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The Effects of Agricultural Development on Ecosystem and the Sustainability of Development

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Abstract: One of the several variants of global warming is the effect of agricultural development on ecosystem. Each of these variants creates a global threat in terms of a cause-effect relationship. In this study, a projection was made to discover possible levels of major elements of agricultural development such as chemical manure, irrigation water, use of pesticide in 2020 year. Thus, the effect of agriculture on ecosystem in the future was estimated on the basis of world scale and Turkey. On the other hand, in the analysis made in accordance with conjectural criterions, it is revealed that Turkey which is acknowledged to be developing is under threat in terms of sustainable development.

Key words: Agricultural development, ecosystem, sustainable development

INTRODUCTION

The negative effects on environment system results from anthropogenic facts which occur in consequence of human activities (William, 2001).

The warming in the Northern Hemisphere on which is focused in recent years is taken up again with the help of the technique named dendrochronology (Michael *et al.*, 2003).

The results indicate that the Northern Hemisphere has warmed up rapidly since 1950 although there are scientists who have different opinions about global warming (Daly, 1996).

In case of continuation of anthropogenic negative facts, it will be inevitable to go through a process starting with global warming and destroying the ecosystem completely.

If the primary elements of ecosystem are considered to be inorganic components such as H₂O, CO₂, Ca, N, P and physical factors such as climate and temperature, organic components, constructive organisms; their effect of the immoderation in their production and consumption on ecosystem is incontrovertible.

One of the important causes of the said immoderation which brings about ecological damage is the development in agriculture.

The purpose of the study is to determine the dimensions of sustainable development for Turkey by taking account of the criterions regarded as necessary for sustainable development and effect of agricultural development on ecosystem.

THEORETICAL FRAME

Human activities increase its speed which is parallel to the raise of population and income. While the population of the world being 1.6 billions in 1900, is multiplied by four at the end of our century and continues to increase in parallel to the rapid growth of population in developing countries. During 20th century, global population reached 6.3 billions of people with a raise of 3.7. Only 1.88 billions of this population lives in developed countries (Anonymous, 1998). According to a scenario assuming lower fecundity, the population of the world will be 7.6 billions in 2050, 5.6 billions in 2100 and as the decrease goes on to 3.4 billions in 2150 (Haupt and Thomas, 2002). In terms of global population density, China, India, USA, Indonesia, Brazil, Pakistan, Russia, Bangladesh, Nigeria and Japan take place in the first ten countries, while Turkey is in the first twenty.

However, it is estimated that in the next 50 years countries such as Nigeria, Congo, Madagascar, and Uganda will incite the increase in population (Anonymous, 2002). Among the negative effects of excessive population growth, the fact that a population growth of 1% engenders an increase of 1.28% in the oscillation of greenhouse gas is one of the significant indicators (Shi, 2001).

The consumption of sources is always current because of the rise in population. If the average consumption is considered to be measured as the per capita gross national income; this rise is expected to accelerate with next century.

The world economy showed a five-time enlargement from 1950 to 1997. With numbers of this period, industrialized countries who have 22.5 trillion dollars of global gross revenues whose sum is 27.7 trillion dollars continue to affect the economic growth. Global gross national income which was procured in 2003 takes a share of 4% from agriculture, 32% from industry and 64% from service sector (Anonymous, 2004a).

Approximately 70% of the world population consists of twenty countries according to the recordings in 2003. These countries also have more than 50% of output produced in the world.

The rapid growth of population and welfare strengthens the human pressure over the global ecosystem. In this way it is influential on the natural ecosystem. According to the recordings of the year 2003, although the national income of China, the world's most populous country, is 1,409.852 billion dollars, the national income of USA, being the third in population order, is 10,881.609 billion dollars. Turkey is the 17th in the list of populous countries and 8th in the list of national income. When a general separation for world countries is made, taking account of the indicators of the World Bank, it is seen in the dispersion of national output in 2003 that while high income countries take 80% of the GNP, low and middle income countries take 20% of it.

