Journal of Applied Sciences

ISSN 1812-5654

science alert

ANSInet
an open access publisher
http://ansinet.com

Journal of Applied Sciences 5 (10): 1762-1766, 2005
ISSN 1812-5654

Future of Global Agriculture: An Ecological Evaluation

Arslan Zafer Gurler, Gulistan Erdal and Halil Kizilaslan
Department of Agricultural Economic, Faculty of Agriculture,
Gaziosmanpasa University, 60240, Tasliciftlik, Tokat, Turkey

Abstract: In this study, environmental effects of agriculture has been tried to be revealed with use of climate changes until 2025 as data. With this aim, forecasting results estimated with data of past 22 years back to year 2002 were included in the study. Subjects of projection were described as consumptions of P, N, pesticides and usage of irrigation water, agricultural areas, population and GDP. With the World wide projection made for the year of 2025, it is estimated values of consumptions as P 51.10^6 tons, N 105.10^6 tons, irrigation water 327,80. 10^6 ha, agricultural areas 5140. 10^6 ha, population 7934. 10^6, National product 76146. 10^6 $. Also, dominant features of countries are determined and analyzed with correlation analysis made between population, GDP and other variables. Generally, while GDP and population variables has no effect on P consumption, it has been seen to be effective especially over N consumption, irrigation water usage and agricultural areas.

Key words: Ecosystem, N consumption, P consumption, irrigation water usage, pesticide consumption, agricultural areas, population value, GDP

INTRODUCTION

During the past 20 years environmental problems in agriculture have increased. These problems are mostly due to the greater intensification, higher productivity and concentration of production[1]. There are anthropogenic components at the focal point of these problems[2]. While consumption increase in relation with population and income level, rising necessity to get more efficiency from unit area, on the other hand, as a result of consumption preferences, causes to development of national income against agriculture reversely. In this process, as a dilemma, while developed countries decreases their agriculture based activities, developing countries' choices becomes increase of agricultural intensity. It is also obvious that the overall organization of world agriculture is imbalanced, since some poor nations still face food shortages, even though the world has an abundance of unused land[3].

Global population had reached 6.3 billion people with a 3.7 increase in parallel with developing countries' rapid population growth along 20th Century. Only 1.88 billion share of this population lives at developed countries[4]. About the futures of population growth different scenarios have been produced[5].

In relation to global population density, countries such as Chine, India, USA, Indonesia, Brazil, Pakistan, Russia, Bangladesh, Nigeria and Japan take first ten places. However, countries such as Nigeria, Congo, Madagascar and Uganda are estimated to propel population growth at next 50 years[6].

Continuous source consumption exists because of population growth. In next century, this increase is waited to accelerate in relation with developed countries' income growth[7] National income produced at 2002 comes from 4% agriculture, 32% industry, 64% services[8]

Twenty countries consisting 70% of World population according to data of millennium start. At the same time, these countries own more than 50% of world output. As a consequence to rapid growth of population and wealth, serious environmental problems as food production, decrease of surface soil and decrease of biodiversity having been waited to occur[9].

According to year 2003 World Bank indications high income countries takes 80% share of GDP. Low and middle income countries' share are about 20%. Share of low and middle income defined countries within 20% share are as East Asia and Pacific 5.6%, Europe and Middle Asia 3.8%, Latin America and caraibes 4.8%, Middle East and North Africa 1.9%, South Asia 2.0%, Sub-Sahara Africa 0.14%[10].

MATERIALS AND METHODS

Low income countries' agricultural intensification with necessity to feed their large populations is causally normal. Also, developed countries complete the cycle by producing input to be used with high efficiency outputs'

Corresponding Author: Gulistan Erdal, Department of Agricultural Economics, Faculty of Agriculture,
Gaziosmanpasa University, 60240, Tokat, Turkey
Fax: +90 356 2521488

Table 1: Agricultural components that effect ecosystem and their projection values

