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MALTEPE UNIVERSITY

SOCIAL SCIENCES INSTITUTE

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# SUSTAINABLE DEVELOPMENT IN INTERNATIONAL TRADE IN RELATION WITH CLIMATE CHANGE IN AGRICULTURAL STUDIES,TURKEY

**Master's Degree Thesis**

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**101122107**

**İstanbul, September 2012**

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**Councilor Istructor:**

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T.C. Maltepe Üniversitesi
Sosyal Bilimler Enstitüsü Müdürlüğü'ne,

13.09.2012 tarihinde tezinin savunmasını yapan Selen BEDÜK'e ait "Sustainable Development in International Trade in Relation With Climate Change in Agricultural Studies, Turkey" başlıklı çalışma, Jürimiz Tarafından Sosyal Bilimler Enstitüsü Uluslararası Ticaret ve Lojistik Yönetimi Anabilim Dalı Lojistik ve Tedarik Zinciri Yönetimi Tezli Yüksek Lisans Programında Yüksek Lisans Tezi Olarak **Oy Birliği/~~Oy Çokluğuyla~~** Kabul Edilmiştir.

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## ABSTRACT

Historically, economic developments have been strongly in relation with increasing energy use and growth of greenhouse gas emissions (GHG). Moreover, therotical concepts of sustainable development in trade and renewable energy issues intersect in global and local considerations. Early evaluations of the effects of climate change on agriculture lead to the trial of new renewable energy technologies. This thesis, which highlights the milestones of the literature related topics, focuses on suggesting a more considerably flexible system called Vermicomposting. The thesis frames the disussion of bringing up a new solution within the context of global agricultural environmental sustainability.

Keywords: Sustainability in Trade, Climate Change, Vermicomposting, Agricultural Sustainability

# ÖZET

Geçmiş tarihe bakıldığında, ekonomik gelişmelerin artan enerji kullanımlarına sebebiyet verdiği saptanmıştır. Ticarette sürdürülebilir gelişimin teorik kapsamı ve yenilenebilir enerji konuları hem ulusal hem de uluslar arası boyuttta ele alınmıştır.İklim değişikliği ile ilgili ilk bulgular yenilenebilir teknolojilein gelişimine sebep olmuştur. Bu tez literatür taraması aşamasında konuyla bağlantılı kilometre taşları olarak adlandirabileceğimiz veriler ışığı altında yazılmıştır ve altenatif bir yenilenebilir enerji sistemi olan Vermicompost'a odaklanmaktadır. Bu tezde küresel tarım ve çevre sürdürülebilirliliği kavramına yeni bir çözüm getirebilme çerçevesinde tartışılmıştır.

Anahtar Kelimeler: Ticarette Sürdürülebilirlilik, İklim Değişikliği, Vermicomposting, Tarımda Sürdürülebilirlilik

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## ABBREVIATIONS

| | |
|---|---|
| **$CH_4$** | : Methane |
| **$CO_2$** | : Carbon Dioxide |
| **FAO** | : Food and Agriculture Organization |
| **EIT** | : Economies in Transition |
| **GATT** | : General Agreement on Tariffs and Trade |
| **GDP** | : Gross Domestic Product |
| **GHG** | : Greenhouse Gas Emission |
| **ICTSD** | : International Centre for Trade and Sustainable Development |
| **IIED** | : Institute of Environment and Development |
| **IISD** | : International Institute for Sustainable Development |
| **IFOAM** | : International Federation of Organic Agriculture Movements |
| **IPCC** | : Intergovernmental Panel on Climate Change |
| **K** | : Potash |
| **MAP** | : Mono Ammonium Phosphate |
| **MARA** | : Ministry of Agriculture and Rural Affairs |
| **N** | : Nitrogen |
| **NAFTA** | : North American Free Trade Agreement |
| **ODS** | : Ozone Depleting Substances |
| **OECD** | : Organisation for Economic Co-operation and Development |
| **P** | : Phosphorous |
| **ppm** | : parts per million |
| **UNEP** | : United Nation Environment Program |
| **UNFCCC** | : United Nations Framework Convention on Climate Change |
| **USDA** | : United States Department of Agriculture |
| **VCT** | : Vermi- Compost Technology |
| **WTO** | : World Trade Organization |

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## 1. INTRODUCTION

In this decade, both phrases ‘Sustainable Trade’ and ‘Climate Change’ have received increasing recognition worldwide. In order to function these terms together, the world is in the urge of international collaborative action. There is potential conflict between trade both as national and international and the emerging global environmental regime to combat climate change. What is climate change? What is the relationship between trade and climate change? How does trade affect climate change? What are the linkages among climate change, trade and sustainability? What is the range of national and international measures that can provide global efforts in sustainable environment in relation with trade and climate change? What are the environmentally friendly solutions in order to lower greenhouse gas emissions? What is the relationship between climate change and agricultural sustainability? What are the crucial precautions to let the market deliver agricultural sustainability?

This thesis aims to improve understanding about the relationship among trade, climate change and agriculture under the current sustainability policy and find valid answers to the questions mentioned above. It shows that trade intersects with climate change in a multitude of ways.Goverments introduce different policies such as regulatory measures and economic opportunities to address climate change where most significantly generate  agriculture and also other relevant sectors. This complex web of measures is supposed to have an enormous impact on international trade and sustainable multilateral trading system. So the environmental benefits will provide an overall good for the world .

The desire for a more sustainable world  has a long history, pre-dating many other areas where sustainability has become an issue in recent decades. Trade is one of the few areas where individuals, families and firms are able to attempt to implement their vision of a sustainable production system. So in order to maintain sustainability in trade , climate change should be highly considered together with agricultural issue which can be seen as the premier instrument in trade.

Trade is a process of exchange requiring that goods can be transported from the place of production to the place of consumption. The 60 years prior to 2008 have been marked by an unprecedented expansion of international trade. In terms of volume, world trade is nearly 32 times greater now than it was in 1950, and the share of global GDP (Gross Domestic Product) it represents rose from 5.5 per cent in 1950 to 21 per cent in 2007. The number of countries participating in international trade has increased: developing countries,for instance,now account for 34 per cent of merchandise trade- about double their share in the early 1960s. (WTO-UNEP Report 2009,75). Consequently, international trade expansion is likely to lead to increased level of gas emissions. There are international efforts at reducing greenhouse gas (GHG) emissions and adapting risks posed by climate change. Many greenhouse gases remain in the atmosphere for long periods of time. As a result, global warming will continue to affect the natural systems of the planet for several hundred years. Current estimates delivered by WTO-UNEP Report in Switzerland, show that when emissions increase by between 25 to 90 per cent in the period from 2000 to 2030, the proportion of greenhouse gases emitted by developing countries becoming significantly larger in the coming decades. So many sectors in the global economy are expected to be affected and these impacts will often have implications for trade. For example, agriculture is one of the most tarde-related area that can be considered to be particularly vulnerable to climate change. In addition to this, agriculture is also a key sector for international trade. According to WTO’s Report, when local temperature increases between 1ºC and 3ºC would have increasingly negative impacts in mid- to high- latitude regions. Depending on the location, agriculture will also prone to water scarcity due to loss of glacial meltwater and reduced rainfall or droughts. Finally, as it is indicated in the report, even trade infrastructures and routes are about to be affected. Port facilities, buildings, roads, railways, airports and bridges are at the risk of damage by rising sea levels or extreme weather instances such as flooding and hurricanes. Moreover, according to The World Bank publication called 'International Trade and Climate Change'(2008), changes in ice, specially in the Arctic, may lead to new shipping routes. Climate change can also increase the vulnerability of the supply, transport and distribution chains upon which international trade depends. As a result, there are multilateral actions to reduce greenhouse gas emissions. The Kyoto Protocol which includes three 'flexibility mechanisms' (emission trading, Joint Implementation and the Clean Development Mechanism), Montreal Protocol which deals with ozone destruction where focused on the consumption and production of nearly 100 ODS(Ozone-Depleting Substances) and one of another well known is Doha negotiations which contributes to reinforce the relationship between the trade and environmental regimes aim in general, to mitigate and adapt climate-friendly technologies in diverse sectors.

As to climate – friendly technologies, first global action may begin by taking steps towards a sustainable energy in agriculture. The WTO (World Trade Organization) Agreement on Agriculture will also affect carbon management globally. Concerns about the environmental and social costs of conventional agriculture have led to a range of 'alternative' agricultural allternatives, specially organic farming. So the evidence regarding the environmental benefits of the organic production system appears in two major areas of concern: the environmental assumptions of the growing international trade in organic products and social assumptions of the increasing power of the organic market by the conventional food buyers, processors and retailers. There are different poit of views about what can and what can not be delivered by the organic farming.

Agriculture lies at the heart of the current round of trade negotiations. Sinha (2009) mentions that agriculture can be a source of carbon emissions and a carbon sink which may affect climate change. So global atmospheric carbon balance is obviously affected by agricultural land use worldwide. Agriculture also binds carbon in crops and soil, and can be reduced through changing tillage methods. The need for a more sustainable agricultural production system has a long history. As a result many 'alternative' organic agricultural systems have developed. This thesis aims to discuss the issue of agricultural sustainability and the development of the organic sector as an alternative solution to climate change. From an environmental perspective, it is obvious that renewable energy is preferable to fossil fuels, and energy-efficiency over inefficiency. The relationship between organic production and the concept of sustainability analysed and trends in the global market outlined.

The globalisation of organic agriculture and the development of organic farming outlined and the relationship between the two briefly discussed. Organic matter plays a key role to achieve sustainability in agricultural production because it posesses many desirable properties such as high water holding capacity, cation exchange capacity (CEC), ability to sequester contaminants (both organic and inorganic) and beneficial effects on the physical, chemical and biological characteristics of soil. On the contrary, widespread use of chemical pesticides became a necessity for the growth of high-yielding varieties of crops which was highly ' susceptible to pests and diseases'. Continued application of chemical pesticides induced 'biological resistance' in crop pests and diseases and much higher doses are now required to eradicate them as Sinha (2009) mentions. The farmers today are caught in a 'vicious circle' of higher use of agrochemicals to boost crop productivity at the cost of declining soil fertility. This is also affecting their economy as the cost of agrochemicals has been rising all over the world (Peggy, 2000). The scientific community all over the world is looking for an 'economically viable, socially safe & environmentally sustainable' alternative to the destructive 'chemical agriculture' which would not only maintain but also provide farm production per hectare of available land as the farmlands all over the world . The new concept of farm production against the destructive 'Chemical Agriculture' has been termed as 'Sustainable Agriculture'. The U.S National Research Council (1989) defined sustainable agriculture as 'those alternative farming systems and technologies incorporating natural processes, reducing the use of inputs of off-farm sources, ensuring the long term sustainability of current production levels and conserving soil, water, energy and farm biodiversity'. The problems related with conventional, industrial agriculture have been noticed earlier. Hodge explains the problems best when he says:

> 'Agriculture has come to draw the inputs which it uses from more distant sources, both spatially and sectorally, to derive an increasing proportion of its energy supplies from nonrenewable sources, to depend upon a more narrow genetic base and to have an increasing impact on the environment. This is particularly reflected in its heavy reliance on chemical fertilisers and pesticides, its dependence upon subsidies and price support and its external costs such as threats to other species, environmental pollution, habitat destruction and risks to human health and welfare' (Hodge, 1993,p.3).

So the idea of sustainable agriculture has developed, in this context. Mainly the word sustainable is derived from the Latin, sustinere, meaning to keep in existence, implying permanence or long-term support (Scofield, 1986). Ikerd describes sustainable agriculture as:

> ‘capable of maintaining its productivity and usefulness to society over the long run…it must be environmentally-sound, resource-conserving, economically viable and socially supportive, commercially competitive, and environmentally sound’ (1993,p.30).

