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Modeling the Green Revolution on Rice Yield in Iran

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ABSTRACT

Present paper is about function of high-yieldingrice production in Iran. So related data about production variables of high-yieldingrice, mechanization ratio to total of cultivated area in the planting and harvesting process, amount of improved seeds, amount of irrigation and fertilizer, also amount of consumption poison of the country for years 1991-2008 are collected. So with considering country's data as time series with using of Cobb - Douglas production function the optimum pattern estimation is obtained. The results of the research show that changing in using of modern machinery and technology, improved seeds, irrigation, fertilizer, pesticides and poisons are effective in implementation of Green Revolution in Iran. Because as is identified in the estimated model with 1% increasing of improved seeds, the production of high yielding rice increased about 4.84 % also with 1% increasing of irrigation, the production of this type of rice increased 1.78%.Also with 1% increasing of mechanization level's ratio to the total cultivated areas in the planting and harvesting process, the production of this rice respectively increases about 2.13% and 1.85%. The results of the research show that the most elasticity is related to the variable of improved seed and the most negative effect is related to variable of pesticide that has been used more than requirement on crop. So according to research's purpose which is about identification of factors' impact such as mechanization, using of improved seeds, irrigation, fertilizer on implementation of Green Revolution in country, can say that estimation model led us to the purpose.

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INTRODUCTION

According to the current population of the world and consequently its increasing, if we had food production with traditional methods so agricultural lands could not provide nutritionalneedingof this population from many years ago, then the theories of Robert Malthus, the classical economist, based on the limitation of natural resources and grow thing of agricultural products in ratio of arithmetic progression in comparative with the population grow thing occurs as geometric progression and finally we will have the descending efficiency in theproduction process. Butwith occurrence ofGreen Revolution which actually caused overcoming of wheat and riceproblems in thedecade of the'60s in Asia also hasresolved problemsin agriculture sector especiallyin thedeveloping countries. The father of agricultural Green Revolution is Dr. Norman Borlaug who innovated the methods for seedimprovement, using of the chemical fertilizer also irrigation that used in rice cultivation and other products widely and creates Green Revolution movement.

2. Theoretical Foundations:

The Green Revolution is as planning that has been started nearly since 1966, till with using of fertileseeds especially wheat andriceraisesthe level ofagriculture indeveloping countries.Usually these variousgrains have shortand tight legs and chemical fertilizer impact on its grow thing rapidly and are resistant against the agricultural pests.Farming of these seeds usually needs to use of pesticides, irrigation,chemical fertilizer and good methods of agriculture. (jounior.1975).The mean of Green Revolution is improvement of agricultural productions and its progression without needing to the fundamental changes; generally Green Revolution means public revolution in increasing of product amount in hectare also increasing of the total amount of all products

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in very large areas of world's countries(Parsa and Osia, 1985). Therefore, the concept of Green Revolution is linked to the concept of productivity increasing.

The Green Revolution raised the production level alsodeveloped the agricultural kinds and causes the food healthy and finally causes more incoming for many farmers in developing countries (Benbalkacem, 2009).Up to now many countries used of this strategy to improve their agricultural productsperformance and trough this way provide their growth and development path , but main countries which are created of breeding of rice'snew seeds, cultivationandproduction are countries like Japan, India, China, Philippine and Taiwan (Danesh, 1972).

Although growing of world population andthe subsequent,increasing of demanding for food, only itself shows thenecessity ofGreen Revolution,but other issuessuch as increasing of villagers migration to towns due to lacking ofincomesecurity,difficulty ofagricultural work especially about rice also changing the using of agricultural lands, climate changes and reducing of ruralyouthtendency about this matter causes more consideration on this issue.

3. Background of the research:

Few similar studies have been done about the way of using effective variables on Green Revolution like improved seeds, fertilizer, technologiesandmechanization also increasing of productivity whichare as follow:

Singh, R.D. and Varma, K.K and Singh, L.R 1972, in a research about ' studying on facilities to increase production and pattern determining foroptimum utilizationofresources in small farms', concluded that cultivation ofhigh-yieldingvarietiesof wheat andriceinIndia causes reduction of unemployment in 1970.

