Citrus Farmers Adoption of Sustainable Agriculture Practices and Its Determinants in the Jordan Valley: The Case of Northern Ghor

Safaa Alwedyan¹ & Aymen Taani²

¹ Freelancer
² Department of Applied Geography, Faculty of Arts and Humanities, The University of AL al – Bayt, Jordan
Correspondence: S, Alwedyan, Freelancer. E-mail: Saffa.alwidyan@yahoo.com

Received: October 5, 2020      Accepted: November 28, 2020      Online Published: December 1, 2020
doi:10.5539/jsd.v14n1p36                  URL: https://doi.org/10.5539/jsd.v14n1p36

Abstract
The adoption of sustainable agricultural practices is widely recognized as essential to ensure agricultural sustainability. This study analyzed factors influencing citrus farmers adoption of sustainable agricultural practices (SAPs) in the Northern Ghor of Jordan valley. The study used a quantitative approach. Simple random sampling was adopted to select 115 farmers in the study area. The study found that the largest proportion 44.4% of the citrus farmers had a fairly high adoption rate of SAPs while 13.0% of ones had high adoption of SAPs. In addition, the study revealed that age was the significant variable that positively influences farmers SAPs adoption, while experience, primary education, and tertiary education have a negative influence on the adoption of SAPs. The study recommends that special attention be given to older farmers to exploit their skills and receptive to implementing SAPs, encourage and guide farmers toward implementing sustainable agriculture techniques and suitable inputs by providing premium and incentive payments to them, and take deterrent penalties against farmers who using inappropriate and harmful applications, or who do not use appropriate applications.

Keywords: adoption, sustainable agricultural practices, citrus farmer, Jordan valley

1. Introduction
The effects of the "Green Revolution" technology on the environment and the issue of sustainability of agricultural growth received attention by many researchers (Nelson et al, 2019; Rahman, 2015; Singh, 2000; Redclift, 1989; and Bowonder, 1979). Nelson et al, 2019 (2019) believed the green revolution technologies led to the decline production of some food crops such as indigenous rice varieties and millets of India. Rahman (2015) linked the over adoption of the agricultural technologies by the farmers to make the Green Revolution effective in India and the degradation of the agro-ecosystem. Singh (2000) considered the widespread adoption of green revolution technologies to be the main cause of significant soil degradation in the Haryana state of India. Redclift (1989) links the problem of environmental degradation to agricultural modernization processes in rural areas of Latin America. Bowonder (1979) in his analysis of the impact of the green revolution in India concluded that increased use of high-yielding variety technology and chemical fertilizers have some indirect effects, including faster depletion of micronutrients.

Anxiety about the negative effect of conventional agriculture and its practices to human health and the environment and natural resources has prompted to development and diffusion of a new pattern of agriculture called sustainable agriculture (Bese et al., 2020), and improving agricultural sustainability has become an important goal country strive to achieve (Brodt et al., 2011; FAO, 2002).

Sustainable agriculture is at the core of the 2030 Agenda and first essential stage to securing zero hunger, where many of the SDGs address issues related to agriculture, especially SDG indicator (2.4.1) which is totally dedicated to it. This indicator defined as the “proportion of agricultural area under productive and sustainable agriculture” (FAO, 2015).

Sustainable agriculture has been identified as the best approach that not only makes to better utilize of natural goods and services for human needs without harming the environment but also reduces the utilize of external inputs; where sustainable agriculture minimize the cost of purchasing inputs by employing farming techniques such as natural biological cycles and farmers skills and knowledge (Shiri et al., 2012; Lubell et al., 2011). It also allows for small farms to keep operating through variegation and increased gains and profits from alternative
methods of marketing, like value-added products, niche markets, or direct marketing strategies (Kheiri, 2015). Sustainable agriculture practically does not mean a return and imply to pre-industrial practices and the repudiation of new techniques. On the contrary, sustainable agriculture must surpass this dichotomous idea and operate just from the fixed principles of sustainability (Adnan et al., 2018). The resulting technologies may reflect a mixture of traditional and new techniques. Hence, it can be said that sustainable agriculture is a trend, not a destination (Khwidzhili and Worth, 2016).

Sustainable agriculture contains a dynamic group of sustainable agricultural practices (SAPs). SAPs that are considered suitable for a specific area might be unsuitable to other areas due to the difference in circumstances (Tey et al., 2012). In another meaning, sustainable agriculture cannot be reduced to one defined group of practices (Pretty and Hine, 2000).

The Jordan Valley population is 494,162. The domestic people of this area were known in the early nineteenth century as Al Ghawarna or Ghorani (sense people of Al Ghor).

In the Jordan Valley, there is a small group of wealthy agriculture who own large landholdings, but also there is a large group of farmers who live close to the poverty line of JD 32.6 per person per month (Kool, 2016). Today, agriculture still dominates the socio-economic reality of the Jordan Valley. Fruit trees, field crops, and vegetables are the major crops in the Jordan Valley (Philippe, 2003). However, the weakness of the farmers knowledge, experience, and capabilities were the main factors affecting the cultivation management practices in the Jordan Valley and farmers resort to using many several unsustainable cultivation techniques and bad cultivation habits. Such weakness has been reflected in several environmental problems related to fertilizer applications and irrigations such as salinity buildup, deterioration of groundwater through leaching of overflow fertilizers, and loss of water through inappropriate network designing and operations (Al-Qinna and Salahat, 2017). Also, the weak linkage between production and consumption quantities leads to lower and fluctuating product prices. Hence, meliorating production and consumption practices toward sustainable agriculture has been considered as a new strategy to solve and address above mentioned problems in the Jordan Valley of Jordan especially in Northern Ghor of Jordan Valley.

One of the major goals for the Jordanian environmental sustainable development is to increase the awareness and realization of farmers on the issues of water savings and environmental and resource protection on the farm (MoEnv, 2009). Although Jordan government has been having efforts in promoting sustainable agriculture practices (UNDP, 2010), related research on Jordan Valley on the extent to which farmers have applied SAPs and the factors that influence farmers adoption of SAPs has been scarce.

The paper, therefore, makes a practical contribution to address the gap in the literature and helps policymakers to put better Strategies and extension programs for the Jordan Valley. The current study was carried as a case study on citrus farmers due to citrus is the main crop in Northern Ghor of Jordan Valley. The objectives of the study were to measure citrus farmers SAPs and determine the factors influencing citrus farmers adoption of SAPs in Northern Ghor of Jordan Valley.

