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Analysis of the Influential Factors on the Crop Rotation Implementation by the Farmers Case Study: Gorgan Township

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Abstract: Crop rotation as the oldest and the most influentioal strategy of crop production includes the cultivation operations of a set of different types of crops in a region and throughout the consecutive seasons to acquaire advantages such as discontinuance of the growth of pathogenic factors, pests, improvement of the soil texture and fertility. But evidences show that the crop rotation advantages as a necessary operation in sustainable agricultural systems have been neglected. The aim of this research is determining the influential factors on implementing crop rotation by the Gorgan township farmers. The research has been of descriptive and correlative type and the statistical population included all the Gorgan towonship farmers of the Gorgan province, whose population is estimated as being 4000 persons according to the available data. Some 351 individuals from this figure have been selected as the research sample using the simple random sampling method. The research tool has been quastionaire, the content validity of which has been estimated thorough intreviwes with agronomy and agricultural extension experts, followed by modification of the quastionaire according to the outcome of their views. The Cronbach alfa coefficient value of the research tool reliability was 0.88. The data analysis has been efected using the SPSS statistical software. The factor analysis results showed that the supportive and agro-ecological factors respectively are among the most important factors definitive of the changes in research variables. Supportive measures regarding cultivation of the recommended crops in the township crop rotation pattern such as guaranteed crop purchasing; supplying the inputs, loan endowment and implementing policies concerning the crop price stability are among the recommendations of the research.

Key words: Crop rotation · Supportive factors · Agro-ecological factors · Gorgan Township · Golestan Province

INTRODUCTION

One of the crucial aspects of the sustainable development is the sustainable agriculture. The sustainable agriculture has been emerged as a system guaranteeing both the environmental health and economical durability. Developing and accepting technologies for acquiring economical benefits by the contemporary agriculture frequently has led to ignoring the environmental and social costs [1]. The sustainable agriculture is not a mere simple or closed pattern to be imposed, but rather a kind of learning process. The sustainability is meeting the requirements of the present generation without pressuring the future generations for meeting their needs. Hence, it can be said that the sustainability is a call for accessing to a dynamic balance between the social, cultural, economical and political factors with emphasis on the necessity of preserving the natural environment the human being is an integral part of. What is in fact sought out is preparing the conditions in which the human being security is provided for all. The sustainability in practice is the equation between the environmental and developmental requirements. Such a balance will be accessible through two means: Easing the pressures and increasing the present potentials. A sustainable agriculture is one promoting the quality of the environment and the basic resources which the agriculture is dependent to in long term, providing the people with the essential food and fibrous requirements, as well as being economically dynamic enough to promote the life quality of the farmers and the society as a whole. The sustainable agriculture is

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a system economically dynamic, ecologically consistent and socially agreeable. The sustainable agriculture system is actually the product of a kind of management strategy capable of aiding the farmer in selecting the right varieties, cultivated varities, the soil fertility, implementing the suitable ploughing methods, properly adjusted crop succession to decrease the consumable inputs costs, minimizing the unfavorable impacts onthe environments, providing sustainability in production and creating profitability [2].

The crop rotation as a soil management mechanism in sustainable agriculture is the sequencial cultivation of two or several agro-plants in a farm, so that they are cultivated subsequently. Crop rotation shares in sustainable agriculture production systems [3]. Crop rotation is a kind of planning for cultivation of certain plants on a land. Also it means replacing and subsequent cultivating different plants from the type, species, variety, etc. point of view. This crop succession can be for two or three years or longer [4]. Although through the previous decades the crop rotation advantages have been practically ignored by most of the farmers and using chemical fertilizers, herbicides and breeder varieties and mechnised agriculture has caused decrease in sequential rotation implementation across the farms [5,6], the crop rotation is still a necessary operation in sustainable agricultural systems [7,8]. Expanding the rotations has been due to realizing the fact that cultivation of a crop in sequence with other crops produces higher performance in comparison with its continuos cultivation. This increase in performance is often compensated by decrease in the number of times a particular crop is cultivated in rotation. While the drop of performance in continuos cultivation or in improperly adjusted rotations causes land fatigue. In such a situation due to the decrease of the crop resistance against the pests and diseases, the crop growth diminishes and ultimately results in decreasing the performance over again. Shortage and imbalance of the nutrients, the impact of the residues of a crop on the next crop due to producing a wide range of poisonous compounds as well as the allelopathy (the hindering effect of the poisonus secretions of a plant root on the growth of other plants) are among the main factors of the land fatigue [9].

