Improving the Ecological Sustainability by Applying the Appropriate Cultivars of Rice: Using AHP

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This study is a survey research. The population of the study was all specialists who have enough data about ways of sustainability rice cultivars that they were identified and studied through Non-probability sampling (purposeful and snowball). To determine the validity of the questionnaire, face and content validity was used, and, to assess the reliability, inconsistency coefficient was used. In order to achieve the main objective the technique of the Analytic Hierarchy Process (AHP) was used. The Expert Choice (EC) 2000 software was used to analyze the data. The application requirement of Analytic Hierarchy Process technique is considering the criteria sustainability of rice cultivation system, on the one hand, and decision alternatives (rice cultivars) on the other hand. Research findings showed that the cultivar of Hashemi is the most suitable cultivar for ecological sustainability of rice cultivation system. **[Moumeni-Helali, H., Ahmadpour, A and Poursaeed, A. Improving the Ecological Sustainability by Applying the Appropriate Cultivars of Rice: Using AHP. International Journal of Agricultural Science, Research and Technology in Extension and Education Systems, 2013; 3(1):13-18]**

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1. Introduction

Nowadays scientists, scholars, politicians, informed consumers, producers, and ecologists (fan of the Environment) all over the world have raised their protesting voices against conventional farming. That is because attempts for maximizing crop yield per a hectare due to indiscriminate use of chemical inputs in industrial agriculture led to catastrophes that endanger the life on Earth in the long term (Maleksaeedi and et al, 2009). In other words, the growing need to expand agricultural production and to achieve an appropriate level of food security led to excessive consumption of chemical fertilizers and pesticides (Osku et al, 2007) which resulted in the Green Revolution (Kassie and Zikhali, 2009).

The evidences indicate that rice yield growing in Asia , has rapidly dropped in the 1980s, from annual growth rate of 2.6% in the 1970s to 1.5% in early 1981(Kassie and Zikhali, 2009). And, since rice is a major crop and staple food of more than half of the world's population, that has been considered as one of the most important human foodstuffs since ancient times, it is to be concerned (Bahrami, 1998). In response to the challenges caused by the Green Revolution, in recent decades , especially in recent years, new attitudes and perceptions known as stable agriculture have been formed on the correct , appropriate, and stable utilization of basic resources . In fact, stable system of agriculture is the result of an administrative strategy . This stable system of agriculture can help farmers in choosing appropriate varieties and cultivars , fertility of the soil , implementing proper ploughing techniques, proper sequencing of plants to reduce the cost of inputs used, minimizing the adverse effects on the environment , providing stability in production and creating profitability (Arabioun et al, 2009), that one of its main aspect is ecological. One of the conditions to achieve stability in agriculture is appropriate use of cultivars. As seed (cultivar) is the basic, essential and vital input for stability in agricultural production growth (ICAR, 2010).

On the other hand, it must be noticed that agriculture is a process that is struggling with the issue of risk and lack of uncertainty every moment of time; because it has a feature that is related to nature which is not under farmers' control. The market also has a great impact on agriculture and will be determined by factors beyond their control (Emadzadeh et al, 2009). Therefore, such a complexity, extension and variety of the activities of a large production unit reveals the need to use

appropriate methods and tools for planning and decision making to determine the optimal level of production and composition of different activities of a firm (Akbari et al, 2005).Therefore, with a systemic look at agricultural sector the importance of using modern and efficient techniques in planning will be determined, in a way, that can assess all factors influencing policies of the sector and its economic impact on separate models for different sectors of agriculture (Asadpour et al, 2005). One of the methods used in planning is using Analytic Hierarchy Process (AHP). AHP is recommended in decision making for solving agricultural problems (Khosravi et al, 2011) and analyzing agriculture's stable systems (Lopez and Requena, 2006). So, this technique can help practitioners and planners to use it and does a proper planning take steps toward sustainability of agricultural activities. Therefore, the present study was to consider the ecological sustainability criteria and using analytic hierarchy process technique (types of multi-criteria decision making) to identify the most appropriate cultivar (*Hashemi, local Tarom, Neda, Fajr, Khazar, Shirudi*) for sustainability of rice cultivation system. The other goal is prioritizing ecological sustainability criteria with regard to the sustainability of rice cultivation system. Several studies were conducted in agriculture using Analytical Hierarchy Process that some of the researches that were conducted in conjunction with agricultural stability will be mentioned below.

In a survey by Poursaeed (2010) entitled "Partnership models of sustainable agricultural development in Ilam province based on multi-criteria decision-making models" The results showed that the environment dimension is very important for sustainability of agricultural activities. In another survey by Poursaeed et al (2010) entitled "Partnership models sustainable agricultural development based on multi-criteria decision making in Iran" done, The results show that reducing immigration of farmers, share of agricultural engineer, mix the ground, raise awareness of farmers, crop rotation, the use of small amounts of fertilizer, the use of small amounts of chemical pesticides, fertilizer recommendations, optimal allocation of important criteria for agriculture sustainable in Iran.