2. Theoretical Frameworks and Literature Review

Sustainable agriculture has been defined as an integrated system of plant and animal production practices, and has an impact on the dimensions of environmental soundness, economic viability, and socio-institutional acceptance (Mishra et al., 2018; Kambewa, 2007; Zhen et al., 2005). This integrated system is qualified for transitioning agriculture into an environmentally-friendly system with maintaining its productivity and competitiveness. (Kassie et al., 2013; Zeweld et al., 2018).

Sustainable agriculture and the adoption of its practices have several long and short-term benefits. In the long run, the adoption of SAPs can reduce external inputs added to increase agricultural output or production (Pretty, 2008; Kornegay et al., 2010). In environmental terms, SAPs help to maintain the water table, increase carbon sequestration, improve soil fertility, and protect the land from erosion reducing sediments load from agricultural lands, as well as achieving socioeconomic and economic welfare, along with the quality of life (Pretty, 2008). Also, there are some negative influences associated with agriculture sustainable practices, such as conservation tillage, which is seen as a controversial issue because it replaces tillage with the great use of pesticides and herbicides (Derksen et al., 1996).

In order for agricultural practices to be sustainable, they must be applied through locally available resources, based on farmers experience and knowledge, or through the use of external inputs that do not cause great harm to the environment (Zeweld et al., 2018). In other words, ensuring sustainability in agriculture requires the integration of SAPs, so that they do not exclude external inputs, but rather encourage the selective application of external
inputs and their integration them to complement local resources (OECD, 2001).

Sustainable agriculture is characterized by its adoption of productive, competitive and effective practices, while at the same time preserving and improving the environment and the entire global ecosystem, in addition to improving the social and economic conditions of local communities (Zaharia, 2010). Therefore, sustainable farming practices require an understanding of the utility of environmental and agricultural management to transform the farming system towards a natural system without reducing productivity (Pretty, 2008). An important point is necessary to remember that sustainability is a concept and not a specific set of practices (Derksen et al., 1996).

Adoption of SAP can be used as a way to understand the progress of sustainable agriculture. In general, there is a difficulty in determining the rate of adoption of SAPs based on observation. Therefore, this insight can be obtained using agricultural surveys, census sets, and syntheses of ground-level information (Tey et al., 2012). Rural sociologists were the pioneers in studies of sustainable farming practices during the early 1940's and late 1950's, as well as contributions from other economists and researchers thereafter (Mishra et al., 2018). Part of the information was gathered from several studies in many countries around the world. The information collected mostly represents SAPs (eg conservation tillage, cover crops, irrigation use, etc.).

Gan et al (2015) have conducted a study on crop rotation with legumes and found that diversifying cropping systems with pulse crops can enhance soil water conservation, improve soil nitrogen (N) availability, and increase system productivity. This is similar to a study Rueda et al (2007) whose compared the effects of three tillage systems and three crop rotation on soil Physico-chemical properties, soil organic carbon (SOC) and N, and was shown that reduced tillage process with appropriate crop rotation could increase the viability of land agriculture in Mediterranean soils.

With regards to cover crops that are planted between main crops, farmers have often used these crops to protect the soil from erosion and prevent loss of nutrients in deep layers through leaching and surface runoff (Sharma et al., 2018). Among the studies related to the effects of cover crops on the soil health and management, Samuel and Nkongolob (2015) study which showed a significant positive effect of cover crop on the physical and biological properties of the selected soil, such as a decrease in soil bulk density in cover crop plots as compared with no-cover crop plots, decrease in the carbon to nitrogen (C/N) ratio with increasing sampling depth and increase in the C/N ratio in no-cover crop plots as compared with cover crop plots.

Nitrogen (N) is applied to agricultural land to increase crop yield and quality. Misselbrook et al (2016) explained Under-application of (N) fertilizer will result in reduced crop yields, soil carbon and profit, and will lead to (N) mining of the soil. Conversely, in the case of Over-application of (N) fertilizer, this can also lead to reduced crop yields and profits, and in surplus available soil (N). Thus, applying at a ratio to match crop needs at an economic and sustainable level is therefore desirable.

Several studies have examined SAPs associated with the harvesting process. Alhassan (2015) cared about the effect of harvest time and storage duration on the Physico-chemical properties of citrus, specifically on vitamin (C) content, which appeared to increase with duration of storage. While Lado et al. (2014) discussed citrus fruit commercial maturity indices which are part of quality fruit standards worldwide. They identified Coloration, soluble solids, acidity, and juice content as parameters for harvest decision.

2.1 Factors Influencing SAPs Adoptions

Factors that contribute to the variance of adoptive decisions across farmers can be ascribed to three groups (1) Farmer and household factors, (2) Biophysical factors, (3) Exogenous factors.

Socio-economic factors refer to the main decision-maker/ farmer). Among the socio-economic factors, educational attainment was mentioned as a clear discrimination in the adoption of SAPs. It is suggested that a farmer with a higher education is more likely to adopt SAPs. With increased knowledge, a farmer becomes less risk averse when evaluating SAPs, and more willing to accept innovation that requires a change in farm operation. Several studies have found that farmers education tends to positively influence their decision to adopt SAPs (D’Souza & Gebremedhin 2019; Thanha & Yapwattananphu, 2015; Ngombe et al., 2014; Teklewold et al., 2013) while a study of Clay et al. (1998) and D’Emden et al. (2006) did not find an influence of education levels on the adoption of SAPs. Another factor is the age of the farmers. Although there is agreement about the influence of age on the adoption and use of sustainable practices, there are disagreements as to which age group is most likely to adopt new agricultural practices. Empirical evidence from studies by (Bese et al., 2020; Cheteni et al., 2014) shows that the elderly were more open to adopting new agricultural technologies and practices than the youth. On the contrary, (Filho, 2018; Kassie et al. 2012) noted that the elderly were hesitant to change. Other important characteristics may include gender, marital status, farming experience, cost of labour, and off-farm employment (Rajendran, et
Agro-ecological factors refer to the biophysical characteristics of a farm. Land tenure was mentioned as a decisive factor in the adoption of SAPs. Since the renewal of a farm lease is subject to review every year, the inability to obtain it will force the farmer to end agricultural activities on that land (Rajendran, et al., 2016). In another sense, farmers will be less likely to adopt SAPs due to the uncertainty of future farming activities on the leased land. Kassie et al. (2009) and Tenge et al. (2004) study supported this interpretation. While Mad et al. (2010) refuted it. Another influencing factor in the adoption of SAPs is farm size. Farmers with larger sized farms have more flexibility in decision-making and thus have greater ability to allocate resources. Hall et al. (2009) found that there is an important and positive relationship to the adoption of SAPs among floriculture farmers with a farm size of 1–5 acres, but not with else land sizes. Other agro-ecological factors have a significant role in a farmer’s decision-making processes, such as farm structure, distance to market, land location, slope of plot and soil quality (Rajendran, et al., 2016; Kassie et al., 2013; D’Emden et al., 2008; Arellanes & Lee, 2003).

