuShanab & Pearson, 2007). People with high PE had high intentions to use a new technology (AbuShanab & Pearson, 2007). Additionally, the influence of performance expectancy on behavioural intention is suggested to be impacted by the moderating effects of gender and age (Venkatesh et al., 2003).

The Effort Expectancy (EE) construct suggests that the level of ease of use affiliated with the user's adoption of a system is an important component in the adoption of a new technology (Venkatesh et al., 2003). In this case, it is composed of three constructs: perceived ease of use (TAM/TAM2) (Venkatesh & Davis, 2000), complexity (MPCU) (Thompson et al., 1991) and ease of use (IDT) (Moore & Benbasat, 1991). Previous research concluded that EE is a positive predictor of behavioural intention so that the higher the perceived ease of use of a new technology, the higher the intention to adopt it (Venkatesh et al., 2003; Bandyopadhyay & Fraccastoro, 2007; Kallaya et al., 2009; Nassuora, 2012). According to Venkatesh et al.(2003), the influence of effort expectancy on behavioural intentions is moderated by gender, age, and experience.

The social influence determinant (SI) refers to the magnitude to which individuals perceive they should adopt a technology based on inputs from people who carry significant positions in their life (Venkatesh et al., 2003). It also consists of "the degree to which peers influence use of the system" (Venkatesh et al., 2003; Slade et al., 2015; Šumak & Šorgo, 2016). Social influence (SI) consists of three variables: a) subjective norms which relate to the person's perception that people who are important to her or him think that they should or should not execute the particular behaviour (Ajzen, 1991; Davis, 1989; Fishbein & Ajzen, 1975; S. Taylor & P. Todd, 1995), b) social factors which connect to the interpersonal arrangements that the individual has made with others as with co-workers (Thompson et al., 1991) and c) image which is the extent to which the use of a new technology is seen to enhance one's image or status in one's social system (Moore & Benbasat, 1991). Based on the review of the literature, it is expected that social influence positively influences the behavioural intention to use a new technology (Bandyopadhyay & Venkatesh et al., 2003; Fraccastoro, 2007; Kallaya et al., 2009; Im et al., 2011; Slade et al., 2015; Šumak & Šorgo, 2016). In addition, Venkatesh et al. (2003) hypothesised that the influence of social influences on behavioural intentions is moderated by gender, age, voluntariness and experience.

Facilitating conditions (FC) represent the organisa-

tional and technical conditions or infrastructure that the individual believes would encourage the use of the system and make it simpler for him or her to use it (Venkatesh et al., 2003). The facilitating conditions determinant consists of three distinct constructs: a) perceived behavioural control (Ajzen, 1991; S. Taylor & P. Todd, 1995), which are the possible internal and external limitations on behaviour related to resources, b) facilitating conditions adapted from (Thompson et al., 1991), which relate to objective factors that persons agree make an act easy to realise, and c) compatibility from (Moore & Benbasat, 1991) which indicates the extent to which a new technology is perceived as being consistent with the current needs and capabilities of potential adopters. Each one of these constructs is operationalised to incorporate technological and/or organisational aspects that are intended to eliminate obstacles to use. Facilitating conditions are found to positively influence use behaviour (de Veer et al., 2011). According to Venkatesh et al. (2003), the influence of facilitating conditions on usage is hypothesised to be moderated by age and experience.

As mentioned above, UTAUT hypothesised that gender, age, voluntariness and experience would moderate the relationships depicted in the model. These variables have been shown to moderate the intention to adopt new technologies in several studies (Pearson et al., 2002; Venkatesh et al., 2003; Al-Gahtani, 2004).

In order to expand the literature on technology investment, such as water saving systems, by analysing the impacts of behavioural, psychological and socioeconomic factors, this paper studied the reasons behind using the current irrigation technique on potato fields, farmers' perception of others' opinions as well as the barriers that could hinder adopting a new irrigation system and the policies that could be used to encourage potato farmers to invest in a micro-irrigation system.

3. MATERIALS AND METHODS

The objective of this study was to explore via focus group discussions how socioeconomic, behavioural and psychological factors influence the adoption of a micro-irrigation system as a mean to save water and avert the water scarcity crises among potato farmers in the Bekaa Valley of Lebanon. The focus groups discussed the socio-economic, psychological and behavioural aspects related to the possible shifting from the current irrigation technique (ordinary sprinkler) to micro-irrigation (drip or mini-sprinkler) that saves more water, induces higher production and better quality in the cultivation of potato crops.

3.1. The focus group protocol

The focus group research protocol was divided into three sections. The first section aimed to start the discussion by introducing the research theme and to collect information about gender, age, education, type of land management, farm size and the annual irrigation water used. Participants also received explanations of the role undertaken by the facilitator and that audio recordings would have only been used for the purpose of this study, thus reasserting the significance of privacy of all participants. It was explained that all participants were free to reveal their opinions related to the discussion and that all answers were to be accepted.

Section two aimed to provide information regarding the potato cultivation, the status of underground water in the Bekaa region as well as the differences between the sprinkler irrigation system and the micro- irrigation system thus highlighting the advantages that could be obtained by implementing a micro-irrigation system.

Section three contained open ended questions related to the UTAUT model that the moderator asked participants of the three main districts of the Bekaa Valley. To trigger the discussion around the behavioural elements of the UTAUT model, section three started by asking participants about their knowledge of the micro-irrigation system and the reasons behind using ordinary sprinklers. This allowed the moderator to explore the degree to which each farmer believed that using a micro-irrigation system would help him or her to attain gains, thus exploring the performance expectancy determinant. The moderator then asked about the farmers' perceptions of easiness of tasks related to the implementation and operation of the micro irrigation system and how they perceived the related technical operations. This permitted the moderator to explore the farmers' effort expectancy towards micro-irrigation systems. Further, participants were asked to list people whose judgment is important to them and who would approve or disapprove the adoption of a micro-irrigation system and the effect of personal moral obligation norms to adopt a micro-irrigation system for the sake of protecting the environment by preserving water resources. This revealed the social influence construct. To measure the facilitating conditions, the moderator explored the farmers' opinion of being able or not to access required resources, as well as to obtain training and the necessary support needed to use micro-irrigation systems. Following the UTAUT model variables, questions related to the moderating variables were raised in the focus groups. The moderator asked participants if they believed that the age of the farmers affect their incentive to adopt new

irrigation practices. Experience was tested by the familiarity of the farmers with the functioning of the micro-irrigation system either by their own trial on their crops or by observing others using it on potatoes or on other crops. For the voluntariness of use, farmers were asked about their tendency to adopt a micro-irrigation system in the case of the presence of external obligations as well as in the case of subsidies offered by the government.

