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WHAT DRIVES FARMERS TO ADOPT PRO-ENVIRONMENTAL BEHAVIOR? EVIDENCE FROM DATE FARMS IN SAUDI ARABIA

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ABSTRACT

Despite widespread knowledge of agriculture's sustainability challenges, more needs to be known about the factors influencing farmers' adoption of sustainable practices. This study examines the specific drivers of pro-environmental behavior among date farmers. A variable model was developed, and a questionnaire was used to gather farmers' perceptions of the factors influencing pro-environmental behavior on date farms. A hierarchical structure of the identified factors was developed using MICMAC analysis on 81 farmers in the kingdom of Saudi Arabia. Our results show that farm size, supply chain pressure, and firm technological capabilities are the most relevant determinants of pro-environmental behavior on date farms. Also, farmers' experiences, learning from other firms in the sustainability domain, and farm image improvement are critical variables in the system of pro-environmental behavior adoption. Finally, we argue that pressure from environmental regulation and the farmers' age are excluded variables. It is crucial to consider that relying solely on encouragement and laws to protect the environment cannot achieve sustainability in agriculture. More attention should be devoted to educating farmers about the importance of pro-environmental behavior and how it can improve their image in front of stakeholders. It is also necessary to organize periodic forums to support mimetic pressure and push farmers to learn from each other. Because farmers' environments in developing countries tend to be similar, it is possible to generalize these results to some extent. This model unveils a fresh perspective on promoting sustainability in agriculture by using novel analytical techniques to map relationships between pro-environmental actions and their influencing factors.

Keywords: new institutional theory, legitimacy theory, human capital theory, cognitive mapping.

INTRODUCTION

In recent years, attention has been clearly directed to environmental preservation and sustainability due to climate change, high levels of pollution, and the emergence of many epidemics and pests (Halaburda and Bernaciak, 2020). In particular, pro-environmental behavior, which represents a critical factor in reaching sustainability in various economic activities, has developed as a new term, especially in agriculture. Although there are several studies on the motives that determine the pro-environmental behavior of farmers, there is no explicit agreement about them. As a result, more research is needed, particularly in agricultural areas where farmer behavior and commitment to environmental conservation are directly affected.

This study seeks to determine the factors influencing date farmers' adoption of pro-environmental behavior in the Qassim region in Saudi Arabia. This region is considered the largest producer of dates in the Kingdom and one of the largest suppliers of several types of dates to the global market. The research problem of this study is considered extremely important, especially in light of the Kingdom of Saudi Arabia's Vision 2030, which aims to create a robust agricultural sector that achieves the anticipated sustainability goals and includes agriculture as one of its most crucial pillars. To protect the environment, it is essential to assess how well farmers adhere to the fundamentals of a sustainable lifestyle (Ataei *et al*., 2018). Agriculture is a significant source of income in developing nations. As a result, environmental changes have significant social and economic repercussions (Yaghoubi Farani *et al*., 2021). In order to develop a clean production policy and maintain pro-environmental behavior, this study seeks to identify the most significant factors influencing farmers' behavior on date farms. Dates are one of the nation's key products since palm trees can survive in arid climates, and the Kingdom of Saudi Arabia is one of the greatest palm tree growers.

It is crucial to use environmentally friendly practices in order to achieve sustainability. Long-term management techniques and the adoption of modern agricultural practices are required to guarantee the survival of palm trees under current conditions and future climate scenarios (Elhendy and Al Katani, 2013). The sustainability of date agriculture is dependent on farmers implementing sustainable agricultural practices. Their decision-making is influenced by beliefs, conventions, experiences, values, tribal patterns, educational attainment, and age (Mobeen *et al*., 2016). Therefore, we identified the factors that drive date farmers to adopt pro-environmental behavior and make sustainable decisions. For this, a theoretical framework based on three theories that are most relevant to the issue of pro-environmental behavior was used. Specifically, we relied on the new institutional, legitimacy, and human capital theories.

The new institutional theory suggests that the behavior of actors within an organization or system is influenced by the institutional environment in which they operate. This means that farmers' behavior is not only influenced by their own individual preferences and beliefs but also by the broader institutional context in which they operate, including social norms, values, and regulations. Legitimacy

theory suggests that organizations, including farms, must maintain legitimacy in the eyes of stakeholders in order to survive and thrive. Farmers must engage in socially responsible and environmentally sustainable practices in order to maintain legitimacy with consumers, regulators, and other stakeholders. Human capital theory suggests that investments in education, training, and experience can enhance an individual's productivity and contribute to their success. This can be applied to farmers who invest in sustainable agriculture practices, which can increase their productivity and profitability over the long term. These theories help us understand how farmers make decisions on sustainable agriculture practices and how they can be encouraged to adopt more pro-environmental behaviors over the long term.

Previous studies indicate that there are 13 factors that are likely to influence their behavior, derived from the use of the three theories previously discussed. Based on a review of studies that fall under the new institutional theory, five hypotheses were developed. First, customer pressures can affect the farmers' pro-environmental behavior. Tey *et al*. (2014) mentioned that certain customer requirements have to be satisfied in agriculture. Second, the pressure of government regulations has a positive effect on farmers' pro-environmental behaviors. Regulation-related restrictions all have a considerably positive effect on farmers' decisions for organic fertilizer and pro-environmental behavior adoption (Lv *et al*., 2023). According to Li *et al*. (2022), environmental regulations and risk perception both significantly affect farmers' desire to adopt sustainable practices. These pressures are related to competitive relations between farmers and agriculture organizations.