It was recognized that exogenous factors have an important influence on the adoption and use of SAPs and in the success of changing farmers' behavior. Among other factors, the information factor was mentioned as discrimination in the adoption of SAPs that relate to the distribution of relevant messages and knowledge to farmers. Access to information is key to adoption; This information may come from one or more sources, such as extension services, social associations, and training/workshops (Pannell et al., 2006). The many services provided by extension agents are essential to motivate farmers to innovate and guide them in their implementation, especially in developing rural agriculture in underdeveloped economies due to the high rates of poverty and illiteracy there. Rojas et al. (2020), Timprasert et al. (2014), and Kassie et al. (2013) revealed a clear positive association between access to and/or visits to extension agents and adoption of SAPs. Many studies detect that creating farmer networks, participation in training courses are influential factors in the adoption of SAPs (Kassie et al., 2013; Timprasert et al., 2014). For example, Zegeye & Haileye (2001) discovered that participation in training courses contributed positively to farmers’ decision to adopt SAPs. Another influencer factor is the access to loans to purchase farm implements required for the adoption of some SAPs. Ng’ombe et al. (2014) indicate that farm households that were able to acquire loans were more likely to adopt conservation farming. Other exogenous factors have a significant role in the adoption of SAPs, like participation of women, sponsorship/funding, and public/private sector involvement (Rajendran, et al., 2016; Ng’ombe et al., 2014).

In summary, the relevant literature indicates that the adoption of SAPs is affected by several farmer and household factors, biophysical factors, and exogenous factors, not only in the Jordan but everywhere in the world. Also, factors that affect the adoption of SAPs are not consistent everywhere in the world, in the sense that one variable that shows to be statistically significant in one location with a positive sign may not necessarily be statistically significant and possess the same direction in other locations (Mishra et al., 2018).

3. Research Methodology

3.1 Study Area

The Northern Ghor represents the area that lies below the Yarmouk River through the village of North Shounah and Addasiya to the village of Kreymeh, it is administratively affiliated to Irbid Governorate in the name of AL Aghwar AL Shamalyyah (Fig. 1). It is associated with nonsaline soils of deep, medium to fine-textured Camborthids and Calciorthids of a moderate slope. The existing water resources of Northern Ghor are from the Yarmouk River, Wadi Arab dam, Wadi Jurum, Ziglab dam, and Wadi Yabis (Al-Qinna & Salahat, 2017).
The area of agricultural land in the Northern Ghor which is part of the Jordan Valley is distributed over 182,000 dunums; 135,000 irrigated areas, of which 63,000 dunums of citrus, approximately 2,100 agricultural units, most of it is concentrated in the extreme north of the Valley, the produced quantities provide approximately about 82% of Jordan's citrus needs (Fig. 2).

The land in the Northern Ghor has been cultivated since the early twentieth century thanks to wells and water from the Yarmouk River. In this period, vegetables and bananas were the main agricultural patterns, and citrus, pomegranate trees, and cereals were cultivated but in smaller areas. The construction of the first part of the King Abdullah Canal at the end of the fifties and early sixties had a major role in modified the land reclamation, where areas planted with vegetables have speedily been planted with citrus. Then during the seventies, bananas trees have been substituted by citrus, and during the eighties anew agricultural patterns appeared but stayed limited because farmers consider the market is better for citrus products than for other patterns of agricultural products (Mourad et al., 2010; Philippe, 2003). According to the Directorate of Agriculture of the Northern Jordan Valley, the main types of citrus that farmers produce currently are oranges, mandarins, citrus, and grapefruit.
3.2 Research Approach

The study employed the quantitative approach. This approach was used because of its advantage in providing a numerical description of the studied phenomenon. In addition to being useful in measuring relationships and its strength between two variables (Apuke, 2017). Both primary and secondary data were gathered, the most important secondary data is the data of the Directorate of Agriculture of the Northern Jordan Valley that was used to identify the location, location, and phone numbers of citrus farmers in the study area. In addition to data from journals, documents, proceedings. Primary data were gained using a structured questionnaire. 115 random respondents were selected in the research area during the period of February- July 2020. The selection of sample farmers was based on the readiness of each farmer to participate in the interview. This was achieved with the close assistance of some staff from the Directorate of Agriculture of the Northern Jordan Valley who participated the researchers in some farms visits. In conducting the study, standard ethical considerations were observed, which guarantee obtaining consent; where farmers gave oral consent to participate in the interview after they heard a summarized explanation of the study's objective. In addition to ensuring confidentiality.

3.3 Data and Descriptive Statistics

Definitions and summary statistics of the variables used in the analysis are presented in Table 1. Twenty-three SAPs, which were applied in the study of Tathdil et al (2008); Thanh et al (2015); And Mishra et al (2018) are considered in this study. The adoption of a sustainable agricultural practice received a score of 1 while non-adoption received a score of 0. Besides, the study considered farmer and farm characteristics; these include variables sex of farmer, age of farmer, marital status of farmer, education level of farmer, farm experience, labor availability, employment, farm income, farm production, farm size, and land tenure. The exogenous factors include variables access to extension services, access to loan, farmer group membership, distance to input market, and Source of information.

Figure 2. The three parts of Jordan Valley with corresponding crops and water resources
Source: (Al-Qinna & Salahat, 2017).