3.2. Sampling and data analysis

Fig. 2 shows the geographical area in which focus groups were carried out in the months of March and April 2020, among the potato farmers using the ordinary sprinkler irrigation system, in the three main districts of the Bekaa Valley (North, Central, and West Bekaa). The total number of potato growers in the area is approximately 500, and the sample of farmers participating the FG were selected using the information furnished by the President of the syndicate of potato growers in the Bekaa Valley. So, 35%, 20% and 45% of the farms are located in North Bekaa, Central Bekaa and West Bekaa, respectively. There was a total of 34 farmers in six focus groups consisting of five or six farmers each. Two focus groups in each of the three main districts of the Bekaa valley were run/organized/led to help ensure a variety of points of views amongst participants and to test their likeliness or unlikeliness to adopt a micro-irrigation system in their farms.

Due to COVID-19 restrictions and safety limitations, three focus group meetings were conducted via a virtual "Zoom" meeting platform among farmers having IT resources. After the restrictions were lifted the three remaining focus groups took place, in conference rooms where all required safety measures were taken.

Farmers taking part in the focus groups were engaged in choices regarding agricultural techniques, type of crops, and irrigation strategies to be implemented in their farms; interviewees were chosen from different ranges of age, different educational levels, having different types of land management, and different farm sizes. The proportion of males among the participants was 100% since there were no women running farms in the area given that potato cultivation fields are largely male owned while female participation is higher in the industrial sector (Konishi, 2017).

All focus groups were audio-recorded, manually transcribed, and qualitatively analysed using NVivo12 software.

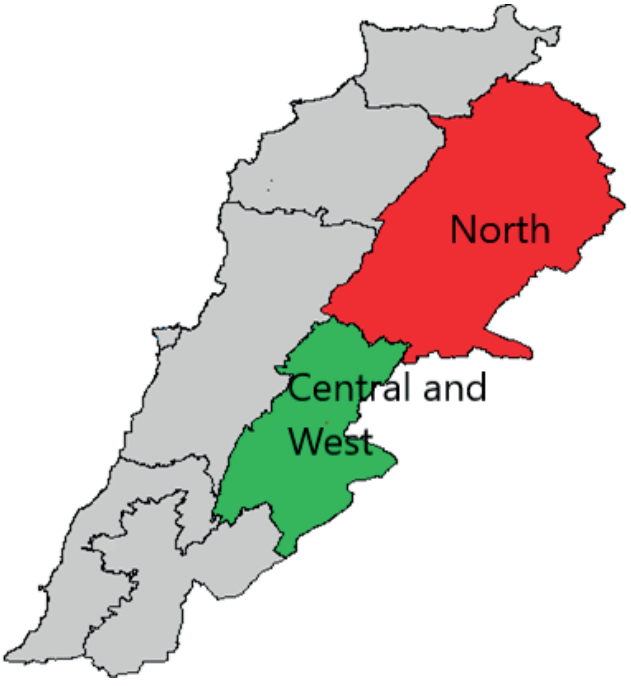

Figure 2. Map of Lebanon map showing the districts of the Bekaa Valley focus group discussions.

4. RESULTS

4.1. Characteristics of participants

Table 1 presents the demographic characteristics. The focus groups were held among a total of 34 farmers of which 11 participants came from West Bekaa, 11 others from North of the Bekaa and 12 farmers were from Central Bekaa. In West Bekaa, the average age was 55 years ranging from 45 to 60 years old for most of the N farmers (N=11). In North and Central Bekaa most of the farmers had a mean age of 46 (N=11) and 52 (N=12) years, respectively. In the cited 3 regions, the percentage of farmers who were older than 60 years was more or less equal (36% for both West and North Bekaa while 33% in Central Bekaa). With regard to the educational level, the minority had a primary level (28%) in West Bekaa, while the majority had a university diploma (64%) in North Bekaa. However, in the region of Central Bekaa most of the participants had a secondary educational level (42%).

As also shown in Table 1, in each focus group there was a diversity in the size of the farms in order to gather the maximum points of views possible. In West Bekaa the average farm was 146 hectares (SD=208), whereas in North Bekaa, the mean farm size was 590 hectares (SD=1,55). In the region of Central Bekaa, it was 663 hectares (SD=1,55).

Table 1. The mean and standard deviation results regarding the demographic data of the sample.

Characteristics	West Bekaa (N=11)	North Bekaa (N=11)	Central Bekaa (N=12)
Mean (SD)			
Age (years)	55 (11)	46 (13)	52 (16)
Farm Size (hectares)	146 (208)	590 (1,555)	663 (1,556)
Age Ranges [N (%)]			
<= 45	2 (18%)	6 (55%)	6 (50%)
>45 and <60	5 (45%)	1 (9%)	2 (17%)
>= 60	4 (36%)	4 (36%)	4 (33%)
Educational Level [N (%)]			
Primary	3 (28%)	1 (9%)	3 (25%)
Secondary	4 (36%)	3 (27%)	5 (42%)
University	4 (36%)	7 (64%)	4 (33%)

Unfortunately, almost all of the participants were not aware of the quantity of the water used in the irrigation of their potato crops, which is an alarming problem.

4.2. Results of the focus groups

This section has the aim of presenting the findings from the six focus groups. After being transcribed from Arabic to English, text files were imported into Nvivo12 to first begin with the codings and finding core themes that reflect what participants were discussing to indicate the frequency of each core theme (Allsop et al., 2022). The results are categorised into the investigated determinants affecting the acceptance of the micro-irrigation system in potato farming and three key moderators. To further emphasise and distinguish statements analysis from quotes, all direct quotes given by the participants will be highlighted in italics in the following findings' part.

4.2.1. Major determinants

4.2.1.1. Performance expectancy

Performance expectancy was measured by the perceptions of using a micro-irrigation system in terms of providing benefits. Firstly, participants were asked about their knowledge of the micro-irrigation system and the reasons behind using the ordinary sprinklers. All the participants showed a basic technological knowledge of the micro-irrigation system stating that it incorporates drip irrigation and mini-sprinklers irrigation. Concerning the reasons for the adoption of the current irrigation system, which is the ordinary sprinklers, the most frequent answer was that sprinklers are less expensive (53%), and changing the ordinary sprinkler network that they have had for many years would cost them a fortune. One of the respondents said:

> I have been using sprinklers for a very long time and changing it and buying a micro irrigation network will be very expensive, especially for covering large areas.