Evenson, Robert E & McKinsey, Jr (1999), in a research with this title 'Technology and climate interaction effects on theGreen RevolutioninIndia'provided a modelfor aGreen RevolutioninIndiaduring1970to 1988 which on it have been combined interrelationshipsof climateandtechnologyintheirmodel.

Jonna P., Estudillo, Keijiro, Otsuka (2002), in a research with studying on three decades ofGreen Revolution in Philippine, tried to investigate goodand modernseeds varieties on productivity increasing, stabilityandefficiency changesof total factors in different ecosystems of Philippine during years 1970 to 1977.

Brazdik, Frantisek (2006) in their research with this title "Measuringtechnical efficiency and affecting factors on rice'sfields inWest Javaisland' with using of Data envelopment analysis method, measure technical efficiency then with Stochastic frontier analysis have beeninvestigated affecting factors on technical efficiency in theareainWest Java of Indonesia during end of years 1970 and earlyyears 1980.

Nakano, Yuko and Others (2011), in a research with this title 'Possibility ofriceGreen Revolution in irrigationplans in countries of Sub-SaharanAfrica, concluded that sufficientirrigation, chemical fertilizerand labor are as fundamental basics of high productivity in countries such as Uganda,Mozambique, Burkina Faso, Mali, Niger and Senegal that informationforUgandaandMozambique are collected in year2007 and for other countries during years 2006 and 2007.

Mohammad Reza Arslanbod and *et al* (2008), in a research 'Statistical and econometric analysis of mechanization role in agricultural production of Azerbaijan-e-Gharbi province', studied on mechanization roleinagriculturalproduction inthisprovince with using of Cobb-Douglas Productionfunction during years 1986 to 2006.

Sothe purpose of this paper is studying on the impacts of effectivefundamental variables on rice Green Revolutionin Iran.

Indeed, present paper tried to measure changing in using of Green Revolution's fundamental variables like modern machineryandtechnology, improved seedsirrigation and fertilizer on the increasing of rice productivity in hectare and occurrence of this revolutionin Iran.

MATERIALS AND METHODS

According to the similar done researchesin thisfield also based on definitions of Green Revolution which is defined as using of high yielding seed, fertilizerand farm machinery incultivation ofa crop. Thesethree variables are enteredasindependent variables inthe model.Since the desired productof thisresearch means rice isvery much dependent to water then irrigationwas regardedas oneof the effective variables.On theother hand because if it faced with pestvanished completely or its performanceis reduced greatly,althoughinfewsimilar studies, the poison variablehasnot been considered, but this variable isentered asone of theindependent variablesinto the model. In fact, it can say that one of the aspectswhich indicate that this paper is new is because of entering of poisonvariable. But another aspectofthis paper is lack of studying on Green Revolution as method of this paper's researchers. Thus the variable of improved seeds mechanization, irrigation, fertilizers andpoison will be entered in estimation model as effective variables on the implementation of rice's Green Revolution in Iran. In economic analysis of agricultural production used of Cobb-Douglas Function in most cases. One of the majored vantages of using of this function is direct calculationof production elasticity about each of theused inputs in the production, so in this paper is used of Cobb-DouglasFunction.Following some definitionsof productivitywill beoffered.

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Productivity and efficiency increasing is as majorissuesin developing countries, in other words efficient using of agricultural resourcesshould be in priority and thepurposesof agriculture producers be whatever, their important aim is achieving to maximum performance (Soltani and Najafi, 1994).Environmental Protection Agency defined productivity as degreeand intensity effective using of each of the production factors. But history of economictheory of productivitymeasurement should be considered in the researches of Tinbergen (1942) and Solow (1957). According to their paper, productivity measurement is listed in the field of production function and is connected to economical growth theory (Khavari nezhad,2006). The productivity of inputs efficiency obtained from the efficiency of outputs, actually can say that productivity or each enterprise's technical efficiency represents ability of it inmaximizingthe production according to certaininput.Because as mentioned in OECD Manual, efficiency is calculated by the following formula:

$$\frac{\text{Quantity index of gross output}}{\text{Quantity index of input}} \quad (1)$$

