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Effect of nitrogen fertilizer different levels on economic indices, energy balance indices and greenhouse gases of current rice cultivars in Guilan

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Abstract

Today, all countries of world try to get progress in productivity in other word; they try to get more output by decreasing input usage. In order to study the effects of application nitrogen level fertilizer on energy indices and economic indices of rice cultivars (*Oryza sativa L.*), an experiment as factorial in RCBD with three replications was conducted during 2009 year in the Rice Research Institute, Iran, Rasht, central of Guilan and Rudsar, East of Guilan. Also, for this purpose, a number of questionnaires were prepared and distributed among the rice producers of the examined region. Factors were cultivar (Khazar, Ali Kazemi and Hashemi), and nitrogen fertilizer levels (0, 30, 60, and 90 Kg N/ha). Results indicated that cultivar and nitrogen fertilizer significantly effected on energy indices and economic indices. Khazar have the highest production energy to consumption energy ratio among cultivars. With increasing N fertilizer application, production energy to consumption energy ratio increased significantly. Hashemi and Khazar have the highest benefit to cost ratio among cultivars. With increasing N fertilizer application, benefit to cost ratio increased significantly. Khazar have the highest productivity among cultivars. With increasing N fertilizer application, productivity increased significantly.

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Introduction

Cereals are the world's major source of food. Rice (*Oryza sativa L.*) is the most important cereal crop in the world and it is the primary source of food and calories for about half of mankind (Khush, 2005). Rice (*Oryza sativa L.*) is one of the most important and delicious food crops of the word. There are 111 rice growing countries in the word that occupies about 146.5 million hectares more than 90% is in Asia. In addition to the vital role of nitrogen in rice cultivation, using it more than necessary level cause's harms to the environment and even decreases yield (Haefele *et al.*, 2006). Nitrogen, a plant nutrient is required by plants in comparatively larger amounts than other elements. Nitrogen is essential component of many compounds of plant, such as chlorophyll, nucleotides, proteins, alkaloids, enzymes, hormones and vitamins (Marschner, 1995). For an optimal yield, the N supply must be available according to the needs of the plant. Nitrogen deficiency generally results in stunted growth, chlorotic leaves because lack of N limits the synthesis of proteins and chlorophyll. This leads to poor assimilate formation and results in premature flowering and shortening of the growth cycle. The presence of N in excess promotes development of the above ground organs with relatively poor root growth. Synthesis of proteins and formation of new tissues are stimulated, resulting in abundant dark green (high chlorophyll) tissues of soft consistency. This increases the risk of lodging and reduces the plants resistance to harsh climatic conditions and to foliar diseases (Lincoln, 2006). Four decades after, although several rice cultivars had been developed, only marginal improvements in the grain yield had been achieved. The stagnation or slowdown of yield improvement in rice had been interpreted as genetically yield limit (Khush *et al.*, 2001; Peng and Khush, 2003).

Efficient use of resources is one of the major assets of coefficient and sustainable production, in agriculture (De Jonge, 2004). Energy use in agriculture has been increasing in response to increasing population, limited supply of arable land, and a desire for higher standards of living. Continuous demand in increasing food production resulted in intensive use of chemical fertilizers, pesticides, agricultural machinery and other natural resources. The development of energy efficient agricultural systems with a low input of energy compared to the output of products should therefore help to reduce the emissions of greenhouse gasses in agricultural production (Dalgaard *et al.*, 2001). Energy use is one of the key indicators for developing more sustainable agricultural practices. Renewable energy sources coming from agricultural crops could play an important role to supply the energy requirement and in terms of environmental effects (Qasemi-Kordkheili *et al.*, 2013).