Also, in the same context a second participant argued

> I still use sprinklers because I have had my equipment for a long time and in order to change it I will spend a lot of money because micro irrigation is a big investment, so I prefer to stay with sprinklers.

Furthermore, when participants were asked about their opinion about the following statement "adopting micro irrigation can be useful in your farm in terms of increasing potato yield, saving energy, labour, and quantities of pesticides and increasing your benefits", 56% of the respondents totally agreed. Some participants reported:

> Yes, I totally agree with this statement in the sense of that micro irrigation controls water, consumes less fuel, and there is more control of the use of fertilizers. When the quantity of the crop increases, revenues and profits will surely increase.
> The more we irrigate the plant with a small amount, only as much as it needs, and at regular times, the more abundant the production and the better the quality and therefore we use less labour and pesticides. So I agree with this statement.

On the other hand, 26% partially agreed with this statement arguing for example that

> *Micro irrigation definitely saves energy by saving water and because the water pressure is slight through it. It certainly increases the yield and increases profits, but I do not think it saves pesticides, as this amount remains the same as the sprinklers.*

However, one of the respondents asserted:

> Since micro-irrigation uses less pressure, this saves energy. Also, when using this irrigation technique, we don't need a large amount of pesticides, but the yield won't increase, it remains the same as in the case of sprinklers.

Finally, 18% of the participants fully disagreed with the statement, as other reported

> In practice, micro irrigation cannot be used on potatoes and cannot be adopted. It does not increase yields, nor save energy, nor reduce the amount of pesticides and it could not increase profits

or

> Micro irrigation does not increase the yield and does not save energy, nor does it reduce the amount of pesticides and fertilizers. Micro irrigation does not add anything to sprinkler irrigation".

The most relevant statements that underpin this construct are the ones that relate to the general benefits associated with micro-irrigation use. Therefore, participants were asked about their perceptions about the possible advantages deriving from the adoption of micro irrigation systems. Based on the content analysis, the most important benefit mentioned by the respondents was water saving. This pattern is evident from the word cloud in Fig. 3 which depicts the most frequently occurring words emerging from the focus group discussions.

In Fig. 3, central words with larger fonts are the most frequent, while distant words with smaller fonts are the less frequent. Thus, the most recurrent words (water, distribution, saving, control, etc.) are important advantages according to farmers. Participants highlighted that micro-irrigation is a water saving technique since it supplies water directly to the soil surface close to the plant roots, rather than the land around. In addition, they believe that micro-irrigation ensures uniform distribution of water by delivering water only wherever necessary and evenly over the whole land despite the presence of wind. Moreover, farmers consider that micro-irrigation enhances the financial benefits by increasing yield, productivity, and therefore, farm profits. They also believe that micro-irrigation is a way to reduce operational costs in terms of reducing energy (less energy for water supply/ low pumping needs) and saving pesticides and fertilizers.

Figure 3. Word cloud of the perceived advantages of micro-irrigation.

Overall, it was revealed that farmers perceived micro-irrigation as a system having many key advantages in potato farming from saving water, labour, and pesticides to increasing profits. Therefore, we expect that "performance expectancy" will be positively associated with the intention of using micro-irrigation technology.

4.2.1.2. Effort expectancy

Regarding the participants' perception of the ease of use of a micro-irrigation system, and whether or not they would be skilled in using it, 62% of them considered micro-irrigation easy to be extended over fields. Half of the 62% said that it saves labour and effort because it is installed once at the beginning of the season and there is no need to worry about moving it. Moreover, the other half believed that micro-irrigation helps to save time. Hence, the farmer can gain more time to take care of other profitable agricultural operations. Accordingly, many participants claimed that

> Micro irrigation is easier than sprinkler irrigation, and it is installed only once per season; therefore, the farmer will not worry about moving the network from one place to another as is the case with sprinklers. Thus, micro irrigation saves labour.

> Micro irrigation does not require significant time and effort to extend and remove the network. It is easier than sprinklers, because the network is extended once at the beginning of the season and does not need to be moved from one part to another part of the land as in the case of sprinklers.

On the other hand, 38% of the participants perceived a high difficulty in extending the network of the micro-irrigation system on large fields and especially in the case of potato farming. They believed that, once extended, it decreases the efficacy of some agricultural operations.

To highlight this problem some respondents commented

> Micro irrigation is very difficult to install and needs a lot of time since the technical process to extend the network takes about a week and more. There is a difficulty in the tasks related to micro irrigation because we can't apply pesticides and carry out all the mechanical agricultural practices when it is installed.

Aside from that, they also argued that the installation of a micro-irrigation system needs a lot of attention and a specialised work force which induces a huge effort due to the complexity of the network equipment that should be implemented. Additionally, one-third of the respondents who perceived a difficulty in the use of micro-irrigation claimed that micro-irrigation is time consuming. Furthermore, another third considered micro-irrigation as labour consuming because the system needs constant attention in order to prevent damage to the hoses. Some participants said

> Micro irrigation initially requires a lot of effort in order to extend the network. Likewise, if the hoses become clogged and we want to replace them then there is great effort and difficulty during the season.
> When installing the micro irrigation system, it will no longer be possible to operate properly on the field as the presence of the hoses restrains us. The sprinklers are much easier than micro irrigation, so that, just in one day, we can install, remove, and transfer 100 sprays. Sprinklers require less labour because you only need one worker to do this, contrary to micro irrigation , which needs a lot of labour.

Furthermore, the effort expectancy construct is relevant to the question of whether participants believe they would/could become skilled at using micro-irrigation on potato crops. On one hand, 88% claimed that they would be skillful in using micro-irrigation. Approximately one third of respondents believed they would do their best to develop their knowledge in order to improve the yield, and possibly to increase their profits; they would get used on any new agricultural practices that give positive results. One-fifth of the 88% participants described micro-irrigation as an easy technique and not difficult to implement on potatoes. These responses can be summarised with the following comment

> Of course, it can be used in a successful way on potato and personally I will use it in a great way since it's not difficult to manage.

Moreover, another fifth thought they would surely become skillful in micro-irrigation after getting appropriate training and guidance. Further, approximately one-fifth of 88% of the participants assumed that they would improve their skills in every new technique to adopt it properly because it could improve their personal skills, thus their productivity. A respondent said:

> As farmers, we are most interested in developing our agricultural practices and noticing their positive results, and we therefore do our utmost to strengthen our skills in any new agricultural technology we adopt.