	Varieties in 2002 year							Varieties in Forecasting, 2025 year						
Countries	X_1 10^6 ton	X_2 10^6 ton	X_3 10^6 ha	X_4 10^3 ton	X_5 10^6 ha	X_6 10^6	X_7 10^6 US $	X_8 10^6 ton	X_9 10^6 ton	X_{10} 10^6 ha	X_{11} 10^3 ton	X_{12} 10^6 ha	X_{13} 10^6	X_{14} 10^6 US $
China	25.43	9.92	54.93	300	534	1302	1204	30.91	14.34	63.08	--	575	1476	11232
India	10.47	4.00	57.20	48	181	1050	533	16.78	6.46	60.44	19	180	1363	1 902
USA	10.88	3.87	22.50	190	412	291	9234	11.83	4.24	24.04	215	405	349	19038
Indonesia	2.21	0.33	4.80	11	45	217	218	02.60	0.28	05.38	--	46	276	760
Brazil	1.82	2.81	2.92	131	364	176	812	30.43	3.57	03.30	271	291	211	1 539
Pakistan	2.34	0.62	17.80	43	27	150	74	3.42	0.94	18.90	77	28	229	238
Russia	0.85	0.33	4.60	150	217	144	381	0.52	0.13	5.41	--	213	137	1 635
Bangladesh	1.05	0.22	4.59	15	9	144	54	1.56	0.12	5.92	19	8	205	140
Nigeria	0.09	0.04	0.23	--	70	121	110	0.03	0.01	0.23	--	72	206	235
Japan	0.46	0.48	2.60	83	5	127	5666	0.29	0.30	2.37	--	5	121	11325
Mexico	1.18	0.35	6.32	36	107	102	375	14.62	0.21	7.68	--	109	132	644
Phlippines	0.48	0.13	1.56	--	12	79	94	0.71	0.22	1.55	--	13	118	157
Germany	1.79	0.33	0.48	33	17	82	2708	2.11	0.19	0.48	75	17	82	5 367
Vietnam	1.06	0.51	3.00	--	9	80	33	1.22	0.89	3.12	--	12	103	111
Egypt	1.07	0.14	3.40	8	3	70	82	1.53	0.13	3.31	24	4	103	277
Etiopya	0.08	0.07	0.19	1	31	69	7	0.10	0.07	0.19	4	31	118	14
Turkey	1.19	0.47	5.21	48	42	70	204	1.51	0.49	5.89	54	42	89	570
Iran	0.88	0.31	7.50	10	61	68	136	1.23	0.09	8.41	19	60	67	245
Thailand	1.02	0.41	4.95	39	20	62	184	1.57	0.58	5.81	50	19	70	959
World	84.75	33.55	280.00	2600	5.019	6225	35311	105.00	51.00	327.80	--	5.140	7934	76146

Sources: [10-13]

Table 2: Correlation of population and GDP data that formed as 25 years series with agricultural variables which assumed to effect ecosystem

Countries	r	X_1	X_2	X_3	X_4	X_5	Countries	r	X_1	X_2	X_3	X_4	X_5
China	X_6	95	96	93	-	93	Mexico	X_6	40	-43	95	-	97
	X_7	88	93	97	-	80		X_7	35	-39	90	-	89
India	X_6	50	53	51	24	04	Phlippines	X_6	90	92	81	-	95
	X_7	95	93	98	29	22		X_7	86	92	61	-	94
USA	X_6	66	-22	88	27	95	Germany	X_6	-75	-95	-85	80	-91
	X_7	64	-23	87	20	-95		X_7	-77	-98	90	78	-96
Indonesia	X_6	95	-25	-	-	77	Vietnam	X_6	95	95	89	66	79
	X_7	92	-33	-	-	67		X_7	94	99	67	65	94
Brazil	X_6	88	66	95	76	99	Egypt	X_6	94	-19	95	0	95
	X_7	93	74	90	77	98		X_7	94	-11	93	-02	93
Pakistan	X_6	99	95	96	75	94	Etiopya	X_6	90	86	85	56	-85
	X_7	99	93	96	75	93		X_7	92	81	83	61	-83
Russia	X_6	50	51	89	07	51	Turkey	X_6	79	10	98	70	74
	X_7	88	86	48	-23	77		X_7	82	19	95	71	73
Bangladesh	X_6	98	49	99	59	-75	Iran	X_6	96	-13	92	31	80
	X_7	95	49	98	54	-72		X_7	82	-53	67	6	51
Nigeria	X_6	93	-19	48	40	0	Thailand	X_6	99	93	98	58	27
	X_7	0	-56	90	63	-2		X_7	96	97	95	69	24
Japan	X_6	-85	-74	-98	-	-97	World	X_6	87	-12	99	-	97
	X_7	-87	-74	-97	-	-96		X_7	86	-13	99	-	96

production. If the balance of this cycle could not be protected than damage of agriculture over ecosystem would be inevitable.

In this study, effect of agriculture over ecosystem will be tried to expose by assuming climate variations till year 2025 as data. This study formed by using data consisting of 22 years back to beginning of millennium have aimed to project and evaluate future.