The rise of population and income in the world triggered the conversion in agriculture not much later. It is known that the practices intended for increasing the efficiency in unit area, which abates the effect of diminishing returns the same production unit so as to supply the needs of the population that is inclined to grow, started with the industrial revolution. These practices, whose consequences such as active irrigation, dense fertilizer and use of strengthened plant species are newly perceived, make up the starting process of the damage given to the ecosystem (Anonymous, 2000a). During the first 35 years of the process which started in between 1960-70 and named as "Green Revolution", however, agricultural activities such as the generalization of the use of pesticides, nitrogen, phosphorus and excessive irrigation water without limitations; increased the effect of ecological damage (Cohen, 1995) while doubling the production.

Spatial economic studies made in the matter of model resolving by using the prudent tools concerning the issues of residential areas, optimal soil allocation and social prosperity criteria along with environmental sustainability, try to solve the problem with quantitative models by using the variants such as organic components, nutrition, use of energy and toxic pollution

(DeTomb, 2000). As these studies indicate, it is known that the source of countryside and city pollution depending on the trade-off between residential areas and working areas, population and income level, affects the treatments depending on the income level of population as much as the population growth. So, the activities producing the pollution primarily depend on these two facts.

MATERIALS AND METHODS

The study the effect of agriculture on environment was tried to point out by predicting the future dimension of assumed influencers of agricultural development statistically in the model. The forecasting process which was formed by using the data of at 40 years was based on Food and Agriculture Organization of The United Nations (FAO), World Bank, Republic Of Turkey, Prime Ministry Turkish Statistical Institute (SIS).

In the study, forming of statistical model has been used Minitab 12 for windows. In the process of study, it is inevitable for trajectory like technical developments in the past, changes in the choices of consumers and environmental arrangements to exist. Alterations on those trajectory may lead to important deviations with predictions. In the prediction made according to the global data and environmental variants concerning agriculture; mathematical forms were used which are best suited to the model so as to reduce these diversions to the least.

In the first stage of the study, it has been used the multiplicative version of Winters' method for projections (Winters, 1960). The model equation is

$$P_1(kM + \tau) = [a_1 + b_1(kM + \tau)]s_{1+\tau} \quad \tau=1, \dots, M; k=1, 2, \dots$$

Winters' multiplicative method constructs three statistically related series, which are used to make the actual forecast: the smoothed data series. This method requires at least two years of back data to calculate a forecast. It is calculated by solving the three "updating formulas" below

$$a_t = a(d_t / S_t) + (1 - \alpha)(\alpha_{t-1} + b_{t-1})$$

$$b_t = \eta(a_t - a_{t-1}) + (1 - \eta)b_{t-1}$$

$$s_t + \tau = skM + \tau = \beta \frac{d_{(k-1)L+\tau}}{\alpha_{(k-1)M+\tau}} + (1 - \beta)s_{(k-1)M+\tau}$$

Table 1: Projecting conclusions

	Fertilizer usage (10 ⁶ Metric Ton)		Irrigation area (10 ⁶ Ha)	Pesticide usage (Metric Ton)	Agricultural area (10 ⁶ Ha)	Population (10 ⁶ Ha)	GNP (Billion \$)	
	N	P						
Turkey 2003	1.19	0.47	5.21	24900	42	70	239	
World 2003	84.75	33.55	280.00	2600000	5.019	6225	36356	
Projections								
Turkey 2020	forecast	01.51	0.42	06.73	14497	41	91	318
	lower	01.15	0.13	06.36	-8230	38	90	260
	upper	01.19	0.70	07.09	37224	44	92	376
World 2020		105.00	51.00	327.80	5600000	5.140	7934	63501

Note: Pesticides; fungicides, herbicides, insecticides

Estimate of initial values;

$$b_0 = \frac{\bar{d}(K) - \bar{d}(1)}{t - m}$$

$$a_0 = \bar{d}(1) - \frac{1}{2}(M + 1)b_0$$

$$s_t = \frac{d_t}{a_0 + b_0}$$

The prediction results of calculated equations are shown on Table 1. Here the subjects for the projection are: Nitrogen (N) and phosphor as (P) fertilizer, use of irrigation water, use of pesticide and agricultural conversion

In second stage of the study, predictions related to Turkey results of sustainable development criterions recommended by Meadows are formed again by predicting with the data of time series.