So in this paper, technical efficiencyof agricultural will be measured due toimplementation thepolicies of Green Revolution which is calculated with using of Formula(1) and because in manycountriesalsoIran landisalimiting factor and mainly the farmers tended to increase their production in one cultivableland, landproductivity is suitable measurement for determining agricultural technicallevel. So amount ofphysical product is considered rice with using of improved seed also the amount of variableinput is rice's area under cultivation. In this paper is used of function(2) in order to investigate effects of Green Revolution policy on the performance of agriculturalcrops.

$$Y = A^{\alpha} H^{\beta} I^{\gamma} FM^{\theta} P^{\lambda} \quad (2)$$

In this model Y is dependent variable and indicated productionof high-yieldingrice inone hectare or performanceof high-yieldingrice and its unit is Kg.

A shows technology that according to ratio of cultivated area which on it is performed mechanizationoperations in theplantingand harvesting process forhigh-yieldingriceto the total cultivated area of this crop is obtained.

H indicates improved seed and its unit is kg.

I shows irrigation, because irrigation statistics was not directly available in statistics letters so it obtained through dividing of improvedseed's irrigation cost on waterpricingfor thistype of seed and its unit is cubic meters.

FM indicates consumption fertilizer which is combination of chemical fertilizers and animal manure and its unit is kg.

P shows using amount of poisons which is combination of herbicides, insecticides and fungicides and its unit is kg.

Practically it is thought that Cobb–Douglas production function is having error terms asmultiplication that inlogarithmictransformation is as plural form, andthusmakes it possibleto direct estimation. Generally,it is importantto recognizethat error term is not too important that after doing necessary changesin the model, added to the end of it for simplicity, while it is an inseparable part of model exponential(Arab mazar, 1991).For estimating we do the logarithm from production function and the error term entered in the model which equation3is obtained.

$$LnY = \alpha LnA + \beta LnH + \gamma LnI + \theta LnFM + \lambda LnP + \sum e_i \quad (3)$$

In this paper data are ordered as frequency which leading to estimations like Pooled Least Square (PLS) with using of Eviews software, so related statistics and information about independent variables also dependent variable inthismodel forprovinces of Khuzestan, Fars, Gilan, Mazandaran and Golestan that their totalproduction about 90 to 95% is from production ofthe whole country. These information are collected through statistics , production costsystem of agriculture department, but because do not obtain significant resultsthrough this estimating method , as can be seen in table2, so data were arranged based on Balanced Panel which leading to estimating as Panel Least square.Inthis way, because of non-consecutive yieldingricecultivation in theFars province, so thisprovincewasremovedfrom other provinces then estimations were performed. But ascan be seenin table3, do not obtain significant resultsthrough this estimating method, so the researchers decide to estimate the model with country dataand not as provincial data as method of time series.

Since1991 was as first year which high-yielding ricehas beencultivated in Iran and 2008 is as lastyear that statisticsfor thistype of rice is available, sodesired information are collected for mentioned period during years 1991 to 2008.Then the static of variables has been checked which found that all variables are I (0).So no need to

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differenceofthe variables. Also model does not have falseregression. Becauseif time series be non-static the false regression will occur that high R^2 shows that is because of time variable and is not because of true real relationship between the variables.(Abrishami,1999). The results of studying on the variables' static with using of LLC method which are sum marizedin thetable1.

Table 1: Studying on reliability of related variables from this paper.

Variable Name	Type of Reliability Test	The Statistic	Prob	Test Result
Log Y	Levin , Lin & Chu t	-6.49	0.0000	Steady Level
$\log A_1$	Levin , Lin & Chu t	-4.73	0.0000	Steady Level
$\log A_2$	Levin , Lin & Chu t	-4.53	0.0000	Steady Level
Log H	Levin , Lin & Chu t	-5.64	0.0000	Steady Level
Log I	Levin , Lin & Chu t	-4.26	0.0000	Steady Level
Log FM	Levin , Lin & Chu t	-5.18	0.0000	Steady Level
Log P	Levin , Lin & Chu t	-6.17	0.0000	Steady Level

Source: research results

Table 2: Arrangement of the data as frequency, the dependent variable of high-yielding rice production Pooled Least Square.