In a survey by Rezaee-Moghadam and Karami (2008) entitled "A multiple criteria evaluation of sustainable agricultural development models using AHP", the results show that the ecological criteria, including prudent use of resources, environmental protection and product quality are the most important criteria for sustainable agriculture in Iran.

In a study by Lopez and Requena (2006) entitled "A Multi-Functional Comparison of conventional versus alternative olive systems in Spain by using analytic hierarchy process" the analytic hierarchy process based on the main criteria of economic, technical, cultural-social and environmental and some other criteria indicated that the system of organic farming and integrated farming system is more valuable than conventional system.

In a survey by Kallas et al (2012) entitled "How Important Are Cultural and Environmental Objectives for Rice farmers in South Senegal?" Done, in their study of the Analytical Hierarchy Process to the priority assess farmers have used the program. Results indicate that farmers tend to use less chemical fertilizers to reduce costs and protect their environment.

2. Materials and methods

This study is a kind of survey and applied research. The statistical population of the present study includes all experts having enough knowledge in aspects of stability and rice cultivars that through Non-probability sampling (purposeful and snowball) 16 cases were identified and studied. The research questionnaires, as research tool, were given to them to fill out. To determine the validity of the questionnaire, face and content validity was used, and, to assess the reliability, inconsistency ratio was used. The questionnaire was designed in accordance with the research topic, in a way that, initially pairwise comparison of criteria. Similarly, the alternatives were two by two compared with respect to each criterion which will lead to the identification of the most proper cultivar. Hierarchical connection method of the goal (Sustainability of rice cultivation system), ecological sustainability criteria (less frequent use of the plough and furrow, less use of chemical pesticides and chemical fertilizers, more use of bio-fertilizers, more save water use, more use

of biological control) and alternatives, by local names (Iranian names) (cultivars including: *Hashemi, Local Tarom, Neda, Fajr, Khazar, and Shirudi*) can be seen in figure 1. It must be notified that cultivars that were planted in the city of Babol (Agriculture-Jihad Management Babol Township, 2012) as alternatives present study was chosen because the city of Babol of other cities in Iran has the largest area under cultivate rice.

The scale of all criteria and alternatives in this study are qualitative. Questions asking from specialists were raised in two parts. At first, the specialists were asked to compare the importance of criteria with regard to the goal, and then, they were asked to compare the alternatives (cultivars) with respect to each criterion. For paired comparison of criteria and alternatives the range of 9 was used (table 1). Comparison of criteria and alternatives and their scoring must obey special rules. Therefore, the inconsistency rate is used for accuracy of judge. In a way that inconsistency rate judgment to 0.1 is acceptable. The geometric mean is used to combine expert opinions because in this study the analytic hierarchy process group method, ideas of more than one person, was used. And, at last, to analyze the data Expert Choice (EC) software was used. Expert Choice software provides the possibility of calculating AHP in five steps (Ghodsipour, 2012):

1. Hierarchical construction:

Any decision in the EC begins with a model in the form of a hierarchy or tree. A simplest hierarchy is consisted of three levels: goal, criteria, and alternatives.

2. Paired comparison:

Paired comparison is a process for comparing importance, preference or magnification of two elements to a higher level element.

3. Synthesis:

In this action the final weight of each item is determined from paired comparisons.

4. Sensitivity Analysis:

Ranking process applies when the number of alternatives is large (hundreds of choices). Since the number of choices of the present study is limited, paired comparison is used.

