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AN EXTENSION PROGRAM TO DEVELOP THE SKILL OF POTATO FARMERS IN THE KURDISTAN REGION OF IRAQ

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Abstract
The research aimed to build an extension program to develop farmers' skills in the Kurdistan Region of Iraq (KRG), The research population included all directors of agricultural extension directorates and all potato farmers in the KRG. The farmers' sample was taken by stratified random sampling including (235 farmers) in seven districts, and the sample of extension directors included all of the population that was (44) directors including (30) respondents (22 farmers and 8 directors) for the pre-test. The total of the instructor sample is 279 respondents; the proposed program was prepared according to the following procedures: literature and forms, expert observations, review of research and articles, conducting field visits, documents and records. The suggested program was built based on some literature, previous studies, and conducting some scientific methods which contained (12) scopes and (94) items initially, the program was presented in its initial form to a group of experts in the field of agricultural extension and management, and after taking their observations into account; the model now includes (12) scopes and (94) items, The results indicate that all scopes and items were kept in the program's final version based on the respondents' agreement extent, And recommends its application in real agricultural work in the KRG.

Keywords: agricultural extension, farmer, extension program, potato (*Solanum tuberosum L.*), building extension program.

1. Introduction

The agricultural extension system aids farmers to be skillful through designing and applying extension programs, the farmer is an important decision-maker to influence managing agricultural crops, accordingly, the farmers' behaviors and skills are taken into consideration. Agricultural extension management includes guiding farmers and assisting their decision-making, developing strategies and plans, enforcing and monitoring developed plans, and regulations (Hamasalih and Mohammad, 2022). Programs are vital parts of extension management, which help farmers to be skillful in scientific and modern ways, increase their production, and find the best way to market their products. The core of extension work is its program which is a comprehensive set of activities created to improve farmers' farming knowledge and production skills (Akeredolu, 2016), Higher-value crops have more potential for differential management since even modest improvements in quality and quantity can increase profitability, the management of higher-value crops is also frequently more intensive (Taylora *et al*., 2018). Crop management have a significant impact on crop yield (Ojeda *et al*., 2021; Avila-Vald *et al.,* 2020; Caldiz *et al*., 2018; Raymundo *et al.*, 2017; Machakaire *et al*., 2016). Nowadays agriculture faces a variety of challenges (Andert *et al*., 2021; Komarek *et al*., 2020) Including food security, the global food system will need to be significantly

improved if it is to be able to sustainably and nutritiously feed the growing world population in the next decades, and the four dimensions of food security are availability, accessibility, use , quality, and stability, potato crop (*Solanum tuberosum L.*), among other food sources, is one that can help meet all these needs (Campos and Qrtiz, 2020). Despite the fact that a major amount of potato production is utilized for seed and animal feed, potato is currently the third most important food crop in the world for human consumption after rice and wheat (Li *et al*., 2015; Campos and Qrtiz, 2020). Moreover, it is the first and most significant vegetable cultivated worldwide (Diop *et al*., 2019). Due to the development of up-to-date, technological techniques and intensive agricultural systems since the middle of the 20th century, traditional agricultural systems have transformed (Meno *et al*., 2021), yet in KRG most of the farmers apply traditional methods to produce potatoes. Increased agricultural productivity and development are largely attributed to agriculture extension, which serves as a significant channel for farmers to access technology (Gholiniya *et al.*, 2004). Agricultural extension has a crucial role in enhancing and increasing agricultural products through developing rural areas in every respect. Furthermore, it is one of the most significant organizations for rural development and it is one of its activities that aims to bring about development in social and economic changes (Al-Doski and HamaSalih 2017), which is a method of education that aims to provide farmers with relevant information and teach them how to use the resources available to them to solve their problems (Hamasalih and Mohammad, 2022; Al-Doski and HamaSalih, 2017). The agricultural extension system is extremely important in the development of rural knowledge and innovative approaches for farmers (Hamasalih and Mohammad, 2022; Rivera and Sulaiman, 2009; Alex and Ziip, 2002). And its mission is to provide information to the rural family as a whole production unit (Al-Doski and HamaSalih, 2017). KRG is fundamentally an agricultural zone in nature and tradition, the agricultural sector is a deeply rooted aspect of the society and economy, In reality, existing agricultural production cannot meet the country's actual needs (Baban, 2015), while agriculture is the primary source of income for many households in rural areas in this region. The local demand for potatoes is higher than local production; hence, importing from neighboring countries fills the gap. In light of these facts, the role of agricultural extension must be activated to determine and overcome the problems contributing to the deficiency of potato productivity. Having set that, potato improves food security since it provides job opportunities and income (Kater *et al*., 2015; Pinstrup-Anderson, 2014).

The aim of the Research:

1. Describe the variables of the respondents.
2. Building an extension program to develop potato farmers' skills in the KRG.
3. Comparing the agreement of potato growers with the proposed agricultural extension program between the governorates of the KRG.

Materials & Methods:

1. Research Methodology In order to achieve the objective of the research, the descriptive approach, which is one of the methods to obtain adequate and accurate information from social reality and contribute to the analysis of its phenomena, was used. (Nassaji, 2015), this approach is

suitable to get detailed data and facts on the proposed extension program to develop potato farmers' skills in KRG.

2. Research Area: the Kurdistan Region of Iraq was chosen as a region to conduct the research, which consists of four provinces, namely (Erbil, Sulaimani, Duhok, and Halabja).

3. The research population and sample: The research population comprised all directors of agricultural extension directorates and all potato farmers. They were (52)* directors and (790)* potato farmers that were divided into (Erbil, Sulaimani, Duhok, and Halabja) governorates. The farmers' sample was taken by stratified random sampling including (235 farmers) in seven districts which represent 30% of the population, while the sample of extension directors contained all the population consisting of (44) directors including (30) respondents (22 farmers and 8 directors) for the pre-test.

* Data of the ministry of agriculture and water resources in the KRG, 2021.

Stages of proposed extension program:

The first stage: The proposed program has been prepared according to the following procedures: undertaking field visits, research and articles, expert's observations and researchers specialized in this field, official records approved in the agricultural departments, the available information regarding the extension program process through the Internet, (12) scopes and (94) items were developed, the total of which was the initial form of the program.