Third, we assume that pressure from environmental organizations has a positive effect on farmers' pro-behaviors. Fu *et al*. (2017) found that group pressure significantly influences the development of individual environmental behaviors. Other studies have affirmed the existence of a positive relationship between pro-environmental behavior and group pressure, such as Banwo and Du (2019). Our fourth hypothesis assumes that learning from others pressure has a positive effect on farmers' behaviors toward agriculture businesses. Thus, it is considered an important factor and helps them follow clean production policies. According to Juárez-Luis *et al*. (2018), pressures have the biggest influence on green practices. Learning from other experiences is primordial in this case (Atanasovska *et al*., 2022). Tey *et al*. (2014) affirm that learning from other firms could influence their behaviors, especially when they know each other and share a common language.

Our fifth hypothesis stipulates that supply chain pressure positively influences farmers to adopt pro-environmental behaviors. Organizations and farms should encourage their employees to become environmentally aware by engaging them in pro-environmental behaviors. Paillé and Boiral (2013) stated that there is growing attention among researchers to find the backgrounds of employees' pro-environmental behaviors at work. In order to satisfy the needs of customers, regulators, and other stakeholders, farmers may be encouraged to adopt more sustainable practices throughout their supply chains.

This study also relied on the legitimacy theory, which implies that the farmer considers polishing his reputation and improving his image in relation to the categories of stakeholders. This is what drives them to adopt pro-environmental behavior in all their decisions and activities. In this regard, Vilkė *et al*. (2021) found that farmers' awareness of environmental responsibility in terms of eco-efficiency and clean production has relevant implications. Farmers may experience negative social or economic effects if they are known in their community for indulging in unsustainable or environmentally harmful practices. They may be discouraged from engaging in unsustainable activities as a result. Farmers are more prone to group pressure, desire to have a good reputation in the group, and anticipate having neighbors' trust (Castro-Campos, 2022). Generally, reputation and image are strong inducers of pro-environmental behavior and can set up a positive feedback loop in which the adoption of sustainable techniques is reinforced by the enhancement of the farmer's reputation.

The effect of farm size on sustainable supply chain management and performance has received little research. Because larger businesses have more resources at their disposal and are subject to more environmental pressure than smaller businesses, company size may have an impact on how well environmental practices are implemented (Wang *et al*., 2023). According to Ren *et al*. (2019), farm size is linked to a statistically significant drop in the amount of fertilizer and pesticides used per hectare. The use of herbicides and pesticides would generally decline by 1.8 % and the use of fertilizers by 0.3 % for every 1 % increase in farm size.

Using previous studies, we developed three hypotheses using this theory as potential determinants of farmers' pro-environmental behavior. The first one stipulates that the engagement of farmers in corporate social responsibility has a positive impact on farmers' pro-environmental behaviors. The second predicts that corporate farm image improvement will positively influence farmers to adopt pro-environmental behaviors. Finally, the third hypothesis related to legitimacy theory predicts that farm size influences farmers positively to adopt pro-environmental behaviors.

On the other hand, human capital theory suggests that there are significant factors that can influence farmers' behavior and their willingness to adopt pro-environmental behavior. Based on this theory, we hypothesized that the farmer's age, time of experience in their field of activity, and gender can largely affect their behavior. Fang *et al*. (2018) found that younger people are more concerned about the environment than older adults. Recent review articles by Glazebrook *et al*. (2020) provide a strong foundation regarding the relationship between gender and environmental concerns in agriculture. Farmers with more experience should be more knowledgeable and proficient when assessing and interpreting information. We concur that farmers with experience are more likely to implement agriculturally pro-environmental practices (Chizallet *et al*., 2023).

Finally, the current study assumes that there are two additional variables that could have explanatory power for farmers' adoption of pro-environmental behavior, which are the technological capability of the farm and the desire to reduce costs. In fact,

farms will require the first to adopt pro-environmental technologies, as well as the ability to create projects to execute and modify their processes, operations systems, and information systems (Oke, 2023). Regarding cost savings, Savari *et al*. (2021) confirm that the familiarity of farmers with the benefits of pro-environmental behavior adoption can lead to their increased positive attitude towards pro-environmental behavior, which can directly lead to increasing crop yields. Thus, it is important to accelerate the transformation of agricultural production methods, dynamically develop green agriculture, and protect the environment while increasing incomes (Liu *et al*., 2023).

MATERIALS AND METHODS

The MICMAC analysis technique

In order to determine the most influential factors on the pro-environmental behavior of date farmers, we relied on mind maps using the MICMAC software. In fact, this technique aims to discover how date farmers view the issue of pro-environmental behavior and what factors they see as actually influencing this responsible behavior. If we identify the factors that are likely to influence farmers' behavior and make them adopt sustainable behavior, it is actually easier to direct their behavior in this area.

