1. Introduction

Understanding Soil-plant relations is vital toward obtaining biological yields under farmers’ fields conditions (Al-Shayaa et al., 2021). Before the advent of ICT revolution, farmers have been fetching information on the subject through traditional sources like agricultural office, extension department, College and the universities; academia and in cases directly from the Ministry. However, during the communication revolution, social media platforms and applications have emerged as extension tools to deliver agricultural information. Many farmers and professionals in agricultural sector are using platforms such as Twitter, Facebook, Youtube and Instagram to share their knowledge and view information, ideas and experiences regarding agricultural problems, solutions and suggestions (Raj and Bhattacharjee, 2013). Information and communication technologies (ICT) help worker in agriculture to learn and develop their potentials by taking or viewing pictures, recording or viewing videos, and listening to voice recordings at their workplace (Cirić et al., 2018). ICT can provide rapid and convenient agricultural extension services by sharing knowledge via virtual communities and group discussions (Chigozie-Okwum and Chinaka, 2016). Social media has become a platform that can connect larger, more distant and diverse communities, considered as innovative extension means to coordinate, communicate, and build knowledge connections not only between extension agents and their clients but also among farmers themselves (Lubell and McRoberts, 2018).

However, using social media as tools for agricultural information delivery may have some issues in content structure, information quality, stakeholders’ participation and transformation of knowledge (Barau and Afrad, 2017). Understanding users’ perspectives helps to develop and provide reliable and engaging agricultural content on social media platforms. Therefore, the impact of social media on users’ agricultural knowledge most have more attention. Thus, this study aimed to investigate the soil-plant relationship by looking at knowledge levels of social media users. The study examined the relationship between the users’ characteristics and their knowledge on soil-plant relationship. Online survey was designed and distributed to gather the data. The number of response was received from 383 respondents where 375 participants provided completed information and the remaining eight responses were eliminated due to quality standards. The results show most of the participants (68.8%) are moderately depend on social media to acquire knowledge on soil-plant relationship and indicated “Twitter” as the highly utilized platform followed by the “Youtube”. Meanwhile, 48.8% of the participants indicated that social media have a high impact on their knowledge-based information on soil-plant relationship and agricultural contents. Inferential analysis shows there was a significant positive relationship (p < 0.01) between independent variables; Twitter, Youtube, Instagram, and Snapchat and the degree of trust on these platforms, and the level’s knowledge on soil-plant relationship (dependent variable). Only 13% of the variance accounted for the impact of social media on participants’ agricultural knowledge-base can be predicted from the combination of participants’ reliance on a set of social media platforms (Twitter, Instagram, Youtube, and Snapchat). The study revealed the trust and confidence of the users using social media on agricultural information/soil plant relationship had a medium effect in social and educational research.

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Research Objectives

(1) Identify to which extent the farmers rely on social media to obtain information on agricultural aspects in general and soil plant relationship in particular to broaden their knowledge-base.

(2) Identify the users perceived impact of social media on agricultural knowledge relevant to soil-plant relationship content.

(3) Predict the impact of social media on participants’ agricultural knowledge-base from a set of independent variables.

2. Methods

An online questionnaire was developed to address the research objectives. The instrument was built according to the guidelines of Radhakrishna’s (2007). Validity was established using input from a panel of experts from College of Agriculture and Food Sciences at King Saud University (KSU) and Iowa State University’s College of Agriculture and Life Sciences. The panel of experts concluded that the questionnaire was valid and appropriate in terms of face, content, and construct to conduct a study. After obtaining the required permission from Standing Committee for Scientific Research Ethics at KSU, a pilot study for the survey was conducted with 40 social media users. Cronbach’s Alpha was used for reliability, and coefficients indicated a high level of internal consistency for all scales (Cronbach’s Alphas = 0.93).

The population of this study included all users from agriculture content accounts on Twitter. Due to the large size of the population (more than 456,600 followers), a convenient random sample was used to represent the population of the study. The calculated sample size, using an equation from Al-Qahtani et al. (2004), was 385. The number of collected responses was 383. However, eight responses were eliminated due to quality standards and 375 completed the questionnaire.

3. Results:

3.1. Participants’ personal characteristics

Table 1 shows that both genders have participated in the survey. Finding shows 63.7% of the participants are males whereas 36.3% of them are females. The results from Table 1 shows that the participants possess a high educational level. 77.4% of the participants hold a university degree where 10.2% of them have completed a graduate study and 22.4% of the participated followers hold a high school diploma or lower. The results stated that most of the participants are employees (66.9%) and work in the public or the private sectors. However, 33.1% of the participants described themselves as an unemployed. In terms of monthly income, the results show that 48% of the participants indicated their monthly income is lower than Saudi Riyal (SR) 10 thousand; 41.6% of them stated their monthly income ranges between SR 10000-20000, and 10.4% of the participants stated their monthly income is higher than SR 20 thousand. Also, the results show that most of the participant users (87.7%) trust the information that they received from social media accounts provide content related to agriculture.