Independent Variables	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
C	49.34	1.57	8.01	15.09	-8.85	-10.08		-13.99	15.24
	(0.36)	(0.16)	(1.42)	(4.21)	(-2.48)	(-2.81)		(-2.51)	(2.46)
Log (A)	-3.01	3.89	0.35	0.41	-4.46	-6.27		-1.19	1.08
	(-2.25)	(3.38)	(0.47)	(0.65)	(-2.60)	(-4.11)		(-3.20)	(0.62)
Log(H)	5.37	0.86	-1.80	-2.47			-0.26	3.58	-2.41
	(1.39)	(0.54)	(-1.90)	(-3.96)			(-1.26)	(3.49)	(-1.84)
Log(I)	-0.64	1.29	0.50	0.65	0.57	0.32	0.23	0.20	0.74
	(-0.73)	(2.94)	(2.18)	(3.39)	(2.76)	(1.99)	(1.79)	0.35	(2.18)
Log(FM)	-0.22	1.70	0.68	0.75	2.85	2.61	0.78	-0.07	0.69
	(-2.63)	(2.80)	(1.92)	(1.89)	(5.36)	(4.53)	(3.56)	(-3.41)	(0.90)
Log(P)	-3.94	-0.17	-0.03		-0.15	-0.11	0.11	-1.92	-0.07
	(-2.63)	(-0.60)	(-0.21)		(-0.99)	(-0.69)	(0.98)	-2.22	(-0.36)
Log(Y(-1))		0.17	0.14				0.46		
		(0.61)	(1.24)				(6.59)		
Log(FM)*Log(P)				-0.01					
				(-0.50)					
Log(A)*Log(H)*Log(FM)					0.17	0.19			
					(3.79)	(4.35)			
Log(A1(-1))							2.48		
							(1.76)		
Log(A2)							13.28		
							(4.57)		
AR(1)		0.36	0.08					0.96	
		(1.97)	(0.65)					(54.31)	
AR(2)	0.50			-0.19	-0.15				-0.14
	(2.41)			(-2.11)	(-1.72)				(-0.84)
AR(3)						0.02			
						(0.27)			
AR(4)	0.53	-0.51					-0.45		
	(2.26)	(-3.02)					(-5.54)		
T*			0.33				-0.10		0.13
			(2.22)				(-2.74)		(0.44)
D**			5.32	4.68	4.73	4.27			5.29
			(7.83)	(13.05)	(12.75)	(9.89)			(3.75)
R^2	0.52	0.74	0.90	0.90	0.89	0.84	0.74	0.60	0.89
$\overline{R}^2$	0.34	0.59	0.87	0.87	0.87	0.82	0.69	0.52	0.86
D.W	1.09	2.58	2.29	1.75	1.52	1.47	2.49	1.98	1.77
F-statistic	2.94	5.05	27.30	35.21	34.43	40.81		8.64	10.66

Source: research results
*T represents the variable of time trend
**D indicates the dummy variable

It should be mentioned that in order to separate the importance of agricultural mechanization in the process of planting and harvesting, mechanization variable is calculated separately in some estimations. Soinestimations is used of equation3and inregression7 is used of equation4.In equation 4 A_1 indicates ratio of cultivated area of this crop which in it mechanization operations is done in planting stage and A_2 shows this relation in harvesting stage.