The second stage: The form was presented in its initial form to a group of experts and specialists in the field of agricultural extension and vegetable crops, total of (22) experts by questionnaire in order to determine the level of their agreement on each scopes and items, a measure of approval consisting of three levels: agree, agree with the amendment (The amendment is mentioned), disagree, and the following weights were given 3, 2 and 1 respectively. As for the level of approval with the amendment procedure, a field related to the proposed amendment was set according to the standard level.

The third stage: As a percentage of agreement 80% was determined by the opinions of experts as a criterion (condition), scopes, or items within the initial proposed form as it obtained the approval of 80% of the experts' opinions, it is entirely valid. The cutting threshold is a commonly used term in educational and psychological research. The items that needed to be modified and merged the similar items with each other were reformulated, and some items were added from expert observations, as the sum of (12) scopes and (94) items distributed over the proposed program.

The fourth stage: Five-point scale of phrases consisting of (agree, agree with modification, disagree), the following weights are assigned to them successively (3, 2, and 1).

Presenting the program to the specialized experts. The apparent honesty of the questionnaire was confirmed and its content validated. As apparent honesty means the degree to which the items relate to the job or behavior to be measured, i.e. all the items of the questionnaire, its instructions and, its appearance must be related to the topic, whereas the validity of the content is intended, The degree to which the test represents the content and objectives of the behavior, and the content

of the content has earned this name because it relates to the content of the behavior be measured (Prasad & Reghunath, 2011).

The data was collected in the personal interview by means of a questionnaire for the respondents, which includes: the first is for personal and employment variables, the second part relates to identifying the degree of consent of the respondents to the proposed program to develop potato farmers' skills in the KRG.

3. Result and Discussion:

3.1 Description of the personal variables of the Respondents:

3.1.1 Description of the personal variables of the farmers:

The results of the research showed that the ages of the respondents ranged between (17 – 74) years, the highest percentage of respondents falls in the age group (41-52) with a percentage of (42%) and the lowest percentage (2%) within the age category is (65 and more), as in (Table 1)**.** The results of the research showed that more than half of the respondents fall into the category (Primary and intermediate). According to the findings, the majority of farmers (62%) had a working experience of less than 10 years. Table (1) indicated that the largest percentage of farmers (55%) falls within the category of agricultural holding (100 dunums or less) and the lowest percentage of farmers (4%) falls within the category (301-400) dunums, the largest percentage of farmers (45%) falls within the rent category, The data indicated that the lowest segment of farmers (5%) belong to the land partnership category. The majority of farmers produced plenty of potatoes for one ton of seeds approximately (41%) of them yielded (16-22 Ton potatoes). Most of the farmers (62%) bought seeds from abroad. And (61%) of farmers have not attended any extension training concerning producing and marketing potatoes, as in table (1).

Table 1. Distribution of potato farmers according to socio-demographic profile

Variables	Categories	Frequency	Percentage
Age	28 and less	17	7
	29-40	70	30
	41-52	90	42
	53-64	44	19
	65 and more	5	2
	Total	235	100
Level of education	Illiterate	36	15
	Read and write	19	8
	Primary School	60	26
	Intermediate	66	28
	High School	17	7
	Diploma	17	7
	Bachelor	20	9
	Total	235	100
Years of working in potato planting	Less than 10	145	62
	11-21	79	34

Variables	Categories	Frequency	Percentage
	22 and above	11	5
	Total	235	100
Farm Size	100 Dunums and less	129	55
	101-200 Dunums	45	19
	201-300 Dunums	29	12
	301-400 Dunums	10	4
	401 Dunums and more	22	9
	Total	235	100
Utilized land for potato planting	100 and less	178	76
	101-200	28	12
	201-300	12	5
	301-400	4	2
	401 and more	13	6
	Total	235	100
Acquisition Type	Agricultural contract	32	14
	Partnership	12	5
	Rent	106	45
	Ownership	85	36
	Total	235	100
Potato yield amount/ton	2-8	65	28
	9-15	74	32
	16-22	96	41
	Total	235	100
Seed Source Location	Other farmers	18	8
	Abroad	145	62
	Personal product	72	31
	Total	235	100
Training course participation	Trained	90	39
	Not-trained	145	61
	Total	235	100

3.2. Description of the personal variables of the extension directors

The directors' age ranged from 32 to 62, among them the age group (42-51 years) had the highest percentage of directors (39%). The majority of extension directors were male (89%). Most of the directors (50%) had studied bachelor, and (14%) of them were specialists in agricultural extension, as in (Table 2).

Table 2. Distribution of extension directors according to socio-demographic profile

Variables	Categories	Frequency	Percentage
Age	41 and less	11	25
	42-51	17	39

	52 and above	16	36
	Total	44	100
Gender	Male	39	89
	Female	5	11
	Total	44	100
Leve l of Education	High School	2	5
	Diploma	17	39
	Bachelor	22	50
	Master	1	2
	Ph.D.	2	5
	Total	44	100
Specialization	Specialist in extension	6	14
	Non-specialist in extension	38	86
	Total	44	100

3.3. Building an extension program to develop potato farmers' skills in KRG

3.3.1. Agreement extent of all scopes of the agricultural extension program

All the scopes that were suggested to the extension program acquired an arithmetic mean between (2.66 - 2.92) and percent weights between (88.7 - 97.3%), and this way they were higher than the central premise of (score 2), therefore they were kept in the final version of the program, as in (Table 3).