On the other hand, 12% of the participants thought they would not become skillful in using micro-irrigation technology on potatoes. Half of those participants were not convinced of the technology and believed it has no benefits on potato cultivation at all.

> No, since I see that it has no benefit in growing potatoes, obviously I wouldn't improve my skills in using it.

The other half considered micro-irrigation difficult and exhausting to be implemented in potato cultivation.

Overall, it was found that "effort expectancy" plays a positive role in user's intention to use micro-irrigation technology.

4.2.1.3. Social influence

In the context of this construct, participants were asked to list people whose judgment is important to them and who would approve and disapprove their adoption of a micro-irrigation system. To this extent, 47% of the participants stated that they don't care about others' opinions, because each of them prefers to take his own decision concerning his work, and they know best what the soil requirements on their lands are; not every technique can be applied on all types of soil. For example, they said:

> I don't care about someone else's opinion. When I make my decision, I am convinced and sure that I will take advantage of it.
> Since I believe that each one has a different point of view, I have my own.

Moreover, 21% of the respondents considered the opinion of "other farmers" or "nearby farmers" important. They expressed their trust in each other's objective opinions about potato cultivation needs (irrigation, etc.) based on the soil type and the climate of the region.

> I only care about the opinion of the farmers, friends and relatives because I trust them and know they won't suggest anything but useful things to help me in agricultural issues.

> I am very interested in the opinion of my neighbouring farmers in the area, because they express their opinion relatively to our area; as each region is different from the other concerning the soil, water availability, air velocity, etc.
> The opinion of other farmers is very important to me because we are in the same sector, and we face the same risks and problems.

In addition, 20% of the farmers highlighted the importance of their family members' opinion such as fathers, sons and/or cousins. Two participants expressed this sentiment as

> My father's opinion is very important to me, because everything I have learned is from him as he has large experience in agriculture in general and especially in potato agriculture.

Furthermore, 12% of the farmers were interested in NGO's judgment and advice, as well as agricultural associations, organisations and engineers. According to those farmers, those organisations realise the significance of new agricultural practices and support the farmer in adopting these practices to develop his farm. They commented:

> I am also interested in the opinion of an agricultural organisation, because whenever it becomes clear that the farmer improves and adopts new technologies in his land, this agency supports and helps him by exporting cultivated yields.

Moreover, farmers responded to the question about the importance of collecting information from other farmers and observing what they think about their possible successes before adopting a new irrigation system. Nearly all participants, 94%, were very interested in having access to the experience and suggestions of other farmers. Inside this group, 50% voted for the collective benefit, and 44% were interested in continuous development and knowledge of existing and new agricultural practices. Two statements can represent the general feeling

> *Collecting information from other farmers is important in order to share experience and increase development. It helps us to discover all new agricultural techniques, to test them and find out if they are useful in the region or not*; *this is a common interest.*
> *For this reason, I created the syndicate of potato farmers to exchange our knowledge and experiences, to share with each other every new agricultural practice, as well as our successes and failures so that we can learn more.*

On the other hand, 6% of the participants were not interested in the exchange of experience, because they believed that each farmer has his own individual specific agricultural practices and requirements. For example,

> Each farmer has his own technologies and the specification of his land which differ from the other.
> Some farmers may give agricultural information that can't be adopted in the same way in my farm.

Obtaining a better understanding of the farmers' perspectives on climate change and water shortage was also connected to this construct. Participants were asked to define what these two terms meant for them. Firstly, half of the farmers believed that climate change and water scarcity lead to loss in yield, thus in profits. According to them, the scarcity of water resulting from climate change causes cultivated areas to be minimised, resulting in huge losses. They also stated that climate change and water scarcity have negative consequences on agriculture in terms of the quality of yields. Moreover, 16% argued that climate change and water scarcity affect potato farming in particular because potato crops are very sensitive to high temperatures and low precipitations. This group of farmers confirmed that climate change directly and negatively affects cultivation, especially potato crops, because it makes it vulnerable to climatic fluctuations. This fact may force them at some point to move from growing potatoes to rain-fed agriculture. Further, 16% of the participants claimed that climate change and water scarcity put agriculture continuity at risk, because they lead to disasters that negatively affect agriculture. Furthermore, 9% defined climate change as a fluctuation of precipitation and temperature during seasons. According to these farmers, climate change has led to changing temperatures during seasons, therefore to low precipitation rates, and consequently water scarcity. They also believed that climate change has caused the reduction of groundwater**.** Finally, 3% of the participants argued that climate change and/or water scarcity do not exist because they still find water in abundance.

In the same context of social influence, 91% of the respondents affirmed that a farmer should have moral norms and personal obligations as regards preserving water for the environment, future generations and for continuing appropriate agricultural practices.

They stated that

> It is compulsory to have ethical and personal values to be forced to save water in order to preserve nature, water wealth and to keep the water resource for our children as well as to ensure the natural and continuous development of agriculture.
> Personally, as I'm worried about climate change, if the government or a non-profit organisation will support us, I will adopt a micro-irrigation technique to conserve water

for the ecosystem's well-being and to maintain a normal life-sustaining environment.

Overall, it seemed that social influence does not influence the farmers' intention to use a micro-irrigation system.

4.2.1.4. Facilitating conditions

This construct is relevant to the question regarding the guidance role of the agricultural/irrigation extension services in the area. Seventy-nine percent claimed that there was no presence at all, neither of agricultural guidance and extension nor of training courses. They stated that the agricultural sector is marginalised and neglected; therefore, the farmers had to rely on their personal experiences or the experiences of other farmers in the surrounding areas. They added that the non-presence of extension services made them unaware of the existence of new agricultural practices. They stated that

> The agricultural sector is marginalised, there are no agricultural policies, not even agricultural extension, and we have become used to relying on ourselves, our individual information, and the information we take from each other. In Lebanon, we do not have agricultural policies, and farmers are not supervised by the Ministry of Agriculture, which does not provide any guidance. Every farmer in this area depends on himself and on his personal experience.

The other 21% of the participants stated that there was limited agricultural extension from some companies and institutions for the purpose of marketing. That is why they did not trust those types of companies and they relied on their personal experience. This common feeling can be summarised in the words of the participants:

> There is no appropriate agricultural extension role, there are some agricultural companies that deal with pesticides, they do some extension courses related only to the subject of insects so as to sell and market their products, but nothing more. So, I only rely on my personal information and experience.
>
> We have some agricultural guidance from some agricultural associations and institutions; they are doing all they can for agricultural extension. I take into account the information they provide, because agricultural guidance is necessary and sometimes it is a way to refresh my memory about things I know, but I do not remember.