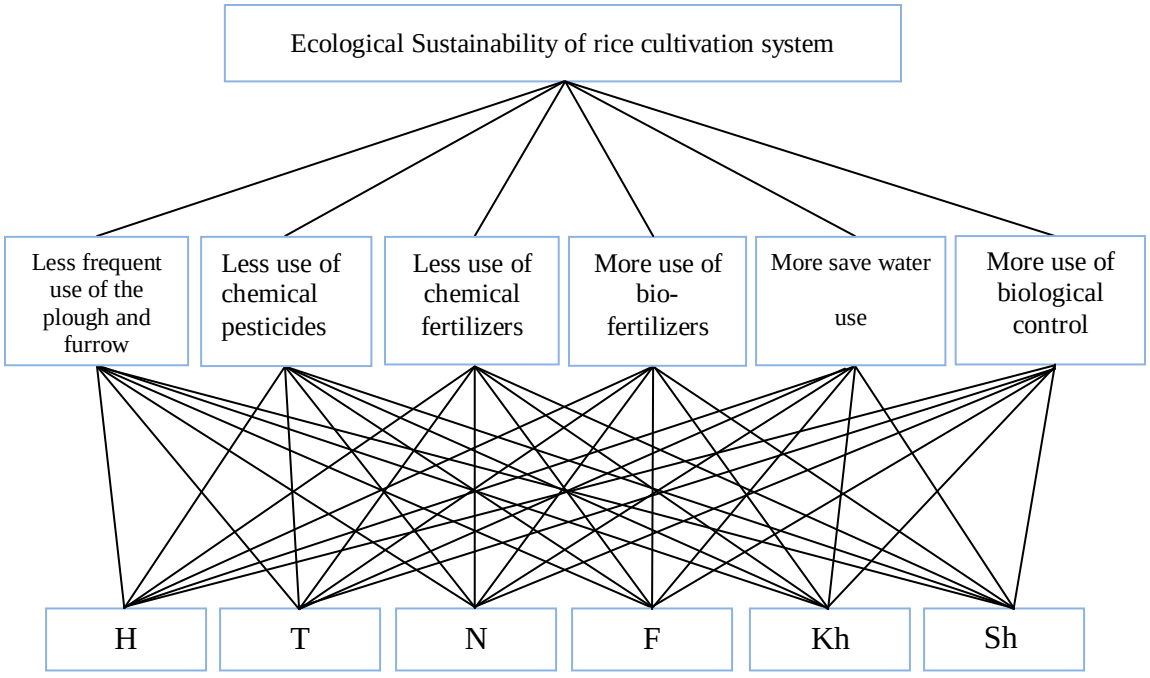

Figure 1. Conceptual model of research

Table 1. Scale of Measurement for the AHP

Importance	Numerical Value
Equally important	1
Moderate more important	3
Strongly more important	5
Very strongly more important	7
Extremely more important	9
Intermediate values	2,4,6,8

3. Results and discussion

3.1. Prioritization of sustainability criteria for sustainable rice cultivation system

According to table 2 less use of chemical pesticides/ha, less use of chemical fertilizers/ha and more use of biological control, respectively, as the main criteria for ecological sustainability are. Less frequent use of the plow and furrow, more save water use and, more use of bio-fertilizers respectively, as the less important criteria for ecological sustainability are.

3.2. Identification of the most Appropriate Cultivar for sustainable rice cultivation system

According to table 3, according to the criteria of less use of chemical pesticides/ha, *Hashemi* cultivar is the first priority.

Table 2. Prioritization of ecological criteria in the sustainability of rice cultivation system in the city of Babol

Criteria	Percent	Rank	IR*
Less use of chemical pesticides/ha	41.0	1	0.06
Less use of chemical fertilizers/ha	18.6	2	
More use of biological control	13.5	3	
More use of bio-fertilizers	11.1	4	
More save water use	10.3	5	
Less frequent use of the plow and furrow	5.4	6	

*IR: Inconsistency Ratio

According to the criteria of less use of chemical fertilizers/ha, *Tarom* cultivar is the first priority. According to the criteria of more use of biological control, *Tarom* cultivar is the first priority. According to the criteria of more use of bio-fertilizers, *Neda* cultivar is the first priority. According to the criteria of more save water use, *Tarom* cultivar is the first priority. According to the criteria of less frequent use of the plow and furrow, *Tarom* cultivar is the first priority.

Table 3. Prioritizing rice cultivars according to ecological sustainability criteria for the sustainability of rice cultivation system in the city of Babol

Criteria respectively priority	Rice cultivars respectively priority and their percentage*						IR**
	1	2	3	4	5	6	
Less use of chemical pesticides/ha	H	T	F	N	Kh	Sh	0.06
	33.7	23.0	13.1	13.1	9.1	8.0	
Less use of chemical fertilizers/ha	T	H	Sh	Kh	N	F	0.06
	39.9	30.2	9.7	7.8	7.4	5.0	
More use of biological control	T	H	N	F	Kh	Sh	0.24
	33.7	31.7	18.9	8.2	5.0	2.5	
More use of bio-fertilizers	N	Kh	F	Sh	H	T	0.02
	21.6	18.8	16.4	14.8	14.3	14.0	
More save water use	T	H	F	Kh	Sh	N	0.1
	38.5	31.5	10.1	8.0	6.9	5.2	
Less frequent use of the plow and furrow	T	N	Kh	Sh	F	H	0.00
	19.0	17.5	16.4	16.1	15.9	15.1	
Overall	H	T	N	F	Kh	Sh	0.06
	27.9	26.4	14.1	11.8	10.5	9.3	

*Rice cultivars (Iranian names): H: *Hashemi*, T: local *Tarom*, N: *Neda*, F: *Fajr*, Kh: *Khazar*, Sh: *Shirudi*
**IR: Inconsistency Ratio

4. Conclusion and Recommendations

Stable agriculture is a concept while considering different aspects is based on ecological dimensionThe most important and the most insignificant ecological factors concerning stabilizing rice cultivation system are less use of chemical pesticides and less frequent use of plough and furrow, respectively. In addition, the efficiencies of different rice cultivars are identified with the emphasis on ecological criteria concerning stabilizing rice cultivation system . Overall, the *Hashemi* cultivar weighs more than the other cultivars; therefore, we can conclude that *Hashemi* cultivar is considered as the most proper cultivar in stabilizing rice cultivation system.

Since the *Hashemi* cultivar for ecological sustainability of rice cultivation was identified as most appropriate cultivar. Therefore, it is suggested that decision makers make efforts in developing and cultivating the *Hashemi* cultivar. In this regard , it seems that rice supervisors, who are in direct contact with the rice farmers during the growing season and provide farmers with consulting services , are the most appropriate individuals for encouraging and motivating rice farmers.

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