Trend analysis fits a general trend model to time series data and provides forecasts. Linear, quadratic and exponential growth trend equations for time series has been write like below:

$$Y(t) = \beta_1 + \beta_2 t + e_t$$

$$Y(t) = \beta_1 + \beta_2 t + \beta_3 t^2 + e_t$$

$$Y(t) = \beta_1 (\beta_2^{-t}) + e_t$$

In study, the most suitable equation in examined statistical forms is used.

We estimated Criteria for Sustainable Development trends for the entire interval for which we had data (1963-2003), a measure of its statistical significance (*: p<0.10, **: p<0.05, ***: p<0.01) and the number of circles on which trends were estimated.

ANALYTIC FINDINGS

The effect of fertilizers usage (N and P) and irrigation on ecosystem: The primary factor which is effective on the ecosystem is the level of N and P used in agricultural production. At the period of prediction time in case of

continuing the fertilizer usage trend in the year of 2003, level of N use throughout the world will approximately rise 24% in 2020, while in Turkey this rate will be 27%. For P fertilizing while this amount is expected as over 50% in the world, predicted for Turkey of it is -11% and upper 10% in the year 2020. It is predicted that while the rate of increase in the world for N and P fertilizers in 2050 will be doubled, in Turkey N will be multiplied with three but P will be decrease. N and P leaking from agricultural system to the earth surface make up the major environmental problem. The most significant problem that P causes is the eutrofication occurring especially in lakes and rivers. Eutrofication is the most important formation which destroys underwater life as well as seriously threatens the public health by transmitting into the water used by people.

On the other hand, unconscious water consumption also causes important problems in terms of ecology. During Green Revolution, methods of reducing the lack of irrigation water which are one of the most significant factors that limit the rise of capacity showed a rapid increase and irrigation gained a very special importance in high input agricultural methods. The effects of irrigational agriculture on its environmental area are examined by several researchers. Generally, it is conveyed that undesirable environmental factors such as soil salinity, mixing of nitrate and pesticides into ground water on the consequence of excessive use of chemicals, contamination of agrochemicals in the surface water, soil erosion and deterioration of soil composition will occur (Anonymous, 2000b; Hornsby, 1990).

Water is used for agricultural irrigation, individual purposes, industrial purposes and as reservoir source in the world. While water used in agriculture nearly was 2800 km³ in 2000, it is estimated to exceed 3200 km³ in 2020. It could be expected that irrigation of 20% of agricultural areas, where of approximately 15% in 2000, will be irrigated. In individual use of water coming after the agricultural use of water in pursuant of the order, the developed countries use water 10 times more than the developing countries (Anonymous, 2005). In world scale water amount for irrigation of agricultural areas is predicted as 327.80×10⁶ ha in 2020 and 529×10⁶ ha in 2050.

Table 2: Criteria for sustainable development and case in Turkey

Human activity	Sustainable*	Critical*	Destructive*	Turkey
Population increase (annual)	<0.5%	1.0-1.5%	>2%	2%
Economic development (GNP)	3%<GNP<5%	8<GNP<10%	GNP>10%	6.47%
Deforestation rate (annual)	>0.1%	0.5-20%	>1%	-
Forest coverage	>30%	15-20%	<10%	9%
Agricultural development (Person/ha)	>0.30	0.15-0.20	0.10	0.39
Self-support ratio	>91%	60-70%	<50%	199.4%
Population density (Person/ha)	<50	100-150	>200	74.4
Population of a city (million)	<0.5	>1	>10	0.3

* Criteria's for Sustainable Development of Meadows

In Turkey, 5210000 ha of area was irrigated in 2003. In case of persisting the trend from the year 1963 to today, it could be said that 6.73×10^6 of area in 2020 will be available for irrigation

The effect of the level of pesticide usage on ecosystem:

There are hundreds of pesticides which are effective on human health through the way of bioaccumulation in the food chain. World Health Organization (WHO) has categorized pesticides according to their possibilities of being harmful for human health. In this categorization, 33 of the most used 700 pesticides are in the group which is very harmful for human health; the others take place in either mediocre or less harmful groups. One hundred and forty nine kinds of pesticides are labeled as harmful in normal use. One hundred and sixty four of them have not been classified yet.