Table 3. Respondents' agreement scores of all scopes of the agricultural extension program

No.	Scops	Rank by Agreement Score	Arithmetic Mean		Mean of Arithmetic Mean	Percent Weight
			Farmers	Managers		
1	Soil preparation	6	2.83	2.76	2.79	93.0
2	Seed preparation	9	2.74	2.68	2.71	90.3
3	Times and methods of planting	4	2.86	2.77	2.81	93.7
4	Fertilization	11	2.69	2.65	2.67	89.0
5	Irrigation	10	2.70	2.65	2.68	89.3
6	Disease and insect pest management	12	2.51	2.80	2.66	88.7
7	Weeds control management	7	2.85	2.72	2.78	92.7
8	Harvesting and collecting	5	2.85	2.76	2.80	93.3
9	Separating and product hierarchy	2	2.87	2.90	2.88	96.0
10	Packaging	1	2.88	2.94	2.92	97.3
11	Storing	8	2.73	2.81	2.77	92.3

12	Marketing	3	2.83	2.88	2.85	95.0
			n= 279			

The scope of (Packaging the potatoes) was ranked first, followed by (Separating and product hierarchy), this can be a result of the respondents' greater expertise in these two scopes so they could approve easily. While the scopes of (Disease and insect pest management), (Fertilization), and (Irrigation) ranked twelve, eleven, and ten, respectively, it might due to the deficiency of information about these three scopes and therefore they could not decide about these scopes efficiently. These three scopes are considered the most important factor in increasing yield and for sustainable growth of potato production.

3.3.2 Agreement extent of all Items of the agricultural extension program:

3.3.2.1 Agreement on Items of soil preparation

All items that were suggested to this scope acquired an arithmetic mean between (2.65 - 2.93) with the percent weight between (88.3-97.6%), and this way they were higher than the central premise of (score 1.5), so they all were kept in the final form of the program, as in (Table 4).

Table 4. Respondents' agreement score of the items of soil preparation

No	Items	Rank	Arithmetic Mean		Mean of Arith. Mean	Percent Weight
			Farmers	Directors		
1	Potatoes should be planted in a sandy loam soil	3	2.89	2.87	2.89	96.3
2	pH laboratory analysis should be performed on the soil, and the pH of the soil should be between 5.5-6	7.5	2.74	2.61	2.68	89.3
3	The organic matter laboratory analysis should be performed on the soil	2	2.84	2.95	2.90	96.7
4	The land should be irrigated before ploughing, for growing weeds to remove growing weeds through ploughing	6	2.74	2.82	2.78	92.6
5	Potato field should be plowed to the depth of 20-30 cm	4	2.89	2.82	2.86	95.3
6	A harrow should be used after plowing to level the soil	1	2.93	2.93	2.93	97.6
7	The land should be left for a few weeks after plowing, or irrigate the land deeply to remove weeds	9	2.75	2.55	2.65	88.3
8	It is better to plant potatoes in a soil where it has already been planted by beans and crops	5	2.87	2.73	2.80	93.3
9	Potatoes should not be planted in a soil where it has already been planted by the aubergine family unless three years passed	7.5	2.82	2.55	2.68	89.3

n= 279

The item (A harrow should be used after plowing to level the soil) was ranked first, this can be a result of harrowing which is a common and necessary process in planting potatoes, this way most of the farmers had information about the significant harrowing. While, the item (The land should be left for a few weeks after plowing, or irrigate the land deeply to remove weeds) was ranked last, it is probably due to not being concerned about this process during soil preparation that is why they could not approve it easily.

3.3.2.2 Agreement on the items of seed preparation

All suggested items acquired an arithmetic mean between (2.38 and 2.96) with a percent weight between (79.3-98.7%), and this way they were higher than the central premise of (score 1.5), so they all were kept in the final form of the program, as in (Table 5).

Table 5. Respondents' agreement scores of the items of seed preparation

No	Items	Rank	Arithmetic Mean		Mean of Arith. Mean	Percent Weight
			Farmers	Directors		
1	Providing seeds of high quality, with a suitable, healthy size physiologically and apparently	1	2.92	3	2.96	98.7
2	Wounded seeds before storing should be put in a normal temperature around for curing and recovering	15	2.78	2.30	2.54	84.7
3	Storing seeds temporarily should be in a normal temperature around while it is 16-20ºC	13	2.60	2.59	2.60	86.7
4	Seeds in summer cannot sprout and they have to be in cooling storage for 10 days before planting to sprout	14	2.57	2.57	2.57	85.7
5	Seeds that are put in cooling storage for some months should have a temperature of 3-4ºC	8	2.79	2.68	2.73	91
6	The humidity of the cooling storage should always be 95%	16	2.47	2.30	2.38	79.3
7	The temperature should be increased gradually until it reaches 16-20ºC to cause sprouting 15-20 days before planting seeds daily	12	2.57	2.68	2.62	87.3
8	If the seed does not sprout, it should be put in hormonal solutions to cause sprouting	10	2.66	2.70	2.68	89.3
9	There should be a ventilator system to regulate the temperature and storage humidity of the seed	3	2.86	2.95	2.91	97
10	Seed weight should be between 40-70 gram	5	2.84	2.80	2.82	94
11	Big seeds should be cut for different parts on the condition that each part has got a sprout	7	2.83	2.66	2.74	91.3

12	In autumn seeds should not be cut since they are susceptible to many diseases and they will get rotten	6	2.81	2.82	2.81	93.7
13	500-800 kg/donum of seeds should be used for planting, and it depends on the weight and the size	4	2.89	2.80	2.84	94.7
14	Seeds should not be planted before sprouting	9	2.76	2.61	2.69	89.7
15	The sprout size needs to be 1-1.5cm before planting	11	2.83	2.43	2.63	87.7
16	Seeds should be sanitized for preventing disease before planting especially in autumn	2	2.90	2.95	2.93	97.7
	n= 279					

The item (Providing seeds of high quality, with a suitable, healthy size physiologically and apparently) was ranked first as seed quality has a great impact on the yield amount, and they were concerned with healthy seed size to produce a good potato in terms of quality and quantity, however, the item (The humidity of the cooling storage should always be 95%) was ranked last, it might be for the reason that they had not stored potato seeds in cooling storage by themselves, consequently, they did not have enough information to confirm the proper rate of humidity of the cooling storage effortlessly.

3.3.2.3 Agreement on the items of the times and methods of planting

The seven suggested items for this scope acquired an arithmetic mean between (2.77 and 2.86) with a percent weight between (92.3-95.3%), and thus they were higher than the central premise of (score 1.5), so they all were kept in the final version of the program (Table 6).