One of the most important issues in recent century is the global warming and greenhouse gas emission is the main factor of this change in weather conditions. There is scientific consensus that global warming poses one of the major environmental challenges in the future. While the bulk of the so called greenhouse gases (GHG) originate from fossil fuel consumption (Pathak and Wassmann, 2007). Greenhouse gas (GHG) emissions from agriculture account for 10 to 12% of all manmade GHG emissions and are the main source of anthropogenic N2O (60%) and CH (50%) (Browne *et al.*, 2011). Ho (2011) calculated the amount of GHG emissions in wheat production and found 2,963 MgCO2 ha where; fertilizer production was responsible 89% of GHG emissions in this crop production. Biswas *et al.* (2008) presented a greenhouse gas (GHG) life cycle assessment of 1 tons of wheat transported to portin south-western Australia, including emissions from prefarm, on-farm and post-farm stages. The results indicated that fertilizer production in the pre-farm stage contributed significantly (35%) to GHG, followed by on-farm CO2 emissions (27%) and emissions from transportation of inputs and wheat (12%).

The aim of this experiment is study effects rice cultivars and nitrogen fertilizer levels on energy balance indices, economic indices and Greenhouse gases emissions in north of Iran.

Materials and methods

Materials

Agricultural research in 2009 at Rice Research Institute in Rasht, Iran, township in Guilan province Center (latitude 37 degrees 16 minutes North and longitude 41 degrees 36 minutes East) and located in East Guilan, Rudsar city (latitude 37 degrees 7 minutes north and longitude 49 degrees 35 minutes East) was performed. Factors tested, including cultivars in three levels (the Khazar, Ali Kazemi and Hashemi) and nitrogen fertilizer at four levels (0, 30 kg ha-1 pure nitrogen: one part at the time of transfer seedlings from the nursery to the main field, 60 and 90 kg ha-1 of nitrogen: in two part at the time of transfer seedlings from the nursery to the main field and in the tillering stage) was the source of urea. In late February the first plowing was done in the second half of May main field after secondary plowing, drawing trowel and after leveling, the scheme was implemented. Sowing in nursery in the first half of May was done and seedlings after 4-3 leaf were transferred to the main field in early Jun. The number of seedlings per hill 3-4 and plant spacing between two seedlings for Hashemi and Ali kazemi cultivars 20×20 cm and for Khazar cultivar 25×25 cm in plots with 12 m2 spaces was determination. The result of soil analysis in two locations was illustrated in table 1. For chemical combat with stem borer worm of rice diazinon 5% was used and for weeds chemical combating satrin herbicide (3-3.5 lit/ha) one week after transplantation was used. Also handy weeding in twice (25 and 50 day after transplantation) was performed. Among the cultivars, improved and late maturity cultivars of Khazar later than the other two cultivars were harvested. Ali-Kazemi and Hashemi cultivars were the native cultivars of Guilan province but Khazar cultivar was obtained through crossing between TNAU7456 cultivar and IR2071-625-1-52 line. Grain yield with harvest from 4 m2 per plot was measured.

Method to calculate the energy

Equivalent values of the mentioned inputs were indicated in table 1.

(Azarpour and Moradi, 2013; Eskandari Cherati *et al.*, 2001, Khan *et al.*, 2010, Moradi and Azarpour, 2011). In order to calculation of energy efficiency indicators, firstly, consumption values for each input were multiplied at equivalent values (Table 2.) and then energy efficiency indicators were computed. For calculation the energy production paddy performance was multiplied at the percentage of protein, fat and starch compounds (Table 3.) and then production energy was computed from the total amounts of the protein, fat and starch multiplied by the energy per gram (Azarpour and Moradi, 2013). For the water input, it is noteworthy that according to the irrigation canal network, farmers for the water extraction do not need to energy consumption considerably. Hence, water energy calculation is sufficient (Azarpour and Moradi, 2013; Moradi and Azarpour, 2011). For determination the relations between energy of input and output, the indicators were defined and applied that energy status of different crops is compared in various crop systems (Azarpour and Moradi, 2013; Moradi and Azarpour, 2011). Consumption values of each input were computed through data from the number of questionnaires (72) which were distributed to the farmers of central and eastern parts of the Guilan province.

The input energy is also classified into direct and indirect and renewable and nonrenewable forms energy equivalents for different inputs and outputs in agricultural production. Indirect energy consists of seeds, chemical fertilizer, chemical poison, and machinery energy while direct energy covered human labor, water and diesel fuel used in the rice production. Non-renewable energy includes diesel fuel, chemical fertilizer, chemical poison and machinery and renewable energy consists of human labor, water and seed.