Definitions and summary statistics of the variables used in the analysis are presented in Table 1. Twenty-three SAPs, which were applied in the study of Tathdil et al (2008); Thanh et al (2015); And Mishra et al (2018) are considered in this study. The adoption of a sustainable agricultural practice received a score of 1 while non-adoption received a score of 0. Besides, the study considered farmer and farm characteristics; these include variables sex of farmer, age of farmer, marital status of farmer, education level of farmer, farm experience, labor availability, employment, farm income, farm production, farm size, and land tenure. The exogenous factors include variables access to extension services, access to loan, farmer group membership, distance to input market, and Source of information.
| Variable name | Variables: definition and codes | Mean   | Std. Dev. |
|---------------|--------------------------------|--------|-----------|
| **Dependent variables** | Adoptions of SAPs | SAPs adoption (=1 if farmer adopted SAPs; 0 otherwise) (min. = 6, max. = 14) | 10.6783 | 1.71959 |
| **Independent variables** | Sex of farmer | Sex of farmer (=1 if male; 0 otherwise) | 1.00 | .000 |
| | Age of farmer | Age of farmer (years) | 56.44 | 13.860 |
| | Marital status of farmer | Marital status of farmer (=1 if single; 0 otherwise) | .04 | .205 |
| | Education level of farmer | | |
| | No education | No education (=1 if attended; 0 otherwise) | .00 | .000 |
| | primary education | Primary education (=1 if attended; 0 otherwise) | .14 | .348 |
| | Basic education | Basic education (=1 if attended; 0 otherwise) | .37 | .486 |
| | Secondary education | Secondary education (=1 if attended; 0 otherwise) | .30 | .462 |
| | Tertiary education | Tertiary education (=1 if attended; 0 otherwise) | .18 | .388 |
| | Farm experience | Farm experience (years) | 26.48 | 9.889 |
| | Labour availability | Labour availability (=1 farmer used hired labour; 0 otherwise) | .90 | .295 |
| | Employment | Employment (=1 if farmer work more than 200 days on the farm; 0 otherwise) | .86 | .348 |
| | Farm income | Farm income (=1 if high income; 0 otherwise) | .37 | .486 |
| | Farm production | Farm production (ton/dunum) | 2.7783 | .42505 |
| | Farm size | Farm size (dunum) | 28.26 | 10.337 |
| | Land tenure | Land tenure status (=1 if owned; 0 otherwise) | .54 | .501 |
| **Exogenous factors** | Access to extension services | Access to extension services (=1 if yes; 0 otherwise) | .79 | .408 |
| | Access to loan | Access to loans (=1 if yes; 0 otherwise) | .10 | .307 |
| | Farmer group membership | Belong to farmer group (yes=1, 0 otherwise) | .03 | .184 |
| | Distance to input market | Distance to input market (km) | 7.13 | 3.631 |
| | Source of information | | |
| | Reading newspaper | Reading newspaper (=1 if several time a month; 0 otherwise) | .00 | .000 |
| | Listening to the radio | Listening to the radio (=1 if at least 5 h a week; 0 otherwise) | .02 | .131 |
| radio otherwise) | watching TV (=1 if at least 5 h a week; 0 otherwise) | .01 | .093 |
|------------------|----------------------------------------------------|-----|------|
| Participation in farming events | Participation in farming events (=1 if yes; 0 otherwise) | .12 | .328 |

Source: Field survey, 2020

3.4 Data Analysis

After data gathering and editing, the analysis was performed by SPSS 23 software. Descriptive statistics such as frequencies, percentage, mean and standard deviations, and multiple regression were used to analyse the data.

Based on the collective adoption score, the farmers were categorized in four groups according to SAPs adopting (low, fairly low, fairly high, and high), these groups were defined by mean and standard deviation as follows: A = Low: \( A \leq \text{Mean} - \text{SD} \); B = Fairly low: Mean - SD < B \leq \text{Mean}; C = Fairly high: Mean < C \leq \text{Mean} + SD; D = High: Mean + SD < D \leq \text{Max}.

4. Result and Discussion

4.1 Characteristics of the Citrus Farmers

Socio-economic characteristics information of the citrus farmers which includes gender, age, marital status, educational qualifications, land tenure, farm experience, and employment status of farmers were collected. This information was pertinent because it helped the authors to obtain some insights into the background of the farmers.

The results showed that all the farmers who participated in the study were male; their ages ranged from 23 to 83 and the mean age was 56.4 years. The majority of farmers were married with a percentage of 95.7%, while the percentage of singles 4.3%. As far as the educational qualification is concerned, no illiterate farmers found, and 37.4% of farmers belonged to basic education; 13.9% of farmers to primary education; 30.4% to secondary education and 18.3% to tertiary education. As far as farmers experience in farming activities is concerned, farm experience ranged from 5 to 45 and the mean was 26.4 years. The results also showed information on farmers employment, where 86.1% of farmers work more than 200 days on the farm.

4.2 The Measurement of Citrus SAPs

Table 2 displays the classification of citrus farmers in according to the levels adoption of SPAs. As shown that only 13.0% of the farmers ranked in high adoption group of SAPs, while most farmers placed in fairly high group 44.4%, fairly low group 30.4%, and the low group only got 12.2% in terms of the adoption of SAPs.

| Groups       | Frequency | Percent | Cumulative percent |
|--------------|-----------|---------|--------------------|
| Low          | 14        | 12.2    | 12.2               |
| Fairly low   | 35        | 30.4    | 42.6               |
| Fairly high  | 51        | 44.4    | 87                 |
| High         | 15        | 13.0    | 100                |

Total 115 100

Source: Field survey, 2020

Figure 3 shows the importance given by the citrus farmers to each of the selected SAPs. The result displayed the practices having a high rate of adoption were linked to pre-harvest and post-harvest phases, such as using irrigation that guarantees maximum efficiency of water, carefully prune and dispose of deadwood, fruit harvest when ripen, and transport fruits as quickly as possible after harvest to the final destination. Even the practices applied at a low rate or not applied were also related to pre-harvest and post-harvest phases, such as chemical analysis of the soil, mulches and cover crop for weed and pest control, and product label establishment.

In terms of irrigation network design and installation appropriateness and the investigated irrigation efficiency, most of the tree farms are appropriate, where the farmers irrigate their trees using open pipe network (GR 16mm) to fill mature single tree basin, and dripper Pipes (GR 16mm) to fill newly Planted trees basin. Farmers are forced
to improve irrigation efficiency; since water availability is limited and is controlled by the water user association that determines the schedule of each farm. Therefore, most farmers created lagoons (circular on-farm storage) with varying sizes. Moreover, most farmers watering trees during evening periods to reduce evaporation from the tree basins or evaporation from the lagoon itself. Besides, most respondents used high yielding varieties with longer shelf life, are cultivated in nurseries Northern Ghor. Also, farmers use indigenous knowledge in agricultural practices.

Results showed that most farmers (93%) harvesting mature fruits. Immature fruits have low quality because of high water loss and mechanical damage. The maturity of fruits is an excellent condition for consumption (Rahman, 2007). In terms of the uses of inputs, about 87.8% of citrus farmers used organic fertilizer. Fertilizers particularly organic fertilizers are used to recover soil fertility and prevent land degradation when the nutrient supply of soil is insufficient (Thanh & Yapwattanaphun, 2015). Citrus farmers in the study area prefer to use organic fertilizers because they are lower in price compared to inorganic fertilizers since the region is famous for raising livestock.