The rotation provides the possibility of various cultivation operations in deifferent times. Hence, no weeds can pervail. Also, research has shown that a combination of good rotation and special cultivation operations has managed controlling some of the soil inhabitant destructive diseases. From other advantages of the crop rotation, controlling the soil erosion, ensuring a balanced working program throughout the year, preventing or limiting the maximum need for water and irrigation periods, preserving the soil moisture from a season to the other and flexibility against changing the market conditions can be mentioned [3].

Crop rotatopn is a global ancient management method which would improve the performance of the agro-systems, according to the most agronomy researchers' consensus. Improving the root activities, enhancing the physical, Chemical and biologic properties of the soil [10,11], reducing the plant diseases [12,13], reducing the Nematode damage [14], decreasing the weed population [15-18], reducing the erosion, provisioning the Nitrogen, enriching the soil organic materials, moisture storage [19], are among the positive effects of the crop rotation. Although some of the agro-environmental factors like the weather conditions, the soil specifications, the quality and quantity of the irrigation and communication means availability in the region are definitive as regards to the success possibility of growing different plants, every farming unit has nevertheless its own special conditions and implementing a limited number of rotations would be possible in it.

Poechman [20] says one of the advanatages of cultivating different plants for the farmer is that when activity diversity exists, the farmer's work load is distributed within the year, but in case a broad area of the farm is caultivated with a single crop, there would be a high work load in harvesting time. Pill [4] believes that for some reasons as applying managerial skills, the complexity of the work and implementing additional plans, the crop rotation may be undesirable to some farmers. Zilstra's [11] belief is that the crop rotation must enjoy flexibility feature when selection. Long term use of the manures or crop rotation ensures increase in the soil fertility, improving the water permeability and enriching the soil organic contents.

Mowat and Spackman [21] conclude in their research that the cultivation deceisions depend on different managerial elements like the soil vegetation cover, weed control, the product price, the farming machinery inventory and the work force. Lohr [22] cites the farmer deceision making about the cultivation pattern as dependent to the market conditions. Ayeenehband [1] beleives that the set of factors to be considerd in designing a sequential pattern of the agro-plants include the soil related factors (type of the organic material, the soil fertility, the water provision, the physical properties and the poisonous materials), the biological factors

(agricultural history, the weeds, natural resources, pests and diseases, domestic animals), climatic factors (temperature, the light, meteoric waters, the vaporation and condensation, micro climate), physical factors (constructional equipments, mechanization, intermediary industries, financial resources, storage) and the human being factors (roural population, knowledge and interests of the farmer, extension, local markets, local cooperatives). The Tenaken and Bel's [23] study results showed that the cultivation options by far depends on the farmer's preference, kind of the soil, pests and diseases, the rainfall volume, the machinery and workforce availability, the denand volume for the crops and the available technology. Khajehpour [24] has mentioned the infuential factors on the selection of the set of cultivation crops and implementing crop rotation on the farm level as including the water economy, the irrigation, the land productivity, the soil erosion control, the weed control, the pests and diseases, the work force and machinery distribution, the socio-economic factors such as the price, the sale, the population and the demand fluctuations, the transportation facilities, the work force availability and the competition with other crops, the farmers experience and habits and the geographical and climatic factors. Dogliotti *et al.* [25] concluded from their study that the farm resources inventory including the mechanization level, the irrigation water, the quality of the inputs, domestic animals production activity, gaining interests, the farmer's management skills, market specifications and type of the farmer's relationship with the market affect the planning procedure of the cultivation activities.