Method to calculate the economic analysis

In the last part of the study, the economic analysis of rice production was investigated. Net return, gross profit, benefit to cost ratio and productivity was calculated. The gross value of production, net return and benefit to cost ratio were calculated using the following equations (Azarpour and Moradi, 2013):

$$\text{Gross value of production (Rails/ha)} = \text{Yield (kg/ha)} \times \text{Sale price (Rails/kg)}$$

$$\text{Net return (Rails/ha)} = \text{Gross value of production (Rails/ha)} - \text{Total cost of production (Rails/ha)}$$

$$\text{Benefit to cost ratio} = \frac{\text{Gross value of production (Rails/ha)}}{\text{Total cost of production (Rails/ha)}}$$

$$\text{Productivity (kg/Rials)} = \frac{\text{Yield (kg/ha)}}{\text{Total cost of production (Rials/ha)}}$$

Method to calculate the greenhouse gases

To find the amount of GHG emission of inputs in wheat production per unit area (hectare), CO_2 emission coefficient was applied (Table 4.). For every GHG producers (diesel fuel, poison, chemical fertilizer, and water) the amount of produced CO_2 was calculated by multiplying the input application rate by emission coefficient that is shown in Table 4. (Ghahderijani *et al.*, 2013).

Table 1. Some physical and chemical properties of experimental filed soil.

Potassium of absorb able (ppm)	Phosphor of absorb able (ppm)	Total nitrogen (%)	PH	Electrical Conductivity (mmhos/cm)	Texture paddy	Location
280	17.8	0.189	7.4	1.12	Silty clay	Rasht
230	9.5	0.052	6.5	1.9	clay	Rudsar

Table 2. Energy equivalents for different inputs and outputs in rice cultivars production.

Parameter	Unit	Hashemi	Alikazemi	Khazar	Energy equivalents
Human labor	h/ha	848.7	848.7	848.7	500
Machinery	h/ha	37.2	37.2	37.2	90000
Diesel fuel	L/ha	127.2	127.2	127.2	9237
Nitrogen	Kg/ha	0, 30, 60 and 90	0, 30, 60 and 90	0, 30, 60 and 90	17600
Phosphorus	Kg/ha	12.6	12.6	16.8	3190
Potassium	Kg/ha	45.1	45.1	61.5	1600
Poison	L/ha	5	5	5	27170
Water	M3/ha	10000	10000	10000	272.2
Seed	Kg/ha	90	90	70	6513
Depreciation for per diesel fuel	L	106.85	106.85	106.85	9583

Table 3. Energy value creating combinations of rice paddy.

Combinations	Energy per gram (kcal)	Percent of compositions
Protein	4	6.6
Fat	9	2.2
Starch	4	80

Table 4. Greenhouse gas (GHG) emission coefficient of inputs.

Parameter	Unit	Hashemi	Alikazemi	Khazar	GHG coefficient ($kgCO_{2eq}ha^{-1}$)
Machinery	h/ha	37.2	37.2	37.2	0.071
Diesel fuel	L/ha	127.2	127.2	127.2	2.76
Nitrogen	Kg/ha	0, 30, 60 and 90	0, 30, 60 and 90	0, 30, 60 and 90	1.3
Phosphorus	Kg/ha	12.6	12.6	16.8	0.2
Potassium	Kg/ha	45.1	45.1	61.5	0.2
Poison	L/ha	5	5	5	5.1
Water	M3/ha	10000	10000	10000	0.057

Results and discussion

Consumption energy

Since the amount of energy consumption is equal in all the repetitions so this indicator was not analyzed. The amount of energy consumption in the studied cultivars under different nitrogen fertilizer contents is illustrated in Fig.1. and increase in nitrogen fertilizer enhanced the amount of energy consumption in all the cultivars. As regards to this point that, optimum transplanting distance of two seedlings for Hashemi and Ali Kazemi cultivars is 20×20 cm and for Khazar cultivar is 25×25 cm, as a result the amount of consumed seed per hectare for Khazar cultivar is 20 kg less than Hashemi and Ali Khazemi cultivars and caused to reduces amount of consumed energy in Khazar cultivar in compared with Hashemi and Ali Kazemi cultivars in all treatments of nitrogen fertilizer consumption. These results are indicated that the energy efficiency in breed cultivar of Khazar is higher than to landrace cultivars of Ali Kazemi and Hashemi.