Ikerd’s description contains biophysical, economical and social aspects of agricultural sustainability. There have been some developments of sustainability in relation to farming systems. For example; Swedish farmers have drastically cut the use of pesticides, herbicides and fungicides by 70 per cent since 1985. The main objective of the thesis is to investigate Vermitechnology as a means of reducing waste disposal into an opportunity to produce high-potential organic fertilizers, capable of enhancing soil fertility, bioremediation and improving crop quality, thereby assisting economical growth and protecting the environment. Vermitechnology or vermicompost ( metabolic products of earthworms feeding on organic wastes) is proving to be highly nutritive ‘organic fertilizer’ and a ‘miracle growth promoter’ rich in NKP (nitrogen 2-3%, potassium 1.85-2.25% and phosphorus 1.55-2.25%), micronutrients, beneficial soil microbes and also contain ‘plant growth hormones & enzymes’. Earthworms and their vermicompost can do a miracle. They can ‘build up soil’, ‘restore soil fertility’, ‘sustain farm production’ and deliver ‘safe food’ for the civilization (UNEP,1996).

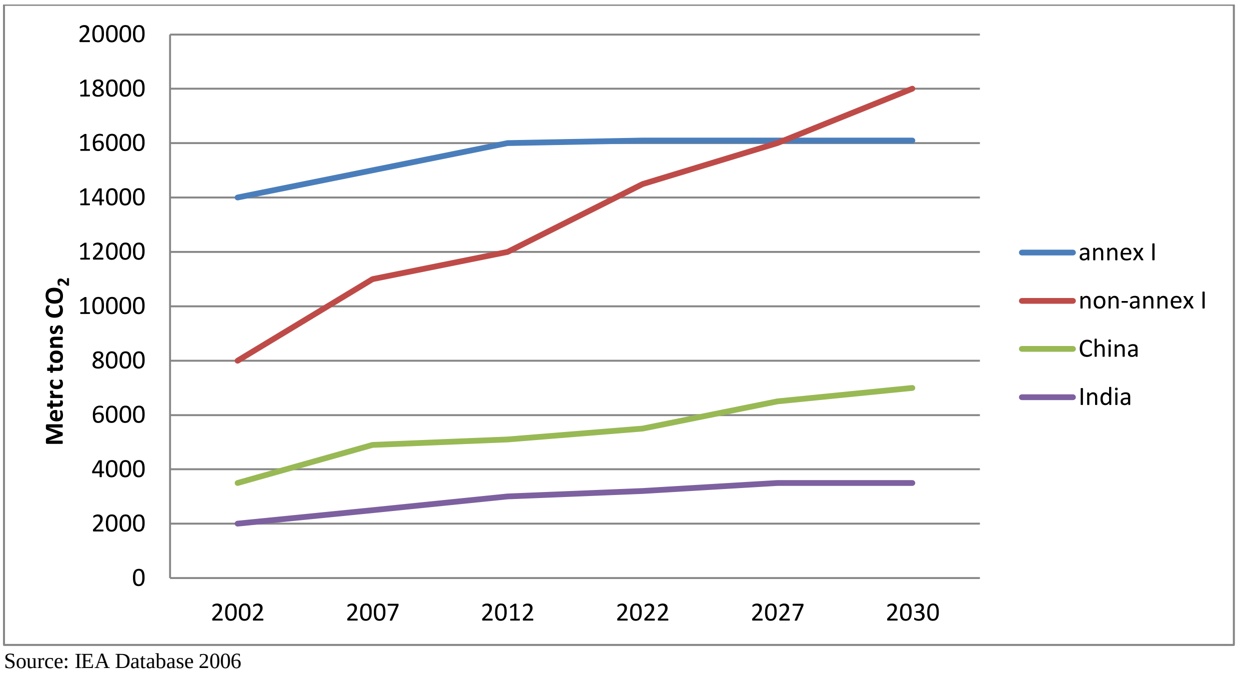
### 1.1.Sustainable Trade and Climate Change

Sustainable trade takes place when the international exchange of goods and services yields positive social, economic and environmental benefits. The key elements of sustainable development are :

1. generating economic value
2. reducing poverty and inequality
3. regenerating the environmental resource base
4. carrying out within an open and accountable system of governance.

So mainly there has been much debate over the last decades on the role international trade plays in determining environmental outcomes. This has led to discussions about trade and environmental quality. According to the World Bank publication the importance of establishing coherent relationship between the trade obligations set out in various bilateral and multilateral trade agreements and environmental policies of countries is now well recognized. Environmental provisions in the General Agreement on Tariffs and Trade (GATT) allow adaption of product-related measures in certain situations if they are 'necessary to protect human, animal or plant life or health'. In addition, other trade agreements such as NAFTA ( North American Free Trade Agreement) and the U.S. – Singapore Free Trade agreement which include provisions that directly address environmental concerns. So there is potential for conflict between trade and the emerging global environment regime to combat climate change. WTO (World Trade Organization) try to promote broader global environmental objectives. For example, a multilateral liberalization of renewable energy sources or an agreement to remove fossil fuels subsidies would equally serve climate change objectives. The WTO negotiations could be used for a cleaner trade technology. There are many areas where climate change agenda intersects with multilateral trade obligations. The broad objectives of the betterment of current and future human welfare are thus shared by both global trade and climate regimes (WTO-UNEP Report, 2009). Yet both climate and trade agendas have evolved largely independently through the years, despite their mutual objectives. While the implementation of the Kyoto Protocol the conflict between economic growth and environmental protection give rise to an opportunity for aligning development and energy policies that they could stimulate production, trade and investment in cleaner technology options. It makes sense to consider both global emission goals and global trade policy objectives together which are shared by most of the countries.

Figure 1.1 $CO_2$ Emission from Energy Use, 2002-2030




Source: IEA Database 2006

Reducing emissions in industrial countries is just one side of the story. It is becoming (See Figure 1.1.) increasingly clear that developing countries will drive the future of global economic growth. The stabilization of $CO_2$ emission can be achieved by developing currently technologies and technologies that are expected to be commercialized in the coming decades in the energy supply, transport, buildings, industry, agriculture, forests and waste management sectors. In the global discourse on climate change, technologies that help in mitigating the impacts by reducing the GHG emissions have been termed variously as ‘environmentally sustainable technologies’. The availability of these climate-friendly technologies is critical if developing countries are to achieve low-carbon growth paths. Scientific studies introduce the concept of ‘stabilization wedges’, which is helpful in understanding the scale of the challenge in order to stabilize carbon emission by 2054 – aiming at a $CO_2$ atmospheric concentration of 500 ppm (part per million) (WTO-UNEP Report,2009). This has also led to proposals for tariff or border tax adjustments to offset any adverse impact of capping $CO_2$ emissions. As more and more countries move toward adopting climate-friendly policies, the economic and trade ramifications are likely to bring increasing attention to the relationship between the trade and climate regimes. The WTO recognizes the importance of seeking to ‘protect and preserve the environment’. The Kyoto Protocol states that parties should ‘strive to implement policies and measures in such way to minimize adverse effect on international trade’. The UNFCCC (United Nations Framework Convention on Climate Change) features similar language in several places (Frankel, 2004), and the Doha Round specifically states that ‘the aims of upholding and safegurding an open and nondiscriminatory multilateral trading system, and acting for the protection of the environment and promotion of sustainable development can and must be mutually supportive’. In the future, both climate change regime and trade investment regime will ideally evolve to accomodate new economic and political circumstances. It would be logical to work together in order to achieve common goals of climate policy and development, especially given the increasing number of developing countries that will also come into play in the coming years.

It would be also useful at the outset to focus on a few areas where synergies can be exploited in the immediate short run. The energy efficiency and renewable energy technologies needed to meet future energy demand and reduce GHG emissions below current levels are largely available. The recent report of the Intergovernmental Panel on Climate Change (IPCC, 2011) also categorically states that the impacts of climate change will vary regionally but aggregated and discounted to the present. So the Kyoto Protocol remains the key international mechanism under which the industrial countries have committed to reduce their emission of carbon dioxide and other greenhouse gases ( see Box 1.1.).

Box. 1.1

The Kyoto Protocol

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) entered into force on February 16, 2005, following ratification by Russia. As of May 11, 2007, 172 countries and the regional economic integration organization (European Economic Community) have ratified, accepted, approved, or acceded to the Kyoto Protocol. The UNFCCC includes the principle, as stipulated in Article 3, paragraph 1, of the UNFCCC, the parties agreed that (i) the largest share of historical and current global emissions of greenhouse gases has originated in developed countries; (ii) per capita emissions in developing countries are still relatively low; and (iii) the share of global emissions originating in developing countries will grow to meet their social and development needs.

Under the Kyoto Protocol, industrialized countries (called Annex I countries) have to reduce their combined emissions to 5 percent below 1990 levels in the first commitment period of 2008-2012. Annex I countries include the industrialized countries that were members of the Organisation for Economic Co-Operation and Development (OECD) in 1992, plus countries with economies in transition (the EIT parties), including the Russian Federation, the Baltic states and several Central and Eastern European states. Countries that have accepted greenhouse gas emission reduction obligations must submit an annual greenhouse gas inventory. Non-Annex I countries (developing countries) that have ratified the Potocol do not have to commit to specific targets because they face potential technical and economic constraints. Nevertheless, they have to report their emissions levels and develop national climate change mitigation programs.

Although the average emissions reduction is 5 percent, each country agreed to its own specific target. Within the Annex I countries, differentiated national targets range from 8 percent reductions for the European Union (EU) to a 10 percent allowable increase in emissions for Iceland.

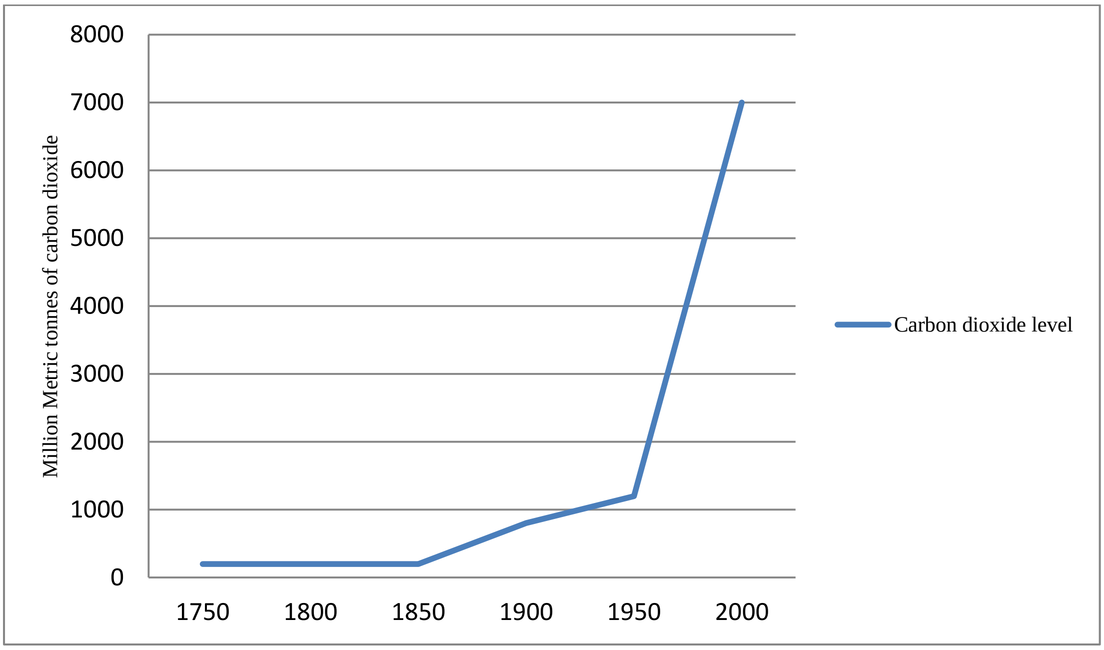
Further, while Annex I countries must put in place domestic policies and measures to achieve their targets, the Protocol does not oblige governments to implement any particular policy, instead allowing countries to seek optimal ways to achieve greenhouse gas emissions reduction and to adjust their climate change strategies to the circumstances of their economies. The Protocol defines three flexibility mechanisms to help Annex I parties lower the overall costs of achiveing emissions targets. The three mechanisms-Joint Implementation(JI), the Clean Development Mechanism (CDM), and emissions trading- allow them to reduce emissions, or increase greenhouse gas removals, in other countries, where it can be done more cheaply than at home.