| Personal Characteristics | % |
|--------------------------|---|
| **Educational level**    |   |
| Secondary School         | 2.7 |
| High School              | 19.7 |
| Bachelor                 | 67.2 |
| Graduate                 | 10.4 |
| **Monthly income**       |   |
| <10,000 SR (Low)         | 48.0 |
| 10,000 – 20,000 SR (Average) | 41.6 |
| More than 20,000 (High)  | 10.4 |
| **Gender**               |   |
| Female                   | 36.3 |
| Male                     | 63.7 |
| **Working status**       |   |
| Unemployed               | 33.1 |
| Employed                 | 66.9 |
| **Trust status**         |   |
| Doesn’t trust            | 12.3 |
| Trust                    | 87.7 |

Spearman’s correlation was used to study the relationships between two independent variables such as the degree of reliance...
on social media platforms, and perceived gained agricultural knowledge regarding twelve topics related to agriculture.

The results from Table 4 shows that there are significant positive relationships between using Twitter and perceived gained knowledge about all of listed agricultural topics. Spearman’s correlations for these relations ranged between 0.340 with “Suitable plants for a region” to 0.107 with “Harvesting time”. The same table shows that there are significant positive relationships between using Instagram and perceived gained knowledge regarding eight of the listed agricultural topics. Spearman’s correlations for these relations ranged between 0.165 with “Suitable temperatures for a crop plant” to 0.114 with “Seeding depth”. Results did not show any significant relationship between using Facebook or WhatsApp with any of perceived gained knowledge regarding listed agricultural topics.

4. Discussion.

In the context of Saudi Arabia, AL-Sakran et al. (2017) found that the participants in their study depend on WhatsApp, YouTube, and Twitter respectively and all these platforms were ranked higher than Facebook on the degree of reliance. Unlike results from this study and AL-Sakran et al. (2017), results of different studies in other countries such as USA, Serbia, India and Bangladesh found that professionals and workers in agricultural sector are dependent on Facebook as the primary platform to share and get information

### Table 2

Participant distribution according to the degree of reliance on social media to obtain information on soil plant relationship and other associated agricultural aspects (n = 375).

| Platform       | Never | Sometimes | Always | M    | SD  |
|----------------|-------|-----------|--------|------|-----|
|                | f     | %         | f      | %    | f   | %   | M    | SD  |
| Twitter        | 31    | 8.3       | 94     | 25.1 | 250 | 66.7| 2.58 | 0.64|
| Youtube        | 25    | 6.7       | 134    | 35.7 | 216 | 57.6| 2.51 | 0.62|
| WhatsApp       | 130   | 34.7      | 130    | 34.7 | 115 | 30.7| 1.98 | 0.81|
| Instagram      | 124   | 33.1      | 162    | 43.2 | 89  | 23.7| 1.91 | 0.75|
| Snapchat       | 141   | 37.6      | 153    | 40.8 | 81  | 21.6| 1.84 | 0.75|
| Facebook       | 311   | 82.9      | 51     | 13.6 | 13  | 3.5 | 1.21 | 0.48|

3-point Lakert scale (High = 3, Moderate = 2 and Low = 1).

### Table 3

Impact of social media on agricultural knowledge (n = 375).

| Topic                                | High | Moderate | Low | M    | SD  |
|--------------------------------------|------|----------|-----|------|-----|
|                                      | n    | %        | n   | %    | n   | %    |
| Planting times and seasons           | 235  | 62.7     | 109 | 29.1 | 31  | 8.3  | 2.54 | 0.65|
| Suitable plants for a region         | 226  | 60.3     | 115 | 30.7 | 34  | 9.1  | 2.51 | 0.66|
| Suitable temperatures for a plant    | 178  | 47.5     | 151 | 40.3 | 46  | 12.3 | 2.35 | 0.69|
| Composting and fertilizer mixing     | 181  | 48.3     | 141 | 37.6 | 53  | 14.1 | 2.34 | 0.71|
| Soil types                           | 167  | 44.5     | 152 | 40.5 | 56  | 14.9 | 2.30 | 0.71|
| Irrigation systems applications      | 157  | 41.9     | 161 | 42.9 | 57  | 15.2 | 2.27 | 0.71|
| Fertilizer application               | 168  | 44.8     | 138 | 36.8 | 69  | 18.4 | 2.26 | 0.75|
| Planting duration                    | 138  | 36.8     | 175 | 46.7 | 62  | 16.5 | 2.20 | 0.70|
| Distance between seeds               | 136  | 36.3     | 168 | 44.8 | 71  | 18.9 | 2.17 | 0.73|
| Seeding depth                        | 136  | 36.3     | 167 | 44.5 | 72  | 19.2 | 2.17 | 0.73|
| Harvesting times                     | 115  | 30.7     | 169 | 45.1 | 91  | 24.3 | 2.06 | 0.74|
| Harvesting methods                   | 108  | 28.8     | 161 | 42.9 | 106 | 28.3 | 2.01 | 0.76|

3-point Lakert scale (High = 3, Moderate = 2 and Low = 1).