The structural analysis method was used, specifically the MICMAC method. First, the variables likely to affect the studied phenomenon are identified. Secondly, the adjacency matrix is filled. Third, an adjacency matrix must be entered into the MICMAC software, and the analysis must be performed via the matrix of direct influence and the matrix of indirect influence (Arcade *et al*., 1999). After constructing an individual cognitive map for each farmer, we combined these individual cognitive maps to obtain the aggregated cognitive map, which summarizes farmers' perceptions around the critical determinants of pro-environmental behavior. We applied the arithmetic mean to go from individual to aggregated cognitive maps (Lajnef *et al*., 2017).

A battery of analysis tools was applied to analyze farmers' perceptions. The centrality analysis was used to identify the most critical factors that can influence the pro-environmental behavior. The MICMAC software can easily generate a variable ranking based on the capacity of each variable or concept to influence other concepts in the whole system and its dependence degree in the studied phenomenon. We focused on the centrality analysis, which supposes that in a given system, the most central concept has the highest number of entry and exit arcs. For this, we concentrated on the aggregated cognitive map generated. We used the influences-dependences chart since it can give a clear idea of how all proposed variables as potential determinants of farmers' pro-environmental behavior are clustered in farmers' mental schemes.

The influences-dependences chart (Figure 1) generated by the MICMAC software comprises four quadrants. The first represents the input/influential variables that seem to significantly impact farmers' pro-environmental behavior adoption (Chatziioannou

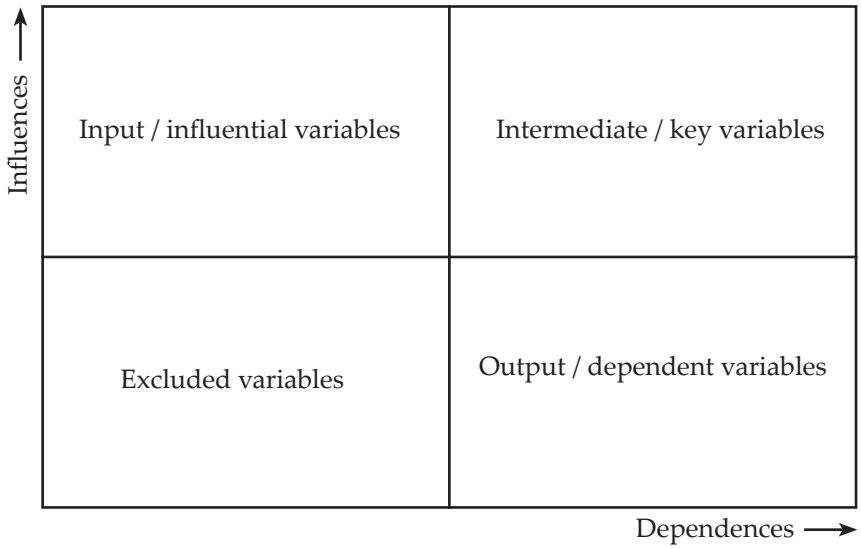

Figure 1. Influences-dependences chart showing the general explanatory value arrangement of the variables.

et al., 2023). Furthermore, these variables are the most influential and can have an explanatory power for the studied phenomenon. The second quadrant contains the relay variables, also called intermediate/key variables due to their ability to influence the whole system (Ben Fatma *et al*., 2021). The third quadrant shows the dependent variables with low influence and strong dependence which have low explanatory power. Finally, the fourth quadrant contains excluded variables that represent variables with no explanatory power, and so are rejected by the system (Chatziioannou *et al*., 2023).

Study area description

This research was carried out in the Qassim region of the Kingdom of Saudi Arabia. It is located approximately 400 km northwest of Riyadh. Al-Qassim is known as the alimental basket of the country due to its distinction in agriculture, especially the production of different types of dates. Data was collected in approximately four months, from January to April 2023. According to official statistics, the Qassim region produces 200 thousand Mg of dates annually (Ben Mohamed *et al*., 2024). This makes the subject of the study particularly important, given the findings of some published studies by Abdallah *et al*. (2018), where the presence of pesticide residues was proven in 18 % of the sample they examined.

Sample collection

The self-structural interaction matrix was produced based on previous studies in the field of pro-environmental behavior. A set of questions was developed to collect basic

data about the farmers who participated in the survey, such as age and experience. Before distribution, the questionnaire was presented to a small group of three farmers to ensure its clarity. Then, it was sent to the Ethics Subcommittee and approved. The purpose of the questionnaire was to make it easier to gather information in order to create the SSIM matrix.

The questionnaire was given to a total of 123 date farmers selected at random. At the end, 81 completed replies were obtained. The farmers interviewed were invited to estimate, for each variable and following our theoretical study and exploration of the field, the influence effects by filling out a structural analysis matrix. This matrix contained all potential determinants of pro-environmental behaviors, and farmers were asked to assign the impact of each variable on other variables. If the relationship is strong between two variables, then a value of 3 is assigned. If this relationship is medium, a value of 2 is assigned. If this relationship is weak, its value is 1. If there is no impact between variables, its value is 0.

RESULTS

The sample was heterogeneous in terms of the gender. It was composed of 87.6 % men and 12.4 % women (Table 1). All age groups were present. This is important to study the phenomenon considering all age groups' perceptions. Our sample contained farmers with different education levels and experiences. The questionnaire was distributed to farmers and was designed in a way that enables us to collect general information about the owner of each farm.