Grain yield

With attention to variance analysis table (Table 5.), the effect of nitrogen fertilizer levels and rice cultivars on grain yield had a significant difference at 1% probability level. The highest amount of grain yield were recorded from Khazar cultiva (3934 kg/ha); application 90 kg N/ha (4328 kg/ha) (Table 6.). On the other hand the lowest amount of grain yield were recorded from Hashemi cultivar (3223 kg/ha) and Alikazemi cultivar (3417 kg/ha); application 0 kg N/ha (2734 kg/ha) (Table 6.). With attention to variance analysis table (Table 5.), the Interaction effect of nitrogen fertilizer levels and rice cultivars on grain yield showed a significant difference at 1% probability level. Comparison of mean between Interaction effect of nitrogen fertilizer levels and rice cultivars showed that (Table 7.), the highest amount of grain yield was recorded from N4V3 treatment (5132 kg/ha), other treatments statistically were in the lower groups.

Production energy

With attention to variance analysis table (Table 5.), the effect of nitrogen fertilizer levels and rice cultivars on production energy had a significant difference at 1% probability level. The highest amount of production energy were recorded from Khazar cultiva (14409190 kcal/ha); application 90 kg N/ha (15849911 kcal/ha) (Table 6.). On the other hand the lowest amount of production energy were recorded from Hashemi cultivar (11805733 kcal/ha) and Alikazemi cultivar (12513330 kcal/ha); application 0 kg N/ha (10013202 kcal/ha) (Table 6.). With attention to variance analysis table (Table 5.), the Interaction effect of nitrogen fertilizer levels and rice cultivars on production energy showed a significant difference at 1% probability level. Comparison of mean between Interaction effect of nitrogen fertilizer levels and rice cultivars showed that (Table 7.), the highest amount of production energy was recorded from N4V3 treatment (18795093 kg/ha), other treatments statistically were in the lower groups.

Production energy to consumption energy ratio

With attention to variance analysis table (Table 5.), the effect of nitrogen fertilizer levels and rice cultivars on production energy to consumption energy ratio had a significant difference at 1% probability level. The highest amount of production energy to consumption energy ratio were recorded from Khazar cultiva (1.39); application 90 kg N/ha (1.43) (Table 6.). On the other hand the lowest amount of production energy to consumption energy ratio were recorded from Hashemi cultivar (1.13) and Alikazemi cultivar (1.20); application 0 kg N/ha (1.05) (Table 6.). With attention to variance analysis table (Table 5.), the Interaction effect of nitrogen fertilizer levels and rice cultivars on production energy to consumption energy ratio showed a significant difference at 5% probability level. Comparison of mean between Interaction effect of nitrogen fertilizer levels and rice cultivars showed that (Table7.), the highest amount of production energy to consumption energy ratio were recorded from N4V3 treatment (2.23) and N3V3 treatment (2.14), other treatments statistically were in the lower groups. These results are indicated that the energy efficiency in breed cultivar of Khazar is higher than to landrace cultivars of Ali Kazemi and Hashemi.

Gross value of production

With attention to variance analysis table (Table 5.), the effect of nitrogen fertilizer levels and rice cultivars on gross value of production had a significant difference at 1% probability level. The highest amount of gross value of production were recorded from Hashemi cultivar (6460592 rails/ha); application 90 kg N/ha (7221504 rails/ha) (Table 6.). On the other hand the lowest amount of gross value of production were recorded from Khazar cultivar (5807746 rails/ha) and Alikazemi cultivar (5453652 rails/ha); application 0 kg N/ha (4611847 rails/ha) (Table 6.). With attention to variance analysis table (Table 5.), the Interaction effect of nitrogen fertilizer levels and rice cultivars on gross value of production showed a non-significant. The amount of higher sale price in quality and market-friendly Hashemi cultivar lead to increasing gross value of production in this cultivar was compared with other varieties.