Also, about 86.1% of citrus farmer implementation the conservation tillage especially reduced tillage system; where the number of tillage process is reduced by either elimination of one or more tillage process from the conventional tillage program (Khursheed et al., 2019). The narrow distance between the trees is one of the major motivations to implementation the conservation tillage.

Biological control is an effective and environmentally friendly way in dominant insect pests and diseases through the work of natural control agents (Sanda and Sunusi, 2016) However, no one of the farmers in the study area used such a technique. On the contrary, we find that around 81.7% of farmers depend on using chemical pesticides.

Regarding the mulches for weed control, no citrus farmers applied this technique. Mulches are fundamental to alleviate soil erosion and improve the water-holding capacity, maintain moisture in the soil facilitating infiltration, and reduce weed growth (Patil et al., 2013). Besides, no citrus farmers applied the cover crop technique for pest control. Farmers have often used these crops to conserve the soil from erosion and prevent loss of nutrients in deep layers out of leaching and surface runoff, which means they reduce the need for chemical inputs such as fertilizers herbicides and insecticides (Sharma et al., 2018; Shakiru et al., 2018).

To expand the consumption market and improve product prices, it is necessary to quality check products every year, where this technique plays a significant role in improving consumers perception and belief about products and improving product prices at the same time. None the less, no farmers applied this technique. Even register product labels that have the same role did not obtain the attention of farmers.

Finally, the popular trend in agricultural production is presently collaboration between farmers and enterprises in product consumption through contracts that help farmers to achieve more gains and profits through value-adding and decrease price fluctuation in the market (Thanh & Yapwattanaphun, 2015). However, the result displayed that no contracts were carried out in selling products between farmers and enterprises. To prevent contamination and spoilage of the produce, fresh equipment and materials should be used to harvest the fruits (Rahman, 2007). Nevertheless, the rate of farmers adopted this technique was not high.
4.3 Factors Influencing Citrus Farmers SAPs Adoption

To determine the factors influencing citrus farmers SAPs adoption, a regression analysis (the Multiple Regression Model) with enter method was conducted. The regression model integrated all of the explanatory variables which had significant correlations with the SAPs adoption. The citrus farmers adoption towards selected SAPs index, which was specified according to their scores gained from the statements associated with 23 selected practices was considered as a dependent variable.

There were 23 explanatory variables, described in the research methodology section entered in the model, of which...
only 4 variables had a statistically significant influence at the 5% level on citrus farmers SAPs adoption. As revealed in Table 3, the partial regression coefficient of the age of farmer was found to have a positive influence, while farm experience, primary education, and tertiary education were found to have a negative influence on citrus farmers SAPs adoption. The R2 value for the model equals 0.232 indicating that 23.2% of the variation in the farmers adoption could be explained by these 4 variables.

Table 4. Results of multiple regression analysis

| Variables                        | B     | Beta  | T-Statistics | P-value |
|----------------------------------|-------|-------|--------------|---------|
| (Constant)                       | 12.266| 7.311 | .000         |         |
| Age of farmer                    | 0.041**| .332  | 2.021        | .046    |
| Marital status of farmer         | 0.387 | .046  | .421         | .675    |
| primary education                | -1.315**| -.266-| -2.387-      | .019    |
| Secondary education              | -.613-| -.165-| -1.430-      | .156    |
| Tertiary education               | -1.399**| -.316-| -2.338-      | .021    |
| Farm experience                  | -.063-*| -.363-*| -2.151-      | .034    |
| Labour availability              | -.842-| -.182-| -1.602-      | .112    |
| Farm income                      | 0.246 | .069  | .653         | .516    |
| Farm production                  | -.065-| -.016-| -1.444-      | .885    |
| Farm size                        | 0.008 | .051  | .485         | .629    |
| Land tenure                      | 0.202 | .059  | .579         | .564    |
| Access to extension services     | 0.184 | .044  | .455         | .650    |
| Access to loan                   | -.448-| -.080-| -.777-       | .439    |
| farmer group membership          | -1.084-| -.116-| -1.019-      | .311    |
| Distance to input market         | -.040-| -.085-| -.871-       | .386    |
| Listening to the radio           | 0.486 | .037  | .373         | .710    |
| Watching TV                      | -2.908-| -.158-| -1.682-      | .596    |
| Participation in farming events  | 0.248 | .047  | .502         | .617    |

N = 115; F= 1.514; R²=.232

***significance at 1% level; **significance at 5% level; * significance at 10% level.

The most significant variable which influences farmers SAPs adoption was age with β = 0.332. This means one standard deviation increase in the age increase the adoption of SAPs by 0.046 standard deviations. This results tallies with Cheteni et al., (2014) who explained that old people were more receptive and open to adopting new farming techniques.

Surprisingly, experience has a negative influence on the adoption of SAPs. Where β of experience was -.363. Results indicate that farmers who have long experience are generally less likely to adopt SAPs. It makes sense that the long experience would increase adoption of SAPs since it should enable farmers to improve their stock of farming knowledge, through leveraging on years of “learning by doing”; where more experienced farmers are possessed better knowledge of farming practices that could help improve yield and income earnings. However, though contrary to the findings of other studies, such as the study of Adeola (2010), the result in this study may be significant and bear other explanations. The plausible explanation that farmers who spent a long time in agricultural work are accustomed to traditional agricultural practices. This finding corroborates with the results of a study by Oladimeji et al. (2020).

Besides, primary education and tertiary education were other important factors negatively influencing farmers SAPs adoption with β = -0.266 and β =-0.316, respectively. For every standard deviation change in primary education and tertiary education farmers SAPs adoption decreases by 0.266 and 0.316 standard deviation,
respectively. In another meaning, farmers who had attended primary education and tertiary education were less likely to SAPs adoption and the variable was statically significant at 5%, p = 0.019 and p = 0.021 respectively.

5. Conclusion and Recommendations

This study examined factors influencing the intensity of the SAPs adoption among citrus farmers in Northern Ghor by using regression analysis. Twenty-three variables representing farmer factors, Biophysical factors, and exogenous factors were used in the analysis.

