Adoption of sustainable agriculture practices by citrus farmers and its determinants in the jordan valley: the case of northern ghor

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ABSTRACT

The agricultural sector in the Jordan Valley plays an important role in the economic system and that the region is essentially Jordan's food basket. The adoption of sustainable agricultural practices is widely recognized as essential to ensure agricultural sustainability. This study analyzed factors influencing citrus farmer's 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. A multiple regression analysis was applied to identify factors influencing the sustainability of citrus farming practices. 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 of farmer, Farm experience, primary education, and tertiary education were factors that affected farmers SAPs adoption. Policy recommendations are proposed to enhance the implementation of sustainable agriculture practices by the citrus farmers in the Northern Ghor of Jordan valley.

Keywords: adoption; sustainable agricultural practice; citrus farmer; Jordan valley

INTRODUCTION

The effects of the "Green Revolution" technology on the environment and the issue of sustainability of agricultural growth received attention only recently **(Singh, 2000; Redclift, 1989; Bowonder, 1979)**. **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.

Sustainable agriculture has been identified as the best approach that not only makes to better utilization 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, Hillis, and Hoffman, 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 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 other meaning, sustainable agriculture cannot be reduced to one defined group of practices **(Pretty and Hine, 2000)**.

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

Figure 1 The Northern Ghor of Jordan valley.

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 the 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.

Scientific Hypothesis

This study had two hypotheses:

1. The citrus farming practices are sustainable in the Northern Ghor of Jordan valley.

2. The socio-economic factors such as farmer and farm characteristics, exogenous factors influence the sustainability of citrus farming practices.

MATERIAL AND METHODOLOGY

Study area

The Northern Ghor represents the area that lies below the Yarmouk River through the village of North Shounahand Addasiya to the village of Kreymeh, it is administratively affiliated to Irbid Governorate in the name of AL Aghwar AL Shamalyyah (Figure 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 and Salahat, 2017)**.

Data Collection

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 their 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 respondents were selected in the research area from February to 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.

Statistical analysis

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 and Yapwattanaphun (2015); 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 the 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 loans, farmer group membership, distance to input market, and Source of information. Based on the collective adoption score, the farmers were categorized into 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 ≤ Mean - SD; B = Fairly low: Mean - SD < B ≤ Mean; C = Fairly high: Mean < C ≤ Mean + SD; D = High: Mean + SD < D ≤ Max.

Table 1 Definition of variables and descriptive statistics.

Variable name	Variables: definition and codes	Mean	Std. Dev.
Dependent variables			
Adoption of SAPs	SAPs adoption (=1 if farmer adopted SAPs; 0 otherwise) (min. = 6, max. = 14)	10.6783	1.71959
Independent variables			
	Farmer and farm characteristics		
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 the farmer	Marital status of the 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
Labor availability	Labor availability (=1 farmer used hired labor; 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 times 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
Watching TV	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

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

RESULTS AND DISCUSSION
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 was 4.3%. As far as the educational qualification is concerned, no illiterate farmers were 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 farmer's 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 farmer's employment, where 86.1% of farmers work more than 200 days on the farm.

The measurement of citrus SAPs

The Most commonly adopted SAPs among citrus farmers are presented in Figure 2.