Selecting and implementing the crop rotation has always been one of the farmers and farming managers' concerns. It is evident that selection and implementation of a kind of crop rotation with positive effects on the preservation, fertility and erosion prevention of the soil, meanwhile guaranteeing a suitable income for the farmer is of utmost importance. In the present conditions, it seems that the farmers select their crop rotation system type more likely based on the factors such as traditional norms, habits, convenience, imitation, the product price, escaping from the risks and calamities and less on the scientific bases. In such a condition the programming system of the agriculture sector support faces problems as regards to the supplying the inputs and the extensional, technical and credential services. In case the influential factors on the farmer's selection concerning the crop rotation system type could be recognized and each factor's share could be specified, the future behavior of the farmer as regards to his selections could be predicted and reported to the farming sector management system; so that it's planning activities would be affected with more realistic perspective. Moreover, it would be possible to more effectively assist the implantation of the crops cultivation patern policy. Accordingly, the overall purpose of this research is determining the factors influentil on the crop rotation implementation by the Gorgan township farmers.

MATERIALS AND METHODS

This research has been of descriptional (non-testing) type. The statistical population of the research included all the Gorgan township farmers of the Golestan province, the number of which being 4000 people according the present data, from which 351 persons have been selected using the Krejcie and Morgan [26] table through simple random sampling as the research sample. The research tool was a questionneir prepared based on the goals, assumptions and questions of the research. Content validity of the research tool has been modified and confirmed through interviews with agronomists and agricultural extension experts. The Cronbach Alfa coefficient value regarding the reliability of the research tool was 0.88. Data analysis has been carried out using SPSS statistical software and the statistical tests included the descriptioanl statistics method and factor analysis.

RESULTS AND DISCUSSIONS

Personal and Economical Specifications of the Surveyed People: The results gained regarding the personal and economical specifications of the farmers showed that most of them aged between 45 years old, their average previous record of farming work reached about 24 years and they averagely possessed above 2 hectares of rainfed lands and 5 hectares of irrigated farming lands. Their average area of under cultivation areas were 7 hectares and the average area of their land pieces reached about 2.5 hectars and they averagely cultivated about two crops in them.

Considerations the Farmers Take into Account in Selecting the Crop Rotation Plans: Taking notice to the mean ranking values, the main considerations most of the under survey farmers paied attention to in selecting a crop rotation plan included gaining more profits, performance of each crop, the financial status and the costs of crop cultivation, the water volume needed for the crop and the selling price of the crops respectively. It can be said

Table 1: Summary of some background characteristics of farmers under study

Variables	Name	Values
Age	Mean	45.00
	SD	11.46
	Max	76.00
	Min	23.00
Agricultural work record	Mean	23.82
	SD	14.99
	Max	60.00
	Min	1.00
Rainfed areas (Ha)	Mean	2.21
	SD	6.13
	Max	50.00
	Min	0.00
Irrigated areas (Ha)	Mean	4.87
	SD	4.72
	Max	20.00
	Min	0.00
Under cultivation areas(Ha)	Mean	7.01
	SD	7.12
	Max	50.00
	Min	0.00
Number of land pieces	Mean	2.56
	SD	2.04
	Max	11.00
	Min	0.00
Number of crops	Mean	1.93
	SD	1.20
	Max	5.00
	Min	0.00

therefore that the main consideration the farmers took into account in selecting a crop rotation plan was "economical considerations". Production of feed crops such as straw, stubble and forage for the domestic animals, the crop compatibility with the irrigation used in the farm, the familial work force availability and the crop insurance are attached less important considerations among the farmers in selecting the crop rotation plans. The important point is that the considerations related to the "sustainable agriculture" like the pests and diseases control, the weed control possibility, the compatibility of the crops with the farm soil, the soil destruction prevention and the crop residues production for enhancing the soil fertility (fertilizer production) are also among the less important considerations amid the farmers in selecting the crop rotation plans, reminding the necessity of the farmers education in the grounds relating to the sustainable agriculture and changing their attitude.

Factor Analysis: Factor analysis is a method assisting in precisely defining the study variables as well as describing the level of relationship between the variables and the desired specification value. As a result of the factor analysis in this research, the Bartletts test with acceptable significance level indicates the appropriateness of the data for the factor analysis. Besides, the KMO value (0.78) shows the suitability of the variables for the factor analysis.