The study pointed out that the largest proportion 44.4% of the citrus farmers was of fairly high adoption group of SAPs while 13.0% of ones belonged to the high adoption group of SAPs. The result displayed practices that had high average of adoption were related to pre-harvest and post-harvest phases, such as using irrigation that guarantees maximum efficiency of water, carefully prune and dispose of deadwood, fruit harvest when ripen, and transport fruits as quickly as possible after harvest to the final destination, even practices applied at a low average or not applied were also related to pre-harvest and post-harvest phases, such as chemical analysis of the soil, mulches and cover crop for weed and pest control, and product label establishment. In addition, the result of the regression analysis showed that 4 variables affecting farmers SAPs adoption. These variables were the age of farmer, farm experience, primary education, and tertiary education. These variables explained 23.2% of the variation of farmers SAPs adoption. The age of farmer was the most positive influence variable on farmers SAPs adoption.

The study recommends that efforts to consolidate citrus farmers SAPs adoption in Northern Ghor should be focus on environmental and economic benefits and give special attention to older farmers to exploit their skills and receptive to implementing SAPs. In addition, the government can encourage and guide farmers in implementing sustainable agriculture techniques and suitable inputs by providing premium and incentive payments to them. Moreover, the government should take deterrent penalties against farmers who using inappropriate and harmful applications such as using excessive chemicals pesticides and fertilizers, or who do not use appropriate applications such as not properly ravage of defective fruit. Finally, it can be said that the study investigated the effect of set selected variables in farmers SAPs adoption, did not address other important variables that could have an impact on adoption. Hence, further research must be conducted to find the variables most related to SAPs adoption for Northern Ghor citrus farmers.

Acknowledgements

Deep gratitude is expressed by the authors to Dr. Mwafak Abu Sahyoun, Director, Directorate of Agriculture of the Northern Jordan Valley, Jordan for his valuable guidance and also for providing information and facilities to carry out the study. The authors are indebted to Mohammed Al-Hourani, Director, Director of Information and Marketing Department and Khalil Mansi, warehouse warden, Directorate of Agriculture of the Northern Jordan Valley for participation the researchers in some farms visits. We would also like to show our gratitude to farmers for their support and cooperation during the field survey.

References

Adeola, R. (2010). Influence of Socio-Economic Factors on the Adoption of Soil Conservation Measures in Ibadan/Ibarapa Agricultural Zone of Oyo State. Report and Opinion, 2(7), 42-47.

Adnan, N., Nordin, S. M., Rahman, I., & Noor. A. (2018). The Effects of Knowledge Transfer on Farmers Decision Making Toward Sustainable Agriculture Practices: in View of Green Fertilizer Technology. World Journal of Science, Technology and Sustainable Development, 15(1), 98–115. https://doi.org/10.1108/WJSTSD-11-2016-0062

Alhassan, A. F., Mohammed, S., & Appiah, F. (2015). Harvesting Time and Storage Duration on the Physico-chemical Properties of the Citrus Fruits (Citrus sinensis var. late Valencia). UDS International Journal of Development [UDSJID], 2(2), 37-46.

Al-Qinna, M., & Salahat., M. (2017). Investigating Agricultural Management Practices and Environmental Sustainability in Jordan. Journal of Environmental Sustainability, 5(1),1-18.

Apule, O. (2017). Quantitative Research Methods: A Synopsis Approach. Arabian Journal of Business and Management Review (Kuwait Chapter), 6(10), 40-47. https://doi.org/10.12816/0040336

Arellanes, P., & Lee, D. R. (2003). The determinants of adoption of sustainable agriculture technologies, in: Paper presented at XXV conference of International Association of Agricultural Economists, Durban, South Africa, August.

Bese, D., Zwane, E., & Cheteni, P. (2020). The Use of Sustainable Agricultural Methods Amongst Smallholder
Farmers in the Eastern Cape Province, South Africa. *African Journal of Science, Technology, Innovation and Development, 12*(4), 1-11. https://doi.org/10.1080/20421338.2020.1724388

Bowonder, B. (1979). Impact Analysis of the Green Revolution in India. *Technological Forecasting and Social Change, 15*(4), 297–313. https://doi.org/10.1016/0040-1625(79)90023-4

Brodt, S., Six, J., Feenstra, G., Ingels, C., & Campbell, D. (2011). Sustainable Agriculture. *Nature Education Knowledge, 3*(10), 1.

Cheteni, P., Mushunje, A., & Taruvinga, A. (2014). Barriers and Incentives to Potential Adoption of Biofuels Crops by Smallholder Farmers in the Eastern Cape Province, South Africa. *Environmental Economics*. https://orcid.org/0000-0002-1301-948

Clay, D., Reardon, T., & Kangasniemi, J. (1998). Sustainable Intensification in the Highland Tropics: Rwandan Farmers’ Investments in Land Conservation and Soil Fertility. *Economic Development and Cultural Change, 46*(2), 351-377. https://doi.org/10.1086/452342

D’Souza, G. E., & Gebremedhin, T. G. (Eds.). (2019). *Sustainability in Agricultural and Rural Development*. Espirito Santo: Routledge. https://doi.org/10.4324/9780429437496

D'Emden, F. H., Llewellyn, R. S., & Burton, M. P. (2006). Adoption of Conservation Tillage in Australian Cropping Regions: An Application of Duration Analysis. *Technol. Forecast. Soc. Change, 73*(6), 630-647. https://doi.org/10.1016/j.techfore.2005.07.003

D'Emden, F. H., Llewellyn, R. S., & Burton, M. P. (2008). Factors Influencing Adoption of Conservation Tillage in Australian Cropping Regions. *Aust. J. Agr. Resour. Econ, 52*(2), 169-182. https://doi.org/10.1111/j.1467-8489.2008.00409.x

Derksen, D. A., Blackshaw, R. E., & Boyetchko, S. M. (1996). Sustainability, Conservation Tillage and Weeds in Canada. *Canadian Journal of Plant Science, 76*(4), 651-659. https://doi.org/10.4141/cjps96-115

FAO. (2002). *World Agriculture: Towards 2015/2030*. Rome: Food and Agriculture Organization of the United Nations.

FAO. (2015). *Sustainable Development Goals*. Rome: Food and Agriculture Organization of the United Nations.

Fillo, D. H. M. (2018). *The Adoption of Sustainable Agricultural Technologies: A Case Study in the State of Espírito Santo, Brazil*. Espirito Santo: Routledge. https://doi.org/10.4324/97804294297541

Gan, Y., Hamel, C., O'Donovan, J. T., Cutforth, H., Zentner, R. P., Campbell, C. A., … Poppy, L. (2015). Diversifying crop rotations with pulses enhances system productivity. *Sci Rep.*, 5(14625). https://doi.org/10.1038/srep14625

Hall., T. J., Dennis, J. H., Lopez, R. G., & Marshall, M. L. (2009). Factors Affecting Growers’ Willingness to Adopt Sustainable Floriculture Practices. *Hort Science, 45*(2), 1346–1351.