Source: UNFCCC, Essential Background, http://unfccc.int/essential_bacground/items/2877.php

Figures 1.2. and 1.3. illustrate this trend of increasing emission levels for the case of carbon dioxide (CO2). Figure 1.2. indicates the increase in global carbon dioxide emissions resulting from consumption of fossil fuels during the past 250 years, while

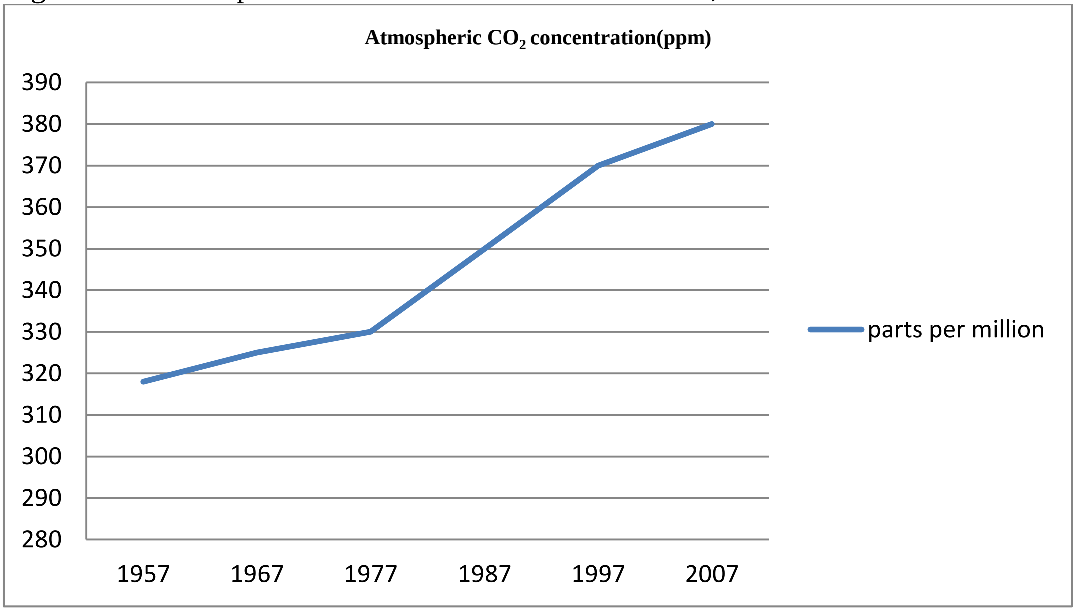
Figure 1.3. shows the increase in the concentration of carbon dioxide in the atmosphere for the past 50 years.

Figure 1.2. Global carbon dioxide emissions from fossil fuels, 1751-2000




Source: Calculations based on data from http://cdiac.gov

Figure 1.3. Atmospheric carbon dioxide concentrations, 1957-2007




Source: UNEP/GRID-Arendal (2008) based on data from NOAA Earth System Research Laboratory,2007.

Table 1.1 Kyoto-Related Fossil-Fuel $CO_2$ Emission Totals

| Kyoto-Related Fossil-Fuel $CO_2$ Emission Totals | | | | |
|---|---|---|---|---|
| **Year** | **Annex B Countries** | | **Non Annex B Countries** | |
| | **Fossil-Fuel $CO_2$ Emissions (million metric tonnes C)** | **Bunkers (million metric tonnes C)** | **Fossil-Fuel $CO_2$ Emissions (million metric tonnes C)** | **Bunkers (million metric tonnes C)** |

| | | | | |
|---|---|---|---|---|
| 1990 | 3904 | 90 | 2111 | 47 |
| 1991 | 3810 | 94 | 2293 | 41 |
| 1992 | 3772 | 102 | 2259 | 45 |
| 1993 | 3694 | 103 | 2327 | 48 |
| 1994 | 3660 | 103 | 2468 | 54 |
| 1995 | 3681 | 114 | 2568 | 59 |
| 1996 | 3708 | 115 | 2654 | 73 |
| 1997 | 3730 | 118 | 2741 | 75 |
| 1998 | 3735 | 122 | 2699 | 82 |
| 1999 | 3665 | 125 | 2704 | 90 |
| 2000 | 3718 | 131 | 2812 | 89 |
| 2001 | 3776 | 120 | 2928 | 91 |
| 2002 | 3752 | 128 | 3008 | 93 |
| 2003 | 3837 | 124 | 3338 | 98 |
| 2004 | 3883 | 134 | 3658 | 107 |
| 2005 | 3931 | 142 | 3908 | 106 |
| 2006 | 3924 | 148 | 4163 | 114 |
| 2007 | 3905 | 151 | 4365 | 122 |
| 2008 | 3880 | 145 | 4595 | 129 |

Source: Gregg Marland and Tom Boden

This table shows the total of $CO_2$ emissions from fossil-fuel use for those countries listed in Annex B of the Kyoto Protocol and for those countries not listed in Annex B. In keeping with the convention of the IPCC methodology for calculating national greenhouse gas emissions, emissions from international bunker fuels (fuels used in international commerce) are not included in the country totals but are shown separately under the country group in which final fuel loading occurred. Note that the list of countries in Annex B of the Kyoto Protocol differs from the list of countries in Annex I of the Framework Convention on Climate Change by the addition of Croatia, Liechtenstein, Monaco, and Slovenia and the removal of Belarus and Turkey.

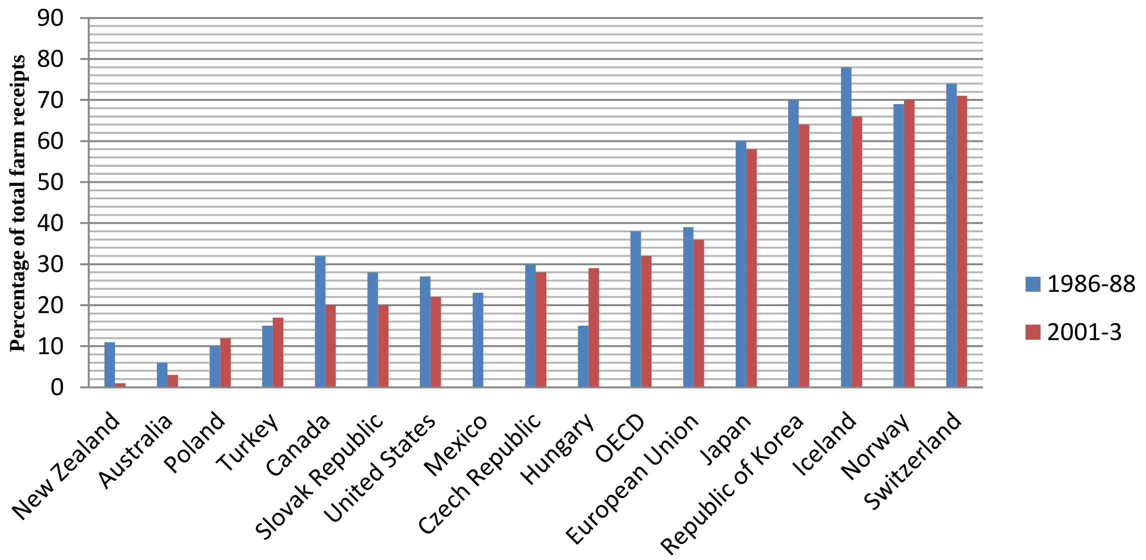
Emissions are estimated for 1990 and 1991 from the republics that were formerly part of the USSR and of Yugoslavia by taking total emissions from the USSR (and Yugoslavia) for 1990 and 1991 and distributing them among the new republics in the same ratio as emissions from those republics in 1992. Consequently, the sum of emissions from all Annex B countries and the sum of emissions from all non-Annex

B countries by about 2% (the value differs from year to year) so that the sum of the two values plus emissions from bunker fuels is equal to Marland's and Boden's best estimate of the global total of emissions (2007). Much environmental damage is due to the increased scale of global economic activity. At the basic level, trade and the environment are related because all economic activity is based on environment. When environment and climate change considered in the same basket agriculture is yet again causing discussions in international trade negotiations. So agriculture sector is the major block in the multilateral trade organisation and its crucial role in minimising the carbon emission.

### 1.2.Sustainable Trade and Agriculture

Agriculture is highlighted as the sector which is most vulnerable to climate change throughout the literature (see Cline, 2007, Nyong, 2008, or IPCC, 2007d). If temperature increases beyond 3ºC, negative impacts will afect all regions of the world. There should be key mitigation technologies and practices currently available which can reduce $CH_4$ with manure management or improve nitrogen fertilizer application techniques to reduce $N_2$ O emissions and to find alternative energy sources in order to replace fossil fuel use. Here, composting of organic waste, controlled waste-water treatment, recycling and waste minimization take great role in corporation with agricultural processes in order to change these wastes into a gain.

Figure 1.4 Agriculture Producer Support in High- Income Economies, by Country, 1986-2003




**Source: OECD database (see www.oecd.org)**

Agricultural protection levels remain very high in these OECD countries. As Figure 1.4 shows, PCEs have fallen least in the most-protective OECD countries. By contrast, tariff protection for OECD manufacturing has fallen over the past 60 years form above 30 percent nominal rate of protection to only about 3 percent now (a level similar to that for OECD agriculture today). This gap in tariff protection means far more resources have been retained in agricultural production in developed countries and hence fewer in developing countries.

Given the importance of agriculture as the ultimate provider of food, fibre and shelter for the human population, no sector has a greater role in moving towards development that is sustainable. But what is sustainable agriculture? Many have investigated the requirements of sustainable agriculture and most agree that food sufficiency, environmental stewardship, socio-economic viability and equity are important ingredients. Sustainable development may be divided into three parts (Douglas,1984):

1. Ecological sustainability which requires that development is compatible with the maintenance
2. Economic sustainability which requires that development be economically feasible
3. Social sustainability which requires that development be socially acceptable.

Sustainable agriculture is a multi-dimensional concept which has led to an array of definitions. The attributes of agriculture range from specific soil-plant interactions at the field level, to international trading arrangements at the global level. At the regional scale agriculture is a key element in natural resource use and land use patterns. At national and global scales, agriculture involves trade equity and food sufficiency. Douglas (1984) identified three different views of sustainability. The first view was called 'sustainability as food sufficiency' which seeks to maximize food production within the constraints of profitability. The second view was 'sustainability as stewardship' defined in terms of controlling environmental damage. The third view was 'sustainability as community' defined in terms of maintaining or reconstructing economically and socially viable rural systems. In agricultural sustainability definitions generally contain three important criteria (Pesek,1994):

1. Environmental quality and ecological soundness
2. Plant and animal productivity
3. Socio-economic viability

All these three criteria must be met before sustainable agriculture is achieved. A system overall should be ecologically sustainable. This concept was developed in response to concerns about the impacts of agriculture practices. Conventional (modern) agriculture is characterized as capital intensive, large scale highly mechanised systems with monocultures of crops and extensive use of artificial fertilizers and pesticides. Sustainable agriculture ideologies arise as alternatives to the conventional approach. Interpreting sustainability as ‘an ability to continue’ will be more meaningful. According to the Food and Agriculture Organization (FAO) sustainable agriculture is ‘the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of environment and conserving natural resource’. Agricultural sustainability assessment is consistent with interpreting sustainable agriculture as the adoption of alternative agricultural practices which is mainly called Organic Agriculture. Actually Organic Agriculture can be divided into two such as: organic farming and organic fertilizer. Indeed, they are inseparable.