In working process, the existence of components as past technological developments, changes of consumer choices, environmental arrangements and their causality for important deviations are unavoidable. With acceptance of mentioned components as data, necessary factors to continue agricultural activities were selected. Most appropriate trend equations to estimate future dimensions of selected factors were calculated and used to create projection values.

Values of year 2002 that involved in the study and estimated results calculated with past 22 years' data which include years 1980-2002 are shown at Table 1. By this way, it is aimed to compare ex-ante data with projection data. In the study, components of the projection were described as Nitrogen fertiliser (N) consumption=X_1, Phosphor fertilizer (N) consumption=X_2, Usage of irrigation water=X_3, Pesticide consumption=X_4, Agricultural areas=X_5, Population value=X_6, Gross Domestic Product (GDP) =X_7 Year 2025 projection values related to same variables were described from X_8 to X_{14}, respectively.

Three hundred and sixty trend equations in 4 different forms for 6 variables that whose effects over ecosystem known were estimated for global level and 19 countries. Values taken from most appropriate 120 equations were used for forecastings. At the same time, with the aim to determine relations between GDP and other variables, nearly 200 correlation coefficients of each country were calculated that containing the variables as population values, GDPs, N, P, irrigated area, pesticide consumption and agricultural area. Correlation matrixes were summarized at Table 2.

RESULTS AND DISCUSSION

Primary component effective over ecosystem is fertilizer level used for agricultural production. If existing fertilizer usage trend continues over estimation period, increases for N usage 24% and P usage 50% has been expected. It is estimated no order change for P usage. While the first 3 of N fertilizer order at the beginning of year 2000 were China, USA and India, by projection of 2025; first order shared by China and Brazil and India takes second so Mexico third. These countries take 80% of world fertilizer consumption (Table 1).

While fertilizer usage in China was below organic until 1980's, after beginning of 1980's 1 fertilizer usage rapidly increased over organic fertilizer. It is stated to pass over 300 kg ha^{-1} for fertilizer usage which was only 0.6 kg ha^{-1} at the beginning of 1950's [14]. Beside that it is worrisome to be no expansion of agricultural areas. Mains of commercial fertilizers are consisting of Nitrogen, phosphorus and potassium. Motions of potassium and Phosphate over underground waters are limited. But N lead to contamination by transforming into nitrate and leaking underground waters with irrigation and rains. Nitrate levels of underground waters increase with continuation of N application[15].

Researches on fertilizer consumption show two contradictory situations. Generally, especially over N fertilizer usage of developed countries from 1980's to year 2002, nearly a 20% decrease had been observed. But, with N fertilizer consumption of developing Asian countries, an increase more than 120% had been calculated.

Duty of fertilizers in relation to increase food production could not been denied. However, high level usage known to cause serious water pollution beside eutrification effect. Asian countries such as Chorea, China, Japan and in the last years Vietnam had practiced high level N applications. Farmers of these countries thought low fertilizer usage should decrease return. Whereas studies carried out at Japan and EU had shown that excessive fertilizer usage causes to decrease efficiency. So even with decreasing fertilizer usage it is showed to continue high efficiency[16].

In this study, pesticide consumption has been taken as a second component effective over ecosystem. Pesticide concept is common name of chemicals used with aim to control pests such as insecticides, rodenticides and fungicides. In some situations, pesticides create toxic effects by infiltrating to ground waters[15].

Developing countries' pesticide consumption nearly 10 fold increased at the last 30 years. World pesticide consumption was 2.6 million tons with a 38000 million USD market value by year of 2002. Eighty five percent of this consumption has been used at agricultural sector.

As a great share of pesticides, ¾ of consumption has been used at developed countries of North America, Western Europe and Japan[17]. Pesticide sales showed an increase of 2.8% in North America, 2% in Latin America, 3% in Japan, 10.5% in Asia-pacific region by the beginning of year 2000[18].

Bayer and BASF which are the leading companies of pesticide production export important share of their products to developing countries. These pesticides bought by developing countries have been used intensively for export products like cotton, coffee, banana, vegetable and flower[19].

By the year 2000 data, 10 companies at the world had 90% of pesticide trade that effective on human health through the way of bioaccumulation in food chain and taken 27 million USD share of this commerce. World pesticide consumption reached 3.2 million tons and value of a 38 million USD global market value at year 2001. Approximately 85% of this consumption is on agricultural sector. As if pesticide usage continues parallel to agricultural development, production and import also has been estimated to increase rapidly.

In the study, Japan and similar developed countries are observed not to explain their pesticide consumption data. Yet, China, USA, Brazil and Russia use 150-300 thousand tons pesticides, respectively. Increase value of world pesticide consumption until year 2025 could not been calculated as a result data deficiency. In this respect, it could be said to increase two fold as a subjective judgment.