By looking at the aggregated adjacency matrix, we can extract the most critical variables central to pro-environmental behavior (Table 2) using the total influence score. The

Table 1. Sample descriptive statistics (n = 81) showing results from the respondents' general information.

Variables	Class	Frequency	Percentage
Age	≤ 30	11	0.135
	31–40	19	0.235
	41–50	18	0.222
	51–60	25	0.308
	> 60	8	0.098
Gender	Male	71	0.876
	Fiemale	10	0.124
Education level	No formal education	17	0.209
	Primary	20	0.247
	Secondary	18	0.222
	Tertiary	26	0.321
Years of experience	≤ 5	24	0.296
	5–10	16	0.197
	11–15	18	0.222
	> 15	23	0.284

Table 2. Adjacency matrix with influence scores assigned to all variables according to their potential impact on each other.

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	Total influences	Total influences and dependences
V1	0	2	1	2	1	1	2	1	2	3	2	2	2	21	44
V2	2	0	2	1	1	1	2	3	2	3	2	3	2	24	48
V3	2	2	0	1	1	1	2	1	2	3	2	2	2	21	42
V4	2	2	1	0	2	1	2	2	2	3	2	3	1	23	44
V5	1	1	1	2	0	2	3	2	2	2	2	3	2	23	44
V6	1	1	1	1	2	0	2	1	2	2	2	1	1	17	35
V7	2	2	2	3	2	2	0	2	2	2	2	3	2	26	53
V8	2	3	2	2	2	1	3	0	1	2	2	2	2	24	45
V9	2	2	2	2	2	2	2	1	0	2	2	2	2	23	47
V10	3	3	3	2	2	2	2	2	3	0	2	3	2	29	59
V11	2	2	2	2	2	2	2	2	2	3	0	2	1	24	48
V12	2	2	2	2	2	2	3	2	2	3	2	0	2	26	54
V13	2	2	2	1	2	1	2	2	2	2	2	2	0	22	43
Total dependences	23	24	21	21	21	18	27	21	24	30	24	28	21		

V_1: pressure of environment regulation; V_2: cost savings; V_3: customer pressure; V_4: farms technological capability; V_5: age; V_6: gender; V_7: experience; V_8: farm size; V_9: corporate social responsibility; V_{10}: corporate image improvement; V_{11}: supply chain pressure; V_{12}: learning from other farms; V_{13}: pressure from environmental organizations.

importance of each variable in the system can be noticed as it measures the extent of the variable's susceptibility to other variables in the system.

Depending on the extent of the variable's effect on the phenomenon of pro-environmental behavior, we find three central variables: corporate image improvement, farmer experience, and the ability to learn from other farms. Especially corporate image improvement, as predicted by the legitimacy theory, can be considered a central variable in the determinants of pro-environmental behavior. This variable has a total score of influences equal to 29, meaning it significantly influences other variables in this system. On the other hand, other studies consider gender to be an essential factor, which may explain why environmentally friendly production policies and behaviors are adopted by certain people. It appears that gender is the weakest variable in terms of its ability to influence the rest of the other variables in the system, according to what farmers see in the study sample, with a score equal to 17.

If we rely on the total influence score to arrange the variables according to their importance, we find that the results are almost constant, especially for the three central variables. Specifically, corporate image improvement is the most affected variable as it receives influences from various other variables in the system, with a total value of 30, followed by the variable of learning from other farms with a score equal to

28. Then, the farmer's experience is greatly affected by the rest of the variables in the system, with a score equal to 27. We also note that three variables are classified as fourth: corporate social responsibility, supply chain pressure, and cost savings. Finally, when taking into account the extent to which a variable can influence and be affected by the rest of the variables, we note that the central variables are: corporate image improvement, learning from other farms, experience, cost savings, supply chain pressure, and corporate social responsibility.

From the aggregated cognitive map (Figure 2), it is possible to notice several influence relationships among the variables that have been proposed to explain the motivation to adopt pro-environmental behavior. The map is overlapping, and several influence relationships exist between variables. These explain that the studied phenomenon has an actual impact on guiding the behavior of farmers in the study sample.

The map shows that the desire to maintain the good reputation, as predicted by the theory of legitimacy, is considered a significant variable, as it affects the majority of other variables in the map and is also affected by them. This indicates the importance of the interpretation proposed by the theory of legitimacy that farmers, in their attempt to build and maintain a good reputation, will adopt pro-environmental behavior to achieve this goal. In this regard, corporate image improvement directs the company towards pressure on costs and the extent of reliance on advanced and environmentally friendly technologies. It also has a considerable impact on the decision to adopt social responsibility and learn from other farms in the field of sustainability.