In the same context of facilitating conditions, participants were asked about the barriers they thought might prevent them from implementing a micro-irrigation system. Participants had the possibility of multiple choices. Several barriers were mentioned by each participant and results are illustrated in Fig.4. All participants considered the most important barrier as the high initial expenses for installing the system: 53% stated they lacked the capital in order to cover the whole area; 53% believed they needed training to raise awareness about the benefits of the system; 44% said the sys-

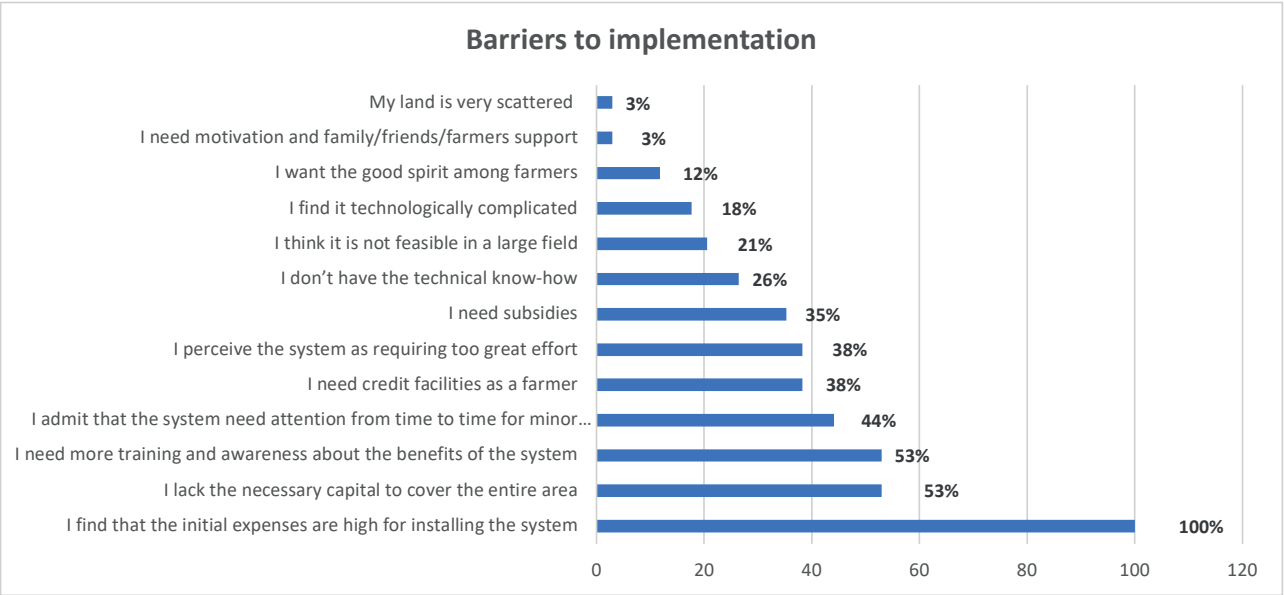

Figure 4. Barriers to implementation of a micro-irrigation system.

tem needed attention and time for minor repairs; 38% emphasised that micro-irrigation was effort consuming; 38% thought that they needed credit facilities as farmers; 35% believed that subsidies were necessary to implement this new technique with high costs; 26% said they did not have the required technical knowledge; 21% believed that micro-irrigation was not feasible on large fields; 18% found it technologically complicated; 12% stated that they wanted the good spirit among farmers because if famers cooperated they could support each other. However, only 3% needed motivation from family and friends in order to implement micro-irrigation, and another 3% believed that their land was very scattered, which impeded the installation of the system.

Overall, facilitating conditions could improve a farmer's use behavior of a micro-irrigation system.

4.2.2. Key moderators

In addition to the previously mentioned four main determinants, the UTAUT model included four main "moderating" factors: gender, age, experience, and voluntariness of use. Given that in this research all the farmers were of the same gender, the paper only included exploration of the possible effects of age, experience and voluntariness of use as moderating factors on the four main constructs.

4.2.2.1. Age

The question that was relevant to this factor was whether the participants believed that the age of the farmers affected their incentive to adopt new irrigation practices and in what way.

It emerged that 62% of the participants considered that age had no influence on the intention of use of a new agricultural technology. They stated that farmers adopted a new technology once convinced of the advantages of that technology. They asserted that, no matter his age, a farmer remains enthusiastic about adopting new technologies, thus developing himself and his land. According to them, if a farmer is convinced of the benefits of modern technology, he will adopt anything that is beneficial for his land. Some respondents commented that

> If it becomes clear to the farmer that the modern irrigation system will give him high profits, he will adopt it no matter what his age is.
> No, age does not decrease the incentive of adopting new agricultural technologies. A farmer who is convinced of the benefits of adopting new irrigation practices or other agricultural practices can only be hindered by financial capacity.
> No, there are young farmers who can't be convinced of changing and developing, whereas there are older farmers (70 years and over) who always are willing to to keep up with progresst.

However, 38% of the participants believed that age decreases a farmer's incentive to adopt new agricultural practices because the age lessens the farmers' enthusiasm. Age was an important moderator in the context of adopting a micro-irrigation system among potato farmers. The younger group affirmed that it would be more difficult to persuade the older generation who does not have initiative to try new technologies, contrary to what the elderly said. Moreover, in their opinion, elder farmers believe they have all the knowledge they need and that satisfies them. Thus, it would be very difficult for them to be convinced of adopting new practices. Those participants also added that, the older the farmer the more he rejects new technologies because he has no faith in them. In this case the usual comment was

> Yes, when a farmer gets older, adopting a new irrigation system on his land becomes a secondary matter for him. He no longer has the urge to learn agricultural practices.

4.2.2.2. Experience

Experience was tested by the familiarity of the farmers with a micro-irrigation system either by their own trial on their crops or by observing others using it on potatoes or on other crops. Based on the analysis of the focus group discussion, some participants assumed that adopting micro-irrigation is not difficult for them as they witnessed its usage by other farmers on potato cultivation or on other crops. Therefore, they have the know-how which increases their incentive to implement it on potato cultivation if they have the capital for the investment. In the same context, a participant stated

> As a member of my family uses micro irrigation on watermelon, I have professional and technical knowledge of this subject, and therefore I will not find great difficulty in using it on potatoes.