Kambewa, E. (2007). *Contracting for Sustainability an Analysis of the Lake Victoria-EU Nile Perch Chain*. Wageningen: Wageningen Academic Publishers.

Kassie, M., Jaleta, M., Shiferaw, B. A., Mmbando, F., & De Groote, F. (2012). Improved Maize Technologies and Welfare Outcomes in Smallholder Systems: Evidence from Application of Parametric and Non-parametric Approaches, Conference, August 18-24, 2012, Foz do Iguaçu, Brazil 128004, International Association of Agricultural Economists. https://doi.org/10.22004/ag.econ.128004

Kassie, M., Jaleta, M., Shiferaw, B., Mmbando, F., & Mekuria, M. (2013). Adoption of interrelated sustainable agricultural practices in smallholder systems: Evidence from rural Tanzania. *Technological Forecasting and Social Change, 80*(3), 525-540. https://doi.org/10.1016/j.techfore.2012.08.007

Kassie, M., Zikhali, P., Manjur, K., & Edwards, S. (2009). Adoption of Sustainable Agriculture Practices: Evidence from a Semi-arid Region of Ethiopia. *Nat. Res. Forum, 33*(3), 189-198. https://doi.org/10.1111/j.1477-8947.2009.01224.x

Kheiri, S. (2015). Identifying the Barriers of Sustainable Agriculture Adoption by Wheat Farmers in Takestan, Iran. *International Journal of Agricultural Management and Development (IJAMAD), 5*(3), 158-169. https://doi.org/10.5455/ijamd.175275

Khursheed, S., Simmons, C., Wani, I. S., Ali, T., SK, R., & GR, N. (2019). Conservation Tillage: Impacts on Soil Physical Conditions—an overview. *Advances in Plants & Agriculture Research, 9*(2), 342–346.

Khwidzhili, R. H., & Worth, S. H. (2016). The Sustainable Agriculture Imperative: Implications for South African
Agricultural Extension. *South African Journal of Agricultural Extension, 44*(2), 19–29. https://doi.org/10.17159/2413-3221/2016/v44n2a367

Kool, J. (2016). Sustainable development in the Jordan Valley Final Report of the Regional NGO Master Plan.

Kornegay, J. L., Harwood, R. R., Batie, S. S., Bucks, D., Flora, C. B., Hanson, J., … Willis, P. (2010). *Towards sustainable agriculture system in the 21st century*: National Academies Press, Washington, DC.

Lado, J., Rodrigo, M. J., & Zacarías, L. (2014). Maturity Indicators and Citrus Fruit Quality. *Stewart Postharvest Review, 2*(10), 1-6.

Lubell, M., Hillis, V., & Hoffman, M. (2011). Innovation, Cooperation, and the Perceived Benefits and Costs of Sustainable Agriculture Practices. *The Journal of Ecology and Society, 16*(4), 23. https://doi.org/10.5751/ES-04389-160423

Mad, N. S., Hairuddin, M. A., & Alias, R. (2010). Economic Benefits of Sustainable Agricultural Production: The Case of Integrated Pest Management in Cabbage Production. *Environ. Asia, 3*(1), 168-174. Retrieved from http://tshe.org/ea/ea_jan2010s.html

Mishra, B., Gyawali, B. R., Paudel, K. P., Poudyal, N. C., Simon, M. F., & Antonious, G. (2018). Adoption of Sustainable Agriculture Practices among Farmers in Kentucky, USA. *Environ Manage, 62*(6), 1060-1072. https://doi.org/10.1007/s00267-018-1109-3

Misselbrook, T., Shabtai, B., Claudia, S., Cordovil, R., Roger, B., Olesen, J., & Vallejo, A. (2016). Field Application of Organic and Inorganic Fertilizers. Background Document for the Joint DG ENV & TFRN workshop: Towards joined-up Nitrogen Guidance for Air, Water and Climate Co-benefits. Brussels, October 11th and 12th, 2016.

MoEnv (Ministry of Environment, Jordan). (2009). *Jordan’s Second National Communication to the United Nations Framework Convention on Climate Change (UN-FCCC).* Ministry of Environment, Amman, Jordan.

Mourad, K., Gaese, H., & Jabarin, A. (2010). Economic Value of Tree Fruit Production in Jordan Valley from a Virtual Water Perspective. *Water Resource Manage, 24,* 2021–2034. https://doi.org/10.1007/s11269-009-9536-9

Nelson, A. R. E., Ravichandran, K., & Antony, U. (2019). The impact of the Green Revolution on indigenous crops of India. *Journal of Ethnic Foods, 6*(8). https://doi.org/10.1186/s42779-019-0011-9.

Ngombe, J., Kalinda, T., Tembo, G., & Kuntashula, E. (2014). Econometric Analysis of the Factors That Affect Adoption of Conservation Farming Practices by Smallholder Farmers in Zambia. *Sustainable Development, 7,* 124-138. https://doi.org/10.5539/jsd.v7n4p124

OECD. (2001). *Adoption of Technologies for Sustainable Farming Systems: Wageningen Workshop Proceedings.* Paris: OECD.

Oladimeji, T. E., Oyinbo, O., Hassan, A. A., & Yusuf, O. (2020). Understanding the Interdependence and Temporal Dynamics of Smallholders’ Adoption of Soil Conservation Practices: Evidence from Nigeria. *Sustainability, 12,* 2736. https://doi.org/10.3390/su12072736

Pannell, D. J., Marshall, G. R., Barr, N., Curtis, A., Vanclay, F., & Wilkinson, R. (2006). Adoption of Conservation Practices by Rural Landholders. *Aust. J. Exp. Agric., 46*(11), 1407-1424. https://doi.org/10.1071/EA05037

Patil S. S., Kelkar T. S., & Bhalerao, S. A. (2013). Mulching: A Soil and Water Conservation Practice Research. *Journal of Agriculture and Forestry Science, 1*(3), 26-29.

Pilippe, V. (2003). *Farming Systems in the Jordan River Basin in Jordan: agronomical and economic description.* International Water Management Institute (IWMI), November 2003.

Pretty, J. (2008). Agricultures Sustainability: Concepts, Principles and Evidence. *Philos Trnasactions R Soc B, 363,* 447–465.