Net return

With attention to variance analysis table (Table 5.), the effect of nitrogen fertilizer levels and rice cultivars on net return had a significant difference at 1% probability level. The highest amount of net return were recorded from Hashemi cultivar (5190392 rails/ha); application 90 kg N/ha (5973504 rails/ha) (Table 6.). On the other hand the lowest amount of net return were recorded from Khazar cultivar (4633546 rails/ha) and Alikazemi cultivar (4183452 rails/ha); application 0 kg N/ha (3383447 rails/ha) (Table 6.). With attention to variance analysis table (Table 5.), the Interaction effect of nitrogen fertilizer levels and rice cultivars on net return showed a non-significant.

Benefit to cost ratio

With attention to variance analysis table (Table 5.), the effect of nitrogen fertilizer levels and rice cultivars on benefit to cost ratio had a significant difference at 1% probability level. The highest amount of benefit to cost ratio were recorded from Hashemi cultivar (5.08) and Khazar cultivar (4.93); application 90 kg N/ha (5.8) (Table 6.). On the other hand the lowest amount of benefit to cost ratio were recorded from Alikazemi cultivar (4.29); application

0 kg N/ha (3.75) (Table 6.). With attention to variance analysis table (Table 5.), the Interaction effect of nitrogen fertilizer levels and rice cultivars on benefit to cost ratio showed a significant difference at 1% probability level. Comparison of mean between Interaction effect of nitrogen fertilizer levels and rice cultivars showed that (Table 7.), the highest amount of benefit to cost ratio were recorded from N4V3 treatment (6.4) and N4V1 treatment (5.97), other treatments statistically were in the lower groups.

Productivity

With attention to variance analysis table (Table 5.), the effect of nitrogen fertilizer levels and rice cultivars productivity had a significant difference at 1% probability level. The highest amount of productivity were recorded from Khazar cultivar (0.0034 kg/rails); application 90 kg N/ha (0.0036 kg/rails) (Table.6). On the other hand the lowest amount of productivity were recorded from Hashemi cultivar (0.0025 kg/rails) and Alikazemi cultivar (0.0026 kg/rails); application 0 kg N/ha (0.0022 kg/rails) (Table 6.). With attention to variance analysis table (Table 5.), the Interaction effect of nitrogen fertilizer levels and rice cultivars on productivity showed a significant difference at 1% probability level. Comparison of mean between Interaction effect of nitrogen fertilizer levels and rice cultivars showed that (Table 7.), the lowest amount of productivity were recorded from N1V1, N1V2 and N1V3 treatments, other treatments statistically were in the lower groups. Breed cultivar (Khazar) because of accepting higher fertilizer and suitable genetic specifications have higher productivity in compared with landrace varieties (Hashemi and Alikazemi). These results are indicated that the productivity in breed cultivar of Khazar is higher than to landrace cultivars of Ali Kazemi and Hashemi.

Direct energy and indirect energy

Direct energy and indirect energy for rice cultivars production under nitrogen fertilizer management were showed tables 8. Since the amount of direct energy and indirect energy were equal in all the repetitions so this indicator was not analyzed. Considering that inputs of human labor, water and fuel for rice cultivars production was the same, in all treatments amount direct energy was equal (3897371 MJ/ha) (Table 8.). Results indicated with increasing nitrogen fertilizer application enhanced the amount of indirect energy in all the cultivars (Table 8.). As regards to this point that, optimum transplanting distance of two seedlings for Hashemi and Ali Kazemi cultivars is 20×20 cm and for Khazar cultivar is 25×25 cm, as a result the amount of consumed seed per hectare for Khazar cultivar is 20 kg less than Hashemi and Ali Khazemi cultivars and caused to reduces amount of indirect energy in Khazar cultivar in compared with Hashemi and Ali Kazemi cultivars in all treatments of nitrogen fertilizer consumption (Table 8.).