To determine the number of factors based on the Kaiser measure, those factors were accepted that their eigen value were considerably higher than 1. Hence, as can be seen from Table 3, some 11 factors whose specific value were higher than 1 were exploited.

It must be mentioned that the eigen value indicates the share of each factor from total of the factors' varrations and the higher its value is, the more its importance and influence would be. As it can be seen from the above Table, the first factor has the highest share (%22.553) and the eleventh factor has the lowest share (%2.504) in the description of the overal variation of the variables. Also, six factors mentioned above have described %77.7 of the overal variation of the varriables. For factor rotation, the Varimax method has been used and as a result, the variable relating to each factor was specified together with its factor load. Based on the Table (4), each one of the exploited factors had the following variables: Thoes varribles relating to the first factor include the guaranteed purchase of the crops (X26), loan endowment (X27), supplying the inputs (X28), price stability and minute fluctuation of the price (X31). The nature of the variables relating to this factor suggests that they could be nominated as the "supportive factor". The variables relating to the second factor include the crop compatibility with the regional climate conditions (X5), the plant root specifications (X6), the crop compatibility with the farm soil and the soil destruction prevention (X7), possibility of the weed control (X11), the pests and diseases control (X12) and the farmers having the required experience, knowledge and skills about the crop cultivation (X21). This factor considering its variables has been nominated as "agro-ecological" factor. The variables consisting in the third factor include the operations before the crop cultivation(X32), crop protection management (X33), harvesting operation (X34), transportation facilities for supplying the crops to the market (X38) and unfamiliarity with other suitable regional crop rotation plans (X40), considering the nature of the which the it was nominated as "farming affairs management". The variables related to the forth variable

Table 2: The respondents' views regarding the considerations in selecting a crop rotation plan

Considerations	Mean Ranking Value*	SD	Priority
Gaining more profit	4.27	0.94	1
Performance of the crops	4.21	0.66	2
Finantial status and the cultivation costs	4.20	0.88	3
The water volume needed by the crop	4.17	0.84	4
Selling price of the crops	4.13	1.03	5
Popularity of cultivation of a crop in the region	4.09	0.78	6
Demand for purchasing the crops in the consumer markets	4.07	1.03	7
Availibility of the inputs (seeds, poisons, etc.)	4.07	0.99	7
Guarranteed purchasing of the crops	4.02	1.06	8
Observing the experts recommendations	4.00	0.87	9
The price stability and minute fluctuation of the crops' prices	3.96	1.03	10
Possessing the experiences, knowledge and skills required for cultivation of a crop	3.94	0.85	11
Availability of the required machinery and tools	3.86	0.84	12
Supplying the inputs	3.86	1.17	12
The facilities required for transportation of the crops to the market	3.85	0.92	13
Compatibility of the crops with the climate conditions	3.83	0.85	14
Facilities reqired for processing of the product	3.81	1.14	15
Supplying the required education and extensional recommendations	3.75	0.97	16
Getting used to the previous rotations	3.73	0.85	17
Quality of the water required by the crops (salinity, etc.)	3.67	1.23	18
Supplying the family feeding requirements	3.60	1.23	19
Availability the local work force	3.51	0.91	20
Pre-cultivation operations (land preparation, plowing, etc.)	3.49	1.02	21
Crop protection management (weedeing, fertilizing, poison spraying)	3.34	0.96	22
Harvesting management (number of mowing times, harvesting procedure, etc.)	3.32	0.90	23
Possibility of loan endowment	3.31	1.29	24
Pests and disease control posibility	3.31	0.85	24
Weed control possibility	3.28	0.87	25
The crop influence on the soil fertility (such as cereals)	3.27	0.97	26
The area under cultivation of the selected crop	3.26	0.97	27
The presence period of a plant in the soil (perennial crops cultivation possibility in the farm)	3.25	1.10	28
Unfamiliarity with other suitable crop rotation plans in the region	3.25	0.96	28
The crops compatibility with the farm soil and soil destruction prevention	3.21	0.96	29
Crop residues production for enhancing the soil fertility (fertilizers)	3.20	0.98	30
Possibility of the crops storage and preservation	2.98	1.00	31
The plant root specifications (the root depth, etc.)	2.92	0.98	32
The crop insurance	2.85	1.36	33
Availability of the familial work force	2.77	1.19	34
Compatibility of the crops with the farm irrigation system	2.73	1.08	35
Straw and stubble production for feeding of the domestic animals	2.64	1.11	36