Table 6. Respondents' agreement score of the items of times and methods of planting

No	Items	Rank	Arithmetic Mean		Mean of Arith. Mean	Percent Weight
			Farmers	Directors		
1	Planting for the spring season in the hot areas should be performed from December 20 to January 15, and in the cold areas from February 1 to March 1	2	2.85	2.82	2.83	94.3
2	Planting for the autumn season in the hot areas should be performed from August 15 to September 10, and in the cold areas from May 10 to June 10	7	2.80	2.75	2.77	92.3
3	Seeds should be planted while the temperature is between 18-30ºC in the day and 14-16ºC at the night	6	2.84	2.73	2.78	92.7
4	The land should be separated in the form of lines, the distance between each line should be 70-80 cm	4	2.87	2.75	2.81	93.7
5	The distance between each seed should be 20-30 cm	3	2.89	2.77	2.83	94.3

6	Planting depth should be 12-15 cm	1	2.88	2.84	2.86	95.3
7	After 30-40 days the soil should be turned over for the plant which has been taken away due to irritating the land	5	2.86	2.78	2.78	92.7
	n= 279					

The item (Planting depth should be 12-15 cm) was ranked first, it can be for the reason that planting depth of potato seeds is quite necessary to prevent sunlight and most of the farmers had information about this fact, whilst, the item (Planting for the autumn season in the hot areas should be performed from August 15 to September 10, and in the cold areas from May 10 to June 10) was ranked last, since in KRG potato farmers were not concerned with planting date, they were rather concerned with weather condition with which they could determine the time of planting, as a result, they could not decide about the time of planting by date properly.

3.3.2.4 Agreement on the items of fertilization

The (10) items that were suggested to fertilization scope achieved an arithmetic mean between (2.44 and 2.86) with a percent weight between (81.3-95.3%), and thus they were greater than the central premise of (score 1.5), so they all were kept in the last model of the program, as in (Table 7).

Table 7. Respondents' agreement score of the items of fertilization

No	Items	Rank	Arithmetic Mean		Mean of Arith. Mean	Percent Weight
			Farmer	Director		
1	While applying organic manure, the soil should be fertilized by poultry manure with an amount of 1000-1250 kg/donum	4	2.83	2.61	2.72	90.7
2	While applying organic manure, animal manure should be used with an amount of 1500-2000 kg/donum	6	2.74	2.61	2.68	89.3
3	It is better that part of the fertilizer is mixed with the soil when ploughing at the time of applying chemical fertilizers	2	2.89	2.80	2.84	94.7
4	The land should be irrigated well after planting seeds when providing chemical fertilizers	1	2.90	2.82	2.86	95.3
5	300-500 kg/donum of NPK chemical fertilizer should be used, by considering the stage of the plant development	5	2.81	2.59	2.70	90
6	Potatoes need a high amount of nitrogen in the first two months, and then they need a high amount of potassium	3	2.85	2.80	2.82	94
7	NPK fertilizer should be applied 3-4 times since planting the seeds, the first time it should be performed after two weeks and later once every 20-25 days	7	2.69	2.48	2.58	86

8	Magnesium rate in a potato land should be 100 pieces in a million. If the rate is less, it should be fertilized with magnesium	10	2.44	2.43	2.44	81.3
9	The field should be fertilized with sulfur with the rate of 5-7.5 kg/donum by dripping, and it depends on its rate in the land	9	2.42	2.61	2.52	84
10	The field should be fertilized with each one of the organic matters and chemical elements (Iron 200, Zinc 100, Boron 100, Manganese 80, Copper 75, Molybdenum 10) manured in a million, and it depends on their rate in the land	8	2.38	2.70	2.54	84.7
	n= 279					

The item (The land should be irrigated well after planting seeds during providing chemical fertilizer) was ranked first, it can be a result that respondents learned this process traditionally, and they had a clue about watering importance when fertilizing to benefit the plant from the fertilizers, while, the item (Magnesium rate in a potato land should be 100 pieces in a million. If the rate is less, it should be fertilized with magnesium) was ranked last, it might be because respondents had not been able to determine the rate of organic matters in the soil as most of them had not conducted soil test and they did not pay attention to organic matters importance in the soil for potato planting.

3.3.2.5 Agreement on the items of irrigation

All suggested items to this scope acquired an arithmetic mean between (2.49-2.91) with a percent weight between (83-97%) , accordingly all the items were kept in the final form of the program, and each item acquired an arithmetic mean of agreement higher than the central premise of (score 1.5), as in (Table 8).

Table 8. Respondents' agreement score of the items of irrigation

No	Items	Rank	Arithmetic Mean		Mean of Arith. Mean	Percent Weight
			Farmer	Directors		
1	Potato fields should be irrigated in an early morning, late evening, or at night	2	2.84	2.91	2.87	95.7
2	It is better for the potato field to be irrigated by dripping	4	2.86	2.57	2.72	90.7
3	Potato necessity for water is different according to the development stage and regulating times of irrigation as well as the weather	1	2.91	2.91	2.91	97.0
4	Potato soil humidity should not be less than 50% continuously, and the land should not be scratched	3	2.84	2.66	2.75	91.7

5	Irrigation should be performed once every 8-10 days in December, January, and February	6	2.71	2.59	2.65	88.3
6	Irrigation should be performed once every 10-12 days in March	9	2.67	2.57	2.62	87.3
7	Irrigation should be performed once every 6-8 days in April	10	2.65	2.55	2.60	86.7
8	Irrigation should be performed once every 5-7 days in May, June, July, and August	12	2.62	2.36	2.49	83.0
9	Irrigation should be performed once every 5-6 days in September	11	2.59	2.57	2.58	86.0
10	Irrigation should be performed once every 7-8 days in October	8	2.58	2.66	2.62	87.3
11	Irrigation should be performed once every 9-11 days in November	7	2.59	2.70	2.65	88.3
12	It is better to stop the irrigation 10-15 days before harvesting the potatoes	5	2.63	2.77	2.70	90.0
	n= 279					

The item (Potato necessity for water is different according to the development stage and regulating times of irrigation as well as the weather) was ranked first, it can be a result that most respondents practiced watering in various months and seasons so they could express their opinion regarding potatoes' need to irrigation, while, the item (Irrigation should be performed once every 5-7 days in May, June, July, and August) was ranked last, it might be because respondents were not concerned with determining the days for watering, they rather thought watering was necessary when the soil tends to get dried.