Another added

> I am adopting micro-irrigation on a small part of my land in vegetable cultivation, so I have experience of how to install it in an efficient way.

4.2.2.3. Voluntariness of use

Moreover, "voluntariness of use" was measured by the tendency to adopt a micro-irrigation system in a situation where there is no external obligation to adopt the technology. External obligations can be defined for example as limited quantity of water usage imposed by the responsible authorities in the region. Almost half of the participants (53%) stated that they can adopt micro-irrigation without external obligations, in order to induce good results and to ensure the continuity of their land cultivation:

> Yes, I will move to a micro irrigation system in order to improve the quality of potatoes and produce more quantities, and the most important thing is to reduce water waste.

However, it is worth mentioning that only one participant asserted that he will gradually adopt micro-irrigation regardless of its high initial cost, because he believed that it will greatly improve the quality and quantity of his potato yield:

> Yes, I will move to the micro irrigation system, but in stages, due to the high cost.

On the other hand, the other half of the participants (47%) have no tendency to adopt micro-irrigation spontaneously without external obligations: half of them consider it an expensive technology and they do not have the financial resources. The other approximate half does not perceive any benefit from adopting it on potatoes, and only very few have abundance of water so they do not need -water-saving irrigation technology. Some comments were:

> No, because I am convinced that the sprinklers are better than the micro irrigation on potato crops, and I don't have the financial resources to try and attempt micro irrigation even on a small part of my land.
> No, because I have enough water and I pay careful attention to the amount of water that the plant needs (manual soil testing) so that I don't waste water and therefore micro irrigation won't help me.
> No, I am not convinced that micro irrigation would be better than sprinklers on my land, so I won't implement it.

Furthermore, participants were asked about the possibility of them adopting micro-irrigation if the government decided to subsidise the use of water-saving irrigation systems. Eighty-five percent of interviewees responded that they would prefer to use a micro-irrigation system if government incentives were available. According to them, subsidies would reduce the financial burden on them at the beginning of the investment, and encourage them to take the first step toward the total adoption of the micro-irrigation system:

> Yes, if the government provides subsidies, conducts training courses and supports us to export our production, of course I will adopt it.
> Yes, I agree, because the state and the government have an obligation to take care of the farmer, who is the core of the Lebanese economy. Hence, micro irrigation is essential and necessary in improving the quality of potatoes to become competitive with potatoes from other countries.

Nonetheless, 15% of the participants insisted on not moving to micro-irrigation system even if there is support, because they do not perceive any benefit from it:

> No, I don't agree… In the end, the productivity will be identical to that of the sprinklers.
> No, although this technique provides large quantities of crop production, it is not suitable for the large areas I cultivate, and thus the moth will surely appear resulting in high losses.

It is crucial to note in this part that individuals who initially tended to adopt micro-irrigation without external obligations are also likely to adopt it if subsidies are given since they reduce the financial burden. Further, participants who said they would not use micro-irrigation because of its expensive cost changed their mind when the interviewer mentioned the subsidies. The most notable change in intentions was that of the participants who had no tendency to adopt the system claiming that it has no benefits. However, 50% of them changed their answers when the question of subsidies was raised. They stated in this section that they would move to micro-irrigation gradually by applying it at first on a small part of the land to test its advantages. For example:

> Yes, it will be possible for me to start adopting it on only one hectare. If my results are positive and there are no diseases, then I will gradually adopt it year after year until I have thoroughly checked its benefits.

4.2.3. The direct determinant: the behavioural intention

The measurement of behavioural intention in this study included the intention and predicted use of a micro-irrigation system. The behavioural intention was measured by asking whether the participants had plans for the adoption of a micro-irrigation system in the following 12 to 24 months as well as the major concerns related to this system.

Fifty-nine percent of the participants said that they did not have any plan for the adoption of micro-irrigation in the next 12-24 months. This group of participants was divided into 3 groups according to the reason for not having a plan for adoption: a) the unstable economic conditions in Lebanon that do not encourage farmers to invest large amounts of capital (the majority); b) the lack of micro-irrigation usefulness in terms of profits and feasibility (a quarter of the respondents); c) lack of financial means (only 10%). The following quotes revealed the participants' views:

> No, because sprinkler irrigation is easier for the farmer and does not require much effort, and I am satisfied with the quality and productivity that I get.
> No, if the government does not support me, I will not adopt the micro-irrigation system.

Then again, 41% of the participants stated that a plan to adopt the micro-irrigation system was possible in the near future. This group was also divided into several groups in terms of implementation conditions: a) presence of subsidies by the government (approximately half); b) better economic situation in the country (one quarter); c) in case of water shortage (6%); d) no conditions at all (14%). The following quotes revealed the participants' views:

> In light of the current conditions in the country, I can adopt it in this period if there is protection for our products and if the State provides support.
> Yes, if the country's situation stabilises, I have the intention to adopt a micro-irrigation system soon;
> Yes, when necessary, and that means if the water runs out on my land, I will adopt a micro irrigation system."

Fig. 5 below shows the different answers obtained when investigating the concerns of the participants regarding micro-irrigation systems. Each participant had the possibility to mention multiple concerns. As is clear, the main concern was the high cost of initial equipment and the possibility of financial losses (47%). In addition, 15% confirmed that micro-irrigation is a labour intensive technique that requires a lot of effort, time and attention. Furthermore, 29% have no concerns at all. The remaining concerns differ in small percentages from the frequent maintenance to the emergence of diseases (fungal and moth), short lifespan, feasibility on large areas, no wind resistance.

Further, when asked about their willingness to adopt a new micro-irrigation system, 82% of the participants said yes and 18% said that they were not willing to.

In conclusion, in order to recapitulate the main results of each construct, Table 2 summarise the findings.