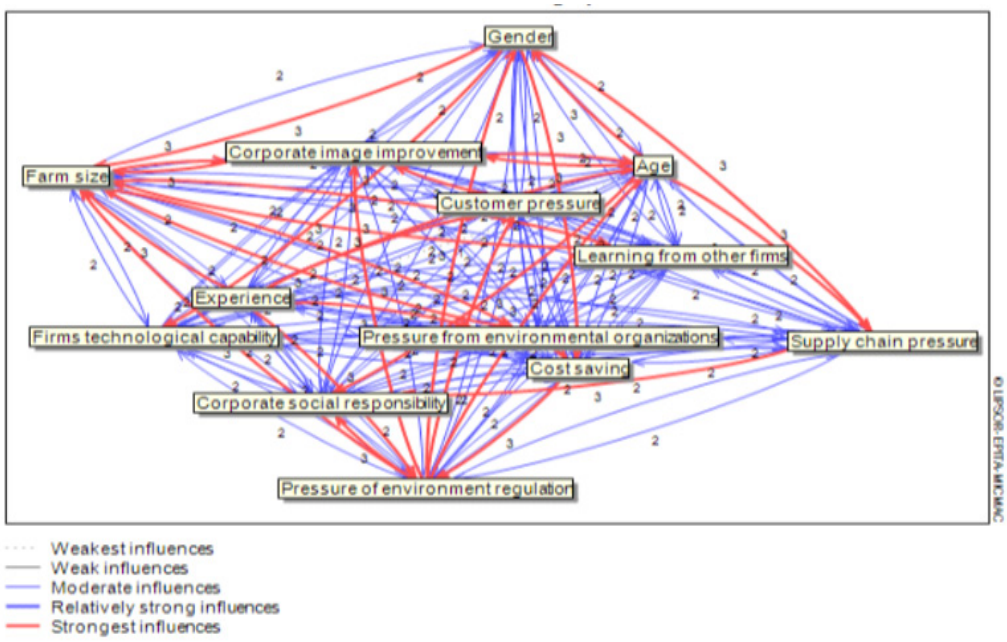

Figure 2. Aggregated cognitive map from direct influences of the variables influencing pro-environmental behavior.

One of the analysis tools that the MICMAC program can provide is the study of indirect relationships. The relationship between the variables goes beyond the limits of direct influence, as there are generally strong relationships between most of the study's variables, except for gender (Figure 3). There is still a robust relationship between creating and maintaining a good reputation for the farm and the ability of the farmer to learn from the experiences of other farms in the field of sustainability. It also appears that the farmer's experience has a strong indirect effect on the majority of the variables in the system, making it a significant variable in the farmers' mental map. Finally, it appears that gender does not significantly affect the rest of the variables that may affect farmers' decisions to adopt pro-environmental behavior. The effect of the rest of the variables on it is also weak.

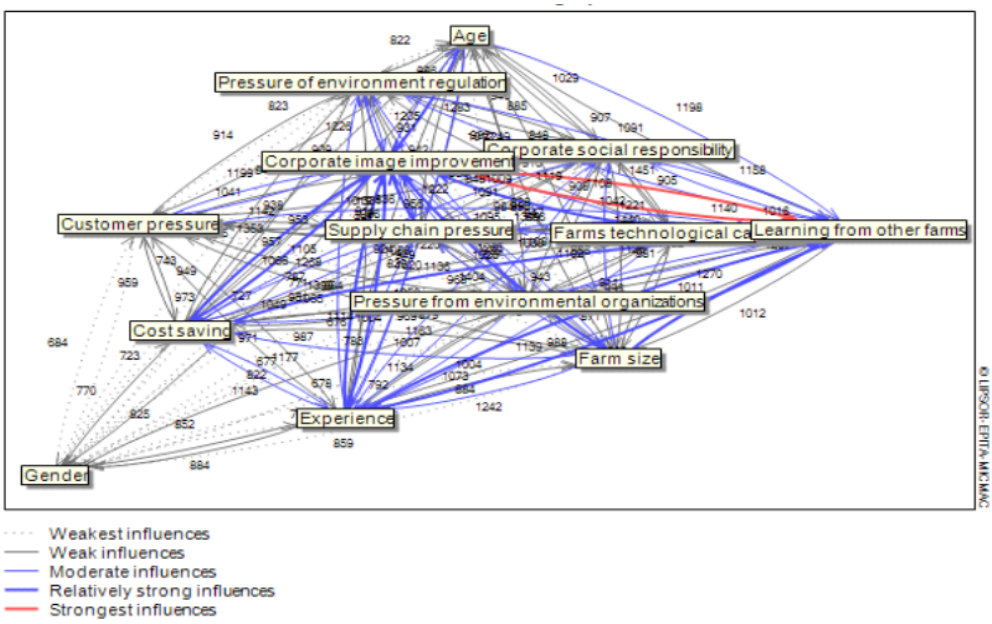

Figure 3. Aggregated cognitive map from indirect influences of the variables influencing pro-environmental behavior.

From the direct and indirect influences-dependences chart (Figure 4), we find that the first quadrant contains influencing variables that directly explain the studied phenomenon, with a large degree of influence and a weak degree of dependence. Farm size emerges as one of the most critical determinants of adopting pro-environmental behavior. Our results are consistent with Vanpoucke *et al*. (2014), as the size of the farm is likely to affect the decision to adopt environmentally friendly and sustainable policies, especially since the theory of legitimacy predicts that the larger the farm, the more obsessed with creating and maintaining a good reputation for it.