### 1.3.Organic Farming & Organic Fertilizer

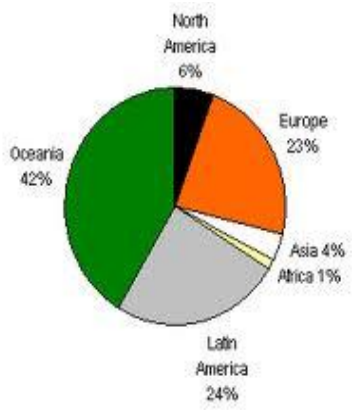
Organic farming welcomes all other approaches to ‘environmentally-friendly’ agriculture. Lampkin defines organic farming as :

> ‘ to create integrated, human environmentally and economically sustainable production systems, which maximise reliance on farm-derived renewable resources and the management of ecological and biological processes and interactions, so as to provide acceptable levels of crop, livestock and human nutrition, protection from pests and disease, and an appropriate return to the human and other resources’ (Lampkin,1994,p.5).

Australia and Argentina have the largest areas of organically managed land (7.6m ha and 2.8m ha respectively) but the largest/greatest areas are in European countries. The amount of organic farmland in Europe is now 3.6 million hectares (IFOAM, 2002).

According to Dr. S. Narayanan, organic farming is one of the several approaches found to meet the objectives of sustainable agriculture. He strongly believes that organic farming should be based on various laws and certification programme which prohibit the use of almost all synthetic inputs, and health of the soil is recognised as the central theme of the method. Organic farming is one of the best method which is thought of as the best alternative to avoid the ill effects of chemical farming. Narayanan also refers Howard’s book called Agricultural Testament (1940) as their guidance book. This book, in general, draws attention to the destruction of soil and deals with the consequences of it. It suggests methods to restore and maintain the soil fertility. The decline in soil fertility nutrients, specially in fields where the chemical inputs are being used in the absence of adequate organic matter is accepted as a reason for low production. Organic farming has several advantages over the conventional one apart from the protection of both the environment and human health. Improved soil fertility, better water quality, prevention of soil erosion etc. are some of them (Narayanan, 2005).

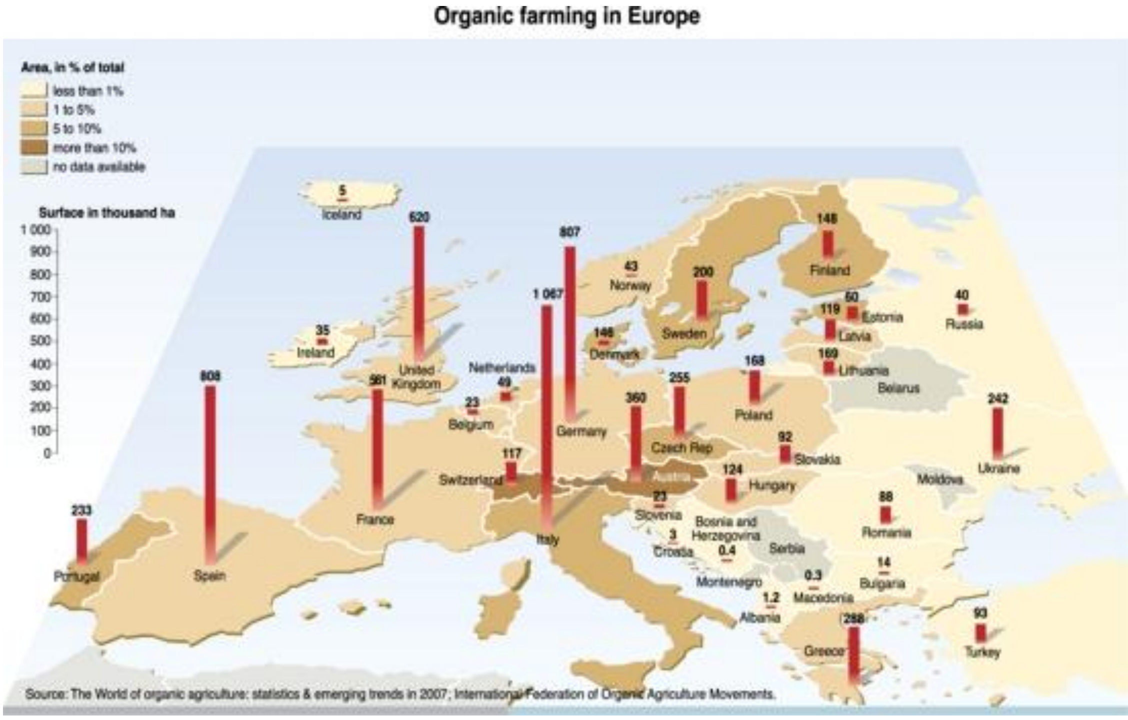
Figure 1.5. Percentage of Organic Farming by Regions




Source:http://www.google.com.tr/search?q=organic+agriculture

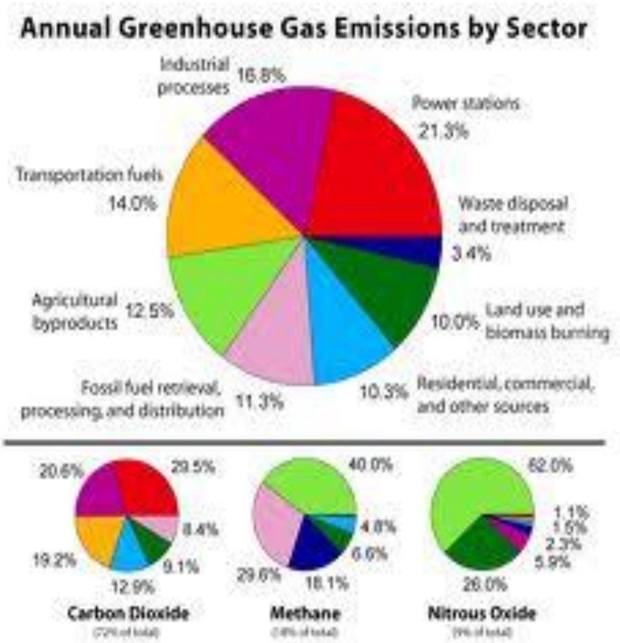
Today, all countries in the world state the importance of human health and environmental problems. As Figure 1.5. points that there is a great awareness of the benefits of organic farming all over the world. The logic behind this increase is the principles of the organic farming. Day by day more people believe that health, environmental care, fairness and ecology should be in balance.

Figure 1.6. Percentages of Organic Farming in Europe




Since the data given in Figure 1.6. is recently calculated in 2007, the highest surface allocation as 1,057,000 ha is designed only for organic farming in Italy. Western Europe countries are sharing really high surface numbers allocated for organic farming whereas eastern part of Europe is still in the trend of developing.

Figure 1.7. Annual Greenhouse Gas Emissions by Sector




At least 60 percent of all nitrous oxide ($NO_2$) emissions, the most potent greenhouse gas are caused by industrial agriculture, primarily from the use of synthetic nitrogen fertilizer. Nearly 40 percent of methane ($CH_4$), the second strongest greenhouse gas, is due to industrial farming practices much of this from intensive industrialized livestock operations. So not only organic farming but also organic fertilizers should take place as an environment-friendly materials.

Lampkin's definition of organic farming talks of sustainable production systems. In order to emphasize his opinion, he says: 'sustainability lies at the heart of organic farming and is one of the major factors determining the acceptability or otherwise of specific production practices'(1994,p.5). Likewise, Henning et al. precede their definition of organic farming by claiming that ' it could serve equally well as a definition of 'sustainable agriculture''(1991,p.877).

Hodege views organic farming as the only truly sustaiänble type of agriculture. But he also adds that this does not mean that every sustainable agricultural method can be considered as organic one. There are two foundations ; first, IFOAM (International

Federation of Organic Agriculture Movement) was founded in France in 1972. It coordinates organic farming efforts in all over the world by promoting organic agriculture as an environment friendly and sustaining method. It focuses on organic farming by highlighting the minimum pollution and low use of non-renewable natural resources through this method. Secondly, another equally important foundation is FAO which also provides support to organic farming. Organic agriculture, in general, is gaining momentum as an alternative method to the conventional system.

Hall, an organic inspector with the Organic Crop Improvement Association (OCIA) in the USA, states that the idea that a crop is organic because ‘nothing has been put on it’ is all too common. This, he argues, is not a sustainable approach and “does a major disservice to the majority of organic farmers who are making excellent progress in developing healthy and naturally resilient whole farm systems” (Hall, 1996a) .

Table 1.2. The World Organic Food Market

| | | 1997 | 2000 (estimates) in billion US $ |
|---|---|---|---|
| 1 | USA | 4.20 | 8.00 |
| 2 | Germany | 1.80 | 2.50 |
| 3 | Japan | 1.20 | 2.50 |
| 4 | Italy | 0.75 | 1.10 |
| 5 | France | 0.72 | 1.25 |
| 6 | UK | 0.45 | 0.90 |
| 7 | Australia | NA | 0.17 |
| 8 | China | NA | 0.12 |
| 9 | New Zealand | NA | 0.58 |
| 10 | Taiwan | NA | 0.10 |
| 11 | Philippines | NA | 0.06 |
| 12 | Others | 1.33 | 10.38 |
| Total | | 10.45 | 19.73 |

Source: SOEL Survey, 2003 & Alam and Shah,2003.

In Table 1.2. the important organic products traded in the international market are mainly dried fruits and nuts, processed fruits and vegetables, cocoa, spices, herbs, oil crops and derived products, sweeteners, dried leguminous products, meat, dairy products, alcoholic beverages, processed foods and fruit preparations. Cotton, cut flowers, animals and pot plants are major non-food products in the world markets.

Organic farming is bound to grow around the world as many countries are developing their own standards and regulations. The US and the European Union have very comprehensive National Organic Programmes and the early nineties have seen organic farming regulations in Japan, Canada and Australia. New Zealand, Israel and Brazil have adopted the organic standards equivalent to those of USA and the European Union. China, Thailand, South Korea, Philippines, Turkey and Mexico have established certifying agencies. India too has adopted the National Programme for Organic Production (NPOP) with national standards.

It is widely recognised the world over that the certification of organic products should be based on the following principles (Narayana, 2005):

I. Organic production and processing standards should be clearly laid down

II. The conformation of production and processing to these stands must be verified

III. Organic labels should be permitted only to those producers which are found conforming to the set standards.

Thus, a label on an organic product conveys that the manufacturer has a license for organic production, an independent agency has inspected the production/ processing practises followed by the producer, and compliance of the list is made. Such an assurance becomes crucial in the generation of consumer confidence in the organic products, particularly as they are costlier than the conventional ones. Due to these developments the organic food market in the world has grown rapidly in the past decade, international trade in organic foods showed an annual growth rate of about 20-22 per cent during this period. For example, just becuase cotton is a very important tradable commodity for the countries, it caught the attention of world leaders and WTO negotiators for several reasons. It led talks both in Doha Development Agenda (DDA) and in WTO.