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$$LnY = \alpha_1 LnA_1 + \alpha_2 LnA_2 + \beta LnH + \gamma LnI + \theta LnFM + \lambda LnP + \sum e_i \quad (4)$$

After function estimating, is discussed on model'scoefficientsand determination of variables which have most andleast impact on productionof high-yieldingrice. Because productioninone hectare that is actually performanceor productivityof rice than to its cultivated area, has been considered during theinvestigation. So obtained coefficients inmodel's estimatingin this paper indicated the amount of affecting on performanceof high-yieldingrice.Since inmanycountriesas well asIran landisalimiting factor and mainlyfarmers tend to increase their products from anarableland, so landproductivity is suitable measurement for determining of technicallevel ofagricultural. The results of performed estimations are sum marizedin tables2, 3and 4.Columnsshow some of the best estimated regressions and in rows there are independent variables also th et-statistic for each variable is located below the value of each coefficients.

Table 3: Arrangement of the data as Balanced Panel 'dependent variable of high yielding rice' Panel Least Square.

Independent Variables	1	2	3	4	5	6	7	8	9
C	33.48		12.53		16.99	43.55		42.03	
	(5.22)		(3.95)		(6.45)	(4.65)		(5.09)	
Log (A)	-30.77	45.64							
	(-4.60)	(6.74)							
Log(H)	-4.02	-0.10	-2.10	0.71	-2.10	-5.25	0.52	-5.02	-2.13
	(-4.25)	(-0.25)	(-4.15)	(2.36)	(-4.17)	(-3.66)	(0.67)	(-3.94)	(-1.71)
Log(I)	0.11	0.61	0.38	0.46	0.34	-0.28	0.70	-0.13	0.38
	(0.42)	(8.89)	(2.38)	(2.59)	(2.16)	(-0.77)	(1.96)	(-0.43)	(0.61)
Log(FM)	-0.38	0.92	0.72	0.40		-0.86	0.84	-0.69	3.78
	(-2.46)	(2.58)	(2.52)	(1.88)		(-2.63)	(1.08)	(-2.85)	(2.90)
Log(P)	-0.54	0.30	-0.04	0.66	-1.34	-0.71	-0.10	-0.80	
	(-1.69)	(1.22)	(-0.30)	(2.66)	(-2.14)	(-2.02)	(-0.22)	(-2.28)	
Log(A)*Log(H)*Log(FM)		-1.24							
		(-4.57)							
Log(A1(-1))			2.94						
			(1.33)						
Log(A1)						-20.48		-20.61	-4.06
						(-8.44)		(-8.53)	(-0.43)
Log(A2)			-2.36	-1.77	-8.41	-16.86	47.18	-18.51	-19.33
			(-0.77)	(-0.26)	(-1.23)	(-1.85)	(3.33)	(-2.17)	(-1.30)
Log(A1(-1))*Log(A2)				16.28	30.44				
				(0.67)	(1.01)				
Log(FM)*Log(P)					0.24				-0.17
					(2.46)				(-1.38)
Log(A1)*log(A2)							-254.33		
							(-4.09)		
AR(2)				0.56					
				(5.15)					
AR(3)									0.23
									(1.40)
AR(4)	0.28		-0.27		-0.26	0.32	0.32	0.32	
	(3.13)		(-3.83)		(-3.88)	(4.66)	(4.19)	(4.92)	
T*									
D**		4.42		5.27					
		(18.91)		(12.83)					
R^2	0.64	0.86	0.73	0.85	0.73	0.59	0.38	0.62	0.03
$\overline{R}^2$	0.59	0.85	0.68	0.83	0.68	0.53	0.30	0.55	-0.08
D.W	1.85	1.35	1.66	1.46	1.57	2.06	1.37	1.95	1.48
F-statistic	13.52		15.90		15.82	10.51			

Source: research results
*T represents the variable of time trend
**D indicates the dummy variable

In first regression, improved seeds coefficients, irrigation and fertilizer are not significant and mechanization coefficient is negative which cannot be justified and Durbin –Watson statistic also shows that there is autocorrelation in equation. So this model is not acceptable. In the second regression, variables such as improved seeds, poison and production are not significant with alag period and Durbin –Watson statistic is high, so this regression is not acceptable. In the third regression, the variables of mechanization, poison and production are not significant. In fourth regression, interaction impact of fertilizers and pesticides is entered in model which is not significant.