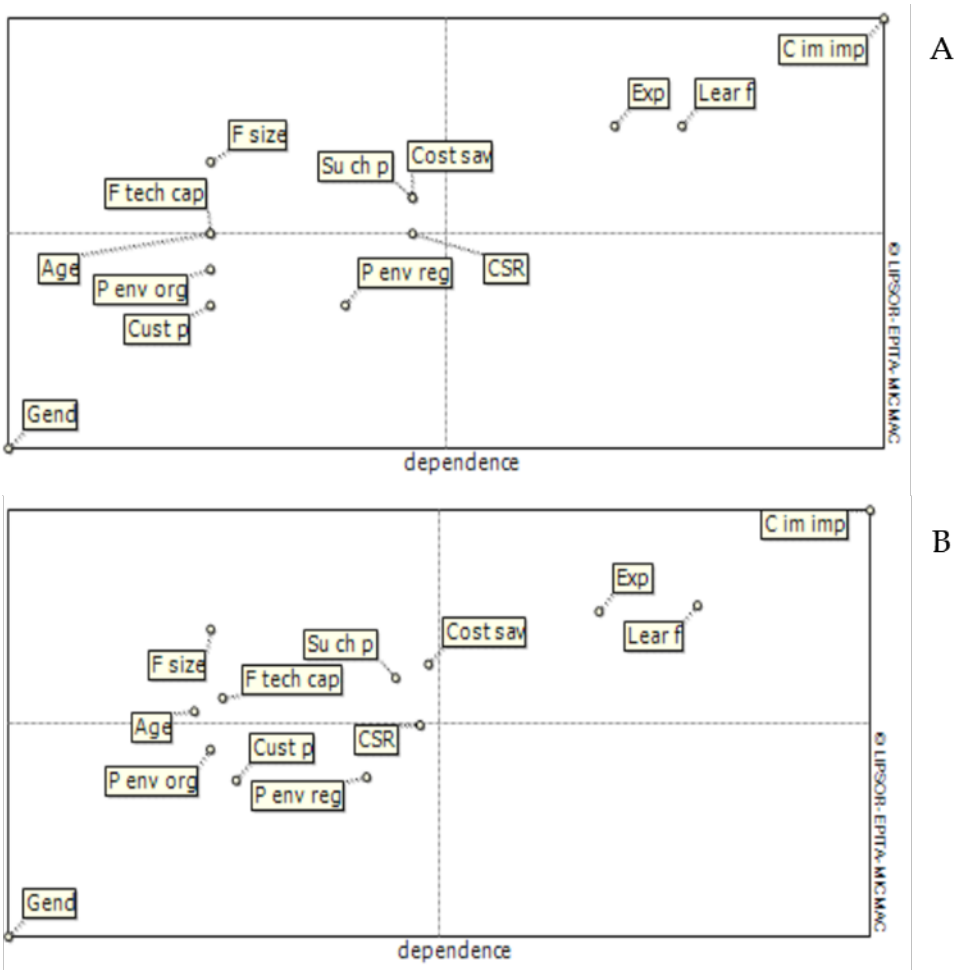

Figure 4. Influences-dependences charts of the variables influencing pro-environmental behavior. A: direct influences-dependences; B: Influences-dependences. F size: farm size; F tech cap: farm technological capabilities; Su ch p: supply chain pressure; Cost sav: cost saving; Exp: farmer experience; Lear f: learning from other firms; C im imp: farm image improvement; Age: farmer age; P en org: pressure from environmental organizations; ust p: customer pressure; P env reg: pressure of environmental regulations; CSR: corporate social responsibility.

Supply chain pressure also has a great impact on the adoption of pro-environmental behavior. In fact, the pressure that supply chains can place on farmers regarding sustainability is considered one of the most important because farmers are simply afraid of losing their position with a particular supply chain if they do not respond to its conditions in terms of sustainability. The pressures of supply chains have a more significant impact on farmers than laws and environmental associations. Our results are consistent with the findings of Bagheri *et al*. (2021), as the principle of cost reduction is a crucial factor in motivating date farmers to adopt pro-environmental behavior.

The technological capacity of the farm and its ability to rely on modern technologies can also explain farmers' adoption of environmentally friendly production policies. This factor is logical, as farms that cannot keep pace with technological developments may not consider adopting pro-environmental behavior, which has been shown to have a strong relationship with technology. These two variables are located on the dividing line between the factors most able to explain the studied phenomenon and the variables that must be excluded. Therefore, we relied on the indirect influences-dependences chart, which suggested that these variables have high explanatory power for the phenomenon of pro-environmental behavior adoption.

The critical variables for adopting pro-environmental behavior are the farm's willingness to create and maintain a good image with various stakeholders, the farmer's experience, and the ability to learn from other farms in the area of sustainability and environmentally friendly practices. These variables can be used to control the system as a whole (Chatziioannou *et al*., 2023). Our results are consistent with Tey *et al*. (2014), who stated that mimetic pressures, represented here in learning from others and emulating them in the field of sustainability, significantly affect their motivation to adopt pro-environmental behavior.

Overall, these results prove the extent to which the three theories discussed can be relied upon in understanding, analyzing, and predicting the phenomenon of pro-environmental behavior. Finally, it was proven that several variables have no direct or indirect relationship with farmers' adoption of pro-environmental behavior in the study sample. These variables are pressure from customers, pressure from environmental protection associations, pressure from environmental protection laws, and gender.