3.3.2.6 Agreement on the items of disease and insect pest management

The (28) items acquired an arithmetic mean between (2.53 and 2.77) with a percent weight between (84.3-92.3%), so all the items were reserved in the final form of the program, also every item acquired an arithmetic mean of agreement higher than the central premise of (score 1.5), as in (Table 9).

Table 9. Respondents' agreement score of the items of disease and insects pest management

No	Items	Rank	Arithmetic Mean		Mean of Arith. Mean	Percent Weight
			Farmers	Directors		
	First: Early Blight					
1	This disease happens due to mold in a high-temperature level 24-29ºC and 90% humidity	3	2.63	2.86	2.75	91.7

2	The symptoms are a dried, dark brown or black spot on the leaf and trunk edge, with 3-4 cm diameter, it has been surrounded by a light-yellow shadow and then it turns the leaf into yellow and the leaf falls down, in potatoes, it has black wounds and irregularity as well as getting rotten	2	2.68	2.82	2.75	91.7
3	This disease is spread through air and irrigation	6	2.62	2.82	2.72	90.7
4	Prevention by planting healthy seeds, following planting cycles, and checking fields weekly 2-3 times. Curing by dripping pesticides, especially at the beginning of bearing the potatoes, or storing potatoes in the cooling storage	1	2.64	2.91	2.77	92.3
	Second: Late Blight					
5	This mold disease grows in cold weather where the temperature is 18-22ºC and humidity is 90%	20	2.62	2.64	2.63	87.7
6	The symptoms include small brown spots around and on the edge of the leaf and then it makes the leaf brown and dry and it leads to the leaf collar and the trunk and covers all the plant until it dies, and yellow spots on the potato peelings and the potato core getting turning into brown	7	2.66	2.75	2.70	90.0
7	It is spread by air and irrigation, and due to mixing the healthy potatoes with the inflected ones in the storage	12	2.61	2.73	2.67	89.0
8	Prevention by considering planting cycles, tomatoes should not be planted close to potatoes in winter, nitrogenous manure should not be applied excessively. Curing by pesticide drippings, and potatoes should be kept in cooling storage	5	2.62	2.84	2.73	91.0
	Third: Scab					
9	This disease grows in a soil where it is dried, alkaline, and it has a high-temperature level	28	2.56	2.50	2.53	84.3
10	The symptoms are brown wounds on the root and trunk, and it has a rough layer on the potato peelings which is either straight or higher or it has a hole, and later it leads to scratching as well as losing the humidity and wrinkling of the potatoes in the storage	9	2.58	2.82	2.70	90.0
11	Prevention and curing by planting healthy seeds, potatoes should not be planted in an infected field unless three years have passed, protecting the soil acidity between 5-6.5, and protecting water level in the soil	14	2.58	2.75	2.66	88.7
	Four: Black leg					

12	Potatoes encounter this disease due to bacteria in a soil where it has a high level of humidity and temperature	19	2.59	2.68	2.64	88.0
13	The symptoms are aquatic small spots below the trunk and they become big and dark and it covers the trunk and then it changes the inner color to black and it gets rotten, the color of the leaves turns into yellow, latter to brown, deteriorating, the plant's dying, and the potatoes get rotten	11	2.57	2.77	2.67	89.0
14	Prevention and curing by planting healthy seeds, a good irrigation system, plants should not be wounded, and harvesting potatoes in dry weather as well as storing them in cooling storage plus sanitizing the materials and the storing place	4	2.60	2.89	2.74	91.3
	Five: Viruses Disease					
15	Potatoes face a large number of viruses which have round shapes like leaf curl virus, or it is straight and it is in the form of a thin line	26	2.37	2.77	2.57	85.7
16	It causes dwarfness and defers the development of the plant, and it deforms the leaves and the potatoes	22	2.37	2.86	2.62	87.3
17	It spreads rapidly in the field due to the transporting insects	18	2.39	2.89	2.64	88.0
18	Prevention by destroying the remaining of the previous plant of the season, sanitizing the field goods continuously, monitoring the field, and performing vaccines. Curing by insect pesticide dripping	16	2.41	2.89	2.65	88.3
	Six: Cutworm					
19	It causes minimizing the potatoes, reducing the quantity, and having a low quality, and the potato will not be suitable for selling when the disease spreads	15	2.49	2.82	2.65	88.3
20	This worm hides itself throughout the day and it is active at the night	10	2.49	2.86	2.68	89.3
21	The worm can cut the saplings in the soil level	13	2.52	2.82	2.67	89.0
22	It infects the potatoes close to the soil surface	21	2.49	2.75	2.62	87.3
23	Prevention by planting healthy seeds and sanitizing before planting, potatoes should not be planted for 3-5 years in the inflected field, planting with the depth 12-15 cm since the worm gets into the soil with the depth 2-4 cm. Curing by insect pesticide dripping	8	2.51	2.89	2.70	90.0
	Seven: Potato Moth					

24	This worm is active and reproduces in a hot, dry weather	23	2.37	2.84	2.61	87.0
25	The moth is spread from the infected leaves to the trunk and the potatoes, and the leaves fall onto the land by getting dried and scratching the soil, and attacking the potatoes	27	2.34	2.73	2.53	84.3
26	This disease is continuous while transporting, packaging, and storing	24	2.36	2.82	2.59	86.3
27	Symptoms include swelling the middle line of the leaf and turning the color to brown and getting the leaf dried, or curling leaves and forming a curtain around, and having holes around the potatoes sprout and getting the potato rotten	25	2.36	2.80	2.58	86.0
28	Prevention by planting seeds which has good immunity, planting with the depth of 15cm, and taking away the infected ones while collecting. Curing by field dripping with moths' pesticides, dripping the land of the cooling storage before taking the potatoes	17	2.38	2.91	2.64	88.0
	n= 279					

The item (Prevention by planting healthy seeds, following planting cycles, and checking fields weekly 2-3 times. Curing by dripping pesticides, especially at the beginning of bearing the potatoes, or storing potatoes in the cooling storage) was ranked first, it can be a result that early blight disease was the most common potato disease in the KRG so the respondents were concerned with preventing and curing early blight to produce healthy and good quality potatoes, however, the item (This disease grows in a soil where it is dried, alkaline, and it has a high-temperature level) was ranked last, it might be because respondents did not have enough information as to which weather will cause scabby tubers.