Ten companies have possessed 90% of the total pesticide trade capacity throughout the world since 2000 and they take a portion of 27 million USD from this commerce. World pesticide consumption reached up to 2.6 million tons in 2003. And the total world market value is 38 million USD. Eighty five percent of this consumption belongs to the agriculture sector. It is estimated that pesticide production and import will rapidly increase in case of pesticide use continues in parallel of development in agriculture (Anonymous, 2004b).

In the study, it is observed that Japan and suchlike developed countries do not declare their pesticide consumption data. In Turkey, pesticide usage is expected to decrease. Thus it has been estimated reach up to upper 37,224 tons in 2020. However, in order, China, USA, Brazil and Russia use 150-300 thousands of tons of pesticide. It is predicted that increase in pesticide use in the world will double itself in the years of 2020 and 2050. In Turkey, however, 2020 prediction is measured as 12%, 2050 prediction as 21%.

The effect of agricultural conversion on ecosystem: The conversion of forests, green areas and other natural elements into agricultural areas for the purpose of global food demand causes the destruction of global habitat.

According to the results on Table 1, it is claimed that the disentanglement of a 10^9 ha area of soil to the use of agriculture means a worldwide loss of an ecosystem, bigger than the lands of USA. Neutral this conversion in agricultural lands is primarily expected for Latin America and Middle Africa concerning the territorial terms. On the other hand, every day 400,000 ha of forest land disappear in the world. In Turkey, it is said that every year over 20,000 ha of forest land cease to exist. This means that in the future, our planet will not be enough for us (Tilman, 2001). To sum up, the most important effect of agricultural transformation is seen on the loss of habitat. The degree of environment effect also changes according to the kind of habitat (plants and animals).

Per contra, the disentanglement of marginal lands decreases productivity. Modern agricultural inputs that damage the ecological balance rise so as to compensate for this situation and this makes up an impasse; a vicious circle step by step. It is obvious that in Turkey agricultural areas reached up to the marginal limit and the trend.

The factors affecting ecosystem and the analysis of sustainability of development considering other main factors:

Although the sustainable development has been defined as the target since the World Summit of Rio de Janeiro in 1992, the desirable development has not been succeeded. According to the scenario of Meadows, the present form will either surpass the planned level or be sentenced to collapse depending on the present trend in population increase, industrial production, steel consumption, or grain production (Meadows, 1995). Though not being a perfect scientific approach, the sums on Table 2 could be used for the criterions for sustainable development. In parallel to these sums, when Turkey is evaluated it could be said that average annual population increase speed is inclined to fall according to the equation of exponential trend. Still, the period average of population increase speed in Turkey is 2%. According to acknowledged criterions Turkey takes place in the valuation of destructive development in terms of population increase speed.

Turkey GNP average annual increase speed is calculated as 6.47%. Along with deviations either with over or under values than trend values, general inclination is speed directional. When this result is considered, Turkey has showed deviation from sustainability to critical area according to the acknowledged criterions for GNP.

Philippines in 1970 and Thailand in 1980 are illustrated as the countries whose annual deforestation rate is higher than 1%. On the contrary, for example, Malaysia was suitable for sustainable development criterions with its forests which were destroyed in a rate of lower than 0.1% during the colonial period in the 19th century. Almost every country must aim at keeping the rate of forested areas over 30% so as to stabilize phenomenon such as climate, ground water, soil transformation, agricultural production (Murai, 1995). According to the records of Ministry of Environment and Forestry, being 2,456.799 people in 7303 villages in the forest, 5,086.973 people in 13011 villages next of the forest, a total of 7,543.772 people live in 20314 villages. This fact is the main determinant of forest and human relationships. So, almost 9% of the population of Turkey lives in or around the forest. That's why deforestation will affect human-forest relationships negatively. According to the envisaged criterions, Turkey has been deviating to the critical gap by exceeding sustainability limit in point of forested areas. When annual deforestation rate is concerned, the same situation is encountered again.