Relying solely on laws to protect the environment and encourage sustainability cannot achieve sustainability in agriculture. On the contrary, more attention should be paid to educating farmers about the importance of pro-environmental behavior and how it can improve their image in front of the relevant parties. It is also necessary to organize periodic forums to support mimetic pressure and push farmers to learn from each other. Awareness of the need to follow social responsibility is also essential and would push farmers to adopt sustainable behavior in the agriculture sector. On the other hand, farmers should be supported technologically and in developing their expertise in the field of dates. Moreover, spreading the culture of green supply chains can significantly help pressure farmers to adopt sustainable policies and behaviors in the field.

Policymakers and extension agencies may create more effective policies and programs to support sustainable agriculture by understanding the variables that drive farmers to embrace these practices. For example, they could offer financial incentives, instruction, and technical assistance to farmers who want to embrace environmentally friendly techniques. Understanding the factors that drive pro-environmental behavior can contribute to the long-term sustainability of date farming in Saudi Arabia. This can help mitigate environmental degradation, preserve natural resources, and ensure the resilience of the agricultural sector in the face of climate change.

CONCLUSIONS

This study attempts to understand the determinants influencing date farmers' decisions to adopt pro-environmental behavior. Our results show that the most critical factors in the date sector are farm size, extent of its technological capabilities, pressure exerted on it by the supply chains in terms of sustainability, obsession with reducing costs, age of the farmer, and the extent of his understanding and desire to follow and apply corporate social responsibility.

The key variables that push farmers to adopt sustainable and environmentally friendly policies and behaviors are the company's desire to create a good image with the relevant parties, the farmer's experience, and the extent to which he can learn from other farms in the field of sustainability. Contrary to what was postulated, we did not find an effect of variables such as pressure on farmers from laws, environmental protection organizations, or pressure from customers. Also, gender was not found to have any effect on the issue of pro-environmental behavior adoption.

Encouraging pro-environmental behavior among farmers through education and peer learning, alongside offering financial incentives and technical support, is essential for sustainable agriculture. Policymakers and extension agencies must understand these drivers to ensure the long-term sustainability of date farming in Saudi Arabia, mitigating environmental degradation and fostering agricultural resilience in the face of climate change.

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REFERENCES

Abdallah OI, Alamer SS, Alrasheed AM. 2018. Monitoring pesticide residues in dates marketed in Al-Qassim, Saudi Arabia using a QuEChERS methodology and liquid chromatography-tandem mass spectrometry. Biomedical Chromatography 32 (6): e4199. https://doi.org/10.1002/bmc.4199

Arcade J, Godet M, Meunier F, Roubelat F. 1999. Structural analysis with the MICMAC method and actor's strategy with MACTOR method. American Council for the United Nations University. Tokyo, Japan. 69 p.

Ataei P, Aliabadi V, Norouzi A, Sadighi H. 2018. Measuring the employees' environmental attitude of agricultural knowledge-based companies based on sociocultural components: a case study from Iran. Environment, Development and Sustainability 21 (5): 2341–2354. https://doi.org/10.1007/s10668-018-0136-9

Atanasovska I, Choudhary S, Koh L, Ketikidis PH, Solomon A. 2022. Research gaps and future directions on social value stemming from circular economy practices in agri-food industrial

parks: Insights from a systematic literature review. Journal of Cleaner Production 354: 131753. https://doi.org/10.1016/j.jclepro.2022.131753

Bagheri A, Bondori A, Allahyari MS, Surujlal J. 2021. Use of biologic inputs among cereal farmers: application of technology acceptance model. Environment, Development and Sustainability 23 (4): 5165–5181. https://doi.org/10.1007/s10668-020-00808-9

Banwo A.O, Du J. 2019. Workplace pro-environmental behaviors in small and medium-sized enterprises: an employee level analysis. Journal of Global Entreprise Research 9 (34). https://doi.org/10.1186/s40497-019-0156-4

Ben Fatma E, Ben Mohamed E, Dana L.P, Boudabbous S. 2021. Does entrepreneurs' psychology affect their business venture success? Empirical findings from North Africa. International Entrepreneurship and Management Journal 17 (2): 921–962. https://doi.org/10.1007/s11365-020-00644-3

Ben Mohamed E, Jarboui A, Garoui N, Ibrahim S, Alsalman AM, Abbassi W. 2024. The determinants of the responsible use of pesticides among date farmers in Qassim region, Saudi Arabia. Cogent Food and Agriculture 10 (1). https://doi.org/10.1080/23311932.2024.2314238

Castro-Campos B. 2022. The Rules-Boundaries-Behaviours (RBB) framework for farmers' adoption decisions of sustainable agricultural practices. Journal of Rural Studies 92: 164–179. https://doi.org/10.1016/j.jrurstud.2022.03.012

Chatziioannou I, Nikitas A, Tzouras PG, Bakogiannis E, Alvarez-Icaza L, Chias-Becerril L Karolemeas L, Tsigdinos S, Wallgren S, Rexfelt O. 2023. Ranking sustainable urban mobility indicators and their matching transport policies to support liveable city futures: A MICMAC approach, Transportation Research Interdisciplinary Perspectives 18: 100788. https://doi.org/10.1016/j.trip.2023.100788

Chizallet M, Barcellini F, Prost L. 2023. Sustainable system of systems at work: unravelling (some of) the complexity of farmers' transition to sustainability. Ergonomics: 1–15. https://doi.org/10.1080/00140139.2022.2163687

Elhendy AM, Alkahtani SH. 2013. The resource use efficiency of conventional and organic date farms in Saudi Arabia. A data envelopment analysis approach. The Journal of Animal and Plant Sciences 23 (2): 596–602.