Table 2 displays the classification of citrus farmers according to the levels of adoption of SPAs. As shown that only 13.0% of the farmers ranked in the 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.
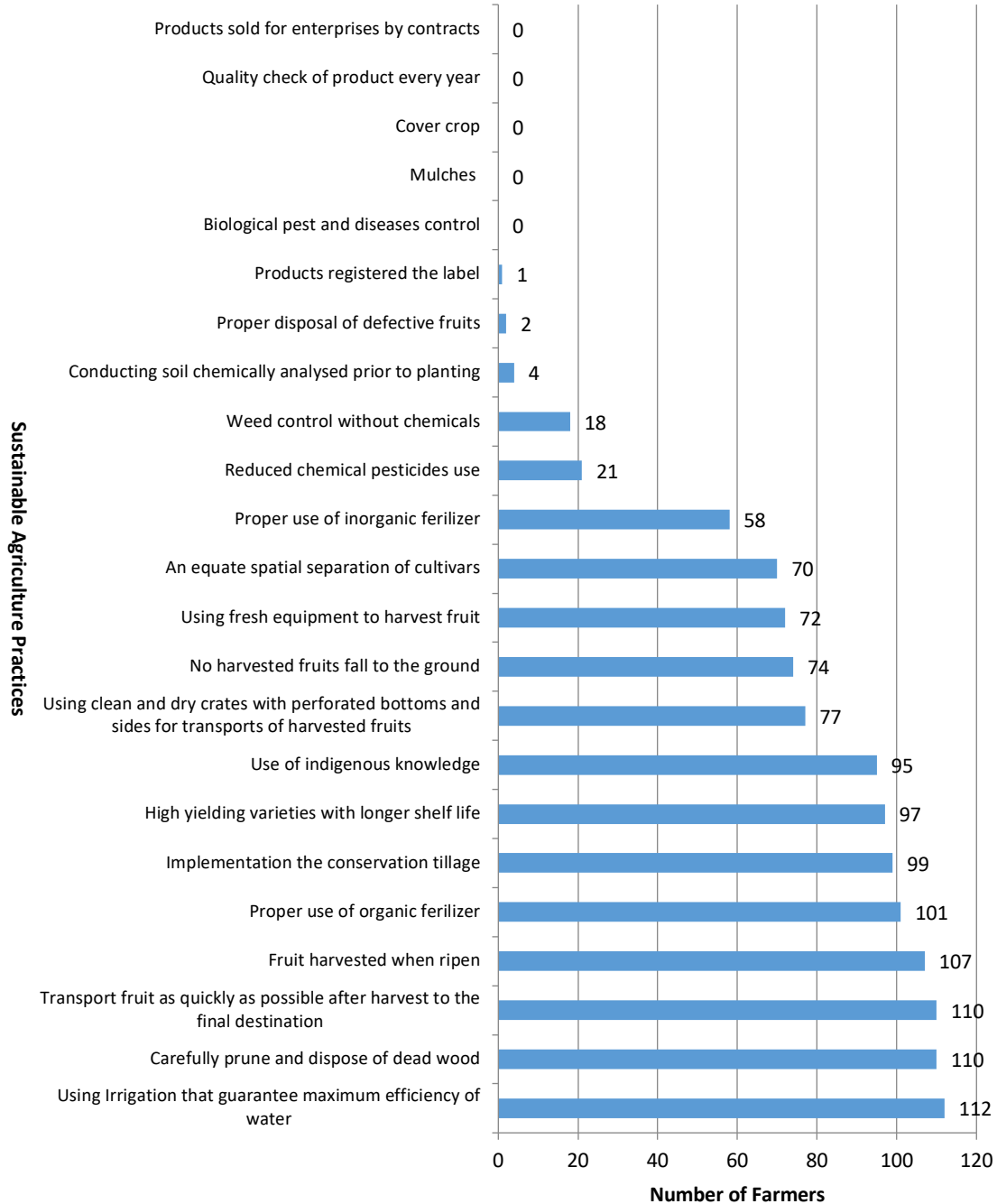

Figure 2 The Most commonly adopted SAPs among citrus farmers.

Table 2 Classification of citrus farmers based on 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	

Table 3 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 the 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**
Labor availability	-1.062-	-.182-	-1.623-	.108
Employment	-.842-	-.170-	-1.602-	.112
Farm income	0.246	.069	.653	.516
Farm production	-.065-	-.016-	-.144-	.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

Note: ***significance at 1% level; **significance at 5% level; * significance at 10% level. N= 115; F= 1,514; R^2= .232

Figure 2 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 an 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 in 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 and 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 farmers implement the conservation tillage especially reduced tillage system; where the number of tillage processes is reduced by either elimination of one or more tillage processes from the conventional tillage program **(Khursheed et al., 2019)**. The narrow distance between the trees is one of the major motivations for the implementation the conservation tillage.

Biological control is an effective and environmentally friendly way to 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. As is known, the use of pesticides leaves amounts of residue on fruits and vegetables **(Roy, Chan and Rainis, 2014; Nakano et al., 2016)**.

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 consumer's perception and belief about products and improving product prices at the same time **(Baldwin et al., 2014)**. 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 and 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 **(Cantwell and Suslow, 2002; Rahman, 2007)**. Nevertheless, the rate of farmers adopted this technique was not high.

Factors influencing citrus farmers SAPsadoption

To determine the factors influencing citrus farmer's SAPs adoption, a regression analysis (the Multiple Regression Model) with entre method was conducted. The regression model integrated all of the explanatory variables which had significant correlations with the SAPs adoption.

The citrus farmer's 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 farmer's SAPs adoption. As revealed in Table 3, the partial regression coefficient of the age of the 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 farmer's SAPs adoption. The R^2 value for the model equals 0.232 indicating that 23.2% of the variation in the farmer's adoption could be explained by these 4 variables.

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, Zwane, and Cheteni, 2020; Cheteni, Mushunje, and Taruving, 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.

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 is 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 other 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.

Concerning the educational attainment variable as clear discrimination in the adoption of SAPs. It is found that the present study results conflict with studies of **(D'Souza and Gebremedhin 2019; Thanha and Yapwattanaphuna, 2015; Ngombe et al., 2014; Teklewold, Kassie, Shiferaw, 2013; Omoare and Oyediran, 2020; Purba et al., 2021)** which suggested that a farmer with higher education is more likely to adopt SAPs. According to these studies, with increased knowledge, a farmer becomes less risk-averse when evaluating SAPs, and more willing to accept innovation that requires a change in the farm operation. It is also in conflict with a study by **Clay et al. (1998)** and **D'Emden et al. (2006)** which did not find an influence of education levels on the adoption of SAPs.

CONCLUSION

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. In addition, the result of the regression analysis showed that 4 variables affecting farmers' SAPs adoption. These variables were the age of the farmer, farm experience, primary education, and tertiary education.

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.

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