*The mean amplitude lies between 1 and 5

Table 3: The KMO value and the Bartlett's test results

Bartlett's test		
Significance level	Sphericity test	KMO
0.00	11889.90	0.72

Table 4: The number and the share of the exploited factors

Factor	Eigen value	Variation percentage of the eigen value	The cumulative frequency of the eigen value variation percentage
1	9.02	22.55	22.55
2	6.26	15.67	38.22
3	3.47	8.69	46.91
4	2.81	7.04	53.96
5	1.88	4.71	58.67
6	1.65	4.12	62.79
7	1.41	3.54	66.34
8	1.28	3.22	69.56
9	1.22	3.04	72.61
10	1.05	2.63	75.24
11	1.00	2.50	77.75

Table 5: Variables related to each value and coefficients gained from the rotated matrix

Factor name	Varriables	Coefficients value (the factor loads)
First factor (supportive factor)	X_{26}	0.88
	X_{27}	0.72
	X_{28}	0.88
	X_{31}	0.88
Second factor (agro-ecological)	X_{5}	0.58
	X_{6}	0.60
	X_{7}	0.69
	X_{11}	0.70
	X_{12}	0.62
	X_{21}	0.77
Third factor (farming affairs management)	X_{32}	0.65
	X_{33}	0.80
	X_{34}	0.76
	X_{38}	0.51
	X_{40}	0.57
Forth factor (inputs availability)	X_{19}	0.80
	X_{20}	0.64
	X_{23}	0.66
	X_{43}	0.55
Fifth factor (storage and processing facilities)	X_{24}	0.79
	X_{37}	0.71
Sixth factor (security-behavioral)	X_{18}	0.62
	X_{30}	0.64
	X_{41}	0.54
Seventh factor (irrigation system)	X_{8}	0.77
	X_{9}	0.76
	X_{10}	0.62
Eighth factor (soil fertility)	X_{16}	0.81
	X_{17}	0.78
Ninth factor (cultivation facilities)	X_{13}	0.79
	X_{22}	0.58
Tenth factor (forage production)	X_{25}	0.74
Eleventh factor (regional cultivation pattern)	X_{39}	0.74

included the availability to the required machinery and tools (X19), availability of the inputs (X20), availability of the local work force (X23) and observing the experts recommendations (X43). Considering the nature of the variables, this facter was nominated as "availability of the inputs". The variables in the fifth factor include the storage of the crops (X24) and the facilities required for the crop processing (X37). Considering the nature of the fifth factor varriables, this factor was nominated as "storage and process facilities". The variables present in the sixth factor include supply of the familial feeding needs (X18), the crop insurance (X30) and getting used to the previous crop rotation programs (41) and considering the nature of these variables, the factor was nominated as "security-behavioral" factor. The variables relating to the seventh factor include the required amount of water for the crops (X8), the water quality (X9) and the compatibility of the crops with the irrigation system of the farm (X10), based upon the nature of which, the factor was nominated as the "irrigation system". The variables included in the eighth factor were producing the crop residues for fertility of the farm soil (X16) and the crop influence on enhancing the soil fertility (X17), considering the nature of which, the factor can be nominated as the "soil fertility". The variables present in the ninth factor include the selected crop cultivated area (X13) and availability of the familial work force (X22), based on the nature of which, the factor was named as "cultivation facilities". The variable present in the tenth factor was the production of feed crops such as straw, stubble and forage for the domestic animals (X25), considering the nature of whih it was nominated as "forage production". The variable included in the eleventh factor is the prevalence of a crop cultivation in the region (X39), considering the nature of which, was nominated as "regional cultivation pattern". All the above mentioned factors in sum described and assigned to themselves %77.7 of the total variation of the variables and the remaining %22.3 of the variation relates to the other factors that could no be predicted. Taking into account the eigen values and the variation percentage of the eigen value, it can be concluded that the supportive and the