Renewable energy and nonrenewable energy

Renewable energy and nonrenewable energy for rice cultivars production under nitrogen fertilizer management were showed table 8. Since the amount of Renewable energy and nonrenewable energy were equal in all the repetitions so this indicator was not analyzed. Despite being the same inputs of labor and fuel consumption due to non-uniform input of seed varieties amount renewable energy were recorded from Hashemi and Ali Kazemi cultivars (3897533 MJ/ha) and from Khazar cultivar (3897402 MJ/ha) (Table 8.). Results indicated with increasing nitrogen fertilizer application enhanced the amount of nonrenewable energy in all the cultivars (Table 8.). As regards to this point that, optimum transplanting distance of two seedlings for Hashemi and Ali Kazemi cultivars is 20×20 cm and for Khazar cultivar is 25×25 cm, as a result the amount of consumed seed per hectare for Khazar cultivar is 20 kg less than Hashemi and Ali Khazemi cultivars and caused to reduces amount of nonrenewable energy in Khazar cultivar in compared with Hashemi and Ali Kazemi cultivars in all treatments of nitrogen fertilizer consumption (Table 8.).

Greenhouse gases emissions

Greenhouse gases emissions for rice cultivars production under nitrogen fertilizer management were showed table 9. Since the amount of greenhouse gases emissions were equal in all the repetitions so this indicator was not analyzed. The highest amount of Greenhouse gases emissions were recorded from N4V1, N4V2 and N4V3 treatments. The lowest amount of Greenhouse gases emissions were recorded from N1V1, N1V2 and N1V3 treatments.

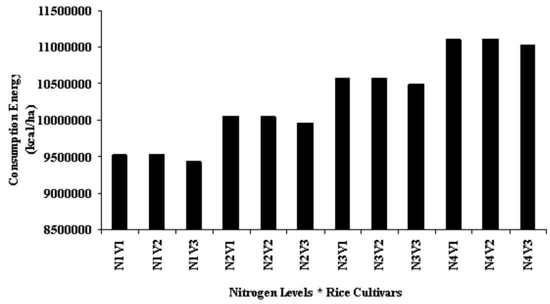

Fig. 1. Consumption energy for rice cultivars production under nitrogen fertilizer management.

Table 5. Analysis of variance on energy balance indices and economic indices for rice cultivars production under nitrogen fertilizer management.

Source of variance	df	Productivity	Benefit to cost ratio	Net return	Gross value of production	Production energy to consumption energy ratio	Production energy	Grain yield
Replication	2	0.00000012	0.0182	25795804704	25795804704	0.002	142614094928	10634
Nitrogen (N)	3	0.00000334^{**}	7.2723^{**}	1.1558^{**}	1.1731^{**}	0.2506^{**}	5.8778^{**}	4383098^{**}
Cultivar (V)	2	0.0000029^{**}	2.1511^{**}	3.0531^{**}	3.131^{**}	0.2127^{**}	2.1745^{**}	1621594^{**}
N×V	6	0.00000018^{**}	0.3777^{**}	442685512242	442685512242	0.0338^{*}	3.9937^{**}	297812^{**}
Error	22	0.00000004	0.1237	181196822400	181196822400	0.0092	989135376085	73759
CV (%)		7.3	7.34	9.11	7.2	7.7	7.7	7.7

Ns, ** and * respectively: non-significant, significant in 1% and 5% area.

Table 6. comparison of mean on energy balance indices and economic indices for rice cultivars production under nitrogen fertilizer management.

Treatments	Productivity (kg/rails)	Benefit to cost ratio	Net return (rails/ha)	Gross value of production (rails/ha)	Production energy to consumption energy ratio	Production energy (kcal/ha)	Grain yield (kg/ha)
Nitrogen							
0 Kg N/ha	0.0022 D	3.75 D	3383447 D	4611847 D	1.05 D	10013202 D	2734 D
30 Kg N/ha	0.0026 C	4.37 C	4160631 C	5395531 C	1.17 C	11756516 C	3210 C
60 Kg N/ha	0.0031 B	5.17 B	5158939 B	6400439 B	1.32 B	14018042 B	3828 B
90 Kg N/ha	0.0036 A	5.80 A	5973504 A	7221504 A	1.43 A	15849911 A	4328 A
Cultivars							
Hashemi	0.0025 B	5.08 A	5190392 A	6460592 A	1.13 B	11805733 B	3223 B
AliKazemi	0.0026 B	4.29 B	4183452 B	5453652 B	1.20 B	12513330 B	3417 B
Khazar	0.0034 A	4.93 A	4633546 B	5807746 B	1.39 A	14409190 A	3934 A

Within each column, means followed by the same letter do not differ significantly at P<0.05.