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Table 4: Arrangement of the data as Time series 'independent variable of production of high yielding rice'

Independent Variables	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
C	-43.03	-0.17	24.67	-17.28	-7.30		32.52	1.33
	(-1.89)	(-0.01)	(1.61)	(-2.85)	(-0.91)		(1.27)	(0.31)
Log (A)	-3.58	3.53			0.41			
	(-0.72)	(2.06)			(0.39)			
Log(H)	8.36	4.36	3.90	4.62	3.61	13.53	9.78	10.74
	(2.24)	(2.99)	(1.35)	(4.16)	(1.96)	(5.01)	(5.51)	(16.18)
Log(I)	2.40	1.90	1.71	1.12	1.26	3.44	-1.90	1.19
	(2.47)	(3.30)	(3.10)	(2.60)	(2.31)	(2.84)	(-3.24)	(12.23)
Log(FM)	1.43	0.18	-1.79	1.48	-0.08	-3.43	-5.60	-2.82
	(1.05)	(0.20)	(-3.34)	(2.85)	(-0.22)	(-2.00)	(-2.42)	(-16.35)
Log(P)	0.03	-1.50	-3.84		0.48	159.08	-2.23	-2.32
	(0.01)	(-0.95)	(-2.21)		(1.05)	(1.19)	(-2.11)	(-11.03)
Log(A1(-1))			-2.08	1.58				
			(-1.03)	(3.52)				
Log(A1)						2.33	5.62	2.02
						(0.82)	(2.42)	(4.97)
Log(A2)			1.15	0.30		0.84	2.71	1.68
			(1.43)	(1.12)		(0.68)	(1.98)	(49.34)
Du*Log(P)				-0.16				
				(-2.26)				
AR(1)	0.58	0.62						0.22
	(2.46)	(4.17)						(26.90)
AR(2)							0.26	
							(2.55)	
AR(3)					-0.08	-0.39		
					(-1.53)	(-1.91)		
AR(4)				-0.40				
				(-5.42)				
MA(1)						-0.99		
						(-32892)		
MA(2)			-0.89					
			(-6.15)					
MA(3)	-0.99			-0.99	-0.99			
	(-7.52)			(-61.43)	(-90.48)			
MA(4)		-0.98	0.96					
		(-47.23)	(62.60)					
T*			-0.59			-0.25	-0.72	-0.48
			(-2.92)			(-1.77)	(-2.29)	(-28.43)
R^2	0.87	0.95	0.97	0.99	0.99	0.96	0.29	0.81
$\overline{R}^2$	0.77	0.92	0.94	0.98	0.98	0.92	-0.51	0.60
D.W	1.78	2.22	2.12	2.47	2.53	2.39	1.49	2.03
F-statistic	9.00	27.66	33.77	86.79	133.13			

Source: research results
*T represents the variable of time trend
**D indicates the dummy variable

In addition, mechanization variable is not significant also mechanization is negative also is not justified. In thefifthregression, interactions of three variables such as mechanization, improved seedsandfertilizer which are three main factors of Green Revolution are entered into the model, althoughissignificant, but mechanization variableisnegative and significant is not justified and poison variable is not significant. The fifthregression is estimated as fourth regression just by changing the degree of auto correlation(AR (3)), that because poison is not significant, also because mechanization coefficient is unjustifiable'-6.27' does not accepted. In the seventh regression intercept was omitted till could obtaina bettermodel. Also for estimating is used of equation4, and since using of planting tools and machinery initiallyperformin autumn or winter (Okhovat,1997) so mechanization is entered into the model withalagperiod in planting stage' A1'.But stillthe coefficients of improved seed and poison are notsignificant. In the eighthand ninth regression is used of Tsls Pooled that instrumental variables are entered into the model. But in theeighth regression, mechanization which is negative is not justified and the coefficient variable of irrigationis not significant. Alsoin theninthregression, variables coefficients of mechanization, fertilizer and poisonare notsignificant; also the variable of improved seed is not justified.