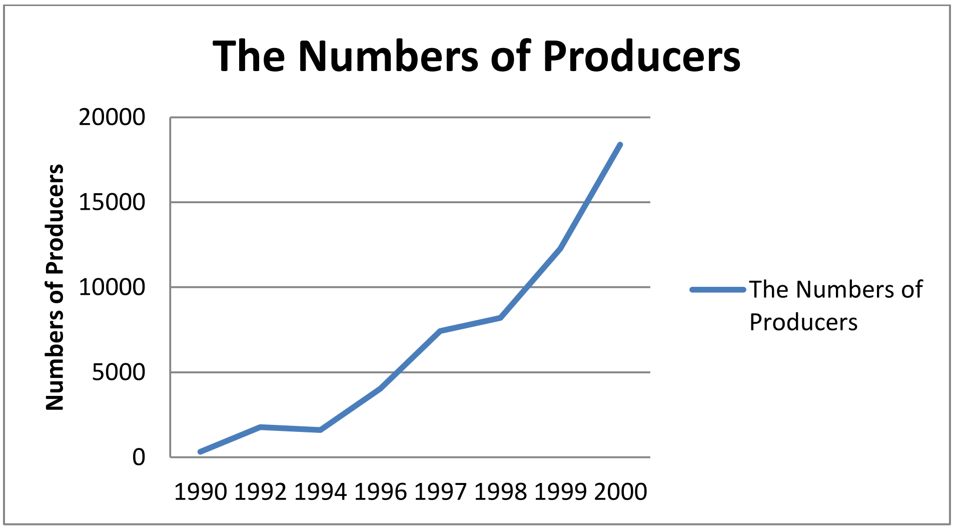
China, India and Pakistan are such major cotton textile-processing centers that are all net importers of cotton. For most of the 15 years, China has produced about 25 percent of the world total whereas Europe is a minor cotton producer (represented mainly by Greece and Turkey) and a large importer. Cotton textile manufacturing has shifted increasingly to developing countries as the textile has been liberalized. Because of the use of pesticides in the cotton crop is very intense and several chemicals are used indiscriminately ignoring the environment, India has been the first and the leader in organic cotton (Venugal, et.al.,1997).

Organic cotton / Eco-cotton / Green Cotton is the cotton grown without inorganic fertilizers pesticides and defoliants and duly certified by a recognized certifying organization. In the last decade, organic cultivation of cotton under certification will be profitable as there is a strong demand for eco-cotton in many Western and Asian countries. There are about 12 countries producing eco-cotton. USA, Greece, Israel, Peru, Egypt, Turkey, China and Australia are important eco-cotton producing countries. Eco-cotton commands a price higher than 30 to 40 per cent of the conventional cotton. But now there is a demand world over for oganically produced cotton and India is in a position to cater to the international market. The ill effects of the conventional farming system are felt earlier in India in terms of the unsustainability of agricultural production.

### 1.4.Organic Farming in Turkey

Indeed farmers were cultivating organic agriculture until 1950s in Turkey. Due to productivity of agricultural production, producers began to use excessive fertilizers and pesticides. The first organic production was performed in the Agean Region with dried figs and raisins. This type of farming was used to produce apricot, hazelnut, cotton and pulses. Thus organic farming spread to other regions (Olhan,1997). Today there are 13,187 producers and approximately 95 types of agricultural products.

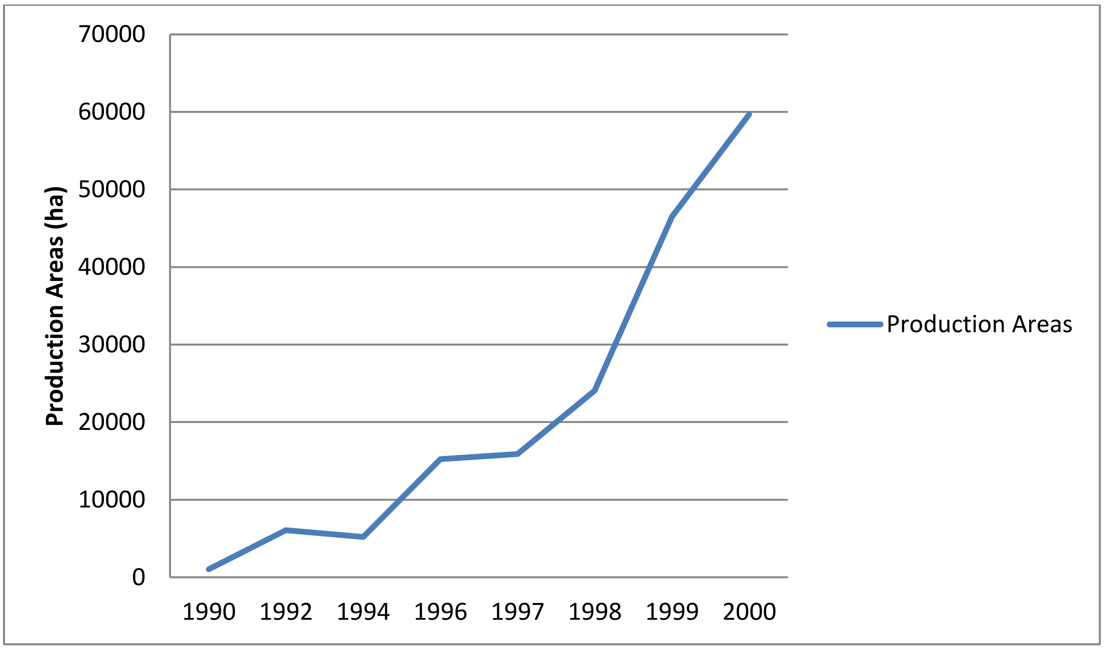
Figure 1.8. The Numbers of Producers




Source: Akkaya et. al.,2001

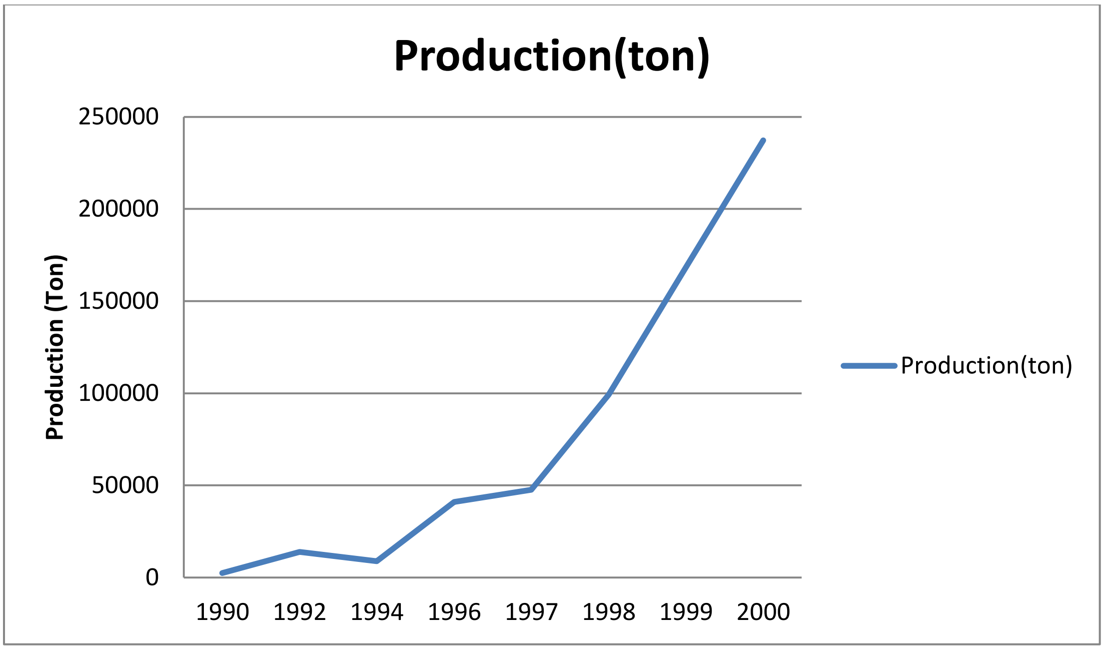
The numbers of producers are provided in Figure 1.8. In 1990, 313 farmers became 13,385 in 2000.

Figure 1.9. Production Areas (1990-2000)



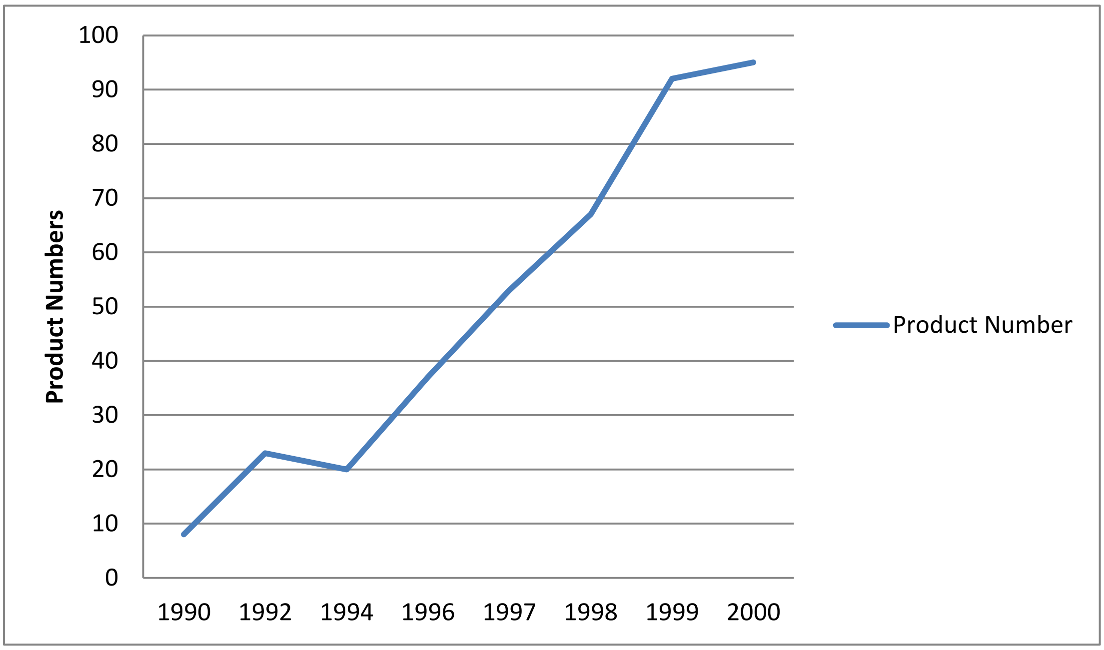

Source:Akkaya, et.al.,2001

Figure 1.10. Production (1990-2000)




The amount of production is clear in Figure 1.10. While the production of organic products was 2,476 tons in 1990 then it was 237,275 tons in 2000. Production appears in all of the regions particularly in İzmir, Malatya, Şanlıurfa, Aydın, Bursa, Hatay, Kütahya, Isparta, Rize and Afyon. In addition to Figure 1.10., in Figure 1.11. the number of organically grown products are given.

Figure 1.11. The Numbers of Organic Agricultural Products




Source: Akkaya, et.al., 2001

Box 1.2. Organically Grown Agricultural Products

| **<u>Vegetal Products</u>** | |
|---|---|
| Edible Nuts | Hazelnuts, Walnuts, Pistachios, Almonds, Peanuts |
| Dried Nuts | Raisins, Apricots, Wild Apricot, Figs, Pruners, Apples |
| Dried Vegetables | Tomatoes |
| Fresh Fruits and Vegetables | Apples, Figs, Strawberries, Plums, Pears, Cherries,Persimmons (Sharon Fruit), Blackberries, and Various Beries, Potatoes |
| Pulses | Lentils, Chickpeas, Dry Beans, Green Peas |
| Spices and Herbs | Bay Leaves, Oregano, Cumin Seeds, Linden Leaves, Sage Tea,Rosemary |

| | |
|---|---|
| Cereals | Wheat, Rice,Corn |
| Industrial Crops | Cotton, Poppy Seed, Arise Seed |
| Others | Capers, Pine nuts, Rosehips, Sesame, Olives |
| **Processed Food** | |
| Frozen Fruits and Vegetables | Apricots, Strawberries, Cherries, Sour Cherries, Berries, Plums, Onions, Squash Tomatoes, Peppers |
| Fruit Juice and Concentrate | Apricot Puree, Pear Juice Concentrate, Sour Cherry Juice Concentrate<br>Apple Juice Concentrate<br>Rosehip Pulp, Apple Pulp |
| Others | Olive Oil, Cracked Wheat |
| **Other** | |
| Agricultural Products | Honey, Apricot Kernels, Dried Rose, Rose Oil, Rose Water, Myrtle Water, Thyme, Oil, Lavender Oil |

Source: Organic Agricultural Products of Turkey, Export Promotion Center of Turkey, Ankara.