Also untidiness of water usage which is an unchangeable component of ecosystem creates negative effects over environment. Effects of irrigative agriculture over existing natural environment have been investigated by many researchers. Generally it is stated to be created undesired environmental effects such as soil salification, leakage of nitrates and pesticides to underground waters in relation with usage of much more chemicals, contamination of surface waters with agrochemicals, soil erosion and damage of soil structure[20].

It may be expected to irrigate 20% of agricultural areas by year 2025 which was already near 15% at the beginning of year 2000. By means of individual water consumption

which takes second to agricultural irrigation, developed countries use ten fold more water than developing countries. While irrigated agricultural areas were 280×10^6 ha in world scale at year 2002, it is estimated to be 327×10^6 ha by year of 2025. Again while India, China and USA had most of irrigated area in year 2002, it is estimated that China would take first order by year 2025.

Along with fertilizer and pesticide usage, salification of agricultural lands comprises approximately 45 million ha. This amount equals nearly 20% of world's irrigated areas. Nevertheless it is said 1.5 ha area becomes barren every years. 70% of world freshwater has been used for agriculture. Drained waters cause to decrease water stock as being excess to rain gained waters[21].

Global water sources two fold decreased at last 25 years. Main problem is about increase of water consumption in relation to population. United States use 49% of total freshwater for agriculture and 80% of that for irrigation. In the Africa and Asia freshwater used for irrigation is nearly 85-90% of total sources[22]. About freshwater usage by year 2025, in agriculture 1.2, in industry 1.5 and in individual consumptions 1.8 fold increases are expected.

As for world agricultural areas, it is estimated to increase approximately 2.5% by year 2025. Increase of agricultural area whilst highest China with 8%, originate from most Asian countries except India. It might be said that while agricultural areas could not be widened; intensive agricultural input applications to get more product from unit area with aim to meet food requirements of increasing population gradually makes negative contributions to ecosystem.

Now, let's try to evaluate results related to correlation coefficients that formed with aim to determine the directions and degrees of relations of population and GDP with other factors whom we assume as alerter of other variables also.

While world values show high correlation of population and GDP with components such as N usage, irrigated area, agricultural area, expose no relation to be exist for P fertilizer.

In relation to population and N fertilizer usage relationship at first a correlation over 95% observed with countries such as Thailand, Pakistan, Bangladesh, Iran, China and Indonesia. Correlation for P fertilizer usage is 90% and over in countries such as China, Pakistan, Philippines, Vietnam and Thailand. High correlation has been observed between population and irrigated area in Thailand, Turkey, Egypt, Bangladesh, Pakistan and China. Sufficient data about pesticide usage could not be founded. Even there is no considerable relationship among existing data (Table 2).

China, USA, Brazil, Pakistan, Mexico, Philippines and Egypt had increased agricultural areas in relation to population. As for Germany, there is a negative relationship between agricultural areas and population. Although not considered to be powerful, a similar relationship also may be mentioned about Bangladesh, Japan, Niger and Ethiopia (Table 2).

A high correlation exist between GDP and P fertilizer usage in Asian countries such as India, Indonesia, Brazil, Pakistan, Bangladesh, Vietnam, Egypt, Ethiopia and Thailand. As for P fertilizer usage again Asian countries are foremost.

Even for the every country except Japan, high correlation exists between income increase and irrigated areas.

High value negative correlations have been founded between income and general agricultural areas in countries such as USA, Japan and Germany.

There is a correlation over 90% between GDP and agricultural areas in countries such as Brazil, Pakistan, Philippines and Egypt.

As a conclusion, globally high correlation between population and agricultural areas increased with dominancy of agriculture dependent countries of Asia, Africa and South America. Again these countries intensively use fertilizer and pesticides produced by developed countries.

Although countries whom have high income potential except China trying to diminish ecological damages for themselves, tertiary countries do not exhibit same behavior as commercial coercion favors. But it might not be forgotten that they also share the same earth and would also share same fate with a possible ecological disaster.

With knowledge of the fact that a population growth of 1% engenders an increase of 1.28% in the oscillation of greenhouse gas, an increase of 30% in the oscillation of greenhouse gases in relation to population has been expected by the year of 2025[23]. Therefore, rapid growing population factor forms the base of ecologic problems by bimodal effect. Middle and low income countries' population increase and untidiness by usage of ecological damage creating agricultural inputs to feed that increasing population and also excessive consumption habits of developed countries whilst parallel that income level have been converting a scenario to reality that nobody could earn and should result with zero total.

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