Pretty, J., & Hine, R. (2000). The Promising Spread of Sustainable Agriculture in Asia. *Natural Resources Forum, 24*(2), 107-121. https://doi.org/10.1111/j.14778947.2000.tb00936.x

Rahman, M. S. (2007). *Handbook of Food Preservation* (2nd ed.). CRC press, New York.

Rahman, S. (2015) Green Revolution in India: Environmental Degradation and Impact on Livestock. *Asian Journal of Water, Environment and Pollution, 12*(1), 75-80.

Rajendran, N., Tey, Y. S., Brindal, M., Ahmad Sidique, S. F., Shamsudin, M. N., Radam, A., & Abdul Hadi, A. H.
I. (2016). Factors influencing the adoption of bundled sustainable agricultural practices: A systematic literature review. *International Food Research Journal* 23(5), 2271-2279. Retrieved from http://www.ifrj.upm.edu.my/23%20(05)%202016/(59).pdf

Redclift, M. (1989). The Environmental Consequences of Latin America’s Agricultural Development: Some Thoughts on the Brundtland Commission Report. *World Development*, 17(3), 365-377. https://doi.org/10.1016/0305-750X(89)90210-6

Rojas, R. J., Canales, R., Gil, J. M., Engler, A., Ureta, B. B., & Bopp, C. (2020). Technology Adoption and Extension Strategies in Mediterranean Agriculture: The Case of Family Farms in Chile. Agronomy, 10, 692. https://doi.org/10.3390/agronomy10050692

Rueda, I. M., Guerra, L. M., Esteban, E., Tenorio, J. L., & Lucena, L. L. (2007). Tillage and crop rotation effects on barley yield and soil nutrients on a Calciortidic Haploxeralf. *Soil & Tillage Research*, 92, 1–9. https://doi.org/10.1016/j.still.2005.10.006

Samuel, H., & Nsalambi, N. (2015). Cover Crop Management Effects on Soil Physical and Biological Properties. *Procedia Environmental Sciences*, 29, 13-14. https://doi.org/10.1016/j.proenv.2015.07.130

Sanda, N. B., & Sunusi, M. (2016). Fundamentals of Biological Control of Pests. *International Journal of Clinical & Biological Sciences*, (16), 1–11. https://doi.org/10.13140/RG.2.2.19011.20002

Shakiru, M., Boz, I., Muradi, A. J., & Moussa, S. K. (2018). Farmers perception of sustainable agriculture: a case study of Musanze District in Raaanda. *International Journal of Agriculture, Environment and Bio research*, 3(6), 291-312.

Sharma, P., Singh, A., Kahlon, C., Brar, A., Grover, K., Dia, M., & Steiner, R. (2018). The Role of Cover Crops towards Sustainable Soil Health and Agriculture—A Review Paper. *American Journal of Plant Sciences*, 9(9), 1935-1951.

Shiri, N., Motamedinia, Z., Hashemi, S. M. K., & Asadi, A. (2012). Agricultural Researchers’ Attitudes toward Sustainable Agriculture and Its Determinants in Ilam Province, Iran. *Advanced Scientific and Technical Research*, 2(1), 121-137.

Singh, R. B. (2000). Environmental Consequences of Agricultural Development: a case Study from the Green Revolution state of Haryana, India. *Agriculture, Ecosystem and Environment*, 82(1), 97-103. https://doi.org/10.1016/S0167-8809(00)00219-X

Tatlıdil, F., & Boz, I. (2008). Farmers’ perception of sustainable agriculture and its determinants: a case study in Kahramanmaraş province of Turkey. *Environ Dev*, 11, 1091–1106.

Teklewoeld, H., Kassie, M., & Shiferaw, B. (2013). Adoption of Multiple Sustainable Agricultural Practices in Rural Ethiopia. *Agricultural Economics*, 64, 597-623. https://doi.org/10.1111/1477-9552.12011

Tenge, A. J, Graaff, J. D., & Hella, J. P. (2004). Social and Economic Factors Affecting the Adoption of Soil and Water Conservation in West Usambara Highlands, Tanzania. *Land Degrad. Dev.*, 15(2), 99-114. https://doi.org/10.1002/ldr.606

Tey, Y., Bruwer, J. L. E., Abdullah, A. M., Cummins, J., Radam, A., Ismail, M. I., & Darham, S. (2012). Adoption rate of sustainable agricultural practices: A focus on Malaysia’s vegetable sector for research implications. *African Journal of Agricultural Research*, 7(19), 2901-2909. https://doi.org/10.5897/AJAR11.1876

Thanh, N., & Yapwattanaphun, C. (2015). Banana Farmers’ Adoption of Sustainable Agriculture Practices in the Vietnam Uplands: The Case of Quang Tri Province. *Agriculture and Agricultural Science Proceeda*, 5(1), 67-74. https://doi.org/10.1016/j.aaspro.2015.08.010

Timprasert, S., Datta, A., & Ranamukhaarachchi, S. (2014). Factors Determining Adoption of Integrated Pest Management by Vegetable Growers in Nakhon Ratchasima Province, Thailand. *Crop Protection*, 62, 32-39. https://doi.org/10.1016/j.cropro.2014.04.008

UNDP. (2010). *Food and Nutrition Security in Jordan towards Poverty Alleviation*. Government of the Hashemite Kingdom of Jordan Project Document.

Zaharia, C. (2010). Sustainable Agricultural Development Concepts, Principles, Eco-efficiency, Eco-equity, Eco-conditioning. *Cercet Agron Mold*, 143(3), 91–100.

Zegeye, T., & Haileye, A. (2001). *Adoption of Improved Maize Technologies and Inorganic Fertilizer in Northwestern Ethiopia*. Ethiopian Agricultural Research Organization (EARO) and International Maize and
Wheat Improvement Center CIMMYT.
Zeweld, W., Huylenbroeck, G., Tesfay, G., Azadi, H., & Speelman, S. (2018). Impacts of Socio-Psychological Factors on Actual Adoption of Sustainable Land Management Practices in Dryland and Water Stressed Areas. *Sustainability, 10*(9), 1-23. https://doi.org/10.3390/su10092963

Zhen, L., Routray, J. K., Zoebisch, M. A., Chen, G., Xie, G., & Cheng, S. (2005). Three Dimensions of Sustainability of Farming Practices in the North China Plain: A Case Study from Ningjin County of Shandong Province, PR China. *Agric Ecosyst Environ, 105*(3), 507–522. https://doi.org/10.1016/j.agee.2004.07.012

**Copyrights**
Copyright for this article is retained by the author(s), with first publication rights granted to the journal.
This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (http://creativecommons.org/licenses/by/4.0/).