Organic product exports include stiff shell, dried fruits, frozen fruits, vegetables, fresh fruits and vegetables, spicesi legumes, rose oil, olive oil and cotton. Turkey, in 2000, imported organic products to twenty countries. EU Countries, North European Countries, Canada, Australia, the USA and Japan are the potential markets for Turkey (Gündüz,2001).

With the help of agreemnet - based production, foreign companies managed to teach farmers about ecological farming (Demiryürek, 2004,p.66). On the contrary, there is less demand in domestic markets to organic food than the international demand. This is because of being lack of information about the use and benefit of the product. People still find organic products expensive than the conventional ones.

## 2. METHODOLOGY

This thesis is based on secondary data. Infomation from the literature of the historical evolution of the Sustainability,Trade, Climate Change and Agriculture enforced with Vermicomposting system collected from the published sources like the websites of the European Union countries, International Federation of Organic Farming Movement (IFOAM), books, periodicals and reports is liberally used for the preparation of this thesis.

## 3. Environmental Friendly Organic Fertilizer –Vermicompost

According to Sinha (2009),chemical agriculture triggered by widespread use of agro-chemicals in the wake of ‘green revolution’ of the 1950s-60s came as a ‘mixed-blessing’ rather a ‘curse in disguise’ for mankind. It dramatically increased the ‘quantity’ of the food produced but severely decreased its ‘nutritional quality’ and also the ‘soil fertility’ over the years. The soil has become addict and increasingly greater amount of chemical fertilizers are needed every year to maintain the soil fertility and food productivity at the same levels. The early response to chemical fertilizers is ‘levelling off’ after a 3% annual increase between 1950-1984.

Increased use of agro-chemicals have naturally resulted into ‘biological droughts’ (severe decline in beneficial soil microbes and earthworms which help to renew the natural fertility of soil) in soils in the regions of green revolution in world where heavy use of agro-chemicals were made. Sinha foresees that higher uses of agro-chemicals also demands high use of water for irrigation putting severe stress on ground and surface waters. Soil and water pollution due to seepage and drainage especially after heavy rainfall were other ill-effects on farmlands. Widespread use of chemical pesticides became a necessity for the growth of high-yielding varieties of crops which was highly ‘susceptible to pests and diseases’. Continued application of chemical pesticides induced ‘biological resistance’ in crop pests and diseases and higher doses are now required to eliminate them.

Studies indicate that there is significant amount of ‘residual pesticides’contaminating our food stuff long after they are taken away from farms for human consumption. Vegetable samples were contaminated 100% with HCH and 50 per cent with DDT . Bhatnager, reported pesticide residues in wheat flour samples. Contamination with HCH was 70%, Heptachlore 2 was 45%, Aldrin 45% and DDT 91%. 60% of water samples were found to be contaminated with Aldrin and 50% with DDT. They were all higher than permissible limits of WHO (World Health Organization).

Adverse effects of agro-chemicals on the agricultural ecosystem (soil, flora, fauna & water bodies in farms) and also on the health of farmers using them and the society consuming the chemically grown food have now started to become more evident all over the world. According to United Nation Environment Program (UNEP) and the World Health Organization nearly 3 million people suffer from 'acute pesticide poisoning' and some 10 to 20 thousands people die every year from it in the developing countries . US scientists predict that up to 20,000 Americans may die of cancer, each year, due to the low levels of 'residual pesticides' in the chemically grown food.

### 3.1. Embracing The Concept of 'Sustainable Agriculture' through Vermiculture

The International Institute of Environment and Development (IIED), London, examined the extent and impact of 'Non-Chemical Sustainable Agriculture' in a number of countries. Sustainable agriculture is synonymous with 'Cleaner Agriculture' as the objective is to reduce or even eliminate the use of dangerous agro-chemicals from food production and also to reduce the use of other precious farm inputs like water and energy whose indiscriminate use to boost food production (to feed the growing masses) has led to widespread environmental destruction by way of soil salinity, waste and pollution (Pretty,1995) . For example, in India several farmers are being motivated to shift to 'organic farming & sustainable agriculture' through vermiculture and give up 'chemical agriculture'. A number of villages in the districts of Samastipur, Hazipur and Nalanda in Bihar have been designated as 'BIO-VILLAGES' where the farmers have completely embraced ORGANIC FARMING by use of earthworms and vermicompost. They have completely given up the use of chemical fertilizers for the last 7 years since 2005. They are growing both cereal (rice, wheat & corn), fruits (banana, guava, mango & lemons) and vegetable crops (potato, tomato, onion, brinjal, cucumber, okra etc) on vermicompost. Farmers of bio-villages feel proud of their food products and they sell at a higher price in market due to their good appearance and taste (Sinha, December, 2008). Vermiculture was practiced by traditional and ancient farmers with enormous benefits accruing for them and their farmlands. There is need to revive this 'traditional concept' through modern scientific knowledge - a 'Vermiculture Revolution'. Sir Charles Darwin called the earthworms as 'farmer's friends'. There is great wisdom in this statement of the great visionary scientist who advocated to use the earthworms, the 'nature's gift' in farm production.

It is necessary to adopt and implement food & agriculture production system which must ensure:

- Maintenance of soil microbiology and fertility by greater use of biofertilizers.
- High productivity and stability of yield over the years.
- Productivity with 'minimum' or 'no' tilling; 'low' use of agro-chemicals (only as helping hand) and integration with biofertilizers and biopesticides.
- Productivity with minimum use of water and even sustain dryness or heavy rainfall.
- Preservation of crop diversity .
- Preservation of soil, water and air quality in the farm ecosystem.
- Preservation of benevolent organisms (predators) flora & fauna in the farm ecosystem.
- Preservation of groundwater table.
- Preservation of good health for all.
- Reduction of water and energy use.

These are the objectives of organic farming & sustainable agriculture. Sustained vermiculture practices and use of vermicompost in farm soil over the years would meet several of the above requirements for a truly sustainable agriculture . According to Singh, vermicompost is rich in microbial diversity and plant available nutrients; improve moisture holding capacity of soils thus reducing water for irrigation; improve physical, biological and chemical properties of soil; increase soil porosity & softness thus requiring minimum tillage . Environmental and economic benefits of vermiculture: First, there will be ample opportunity to reduce energy use and secondly, reduction of greenhouse gas emissions in vermicompost production locally at farms by the farmers themselves. Huge amount of energy is used and GHG emitted at chemical fertilizer factories apart from 'toxic and hazardous wastes' that is generated. Farm energy requirements might be reduced by 40% by more efficient methods of food production through vermiculture technology. Earthworms are an important organism in the soil doing great service for mankind for millions of years now. It combines immense social, economic and environmental values together which is now being realized and recognized. A newer branch of biotechnology called 'Vermiculture Technology' is emerging by the use of earthworms to solve various environmental problems from waste management to land (soil) improvement. Sir Charles Darwin, the great visionary biological scientist highlighted about its role in 'soil improvement and farm production' long time ago and traditional farming community was also practicing vermiculture in their farms (Darwin, 1881). Unfortunately, very little attention was given to it by post-Darwin biological scientists and the modern agricultural scientists and also the farming community of world who saw 'agrochemicals' as a technological boon to produce more food in shorter time. Biological and agricultural scientists all over the world, after getting utterly disappointed by modern chemical agriculture which is destroying the soil and also adversely affecting human health (the ‘boon’ turning into ‘bane’) is now looking back into the ‘traditional wisdom’ and trying to revive the dreams of Charles Darwin. If there is decline in the use of external inputs (agro-chemicals), with more use of locally produced biofertilizers (vermicompost) the costs of food produced by farmers practicing sustainable agriculture will be reduced significantly. There will be more useful trees, more farm wildlife, increased groundwater in wells and ponds, cleaner non-polluted water bodies, more soft & nutritive soils with biological organisms in and around the farmlands in the farm ecosystem where sustainable agriculture is practiced by vermiculture. These will help boost the ‘economic prosperity’ of farmers. Earthworms when present in soil inevitably work as ‘soil conditioner’ to improve its physical, chemical and biological properties and also its nutritive value for healthy plant growth. This they do by soil fragmentation and aeration, breakdown of organic matter in soil & release of nutrients, secretion of plant growth hormones, proliferation of nitrogen-fixing bacteria, increasing biological resistance in crop plants and all these worm activities contribute to improved crop productivity. Worms swallow large amount of soil with organics everyday and digest them by enzymes. Only 5-10 percent of the digested material is absorbed into the body and the rest is excreted out in the form of fine mucus coated granular aggregates called ‘vermicastings’ which are rich in NKP (nitrates, phosphates and potash), micronutrients and beneficial soil microbes (Bhardwaj,1985).

Value of earthworms in plant propagation was emphasized by the great Indian author Surpala in his epic ‘Vriksha-ayurveda’ (Science of Tree Growing) as early as in the 10th century A.D. He recommended to incorporate earthworms in soil of pomogranate plants to obtain high quality fruits . This traditional wisdom has been scientifically verified today for successful & sustainable growth of several fruits, vegetables and cereal crops today without the use of agrochemicals (Sadhale, 1996).

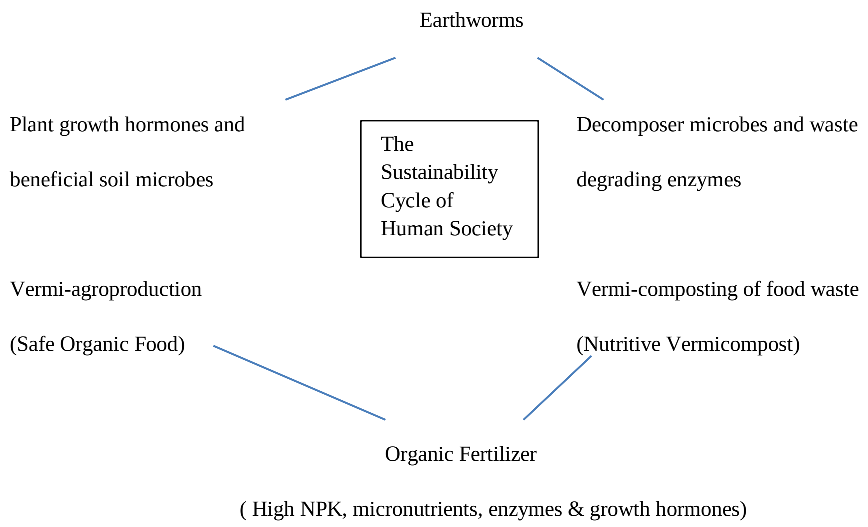
Earthworms have over 600 million years of experience in waste & land management, soil improvement & farm production. No wonder, Sir Charles Darwin called them as the 'unheralded soldiers of mankind and farmer's friend working day and night under the soil'.

Vermiculture biotechnology promises to provide cheaper solutions for:

- Management of municipal & industrial solid wastes (organics) by biodegradation & stabilization and converting them into nutritive organic fertilizer (vermicompost)- 'THE VERMI-COMPOSTING TECHNOLOGY' (VCT). It amounts to converting 'trash into treasure' or getting 'wealth from waste' or 'gold from garbage. (Value of earthworms in waste management was emphasized by Greek Philosopher Aristotle who called as 'intestine of earth' which meant that they can digest wide variety of materials from earth).
- Restoring & improving soil fertility and boosting food productivity by worm activity and use of vermicompost (miracle growth promoter) without recourse to the destructive agro-chemicals (Fraser-Quick, 2002).

Nations of world today is seeking the most cost-effective, economically viable, environmentally sustainable & socially acceptable technology that can convert all 'organic waste' into a valuable 'resource' to be used back into the human society. Upon Sinha's projections, tests and trials, earthworms have potential of generating NPK equal to 10 million tonnes annually in India (and other nations too) as huge amount of organic waste is generated every year and 1,000 tonnes of organic wastes can be degraded to 300 tonnes of nutritive vermicompost rich in NPK and all essential micronutrients by about few million worms whose population almost double every year . The organic division of the MSW (about 70-80%) containing plenty of nitrogen (N), potash (K) and phosphorus (P) is a good source of macro and micronutrients for the soil. Vermicomposting of all waste organics especially the ‘food & garden waste’ of society and using the nutritive end-product to grow ‘food’ again will establish the concept of ‘circular metabolism’ for a sustainable society (see Table 3.1.).