3.3.2.7 Agreement on the items of weeds control management

The (2) suggested items acquired an arithmetic mean between (2.78 and 2.79), and they gained an arithmetic mean of agreement higher than the central premise of (score 1.5) as in (Table 10).

Table 10. Respondents' agreement score of the items of weeds control management

No	Items	Rank	Arithmetic Mean		Mean of Arith.	Percent Weight
			Farmers	Directors		
1	Pesticides of wide leaves and thin leaves can be utilized at the beginning of planting and before the plants growing	2	2.85	2.70	2.78	92.7

2	When the plant grows, thin-leaf pesticide should be used, and the wide-leaf weeds should be removed manually or by machine	1	2.86	2.73	2.79	93.0
n= 279						

The item (When the plant grows, thin-leaf pesticide should be used, and the wide-leaf weeds should be removed manually or by machine) was ranked first, it can be a result that the respondents dealt consciously with plants when the plant is growing to prevent the potatoes from side effects of pesticide, followed by the item (Pesticides of wide leaves and thin leaves can be utilized at the beginning of planting and before the plants growing) was ranked last, it might be because respondents were not concerned with applying pesticide before growing the plant.

3.3.2.8 Agreement on the items of harvesting and collecting

All the items that were suggested to this scope acquired an arithmetic mean between (2.70 and 2.86) with a percent weight between (90-95.3%), so all the items were kept in the final form of the program, and every item acquired an arithmetic mean of agreement higher than the central premise of (score 1.5) as in (Table 11).

Table 11. Respondents' agreement score of the items of harvesting and collecting scope

No	Items	Rank	Arithmetic Mean		Mean of Arith. Mean	Percent Weight
			Farmers	Director		
1	Potatoes should be harvested after 100-120 days from planting, and it depends on their type	3	2.84	2.80	2.82	94.0
2	The green part should be plucked before harvesting the potato in 7-10 days	5	2.84	2.57	2.70	90.0
3	Potatoes should be harvested in an early morning	4	2.85	2.75	2.80	93.3
4	The mud and the dust of the potatoes should be removed manually or by machine	1	2.87	2.84	2.86	95.3
5	They should be accumulated in a cool part of the field in small groups until they are transported to market, and the thickness of the layers should be 15-25 cm	2	2.85	2.84	2.85	95
n= 279						

The item (The mud and the dust of the potatoes should be removed manually or by machine) was ranked the first because cleaning potatoes after harvesting and collecting is considered as one of the most important parts of the process, it makes the potatoes to be more attractive to consumers, additionally, most of the respondents had practiced this, so they could express their opinion concerning this step clearly, nevertheless, the item (The green part should be plucked before

harvesting the potato in 7-10 days) was ranked last, because respondents were not certain about the number of days needed to pluck the green part before harvesting.

3.3.2.9 Agreement on the items of Separating and Product Hierarchy

The (3) items acquired an arithmetic mean between (2.786 and 2.938) with a percent weight between (92.86-97.93%), therefore all three items were reserved in the last form of the program, also they gained an arithmetic mean of agreement higher than the central premise of (score 1.5), as in (Table12).

Table 12. Respondents' agreement score of the items of separating and product hierarchy

No	Items	Rank	Arithmetic Mean		Mean of Arith. Mean	Percent Weight
			Farmers	Director		
1	Wrinkled and weak potatoes should be separated and taken away	1	2.90	2.98	2.938	97.93
2	Wounded potatoes should be separated, and curing the wound at a temperature of 15-18ºC and should be put in a part of the field where air can reach it	3	2.82	2.75	2.786	92.86
3	The potatoes should be classified into three categories (small, medium, and big) on the basis of size	2	2.89	2.98	2.935	97.83
	n= 279					

The item (Wrinkled and weak potatoes should be separated and taken away) was ranked first, for the reason that respondents thought that wrinkled and weak potatoes would cause improper products and they could not sell them in a good marking way since the consumer does not desire to buy any wrinkled or weak potatoes, and it makes the products wasted, while, the item (Wounded potatoes should be separated, and curing the wound at a temperature of 15-18ºC and should be put in a part of the field where air can reach it) was ranked last, because a few of the respondents had practiced curing the wounded potatoes, accordingly they did not have good information about the temperature degree which is needed for curing wounded potatoes process.

3.3.2.10 Agreement on the items of potato packaging

The (2) items that were suggested to packaging scope acquired an arithmetic mean (2.91 plus 2.92) with a percent weight (97-97.3%), and they gained an arithmetic mean of agreement higher than the central premise of (score 1.5), so both items were kept in the final form of the program, as in (Table 13).

Table 13. Respondents' agreement score of the items of potato packaging

	Ran	Arithmetic Mean	Mean	Per cent

No	Items		Farmers	Director		
1	Carton box or net sack should be used for carrying and transporting the potatoes	1	2.89	2.95	2.92	97.3
2	The potato should be put in a way that air can go and come out of the net sack or a carton box for each one	2	2.88	2.93	2.91	97.0
	n= 279					

Item number one was ranked first as both carton box and net sack were the best options for packaging potatoes from the respondents, and it prevents the potatoes from getting rotten, followed by item number two which ranked second since respondents were not concerned with putting the potatoes during the packaging process.

3.3.2.11 Agreement on the items of storing scope

In (Table 14), all items acquired an arithmetic mean between (2.58 and 2.92) with a percent weight between (86-97.3%), and each item acquired an arithmetic mean of agreement greater than the central premise of (score 1.5), this way all the items were kept in the final version of the program.