5. DISCUSSION

The purpose of this study was to obtain a deeper understanding of the influential determinants (socio-economic, psychological and behavioral factors) for

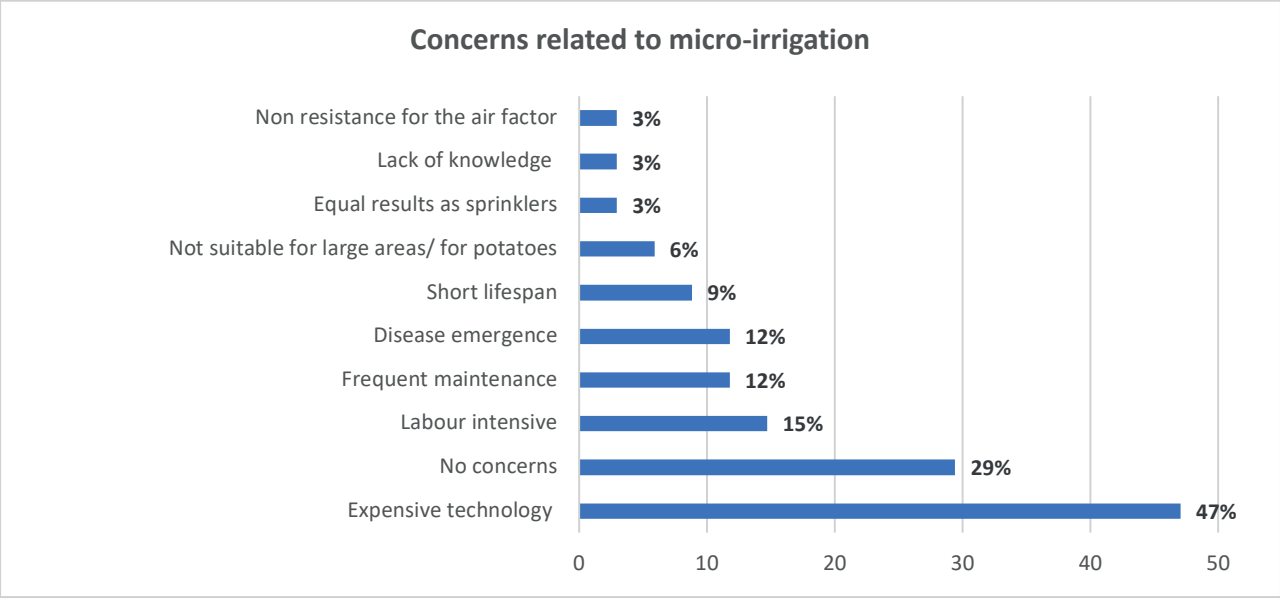

Figure 5. Concerns related to micro-irrigation systems.

Table 2. Main findings from the focus group discussions.

Construct or Moderator	Questions	Findings
Performance Expectancy	A. Knowledge of micro-irrigation systems.	Basic technological knowledge of micro-irrigation systems stating that it incorporates drip irrigation and mini-sprinklers irrigation.
	B. The reasons behind using ordinary sprinklers.	Sprinklers are less expensive.
	C. Possible advantages deriving from the adoption of micro irrigation systems.	Water saving, uniform distribution, yield increase, farm profits, energy cost reduction, reduction of pesticides and fertilizers.
Effort Expectancy	A. Perception of the easiness of use of a micro-irrigation system.	Easy extension over the field, labour and effort saving, time saving.
	B. Skillfulness in using micro-irrigation.	88% of farmers claimed that they would be skillful in using micro-irrigation.
Social Influence	A. List people whose judgment is important to farmers and who would approve or disapprove the adoption of a micro-irrigation system.	47% stated that they did not care about others' opinions. 21% considered the opinion of "other farmers" or "nearby farmers" important. 20% highlighted the importance of their family members' opinion such as fathers, sons and/or cousins. 12% of the farmers were interested in NGO's judgment and advice, as well as agricultural associations, organisations and engineers.
	B. The importance of collecting information from other farmers and observing their possible successes before adopting a new irrigation system.	94% of farmers were very interested in having access to the experiences and suggestions of other farmers.
Facilitating Conditions	A. The guidance role of the agricultural/ irrigation extension services in the area.	79% claimed that there was no presence, neither of agricultural guidance and extension nor of training courses. They stated that the agricultural sector was marginalised and neglected; therefore, the farmers had to rely on their personal experience or the experience of other farmers in the surrounding areas.
	B. Barriers that farmers thought might prevent them from implementing a micro-irrigation system.	The most important barrier was the high initial expense of installing the system.
Age	A. The age of the farmers affects their incentive to adopt new irrigation practices.	62% of the participants considered that age had no influence on the intention of use of a new agricultural technology because no matter his age, a farmer remains enthusiastic about adopting new technologies, thus developing himself and his land.
Experience	A. The familiarity of the farmers with micro-irrigation systems either through their own trial on their crops or by observing others using it on potatoes or on other crops.	Participants assumed that adopting micro-irrigation is not difficult for them as they witnessed its usage by other farmers on potato cultivation or on other crops. Therefore, they have the know-how which increases their incentive to implement it on potato cultivation if they have the capital for the investment.
Voluntariness of use	A. The tendency to adopt a micro-irrigation system in a situation where there is no external obligation to adopt the technology.	Half of the participants (53%) stated that they can adopt micro-irrigation without external obligations, in order to induce good results and to ensure the continuity of their land cultivation.
	B. The possibility of adopting micro-irrigation if the government decides to subsidise the use of water-saving irrigation systems.	85% of the participants stated that they would adopt a micro-irrigation system if there were subsidies from the government. According to them, subsidies would reduce the financial burden on them at the beginning of the investment and encourage them to take the first step toward the total adoption of a micro-irrigation system.

Construct or Moderator	Questions	Findings
Behavioural Intention	A. A plan for the adoption of a micro-irrigation system in the following 12 to 24 months as well as the major concerns related to this system.	59% of the participants said that they do not have any plan for the adoption of micro-irrigation in the next 12-24 months due to the unstable economic conditions in Lebanon which do not encourage farmers to invest a large amount of capital; the lack of micro-irrigation usefulness in terms of profits and feasibility and the lack of financial means. 41% of the participants stated that a plan to adopt the micro-irrigation system is possible in the near future if there is the presence of subsidies by the government.
	B. Concerns regarding micro-irrigation systems.	The main concern was the high cost of initial equipment and the possibility of financial losses (47%). 15% confirmed that micro-irrigation is a labour intensive technique that requires a lot of effort, time and attention. 29% have no concerns at all. The remaining concerns differ in small percentages from frequent maintenance to the emergence of diseases (fungal and moth), short lifespan, feasibility on large areas, no wind resistance.

potato farmers' adoption of micro-irrigation technology on their lands in the Bekaa region in Lebanon. This research further examined which factors seem to influence the farmers and their willingness to use a micro-irrigation system.

Based on the focus group analyses performed, performance expectancy, effort expectancy and facilitating conditions could have a significant effect on the acceptance of micro-irrigation technology while social influence does not.