Table 7. Comparison of mean on energy balance indices and economic indices for rice cultivars production under nitrogen fertilizer management.

Treatments	Productivity (kg/rails)	Benefit to cost ratio	Production energy (kcal/ha)	Production energy to consumption energy ratio	Grain yield (kg/ha)
N1V1	0.0021 B	4.18 EFG	9616729 H	1.45 D	2626 H
N1V2	0.0021 B	3.60 GH	10413843 GH	1.57 BCD	2844 GH
N1V3	0.0023 B	3.46 H	10009033 GH	1.53 CD	2733 GH
N2V1	0.0024 AB	4.76 DE	11020166 FGH	1.54 BCD	3009 FGH
N2V2	0.0025 AB	4.01 FGH	11656665 EFG	1.63 BCD	3183 EFG
N2V3	0.0029 AB	4.33 EF	12592716 DEF	1.78 BC	3439 DEF
N3V1	0.0027 AB	5.42 BC	12611830 DEF	1.64 BCD	3444 DEF
N3V2	0.0028 AB	4.52 BEF	13202377 CDE	1.72 BC	3605 CDE
N3V3	0.0037 AB	5.56 BC	16239920 D	2.14 A	4435 B
N4V1	0.0030 AB	5.97 AB	13974204 CD	1.70 BCD	3816 CD
N4V2	0.0031 AB	5.03 CD	14780436 BC	1.80 B	4036 BC
N4V3	0.0044 A	6.40 A	18795093 A	2.32 A	5132 A

Within each column, means followed by the same letter do not differ significantly at $P<0.05$.

Table 8. Division energy for rice cultivars production under nitrogen fertilizer management.

Treatments	Nonrenewable energy (MJ/ha)	Renewable energy (MJ/ha)	Indirect energy (MJ/ha)	Direct energy (MJ/ha)
N1V1	5630062	3897533	5630224	3897371
N1V2	5630062	3897533	5630224	3897371
N1V3	5539571	3897402	5539602	3897371
N2V1	6158062	3897533	6158224	3897371
N2V2	6158062	3897533	6158224	3897371
N2V3	6067571	3897402	6067602	3897371
N3V1	6686062	3897533	6686224	3897371
N3V2	6686062	3897533	6686224	3897371
N3V3	6595571	3897402	6595602	3897371
N4V1	7214062	3897533	7214224	3897371
N4V2	7214062	3897533	7214224	3897371
N4V3	7123571	3897402	7123602	3897371

Table 9. Greenhouse gas emissions of inputs for rice cultivars production under nitrogen fertilizer management.

Treatments	GHG emissions ($kgCO_{2eq}ha^{-1}$)
N1V1	961
N1V2	961
N1V3	965
N2V1	1000
N2V2	1000
N2V3	1004
N3V1	1039
N3V2	1039
N3V3	1043
N4V1	1078
N4V2	1078
N4V3	1082

Conclusion

It is noteworthy that high-yielding rice is an appropriate option for increasing rice production regarding the limitation of Guilan province paddy fields. The saturation of internal markets with the similar external varieties reveals the necessity of changing in rice production system. Recognition of the growth and productivity direction of energy indicators in Iran agricultural sector in terms of having economic poor infrastructures and intense competition in the global arena helps to achieve better economic opportunity. Resources and facilities should be directed to the way in which we can get faster our proper position in international relations. According to the results of this experiment and studying economic indices and energy balance indices it can be stated that the status of energy consumption management in the production of Khazar high-yielding and breeding cultivar was more appropriate and the requirement of rice production in the country and limitation of energy resources which are mainly non-renewable, production of high-yielding cultivars is the step to the more sustainable agriculture.

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