Table 14. Respondents' agreement score of the items of storing

No	Items	Rank	Arithmetic Mean		Mean of Arith. Mean	Percent Weight
			Farmers	Directors		
1	Only potatoes that are healthy, intact, and grown should be stored	1	2.91	2.93	2.92	97.3
2	Potatoes can be kept in cooling storage for six months	4.5	2.80	2.82	2.81	93.7
3	The cooling storage temperature should be 3-4ºC	4.5	2.69	2.93	2.81	93.7
4	The cooling storage humidity of potatoes should be 85-90%	6	2.69	2.70	2.70	90.0
5	There should be sufficient air coming and going out in the storage for regulating temperature and humidity	3	2.80	2.95	2.88	96.0
6	There should not be light in the cooling storage of potatoes	2	2.82	2.95	2.89	96.3
7	The process of curing wounds should be performed to the wounded potatoes in the first 5-20 days of the storing	7	2.66	2.73	2.70	90.0
8	Curing the wounded potatoes should be performed at a temperature of 15-18ºC and 95% humidity, and the place should be dark	9	2.62	2.55	2.58	86.0

9	Potatoes should not be stored close to fruits	8	2.57	2.75	2.66	88.7
	n= 279					

The item (Only potatoes that are healthy, intact, and grown should be stored) was ranked first, it can be a result that all potatoes are in danger in cooling storage if unhealthy potatoes are stored, while, the item (Curing the wounded potatoes should be performed at a temperature of 15-18ºC and 95% humidity, and the place should be dark) was ranked last, because respondents confirmed that they had not practiced this process and they did not have enough information about the details of curing the wounded potatoes in cooling storage and storing, that's why they could not decide about the proper degree of temperature and humidity.

3.3.2.12 Agreement on the items of the marketing

The (9) items acquired an arithmetic mean between (2.63 and 2.93) with a percent weight between (87.7-97.7%), accordingly all the items were reserved in the last version of the program, and each item achieved an arithmetic mean of agreement greater than the central premise of (score 1.5), as in (Table 15).

Table 15. Respondents' agreement score of the items of marketing

No	Items	Rank	Arithmetic Mean		Mean of Arith. Mean	Percent Weight
			Farmers	Directors		
1	Potatoes should be transported directly after harvesting and collecting in an early morning to the market or the industrial factories	7.5	2.88	2.86	2.87	95.7
2	They should be transported to the market or factories by refrigerated truck	4	2.86	2.91	2.89	96.3
3	The price of selling potatoes should be compatible with the policy pricing of the agricultural ministry	6	2.87	2.89	2.88	96
4	Farmers should have contracts with the fruit and vegetable market or the industrial factories to ensure marketing the potatoes	2	2.90	2.89	2.89	96.3
5	It is better that farmers plant potatoes by the demand of the consumer	1	2.89	2.98	2.93	97.7
6	Potatoes should not be put for selling in the street under the sunlight	4	2.86	2.91	2.89	96.3
7	The potatoes that are delivered to the market should have a medium size	9	2.54	2.73	2.63	87.7

8	Potatoes should be transported directly after harvesting and collecting in an early morning to the market or the industrial factories	7.5	2.88	2.86	2.87	95.7
9	They should be transported to the market or factories by refrigerated truck	4	2.86	2.91	2.89	96.3
	n= 279					

The item (It is better that farmers plant potatoes by the demand of the consumer) was ranked first, it can be the result that consumers' demand was quite important for the respondents since it reduces the potato products waste, whereas, the item (The potatoes that are delivered to the market should have a medium size) was ranked last, because respondents thought that big potatoes were good, they were not certain about the quality of medium size potatoes in terms of organic matters.

3.4. The comparison of potato farmers' agreement toward the suggested agricultural extension program in the Sulaimani, Hawler, Duhok, and Halabja governorates:

To compare the potato farmers' agreements toward the suggested program in the four different cities in the Kurdistan region of Iraq, the ANOVA test was used with the calculated F-value of (85.85) which was more than the table value at the significant level of (0.05), it implies that there was a significant difference in potato farmers agreement toward the suggested program, as in (Table 16,17).

Table 16. Comparison of potato farmers' agreement toward the suggested program

No.	Governorates	Mean	Number of potato farmers	%
1	Erbil	2.77	60	25.5
2	Sulaimani	2.59	55	23
3	Duhok	2.82	100	43
4	Halabja	2.30	20	8.5
	Total	2.71	235	100

Table 17. Differences in farmers' opinions according to cities (Erbil, Sulaimani, Duhok, and Halabja)

		Sum of Squares	df	Mean Squares	F	Sig
Total estimate of farmers' agreement based on cities	Between Groups (combined)	5.580	3	1.860	85.85	.000
	Within Groups	5.005	231	.022		
	Total		234			

To identify the main source of this difference (LSD) test was used, whose calculated value was (0.032) degrees at the significant level of (0.05), the average agreement of potato farmers in

governorates of Duhok and Irbil were higher than the Sulaimani and Halabja, because in Duhok and Irbil; some non-governmental companies offered potato farmers to some special training course in Iraq and abroad about producing and marketing potatoes to improve the quantity and quality of potatoes due to the point farmers had known the importance of this program for the KRG to be an useful guide for developing farmers' skill and for any other people that have desire to work on potato field or to start work with planting and producing potatoes, on the other hand, the average agreement of potato farmers in Halabja was less than the average of others, because a little farmers in Halabja had started to plant potatoes and they followed the traditional way of producing and marketing potatoes, moreover, they had never been in any special training course about potato production and marketing so they did not believe that how much this program necessary, as it can be seen in (Table 18):

Table 18. Direction (range) of significant differences regarding the suggested program:

Categories	Duhok	Irbil	Sulaimani	Halabja
Mean	2.82 a	2.77 a	2.59 b	2.30 c

4. Conclusion

The results indicate that all scopes and items were kept in the program's final version based on the respondents' agreement extent as potato farmers strongly desired to increase their production in quality and quantity, since in KRG the new generation is consuming a substantial amount of potatoes as a staple meal compared to the past, therefore the demand for good quality potatoes is raising, and it was the farmers' motivation to consider planting and producing potatoes more than before. In addition, potato farming practice has some significant problems and some big-scale potato farmers are suffering from wasting their products due to a lack of marketing knowledge and skills, and they need to be developed with novel techniques and technologies.

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References

Akeredolu, M., 2016. Module 3: Agricultural Extension Programme Management module is developed as part of the New Extensionist Learning Kit. Global Forum for Rural Advisory Services, Switzerland.

Al-Doski, Abid A.H., HamaSalih, Ch. M., 2017. Local Participation Level of Rural Women in Halabja Governorate in Kurdistan Region of Iraq. Zagazig, J. Agric. Res., 44(4), 1449-1456. https://doi.org/10.21608/zjar.2017.52970.