The effect of performance expectancy on behavioural intention was found to be relevant for many participants, which reflects the perceived benefits obtained using micro-irrigation systems. The benefits were identified as saving water, reducing labour effort and time, saving energy, increasing yield, improving crop quality and improving agricultural operations. Farmers' performance expectancy might increase by emphasizing the usefulness of micro-irrigation systems. That means if the advantages of micro-irrigation systems were presented in meetings conducted by specialists, this probably would increase the acceptance and adoption by people who were against this method, and who preferred ordinary sprinklers. Almost all the participants declared that generation of good results and water saving were the main advantages of micro-irrigation systems. However, they were very anxious about losing financial investments if they could not apply this method without professional guidance. This asserts the idea of the essentiality of establishing agricultural guidance, in order to promote the advantages of micro-irrigation systems and its usage. This result was found to be consistent with previous research findings (Louho et al., 2006; Bahramzadeh & Shokati Mogharab, 2010; Im et al., 2011; Yu, 2012; Nejadrezaei et al., 2015; Sa'ari et al., 2017; Ronaghi & Forouharfar, 2020) that have found a positive relationship between performance expectancy and behavioural intention to use technology.

Effort expectancy was measured by the perception of ease of learning and using the system, as well as how much effort should be spent on using the micro-irrigation system on potatoes. From the focus group analysis, it seemed that farmers preferred to adopt an easy way to use systems which required less effort and time than ordinary sprinklers on potato crops. Furthermore, almost all participants, including a part of those who showed a high effort and attention concerns in extending the micro-irrigation system on their potato lands, demonstrated their willingness to learn about the micro-irrigation functions. For that, organising training and pilot studies could be a way for farmers to decrease their level of doubt. During on-field training courses, farmers discover how micro-irrigation functions, and the right way to install it in potato fields. Similar with other research (Venkatesh et al., 2003; Louho et al., 2006; Birch & Irvine, 2009; Im et al., 2011; Nkandu & Phiri, 2022), effort expectancy could have an effect on behavioural intention.

The third determinant, social influence, seemed to have an insignificant impact on behavioural intention to use micro-irrigation. This result was consistent with Venkatesh et al.(2003), Rosen(2005) and Yang et al.(2020). In his research, Venkatesh et al. (2003) had found that the adoption of a new system depends on the user's beliefs and not others' opinions. Social influence was not found to affect potato farmers' willingness to adopt a micro-irrigation system since the vast majority does not care about the opinion of nearby farmers, fam-

ily members, NGOs, engineers, agricultural associations or organisations. This is why promoting the importance of agricultural associations and farmers' gatherings, would revitalise the spirit of collaboration among farmers and the cooperation between them which enhances the spread of innovations as highlighted by Nkegbe & Shankar (2014) and Lopolito et al. (2022).

Lastly, the facilitating conditions determinant was measured by evaluating the available resources and support to use micro-irrigation systems. The study results clearly depicted the direct effect of facilitating conditions on use behaviour of using micro-irrigation systems consistently with Venkatesh et al. (2003), Hung et al. (2006) Wang & Shih (2009) and Im et al. (2011). Guidance departments at the Ministry of Agriculture, non-governmental organizations (NGOs) working in agricultural extension, particularly on the subject of climate change, social media advertising raising awareness of new ways of saving water, and any other available services to assist individuals in adopting and using micro-irrigation systems could be an important way to increase the adoption of a micro-irrigation system. Nevertheless, all farmers confirmed that these conditions were unavailable in Lebanon, and there was no guidance regarding agricultural practices in the country, which meant that they could not know about the benefits of micro-irrigation, or its right usage.

With respect to the moderating effect of age, it was found that it was an important moderator in the context of adopting a micro-irrigation system among potato farmers. The younger group affirmed that it would be more difficult to persuade the older generation who did not have the initiative to try new technologies, contrary to what the elderly said. In fact, moderation by age impact was reported in several studies (Venkatesh & Morris, 2000; Venkatesh et al., 2003; Morris et al., 2005).

Experience was considered by Venkatesh et al. (2003) as one of the important factors that affect behaviour intention. In this study, it was shown that the effect of effort expectancy on behaviour intention was in fact moderated by experience. The findings of this study revealed that, in terms of micro-irrigation usage, experienced farmers were more likely to accept and use micro-irrigation than inexperienced farmers.

However, it appeared that experience was not a moderator of the effect of the facilitating conditions construct on use behaviour because farmers with different levels of experience have almost the same perceptions towards the resources supporting the use of micro-irrigation. This result is not consistent with the study of Alshehri et al. (2013) who claimed that experience moderates the effect of facilitating conditions on use behaviour.

Voluntariness of use had moderated the effect of social influence on behaviour intention. It was measured on the basis of not using external obligations or incentives in order to implement the new irrigation system. The results confirmed that in the case of subsidies, the level of adoption would increase, and farmers would definitively implement the system. That is, if the micro-irrigation system was financially subsidised, almost all farmers in Lebanon would adopt it. Furthermore, the study findings showed that almost half of the participants did not have the tendency to adopt a micro-irrigation if there was no external obligation which is consistent with what Venkatesh et al.(2003) had reported. In this case, if the government granted subsidies to support the implementation of a micro-irrigation system, the vast majority would adopt it gradually or immediately. This is compatible with what Nkegbe & Shankar (2014) found, that providing facilities to farmers, such as accessing credits in their case, could promote and intensify the adoption of agricultural technology.

6. CONCLUSIONS

The aim of this study was to investigate the potato farmers' behaviour in adopting a micro-irrigation system. To achieve this objective, we adapted the unified theory of acceptance and use of technology (UTAUT) model.

The outcomes offer visions for policymakers to encourage potato farmer to adopt a new micro-irrigation system. Firstly, farmers are willing to accept micro-irrigation technology when they can make gains and reduce task uncertainty on their farming activities. Secondly, they are keen to adopt a micro-irrigation system if they find that it reduces effort and time spent on their farming activities. Finally, it is relevant to encourage farmers to adopt it through financial aids or subsidies which provide opportunities for farmers to decrease the financial burdens on them. Furthermore, agricultural extensions, field training and pilot area studies are also important in increasing the farmers' intention to adopt a micro-irrigation system.

However, the study suffers from some limitations. Legal restrictions and safety measures linked to the COVID19 pandemic were a reason for the limited sample size. Also, the sample used lacked gender differentiation since no females operated farms in the study area. Thus, it would be useful to repeat the analysis with a larger sample for focus group discussions incorporating female participation and extending the study to other countries.

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