Fang WT, Ng E, Zhan YS. 2018. Determinants of pro-environmental behavior among young and older farmers in Taiwan. Sustainability 10 (7): 2186. https://doi.org/10.3390/su10072186

Fu X, Ueland SM, Olivetti E. 2017. Econometric modeling of recycled copper supply. Resources, Conservation and Recycling 122: 219–226. https://doi.org/10.1016/j.resconrec.2017.02.012

Glazebrook T, Noll S, Opoku E. 2020. Gender matters: Climate change, gender bias, and women's farming in the global south and north. Agriculture 10 (7): 267. https://doi.org/10.3390/agriculture10070267

Halaburda M, Bernaciak A. 2020. Environmental protection in the perspective of CSR activities undertaken by polish enterprises of the construction industry. Economics and Environment 75(4): 122–133.

Juárez-Luis G, Sánchez-Medina PS, Díaz-Pichardo R. 2018. Institutional pressures and green practices in small agricultural businesses in Mexico: The mediating effect of farmers' environmental concern. Sustainability 10 (12): 4461. https://doi.org/10.3390/su10124461

Lajnef K, Ellouze S, Ben Mohamed E. 2017. How to explain accounting manipulations using the cognitive mapping technique? An evidence from Tunisia. American Journal of Finance and Accounting 5 (1): 31–50.

Li M, Liu Y, Huang Y, Wu L, Chen K. 2022. Impacts of risk perception and environmental regulation on farmers' sustainable behaviors of agricultural green production in China. Agriculture 12 (6): 831. https://doi.org/10.3390/agriculture12060831

Liu U, Gianella M, Dávila P, Udayangani L, Maraeva G, Patricia D.A, Mauricio D, César O, Rafael L.S, Bacci S, Efisio M, William M, Olivia M, Hugh W. P, Isela R.A, Michael W, China W, Tiziana U. 2023. Conserving useful plants for a sustainable future: species coverage, spatial distribution, and conservation status within the Millennium Seed Bank collection. Biodiversersity and Conservation 32: 2791–2839. https://doi.org/10.1007/s10531-023-02631-w

Lv N, Liu F, Zhu H, Wang G. 2023. Effect of government intervention and market incentives on farmer organic fertilizer application behavior and agricultural emission reduction. Natural Hazards Review 24 (1): 04022035. https://doi.org/10.1061/(asce)nh.1527-6996.0000595

Mobeen N, Shahabuddin S, Faiz S, Adosri F. 2016. Attitude of Al-Qassim, Saudi Arabian farmers towards extension employees in leadership ability and communication of innovative adoption. Asian Journal of Agricultural Extension, Economics and Sociology 11 (2): 1–7. https://doi.org/10.9734/ajaees/2016/24543

Oke A. 2023. Beyond the psychology of self and individual's pro-environmental behaviours: exploring how technology innovations can help organisations achieve and promote sustainability. Technological Sustainability 2 (1): 1–19. https://doi.org/10.1108/techs-02-2022-0013

Pascal Paillé P, Boiral O. 2013. Pro-environmental behavior at work: Construct validity and determinants. Journal of Environmental Psychology 36: 118–128. https://doi.org/10.1016/j.jenvp.2013.07.014

Ren C, Liu L, Grinsven H.V, Reis S, Jin S, Liu H, Gu B. 2019. The impact of farm size on agricultural sustainability. Journal of Cleaner Production 220: 357–367. https://doi.org/10.1016/j.jclepro.2019.02.151

Savari M, Zhoolideh M, Khosravipour B. 2021. Explaining pro-environmental behavior of farmers: A case of rural Iran. Current Psychology 42 (9): 7752–7770. https://doi.org/10.1007/s12144-021-02093-9

Tey YS, Li E, Bruwer J, Abdullah AM, Brindal M, Radam A, Ismail MM, Darham S. 2014. The relative importance of factors influencing the adoption of sustainable agricultural practices: A factor approach for Malaysian vegetable farmers. Sustainability Science 9 (1): 17–29. https://doi.org/10.1007/s11625-013-0219-3

Vanpoucke E, Vereecke A, Wetzels M. 2014. Developing supplier integration capabilities for sustainable competitive advantage: A dynamic capabilities approach. Journal of Operations Management 32 (7–8): 446–461. https://doi.org/10.1016/j.jom.2014.09.004

Vilkė R, Gedminaitė-Raudonė Ž, Baležentis T, Štreimikienė D. 2021. Farmers' awareness of eco-efficiency and cleaner production as environmental responsibility: Lithuanian case. Corporate Social Responsibility and Environmental Management 28 (1): 288–298. https://doi.org/10.1002/csr.2049

Wang Y, Möhring N, Finger R. 2023. When my neighbors matter: Spillover effects in the adoption of large-scale pesticide-free wheat production. Agricultural Economics 54 (2): 256–273. https://doi.org/10.1111/agec.12766

Yaghoubi Farani A, Mohammadi Y, Ghahremani F, Ataei P. 2021. How can Iranian farmers' attitudes toward environmental conservation be influenced? Global Ecology and Conservation 31: e01870. https://doi.org/10.1016/j.gecco.2021.e01870