Alex, G., W. Zijp, 2002. Rural extension and advisory services, Rural development strategy background, World Bank, USA.

Andert, S., Ziesemer, A., & Zhang, H., 2021. Farmers' perspectives of future management of winter oilseed rape (Brassica napus L.): A case study from north-eastern Germany. European Journal of Agronomy, 130, 126350. https://doi.org/10.1016/j.eja.2021.126350.

Avila-Vald ´ ´es, A., Quinet, M., Lutts, S., Martínez, J.P., Lizana, X.C., 2020. Tuber yield and quality responses of potato to moderate temperature increase during Tuber bulking under two water availability scenarios. Field Crops Res., 251, 107786. https://doi.org/10.1016/j.fcr.2020.107786.

Baban, S., 2015. "Managing the Impacts of Planned Urbanisation on Sustainable Agriculture in the Kurdistan Region, Iraq", Athens: ATINER'S Conference Paper Series, No: GEL2015-1654.

Baban, S., 2015b. 'Revitalizing Agriculture and Water Sectors in the Kurdistan Region, Iraq', Athens: ATINER'S Conference Paper Series, No: GEO2015-1618.

Caldiz, D.O., Viani, P.G., Giletto, C.M., Zamuner, E.C., Echeverria, H.E., 2018. Improving yield and quality of processing potato crops grown in the Argentinian pampas: the role of N, P and S and their impact on CO 2 emissions. Potato Res. 61, 147–168. https://doi.org/10.1007/s11540-018-9364-5.

Campos, H., Ortiz, O., 2020. The Potato Crop. ISBN 978-3-030-28682-8 ISBN 978-3-030-28683-5 (eBook). https://doi.org/10.1007/978-3-030-28683-5

DIOP, P., SYLLA, E. S., DIATTE, M., LABOU, B., DIARRA, K., 2019. Effect of cut seed tubers and pre-germination on potato tuber yield. Int. J. Biol. Chem. Sci. 13(7), 3157-3163, ISSN 1997-342X (Online), ISSN 1991-8631 (Print).

Gholiniya, M. J., Zarefiyan, Sh., 2004. Consultative process agricultural extension development with emphasis on future mission, Tehran Journal of Agricultural Economics and Development, 6(3),116.

HAMASALIH, Ch. M., NEIMA H. A., HARUN R., HASAN K. J., 2019. Rural women indigenous knowledge of traditional food and household food security in Kurdistan Regional Government, Iraq. ProEnvironment, 12, 257 – 263. http://journals.usamvcluj.ro/index.php/promediu

HAMASALIH, Ch., MOHAMMAD Kh., 2022. Rural Farmers' Participation in Planning Process of Agricultural Extension Management: A Review. ProEnvironment, 15(50), 213–220.

Kanter, R., Walls, HL., Tak, M., Roberts, F., Waage, J., 2015. A conceptual framework for understanding the impacts of agriculture and food system policies on nutrition and health. Food Secure, 7(4):767–777.

Komarek, A. M., de Pinto, A., Smith, V. H., 2020. A review of types of risks in agriculture: What we know and what we need to know. Agricultural Systems, 178, 102738. https://doi.org/https://doi.org/10.1016/j.agsy.2019.102738

Li, Sh., Duanb, Y.,, Guoc, T., Zhangc, P., Hea, P., Johnstond, A., Shcherbakove A., 2015. Potassium management in potato production in Northwest region of China. Field Crops Research, Volume 174, 15 March 2015, Pages 48-54. https://doi.org/10.1016/j.fcr.2015.01.010 http://www.elsevier.com/locate/fcr

Machakaire, A.T.B., Steyn, J.M., Caldiz, D.O., Haverkort, A.J., 2016. Forecasting yield and tuber size of processing potatoes in South Africa using the LINTUL-potato-DSS model. Potato Res. 59, 195–206. https://doi.org/10.1007/s11540-016-9321-0

Meno Laura, Escuredo Olga, Rodríguez-Flores M. Shantal, Seijo M. Carmen (2021). Looking for a sustainable potato crop, Field assessment of early blight management. Agricultural and Forest Meteorology 308-309 (2021) 108617. https://doi.org/10.1016/j.agrformet.2021.108617.

Nassaji. H. (2015). Qualitative and descriptive research: Data type versus data analysis. Language Teaching
Research, 19, 129–132. https://doi.org/10.1177%2F1362168815572747.

Ojeda Jonathan J., Rezaei Ehsan Eyshi, Kamali Bahareh, McPhee John, Meinke Holger, Siebert Stefan, Webb Mathew A., Ara Iffat, Mulcahy Frank, Ewert Frank, 2021. Impact of crop management and environment on the spatio-temporal variance of potato yield at regional scale. Field Crops Research 270 (2021) 108213. https://doi.org/10.1016/j.fcr.2021.108213.

Pinstrup-Andersen P., 2014. Food systems and human nutrition: relationships and policy interventions. In: Thompson B, Amoroso L (eds) Improving diets and nutrition: food-based approaches (Chapter 2). CABI, Wallingford, pp 8–20.

Prasad, S. V., & Reghunath, K. P. (2011). Evaluation of safety performance in a construction organization in India: A study, ISRN Civil Engineering, 2011, Article ID 276545, 3pp. https://doi.org/10.5402/2011/276545.

Raymundo, R., Asseng, S., Prassad, R., Kleinwechter, U., Concha, J., Condori, B., Bowen, W., Wolf, J., Olesen, J.E., Dong, Q., 2017. Performance of the substor potato model across contrasting growing conditions. Field Crops Res., 202, 57–76. https://doi.org/10.1016/j.fcr.2016.04.012.

Rivera, W.M., Sulaiman, V.R., 2009. Extension: Object of Reform, Engine for Innovation. Outlook on agriculture 38 (3), 267–273. https://doi.org/10.5367/000000009789396810.

Taylora, James A., Chena, H., Smallwoodb, M., Marshall, B., 2018. Investigations into the opportunity for spatial management of the quality and quantity of production in UK potato systems. Field Crops Research, 229 (1), 95-102. ISSN 0378-4290. https://doi.org/10.1016/j.fcr.2018.10.002.