During the period of research, agricultural area per capita was 0.39 and according to the acknowledged criterions Turkey takes place in the valuations of sustainable development in terms of agricultural development.

Self-sufficiency is discussed in terms of grain production and consumption balance. Projections show that a great instability in the balance of grain production and consumption will occur until 2030. It is claimed that only in countries such as USA, China, India and Russia this gap will reach up to 204 tons (Brown and Kane, 1994). The fact that self-sufficiency rate is over 90% is estimated as a sustainable valuation. Valuations lower than 50% indicate deficiency in global terms. During the period of research self-sufficiency rate is calculated as averagely 119.4% in Turkey. According to the acknowledged criterions, Turkey takes place in sustainable development.

Rapid industrialization causes high energy consumption and the pollution it creates. Immigration to larger cities speeds up this process. Urban environment conditions could be regarded as stable for a density of 50 people in 1 ha. When density increases to over a 200 people in one hectare, it gains an excessively crowded value. The population of a city should be less than 0.5

million for a habitable environment. Average value in Turkey is 0.3 and it is seen that it has not yet been reached up to critical values in terms of sustainable development for conjectural criterions. Period average of population density in Turkey is found as 74.41 people/ha. In respect of this value, Turkey has shown deviation from sustainability to critical area in terms of population density and esteemed criterions.

RESULTS AND DISCUSSION

While a portion of more than 1.2 millions of people of 6 billions of people living in the world make both ends meet with 1 dollar a day, more than 2 millions of people earn a living in marginal limits. While the GNP is estimated to rise 75% in 2020 in the world, in Turkey it will be 33% or upper 57%.

In developed countries, the fact that GNP is high incites consumption. In parallel of consumption increase, oscillation of greenhouse gas will rise. Agriculture sector is also responsible for destruction in biological diversity and the loss of drinkable water along with the problems that it creates for human life such as pesticides, hormones, modification in the genes of organisms. In opposition, more than 30% of greenhouse gases that cause global warming are agriculture sourced.

In underdeveloped economies, population increase speed is high and the population needs nutrition. Agriculture which characterizes these economies affects the ecosystem negatively while it is made through traditional ways along with agricultural transformation, increasing the use of intensive input. On the other hand, ecological destruction will rapidly increase depending on the fact that immigration from rural areas to urban areas raises the production more in profitable sectors because of the instability stemming from income division between the sectors.

However agriculture affects ecosystem, primary cause is human sourced. While Malthus (1776-1834) and his follower economists referred to the negative effects of population increase, another group of economists claimed that population growth would raise the demand for the goods and would fall the cost of output per unit in long terms. Whatever the reason is, population growth improves the economic activities of both developed and underdeveloped countries. This vicious circle, the use of soil and habitat conversion, is expressed as the zero-sum play in which there is no way of saving the situation and one side would lose while the other would win.

When study findings are concerned, Turkey could be said to be near the critical limit of sustainable development. This, in fact, seems to be like a conclusion waiting for global sustainability. Developing countries

agree that the effects of agriculture on environment are more controllable in comparison with industry. Yet, the so-called controllability level will fall proportionally to the rise of input which industry transfers to agriculture. Also, although the risk entertained by industrial effects is able to be calculated empirically and quantitatively, it is not possible to state the uncertainties that agriculture faces with statistical prudence. Tsunami catastrophe in 2004 is a clear indicator of this. The scorching heat of 2003's summer, the abnormal caloric differentiations in north and south hemispheres in 2004, the glacier scenarios which have been discussed much for the last five years, in contrary to this the Kyoto Treaty which was not signed by the USA; all announce the global disasters in the future.

Population growth and the consumption triggered by the income raise in the population make the world go through a vicious circle. Maybe it is not too late to free human activities from being harmful for ecosystem and bring them to a beneficial level by reasonable approaches for a habitable world instead of a sustainable development.

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