A scan be seen, did not cometoa reliableconclusion witharranging data as frequency and estimation as PLS.So we will continue the model's estimation with arranging data as BalancedPanel which will lead to estimation as Panel Least Square. In this way, Fars provincedue tonon-continuoususing ofimproved seedwill be deletedfrom themodel.In the following, the best obtainedresults with using thismethod are givenin thetable3. In the firstregression, table3 the coefficient of improvedseed isnegativeand significant whichis not justified also

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irrigation coefficientis not significant. In thesecondregression, interceptwas removed and interaction effect ofmechanization, improved seedsandfertilizer which are 3main factors of Green Revolution and also dummyvariable forincreasing about production during years 1993 to 1996 are entered into the model. Being significant and negative of interaction of Green Revolution's threebasic factors, large coefficientof mechanization and lack of being significant of improved seedand poison all of them cause rejection of this model. In the third regression, mechanization was divided in the planting and harvesting time and since using of planting tools and machinery initially performs in autumn or winter (Okhovat, 1997), so mechanization is entered into the model withalagperiod in planting stage.But again the coefficients of mechanization were not significant in planting and harvesting stages and also pesticide. In forth regression, the intercept was omitted, maybe obtain the better pattern and the interaction effect was entered into the model in planting and harvesting stages as one of the variables. In fifth regression, in addition to the interaction effects of these two variables the interaction effect of fertilizer and pesticide also was entered to the model, but again non-significant of some variables cause rejection of these tworegressions. In sixth and seventh regression, is used of TSLSmethod. In sixth regression, the irrigation coefficient was not significant and mechanization coefficients were high. In seventh regression, also the interaction effect of mechanization was entered in to the pattern in planting and harvesting stage, but again because of non-significant of some coefficients, this regression was not accepted. In eighth and ninth regression was used of generalized method of moments (GMM). In the eighth regression, the irrigation variable coefficient was not significant and negativity of improved seeds and mechanization's coefficients were unjustifiable.

In ninth regression, the intercept was omitted from the pattern and the interaction effect of fertilizer and pesticide was entered into the model. But also this model was not accepted because of non-significant of some coefficients such as mechanization in planting and harvesting stages, irrigation, unjustifiably of some variables like improved seed also low statistic of R^2. Therefore, with existence of estimation of many models like Fixed Effect, Random Effect and Sur, with using of frequency and Balanced Paneldata did not get a reliable estimation. So in the following, the data ordering is as frequency and estimation will be examined as Time series that is used of Iran's data as one cross and the results of best obtained estimations with using of this way has been shown in table 4.

In first regression, the coefficients of mechanization and pesticide were not significant. In second regression, the coefficients of fertilizer and pesticide were not significant too. In third regression, the variable of time trend (T) was entered into the pattern and mechanization was separated in plantingand harvestingstage. As mentioned previously, because using of instrument and machineries of cultivation initiallyperforminautumn or winter (Okhovat, 1997), mechanization was entered into the pattern with a lag in plantingstage (A1). In this pattern, the coefficients of mechanization in plantingand harvestingstage and improved seeds were not significant. In forth regression, the dummy variable creates through multiplication of pesticide's independent variable in dummy variable(Du*Log (P))and it was because of sudden volatility in consuming pesticide. But in this regression the mechanization coefficient was not significant in harvesting stage, so this estimation was not accepted, too. In fifth and sixth regression, was used of TSLS method. The fifth regression was not accepted because of non-significant of mechanization, fertilizer and pesticide coefficients. In sixth regression, the intercept was omitted and mechanization was separated in planting and harvesting stage also the variable of time trend entered into the model, but again because of non-significant of some coefficients, this regression was not accepted. In seventh and eighth regression was used of GMM method. In the seventh regression, negativity and significant of irrigation coefficient was unjustifiable and in eight, the mechanization was separated in planting and harvesting stage and the variable of time trend was entered into the model. In this regression, all coefficients were significant and justifiable. The mechanization coefficients were positive and significant in planting and harvesting stage that indicates using of agricultural machineries which are just for rice causes increasing of productivity of this crop. The coefficient of the improved seed (4.84) indicates that by increasing of 1% of this variable with considering that all conditions are as stability mood, production of this type of rice increases to 4.84%.