Table 3.1. Circular Metabolism & The Sustainability Cycle of Human Society



Picture 3.1. Versatile waste eater and decomposer *Eisinia fetida*

Source:Am-Euras.J.Agri&Environ.Sci.,5,2009

Enormous power of reproduction and rapid rate of multiplication: Earthworms multiply very rapidly. They are bisexual animals and cross-fertilization occurs as a rule. After copulation the clitellum (a prominent band) of each worm eject lemon-shaped ‘cocoon’ where sperms enter to fertilize the eggs. Up to 3 cocoons per worm per week are produced. From each cocoon about 10-12 tiny worms emerge. Studies indicate that they double their number at least every 60 days. Given the optimal conditions of moisture, temperature and feeding materials earthworms can multiply by $2^{8.}$ 256 worms every 6 months from a single individual. Each of the 256 worms multiplies in the same proportion to produce a huge biomass of worms in a short time. The total life-cycle of the worms is about 220 days. They produce 300-400 young ones within this life period . A mature adult can attain reproductive capability within 8-12 weeks of hatching from the cocoon. Red worms takes only 4-6 weeks to become sexually mature . Earthworms continue to grow throughout their life and the number of segments continuously proliferates from a growing zone just in front of the anus (Hand, 1988).

Earthworms are very sensitive to light, cold and dryness. They tend to migrate away temporarily into deeper layers of soil when subjected to light, too cold or too hot situations. This is of great survival to them especially in cold winters and hot summers. Adapted to survive in harsh environment: Some species e.g. *Eisinea fetida* are highly adapted to survive in 'harsh' conditions where no creature on earth can survive.They have an ability to degrade most organic wastes rapidly into nutritive vermicompost. Researches into vermiculture have revealed that worms can feed upon wide variety of organic wastes and provides sustainable solution for total waste management.

Livestock rearing waste such as cattle dung, pig and chicken excreta makes excellent feedstock for earthworms. Animal excreta containing excessive nitrogen component may require mixing of carbon rich bulking agents (straw, saw dust, dried leaves and grasses, shredded paper waste etc.) to maintain proper C/N ratio. Paunch waste materials (gut contents of slaughtered ruminants) from abattoir also make good feedstock for earthworms.

The worms secrete enzymes proteases, lipases, amylases, cellulases and chitinases in their gizzard and intestine which bring about rapid biochemical conversion of the cellulosic and the proteinaceous materials in the waste organics. Earthworms convert cellulose into its food value faster than proteins and other carbohydrates. They ingest the cellulose, pass it through its intestine, adjust the pH of the digested (degraded) materials, cull the unwanted microorganisms and then deposit the processed cellulosic materials mixed with minerals and microbes as aggregates called 'vermicasts' in the soil (Dash, 1978) .

Most earthworms consume, at the best, half their body weight of organics in the waste in a day. *Eisenia fetida* is reported to consume organic matter at the rate equal to their body weight every day. Earthworm participation enriches natural biodegradation and decomposition of organic waste from 60 to 80%. Reseaches indicate that given the optimum conditions of temperature (20-30 °C) and moisture (60-70%), about 5 kg of worms (numbering approx.10,000) can vermiprocess 1 ton of waste into vermi-compost in just 30 days .Upon vermi-composting the volume of solid waste is significantly reduced from approximately 1 cum to 0.5 cum of vermi-compost.

Vermicompost is a nutritive ‘organic fertilizer’ rich in NKP (nitrogen 2-3%, potassium 1.85-2.25% and phosphorus 1.55-2.25%), micronutrients, beneficial soil microbes like ‘nitrogen-fixing bacteria’ and ‘mycorrhizal fungi’ & plant growth hormones. Kale & Bano reports as high as 7.37% nitrogen (N) and 19.58% phosphorus as P2O5 in worms vermicast. They are scientifically proving as ‘miracle plant growth promoters’ much superior to conventional composts and chemical fertilizers (Sinha, 2007).

In order to reinforce decomposer microbes to promote rapid waste degradation: Earthworms promotes the growth of ‘beneficial decomposer aerobic bacteria’ in waste biomass and this they do by several ways-by improving ‘aeration’ through burrowing actions, by releasing ‘chemical mediators’ along their gut and body surface and indirectly through protozoa which they activate, which act at low concentrations on microbial metabolism, as vitamins or as chemical catalysts . Earthworms hosts millions of decomposer (biodegrader) microbes in their gut (as they devour on them) and excrete them in soil along with nutrients nitrogen (N) and phosphorus (P) in their excreta. The nutrients N & P are further used by the microbes for multiplication and vigorous action (Binet, Fayolle & Pussard, 1998).

Edward and Fletcher (1998) showed that the number of bacteria and ‘actinomycetes’ contained in the ingested material increased up to 1000 fold while passing through the gut. A population of worms numbering about 15,000 will in turn foster a microbial population of billions of millions.

The ability to kill pathogens & disinfect its surroundings: The earthworms produce coelomic fluids that have antibacterial properties and destroy all pathogens in the media in which it inhabits . They also selectively finish the protozoa, bacteria and fungus as food. They seem to realize instinctively that anaerobic bacteria and fungi are undesirable (causing rotting and foul odor) and so feed upon them preferentially. They also produce 'antibiotics' and kill the pathogenic organisms in their surroundings. This attribute of earthworms is very useful in composting of waste where the end-product becomes 'disinfected', 'odorless' and free of harmful microbes.

The removal of pathogens, faecal coliforms (*E. coli*), *Salmonella* spp., enteric viruses and helminth ova from human waste appear to be much more rapid when they are processed by *E. fetida*. of all *E.coli* and *Salmonella* are greatly reduced . Its ability to bio-accumulate toxic chemicals and detoxify the medium in which it lives: Several studies have found that earthworms effectively bio-accumulate or biodegrade several organic and inorganic chemicals including 'heavy metals', 'organochlorine pesticide' and the lipophilic organic micropollutants like 'polycyclic aromatic hydrocarbons' (PAHs) residues in the medium in which it inhabits. No farmlands in the world today where heavy use of agrochemicals were made in the wake of 'green revolution' are free of organic pesticides.

Several studies have found that there is a definite relationship between 'organochlorine pesticide' residues in the soil and their amount in earthworms, with an average concentration factor (in earthworm tissues) of about 9 for all compounds and doses tested (Ireland, 1983).

The ability of heavy metals removal by earthworms is of particular significance while using vermicomposts made from urban solid wastes. Urban waste may contain considerable heavy metals and when processed by earthworms only that they can become free of heavy metals. Their ability to tolerate & reduce soil salinity: Studies indicate that *Esinea fetida* can tolerate soils nearly half as salty as seawater i.e. 15 gm/kg of soil and also improve its biology and chemistry. (Average seawater salinity is around 35 g/L). For example; farmers at Phaltan in Satara district of Maharashtra, India, applied live earthworms to their sugarcane crop grown on saline soils irrigated by saline ground water. The yield was 125 tones/hectare of sugarcane and there was marked improvement in soil chemistry. Within a year there was 37% more nitrogen, 66% more phosphates and 10% more potash. The chloride content was less by 46%. Farmer in Sangli district of Maharashtra, India, grew grapes on eroded wastelands and applied vermicasting @ 5 tones/hectare. The grape harvest was normal with improvement in quality, taste and shelf life. Soil analysis showed that within one year pH came down from 8.3 to 6.9 and the value of potash increased from 62.5 kg/ha to 800 kg/ha (Parle,1963). There was also marked improvement in the nutritional quality of the grape fruits.

### 3.2.Vermiculture as a Global Movement

The movement was started in the middle of $20^{th}$ century and the first serious experiments for management of municipal/industrial organic wastes were established in Holland in 1970 and subsequently in England and Canada. Later vermiculture were followed in USA, Italy, Philippines, Thailand, China, Korea, Japan, Brazil, France, Australia and Israel. However, the farmers all over the world have been using worms for composting their farm waste and improving farm soil fertility since long time. In UK, large 1000 mt vermi-composting plants have been erected in Wales. The American Earthworm Technology Company started a 'vermi-composting farm' in 1978-79 with 500 t/month of vermicompost production. Hartenstein & Bisesi reported on the management of sewage sludge and effluents from intensively housed livestock by vermiculture in USA. Japan imported 3000 mt of earthworms from the USA during the period 1985-87 for cellulose waste degradation . The Aoka Sangyo Co. Ltd., has three 1000 t/month plants processing waste from paper pulp and the food industry. This produces 400 ton of vermicompost and 10 ton of live earthworm.

When it is put into numbers, properties of farm soil using compost vis-a-vis chemical fertilizers: Suhane (2008) studied the chemical and biological properties of soil under organic farming (using various types of composts) and chemical farming (using chemical fertilizers-urea),(N), phosphates (P) and potash (K). Results are given in Table 3.2. per month.

Table 3.2. Farm Coil Properties Under Organic Farming and Chemical Farming

| Chemical & Biological Properties of Soil | Organic Farming (Use of Composts) | Chemical Farming (Use of Chemical Fertilizers) |
|---|---|---|
| 1. Availability of nitrogen | 256.0 | 185.0 |
| 2. Availability of phosphorus | 50.5 | 28.5 |
| 3. Availability of potash | 489.5 | 426.5 |
| 4. Azatobacter (1000 / gm of soil) | 11.7 | 0.8 |
| 5. Phospho bacteria (100,000/kg of soil) | 8.8 | 3.2 |
| 6. Carbonic biomass (mg/kg of soil) | 273 | 217 |

Source: Suhane, 2007.

Table 3.3. NPK Value of Vermicompost Compared With Conventional Cattle Dung Compost Made From Cattle Dung

| | Nutrients | Cattle Dung Compost | Vermicompost |
|---|---|---|---|
| 1. | N | 0.4-1.0% | 2.5-3.0% |
| 2. | P | 0.4-0.8 % | 1.8-2.9% |
| 3. | K | 0.8-1.2% | 1.4-2.0% |

Source: Argarwal,1999;Ph.D Thesis, University of Rajasthan,India.

Table 3.4. Agronomic Impacts of Vermicompost, Earthworms and Vermicompost vis-a-vis Chemical Fertilezer on Growth and Development of Potted Egg Plants.

| Treatments | Av.Vegetative Growth (in iches) | Av.No.of Fruits/Plants | Av.Wt.of Fruits/Plants | Total No.of Fruits | Max. Wt.of One Fruit |
|---|---|---|---|---|---|
| Earthworms(50)+ Vermicompost (250gm) | 28 | 20 | 675gm | 100 | 900gm |

| | | | | | |
|---|---|---|---|---|---|
| Vermicompost(250gm) | 23 | 15 | 525gm | 75 | 700gm |
| Chemical Fertilizer (NPK)Full dose | 18 | 14 | 500gm | 70 | 625gm |
| CONTROL | 16 | 10 | 425gm | 50 | 550gm |

Source:Agarwal,1999;Ph.D Thesis, University of Rajasthan, India.

Earthworms and its vermicompost can work as the main ‘driving force’ in sustainable food production for food security while maintaining soil health and fertility. They can ‘completely eliminate’ the use of chemical fertilizers and ‘significantly reduce’ the use of chemical pesticides in crop production & also the huge water requirements for crop irrigation which became essential in chemical agriculture. This is being termed as ‘Sustainable Agriculture’.