### Table 4

Spearman’s correlations between reliance on social media and perceived impact on agricultural knowledge.

| Perceived impact on agricultural knowledge | Twitter | Instagram | Snapchat | Youtube |
|-------------------------------------------|---------|-----------|----------|---------|
| Suitable plants for a region              | 0.340*  | –         | –        | 0.117*  |
| Suitable temperatures for a plant         | 0.237*  | 0.161*    | –        | –       |
| Planting times and seasons                | 0.285   | 0.129*    | –        | –       |
| Distance between seeds                    | 0.189*  | –         | –        | –       |
| Seeding depth                             | 0.156   | 0.148*    | –        | –       |
| Planting duration                         | 0.169*  | 0.114*    | –        | –       |
| Soil types                                | 0.199*  | 0.132*    | 0.165*   | –       |
| Composting and fertilizer mixing          | 0.122*  | 0.157*    | 0.127*   | –       |
| Fertilizer application                    | 0.123*  | –         | 0.112*   | –       |
| Irrigation systems applications           | 0.220*  | –         | 0.159*   | 0.162** |
| Harvesting times                          | 0.107*  | 0.165*    | 0.102*   | –       |
| Harvesting methods                        | 0.121*  | 0.139*    | 0.117*   | 0.158** |

*p < 0.05.

**p < 0.01.
related to agriculture (Elmer et al., 2016; Ćirić et al., 2018; (Mamgain et al., 2020); Barau and Afrad, 2017). Lubell and McRoberts (2018) found that Facebook, Twitter and Instagram are among top five social media platforms used to disseminate information related to agriculture. Thakur and Chander (2018a, b) found that Youtube is being utilized actively for sharing knowledge related to a verity of agriculture subsectors.

Regardless the degree extent and scale of the utilization of a particular platform, Bhattacharjee and Raj (2016) concluded that ICTs are valuable assets that have potentials to engage clients of agricultural extension and help to outreach rural communities. Barau and Afrad (2017) indicated that using social media in agricultural extension services enables stakeholders to deliver, interact, and share agricultural knowledge on various topics on farming and issues that facing farming communities. They concluded that social media platforms are becoming popular in terms of agricultural knowledge, which shows users' need and desire for valuable and trusted agricultural information.

Other studies in this field have explored more agricultural subsector topics that interest farmers. For example, Thakur and Chander (2018a, b) found that farmers seek information about crop protection and minimize livestock diseases. Social media agricultural uses have exceeded sharing technical agricultural information to social oriented information. Browning and Herrick (2014) found that social media platforms are useful tools for food marketing, and promoting social initiatives. Bhattacharjee and Raj (2016) stated that social media are being used to launch awareness campaigns and promote workshops and training programs.

Although studied social media platforms have significant positive relationships with follower perceived impact on agricultural knowledge, the values of these relationship are relatively low. This brought a question to discussion, what issues could agricultural extension via social media has that affect the followers' knowledge. In fact, there are many studies have dive into this question. The quality of information being shared (Thakur and Chander, 2018a, b), the relevancy of information ([Raj and Bhattacharjee, 2013; Lubell and McRoberts, 2018], lack of consistent efforts to use ICTs from extension systems (Mamgain et al., 2020; Bhattacharjee and Raj, 2016) are some factors that may affect knowledge transfer. Also, (Mamgain et al., 2020) suggested that stakeholder should shift their perceptions regarding social media from time-wasting applications to tools that help learning and exchanging new information and ideas. Similarly, Ćirić et al. (2018) maintains that the degree of openness for modern technologies may help farmers to access information, learn new knowledge and solve problems. Many studies have established that social media promote agricultural knowledge, offer solutions to the many issues faced by the farmers and thus make positive impact. A set of technical suggestions were provided from (Thakur and Chander, 2018a) such as easy availability of information in multiple forms, regular learning, multimodal information delivery.

Other suggestions were related to construction of the content and extension services. Barau and Afrad (2017), Typhina et al. (2015) and Lubell et al. (2014) indicated that agricultural extension through social media must follow a more bottom-up model where extension services are provided as a response to farmers' desire and need.

5. Conclusions

- This study shows that social media platforms have a high impact on (fellow farmers) followers' agricultural knowledge regarding local issues such as farming seasons, suitable corps for a region, and temperature. That highlights the importance of localization of agricultural content for each country, state or region. Therefore, professionals providing online extension services should remain focused on and adhered to content on local issues during their discussions.
- The newest social media platforms (Twitter, Instagram and Snapchat) have correlations with the perceived impact on knowledge on agricultural aspects including soil-plant relationship. That shows that farmers are using platforms that provide brief but readily available information in the forms of text, pictures, or videos. It can be concluded that providing brief information in different forms more effectively enhance the agricultural knowledge of the users.
- This finding of this study is in line with the different studies on that farmers are depending on Twitter and Youtube to obtain agricultural knowledge more than other platforms like Facebook. This result could help professionals who work in extension and accounts that provide content related to agriculture in designing and implementing online extension programs.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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