agro-ecological factors are the most important factors describing the changes of the research variables respectively. The results gained showed that most of the farmers are middle-aged and highly experienced in farming work. The farmer experience is an important factor in implementing the crop rotation plans. Limited diversity of the crops they cultivate indicates that the cultivation variety and inserting different crops in the production system and consequently, applying different crop rotations does not maintain an appropriate position in their production activity, making chang of their professional behaviour a must. The main consideration for the farmers in choosing their crop rotation plan is "economical considerations" and the considerations relating to "sustainable agriculture" such as the psts and disease control, the possibility of weed control, the compatibility of the crops with the farm soil and the soil destruction prevention, production of the crop residues for the farm soil fertility (fertilizer production) are from the less important considerations among the farmers in selecting the crop rotation plan. This propounds the necessity of the farmers education as regards to sustainable agriculture an making change in their attitudes. The factor analysis showed that the supportive and agro-ecological factors respectively are the most important factors describing the changes of the research variables.

Recommendations:

- Taking into notice the suitable effect of the crop rotation implementation program of legume and cereals on the soil fertility and decreasing the consumption of nitrogenized fertilizers in line with achieving the sustainable agriculture goals and considering the fact that most of the farmers implement the said crop rotation program in their farms, it is recommended that for continuation of this professional behavior, the necessary actions are taken as regards to suitable planning for supporting and encouraging this group of farmers through providing them with technical and extensional services, granting low interst loans, crop insurance, seeds with suitable quality, etc.
- As the product performance is one of concerns of most of the farmers in selecting a crop rotation plan, it is recommended that strict attention is paid to the crop performance category and introducing high yield crops to the farmers throughout the research programs and local cultivation pattern policies.
- Since gaining more profits is one of the impotant considerations among most of the farmers in selectinfg a crop rotation plan, it is recommended that the necessary measures are taken ragarding implemeting an equitable and real pricing system for the agricultural crops as well as empowering the agricultural coperatives and establishing regional and local markets for presenting agro-crops.
- As the water volume needed for the crops is one of the major concerns of the farmers in selecting a crop rotation plan, it is recommended that in research programs and introducing the new varieties to the farmers, strict attention is paied to the issue of water requirement and supplying the cultivation water, together with due attention to the type of the cultivated varieties.
- Taking into account the effect of the selling price in selecting the crop rotation plan, it is recommended that strict attention is paid to training of the farmers concerning the supply and demand mechanism in different times and creating the market status prediction skill in them and consequently increasing their deceision making ability as regards to their crop rotation plan. Also the necessary actions must be taken regarding adopting the market control policies, removing the mediators, crop guaranteed purchasing and market research to the aim of developing and extending appropriate crop rotation and regional cultivation patterns.
- As the financial status and the required costs for crop cultivation is a consideration the farmers expressly take note of in selecting the crop rotation type, it is recommende that the finantial and banking facilities are vested in them within the shortest time and the lower interest rates of return possible, aiming at empowering the farmers' financial power and supplyinng them with the required costs for crop cultivation. Also serious attention must be paid to educating the farmers as regards to using and the spending procedure of the facilities.
- Concordant with providing the recommendations relating to the crop rotation patterns in the township and encouraging the farmers as regards to implementing such recommendations, the necessary supportive measure must be taken regarding cultivating the recommended crops, including guarranted purchasing of the crops, upplying the inputs, lown endowment, price stability and minute fluctuation of the prices.

- In recommendations relating to the pattern and system of the crop rotation, strict attention must be paid to aspects like compatibility of the crops with the township climate, compatibility of the crops with the farm soil and soil destruction prevention, the pests and diseases control possibility, the farm weed control possibility and the farmer's experties, knowledge and skills as regards to the recommended crops cultivation.

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