## 4. DISCUSSION

Vermicompost production and use is an 'environmentally friendly, protective and restorative' process as it diverts wastes from ending up in landfills and also reduces emission of greenhouse gases (GHG) due to very small amount of energy used in its production process. Application of vermicompost in farm soil works as soil conditioner and help in its regeneration by improving its physical, biological and chemical properties. Vermicompost production is also an 'economically productive' process as it 'reduces wastes' at source and consequently save landfills space. Over the past 5 years the cost of landfill disposal of waste has increased from $ 29 to $ 65 per ton of waste in Australia. Then, landfills have to be monitored for at least 30 years for emissions of GHG and toxic gases & leachate (Waste Juice) which also incur cost. During 2002-2003, waste management services within Australia cost $2458.2 millions. Even in developing nations where there are no true landfills, dumping of wastes incurs high cost on local government. Whereas, earthworms converts a product of 'negative' economic & environmental value i.e. 'waste' into a product of 'highly positive' economic & environmental values i.e. 'highly nutritive organic fertilizer' (brown gold) which improve soil fertility and enhance farm productivity to produce 'safe food' (green gold) in farms. Vermiculture can maintain the global 'human sustainability cycle' for example; producing food in farms back from food & farm wastes. Vermicomposting is a self-promoted, self-regulated, self-improved & self-enhanced, low or no-energy requiring zero-waste technology, easy to construct, operate and maintain. It excels all other waste conversion technologies by the fact that it can utilize waste organics that otherwise cannot be utilized by others. It also provides all other biological or mechanical technologies for production of 'bio-fertilizer' because it achieves 'greater utilization' than the rate of 'destruction' achieved by other technologies and the process becomes faster with time as the army of degrader worms and the decomposer microbes multiply in millions in short time . Earthworms involves about 100-1000 times higher ‘value addition’ in any medium (composting wastes or soil) wherever it is present.

On the contrary, in chemical agriculture, the amount of chemicals used per hectare has been steadily increasing over the years to maintain the same yield of previous years as the soil became ‘addict’. Nearly 3 – 4 times of agro-chemicals are now being used per hectare what was used in the 1960s. And the cost of chemical fertilizers has also been steadily increasing since then. In Australia, the cost of MAP fertilizer has risen from AU $ 530.00 to AU $ 1500.00 per ton since 2006. There is also significant loss of chemical fertilizer from the farm soil due to oxidation in sunlight. Suhane calculated that upon application of 100 kg urea (N) in farm soil, 40-50 kg gets oxidised and escapes as ‘ammonia’ ($NH_3$) into the air, about 20-25 kg leaches underground polluting the groundwater, while only 20-25 kg is available to plants. In the light of these, this thesis indicates that vermicompost is several times more powerful crop nutrient than the conventional composts and hence significantly lower amount of vermicompost is required for crop growth and production. Suhane asserts that it is at least 4 times more nutritive than cattle dung compost. In Argentina, farmers who use vermicompost consider it to be seven times richer than conventional composts in nutrients and growth promoting values . Atiyeh (2000) found that the conventional compost was higher in ‘ammonium’, while the vermicompost tended to be higher in ‘nitrates’, which is the more available form of nitrogen to promote better growth and yield. It is also found that vermicompost has higher N availability than the conventional compost on a weight basis and the supply of several other plant nutrients e.g. phosphorus (P), potassium (K), sulfur (S) and magnesium (Mg), were significantly increased by adding vermicompost as compared to conventional compost to soil (Atiyeh et.al.,2000). Then vermicompost contains nutrients for long time and while the conventional compost fails to deliver the required amount of macro and micronutrients including the vital NKP (nitrogen, potassium & phosphorus) to plants in shorter time, the vermicompost does . This was verified by Bhatia, Sinha, Bharambe, Chauhan and Valani.

The technology is being commercialized all over the world for mid-to-large scale vermicomposting of most organic wastes (food & farm wastes & green wastes and also the sewage sludge) and several companies have come up in the last few years in U.S., Canada, New Zealand, Japan and France. For example; the Envirofert Company from New Zealand, is vermicomposting thousands of tons of green waste every year. They claim that each worm eat the cooked green waste at least 8 times leaving an end product which is rich in key minerals, plant growth hormones, enzymes and beneficial soil microbes. Envirofert is also planning to vermicompost putrescible food waste from homes, restaurants and food processing industries in New Zealand. They intend to process approximately 40,000 tones of food wastes every year to produce vermicompost which would eventually replace chemical fertilizers in farm production in New Zealand. (www.envirofert.co.nz)

Switching over to sustainable agriculture by vermiculture can truly bring in 'economic prosperity' for the farmers and the nations with 'environmental security' for the earth.

## 5. RESEARCH

SWOT analysis is thought to evaluate the Strengths, Weaknesses, Opportunities and Threats of Vermicomposting as an environmentally- friendly alternative agricultural system. In this way, it is going to identify internal and external factors that are favourable or not and specifying the objective of the business venture. So within the light of SWOT analysis, it would be easier to determine whether organic farming through Vermicomposting is attainable and/or logical to make an investment on it.

| Strengths | Weaknesses |
|---|---|
| • Indigenous farming system<br>• Relevant labour force<br>• National Organic Movements<br>• Low cost of production<br>• Availability of technologies for organic production<br>• Agro-bio diversity<br>• Strongly motivated and committed organic sector | • Poor image of marketing<br>• Lack of awareness of benefits of organic agriculture<br>• Institutional weaknesses such as certification<br>• Lack of added value<br>• Lack of reliable data and information on organic agriculture<br>• Poor ideal market opportunities and infrastructure |
| **Opportunities** | **Threats** |
| • Availability of uncontaminated land<br>• Increasing interest in organic agriculture<br>• Incresing global demand for organic<br>• Increasing local awareness of benefits of organic foods<br>• Provides answers to environmen concerns (climate change)<br>• Increasing support from international communities<br>• Common work and standard<br>• Governmental support in policy programmers for organic agriculture | • Small quantities and irregular supply limit market opportunities<br>• Focus on high value crops<br>• Some crops are very difficult to produce e.g tomatoes<br>• Trust gap between exporting companies and farmers<br>• Availability of clean and appropirate seeds<br>• Donor dependency |

## 6. The Future Prospect of Organic Farming in Turkey

In Turkey, luckily, there are still agricultural areas where farmers do not use synthetic pesticides and fertilizers. With the advantage of Turkey's favourable climate and geographical position, Turkey has a great chance for organic production both in European market and Turkish home market. According to Turkish Agriculture Industry Report prepared by Republic of Turkey Prime Minisrty in 2010, organic agriculture activities are increasing with the spreading of organic lands in all regions with a total of 141,752 hectares, more than double of 1996's number. There is also an increase in the variety of products in 15 years from 37 to 247 in 2008. Bearing the objective of export capacity numbers in 2023 around 500 billion USD, organic farming should specify its route and capacity beforehand. Year by year, Turkey should take a larger share in the global organic farming market. According to Ministry of Agriculture and Rural Affairs (MARA) data there are 35.565 organic farmers in Turkey and farm areas rose to 501.641 ha. In these areas, Turkey produces more than 212 different types of organic products (MARA, 2011). The farming areas allocated to organic agriculture, in Turkey, has increased from 89.827 hectares in 2002 to 501.641 hectares in 2009, increasing by about 17. 9 % but there are still lack of capacity in standardization of indurtial organic farming methods.

Despite the increase in the number of farms, production values and crop range, most of the organic products are destined to the export markets. European Union countries, and particularly Holland, Germany, France, Switzerland, and the UK are main export markets for Turkish organic products (Aksoy, 1999). The main reason for this development was the Ministry of Agriculture increased its policy interventions to support production and trade of certified organic products.

As mentioned earlier, the majority (about 80-90%) of the production of organic agricultural products is being exported. Local consumers show little interest in organic products due to the high price margin between organic and conventional products. On this account Turkish organic agricultural products are becoming more and more familiar to foreign importers. Turkey's export rates related to Turkish organic products are indicated in Table 6.1.

Table 6.1. General Data of Organic Agricultural Production in Turkey (Including the Transition Period)

| Years | Type of Products | Number of farms | Total farming area | Total Production Area (ha) | Total Production (tons) |
|---|---|---|---|---|---|
| 2002 | 150 | 12.428 | 57.365 | 89.827 | 310.125 |
| 2003 | 179 | 14.798 | 73.368 | 113.621 | 323.981 |
| 2004 | 174 | 12.806 | 108.598 | 209.573 | 378.803 |
| 2005 | 205 | 14.401 | 93.134 | 203.811 | 421.934 |
| 2006 | 203 | 14.256 | 100.275 | 192.879 | 458.095 |
| 2007 | 201 | 16.276 | 124.263 | 174.283 | 568.128 |
| 2008 | 247 | 14.926 | 109.387 | 166.883 | 530.225 |
| 2009 | 212 | 35.565 | 325.831 | 501.641 | 983.715 |
| | | | | | |
| **2023** | **423** | **291.250** | **10.511.948** | **15.644.630** | **9.897.701** |

Source : http://www.tarim.gov.tr access 14 Ocak 2011

Finally, the support given by the government for organic agriculture is designed annualy depending on each product. Legal framework related to this procedure is set an run by the Agricultural Ministry. In the light of these, total production in tons, total production area and number of farms were forecasted by 2023 based on the historical growth rate information given by www.tarim.gov.tr. In 2023, there will be 291,250 farms with %16 growth, 15,644,630 ha production area with %28 growth and 9,897,701 tons of production with %18 growth annualy. Bearing the fact that Europe is the biggest organic market in the world, with the help of %28 annualy growing production area, Turkey has an opportunity to export organic products to Europe where the income level is higher than Turkey. So, Turkey's export is forecasted in Table 6.2. Turkey's total export is expected to be $500bn in 2023 whereas it was $145bn as of August 2012. Total agriculture export will be $65bn in 2023 with %11 growth rate annualy. On the other hand $0.3bn of organic products export in 2011 will reach $2.5bn in 2023 with %19 growth rate. Organic export share in total agriculture export will be tripled in the next ten years.

Table 6.2. Turkey's Export Forecast

| USD (bn) | 2011 | 2023 | CAGR (%) |
|---|---|---|---|
| Total export | 134,9 | 500,0 | 12% |
| Agriculture export | 17,6 | 59,5 | 11% |
| Organic export | 0,3 | 2,5 | 19% |
| Share in total | 0,2% | 0,5% | |

That will help Turkish economy to export with value added products in coming years. As a result, with the correct susidies given to the agricultural industry , organic market share may be increased both in national and international arena.

# 7. CONCLUSION

The search for sustainability appears in every aspect of life; trade, environment and social life. Therefore, it is definite that the idea of sustainable development will promote better future for everyone in the world. It is almost impossible to imagine future trade, environment or social life activities without systems that envision sustainability. When climate change gained acceleration worldwide, all trade activities have started to look for new systems or strategies which will minimize greenhouse gas emissions.

In this sense, climate change and trade activities become inseperable where the most important sector which directly affects human health is agriculture. Agricultural sustainability means a lot when it is linked with the future of human health. It is both the cause of greenhouse gas emission and the solution of all the dirt with the help of Vermicomposting system. Vermicompost system acts first as an organic fertilizer where organic farming is aimed. But also Vermicompost system is a real alternative recycle process where carbon emissions seem at very low levels. Thus, Vermicomposting system can be widely used in many recycling areas where the organic idea gains importance. Its major function area is organic farming different from of its kinds, it is a non-stop process done greatly by earthworms. This organic fertilizer is called ‘Black Gold’ in the world because of its richness in minerals and all relevant ingredients. Turkey has begun to give more importance to organic farming day by day and in near future Turkey may act one of the major organic farming hub in the region. With Vermicomposting system, Turkey may lead a different sustainable development program in agricultural systems. In order to achieve this goal, there should be both subsidies and educational support given by governmental offices. Increasing awareness about the necessity of organic farming needs more well-designed systems as Vermicomposting where it provides sustainabilty in its nature. To sum up, Turkey should be well informed about the possible ways of fine sustainable organic farming systems at its best. Turkey's export values may gain real momentum by using this system. So, relevant studies are carried out both in European countries and mainly in India. There is no reason not to look what is there under the earth.

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