Irrigation coefficient which is positive and significant shows positive effectof this variableon the productionand performanceof high-yieldingrice that for every1% increasing of irrigation and with no changing for other variables andconditions so production of this type of rice increases to 1.78%. There is an article similar to this result with title of "Views on food production" by Kunio Tsubota. He believesthatfor moving toward Green Revolution, relatively small increasing of landswhichirrigate is as main variable foroccurrence ofnewGreen RevolutioninAfrica.

moreover as another similarity, according to the article "Lessons from Three Decades of Green Revolution in the Philippines" by Jonna P. Estudillo and Keijiro Otsuka,(2002), The contribution of modern varieties (MVs) of rice to yield cum irrigation to total factor productivity(TFP) growth is about 50 percent in Central Luzon in Philippines.

On the other hand, for planting some crops like rice farmers use of fertilizer in order to increaseproductivity and performance also they use of pesticide in order to prevent pestthat cause reduction in product performance

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and losing it. But in this paper coefficients of fertilizer and pesticide are negative which show consumption ofthese two variablesis very highin Iran and using of these two chemicalvariables notonly increases the product performance but alsoreduces it.The most negative effect is for fertilizer variable and shows that onepercent increasing in using of this variable, while only thefertilizer variable change and other variables also conditions are fixe, cause to reduction in productivity about 2.49 %. In this estimation, $R^2 = \%80$ $\overline{R}^2 = \%57$ indicate that 80% of dependent variable's changes were justified by independent variables. And the statistics of Durbin-Watson which is 1.83 indicates that regression is not autocorrelation because placed in non- autocorrelation district.

5. Conclusion:

Since the estimated model is as logarithmic, so the coefficients indicate the elasticity. In the final estimated pattern with time series method, the most positive effect related to improved seed and shows with 1% changing of improved seed the production of high yielding rice will increase up to 4.84 %. So as expected, the improved seed has positive effect on production of high yielding rice. On the other hand, with increasing of 1% irrigation the production of this kind of rice increases about 1.78% that for all mentioned variables, the assumption of stability of other conditions should be considered. With 1% increasing ratio of mechanization level to total cultivated area in planting and harvesting stage and with non-changing of other variables and conditions, production of this kind of rice increases respectively about 2.13 % & 1.85 % that indicates using of special agricultural machineries for rice caused increasing the productivity of this product in planting and harvesting stage. As the results indicate the most elasticity is related to improved seed and thenmechanization operation is in planting process, this result is similar to Arslanbod *et al*'s paper. (2008), in their paper seed'wheat'has thehighest elasticity and machineries have second place.

In this paper the most negative effect related to the pesticide variable that was used more than need. 1% increasing in consumption of this variable if only the pesticide changes and other variables and conditions be fixed caused decreasing of productivity about 4.31% and1% changing in the fertilizer consumption with this assumption that other conditions are stable, caused changing up to2.49 % for producing this crop which indicates the consumption of these two variables is very high in Iran and consumption of these two chemical variable, not only caused any increasing of productivity but also has reduced it. So according to the purpose of this paper, means studying on the effect of basic variables of Green Revolution like mechanization, improved seed, irrigation, fertilizer and pesticide inimplementation ofGreen Revolution about riceproduction in Iran, it should be mentioned that obtained results are as that our purposes were.

According to the obtained results, although changing in applying pesticides chemical fertilizer, machineries and modern technology are effective in implementation ofGreen Revolution, also the amount and manner of applying of these variables are very important. Somay beproposed, reasonableincreasing of area under cultivation of high-yieldingcrops is with exact and scientific studies.

Finally, we could say that whatever the Norman Borlaug planned nearly 50 years ago and tried for its achievement, means increasing of product and productivity which is now as an essential requirement of Iran, because increasing of productivity finally will lead to self-sufficiency that this matter decreases importing ofconsumer goods and increasing ofinvestment potential in other fields, but before occurrence ofGreen Revolution should provide infrastructuresin the field ofindustry, education, planning and management. Because it goesso fastthatcould not stop it at the time of occurrence or do anything in that time.

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