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Impact of Agricultural Technologies Employed for Food and Textile Fibres Production on Environment and Human Health

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Abstract

The Agricultural sector is focal point of lively hood and it not only provides employment in the most of the developing countries like India but also feeds the huge population of the world. The farmers have contributed remarkably in achieving self-sufficiency in food, clothing, paper, etc across the globe by adopting various types of agriculture technologies and farm related practices with the help of advanced heavy machineries. The population of the world is exploding with time and it will be very difficult to coup up the demand of food and clothing. It is misconception that all the crop based biodegradable natural fibres such as cotton, hemp, jute, remie, sisal, etc are eco-friendly in nature. But in fact their mass production affects the ecology and biodiversity too. The agricultural production systems necessitate farmers to use excess inorganic fertilizers, synthetic pesticides, irrigation systems by use of excesses ground water and new seed varieties. Excessive application of pesticides created a lot of environmental problems e.g. contamination of food grains, surface water and groundwater contamination and biomagnifications, etc. The excessive use of inorganic fertilizer are responsible for eutrophication whereas the excessive use of ground water has created the scarcity of water and lowering of water table, soil salinity and water logging in the certain areas.

Introduction

The population of the word is exploding with time and fulfilling the basic requirements such as food, clothing and shelter to all is really great challenge for the society. The 'Green Revolution' increased the crop productivity across the globe and

feeds more than 6000 million people. Beside these by increasing yields on land already in production, hundreds of millions of hectares of tropical forests and other natural environments were saved from conversion to agriculture. (Toenniessen et al, 2003). Global cereal production has doubled in the past 40 years due to applications of various mass production technologies such as automation in agricultural machineries, use of synthetic fertilizers, pesticides, irrigation technology and especially the genetic improvement of crops, combined with complementary agronomic practices. It is estimated that again agricultural production has to be increased two folds by 2050 due to increase in population. The agricultural production already has great burden on ecology due to excess use of pesticides, synthetic fertilizers and water resources. Hence doubling food and fibre production again at this level will be really difficult task as well as will have more adverse effect on the environment (Tilman *et al*, 2002).

Agriculture and agriculture allied sectors are major players in economy of India and contribute nearly 22 per cent of Gross Domestic Product (GDP), while about 65 -70 per cent of population depends on agriculture for livelihood (Sachdeva, 2007). The scenario of Indian agriculture has changed drastically after first green revolution in 1960. A vast majority of the population in India are engaged in agriculture and are therefore, exposed to the pesticides and fertilizer used in agriculture (Patil and Katti, 2012). Beside foods, farming is also associated with fibre production i.e. cotton, jute, linen, coir, etc. The cotton fulfils around one third consumption of textile and clothing. In India cotton covers around 7% of the total crop coverage after the rice. Cotton has great impact on environment being sharing significant proportion in total agricultural business as leading crop.

At the one hand human being is benefited with this green revolution by fulfilling the hunger but at the other hand it divested the ecology and biodiversity due to use of huge amount of pesticides, fertilizers and water. In present era most of the rivers, ponds and canals have been dried up or polluted due to aforesaid reasons. It is a great question that how we can preserve our environment with this greedy exploitation of agricultural production. Acid rain, deforestation, depletion and drying of most of the natural water resources, depletion of ozone layer, melting of glaciers, global warming, discharge of toxic wastage by industrial units and automobiles into environment are some of the environmental problematic issues which are also exaggerated due to industrialisation of agricultural sector in greed without concerning the sustainability and biodiversity issues.

The present paper discuss about the various technologies used in agricultural sector and their impacts on environment and biodiversity. The impact of inorganic fertilizers as well as pesticides on environment and human health has been discussed in general with emphasises on Punjab and Haryana. The necessity of sustainable farming by the help of organic manure, bio-fertilizers and traditional farm practices i.e. integrated pest management or natural pesticides in favour good quality of food, fibre and biodiversity is also described in paper as remedial action. In the forthcoming sections various agricultural methods has been illustrated in brief with their environment impacts and at last sustainable organic farming is discussed as remedial measures. The cultivation of cotton and its impact on environment has been also discussed in detail.

Different Types of Agricultural Technologies

The Killebrew and Wolff (2010) has discussed various types of agriculture technologies and farm related practices such as monoculture, poly-culture, continuous cropping, crop rotation, conventional tillage, intensive hillside cultivation, intensive livestock systems, etc. The various types of agricultural technologies are discussed briefly below as:-

Monoculture Vs Polycultural Farming: The planned agricultural production must have harmony with "associated" biodiversity such as the micro-organisms, insects, population of bees, flies, moths, bats, birds, and other wildlife. However, the monoculture adopted across the globe for mass agricultural production has severely affected the biodiversity and the pollination processes (Gliessman, 2000). The monoculture systems are more susceptible towards the pest and insect than poly-cultures hence needs more use of pesticide further deteriorate the environment (Millennium Ecosystem Assessment, 2005).

Poly-culture farm practice is similar to natural ecosystem as multiple species grow in same area benefit the flora and fauna that live within the environment. The species have different nutrients needs at different depth of the roots in soil, hence less burden on soil and less fertilizer required. Research indicates that the crop yield for poly-cultures is greater with more nutrient value than a monoculture. In this system crop is more resistive to pest as well as climate and weather extremes. It needs less inputs of pesticide although it is more labour intensive. Over all poly-culture is more sustainable than monoculture practice (Progressiprocity; http://true-progress.com/).

Continuous Cropping Vs Crop Rotation: Farmers used crop rotation in cultivation to manage soil fertility in traditional farming practise. To get more production farmers have shortened or abandoned fallow periods and crop rotations in favour of continuous production required synthetic fertilisers to compensate the nutrients. Beside these continuous cropping needs more pesticide due to disruption of natural pest balance. The more use of pesticide and fertiliser in continuous cropping has negative environmental effects (Wood et. al, 2000; Millennium ecosystem assessment, 2005 and Dewar, 2007). In crop rotation practice the type of crop is changed on particular location of a farm from season to season. The different crops have different nutrients requirements and maintain the soil fertility, needs less fertilizers and pesticides (Sustainable Crop Production, May, 2015).

Conventional Tillage Vs No Tillage: In tillage soil structure is loosened by mechanical means to controls the weeds and crop residues. This process reduces soil organic matter, resulting soil able to absorb and retain less amount of water and more prone to erosion and run-off. This process release excessive CO_2 due to decomposition of soil organic matter as well as combustion involved in fossil fuels in mechanical tillage tools (Smith et al., 2008). Due to associated disadvantages of tillage minimum tillage is being used for soil conservation. The less tillage control soil erosion and compaction, increase aeration and reduce loss of water and critical nutrients (Sustainable Crop Production, May, 2015).

Intensive Cultivation in Hill side Areas: The hillside land has normally poor quality of soil and continual transfer of nutrients towards lower part of the land necessitates the use of fertilizers. Most of the applied fertilizer and pesticide accumulates in rivers, ponds and make the water recourses toxic.

Intensive Livestock System: The animal stocking have been increased many fold due to increase in demand of meat, leather, wool, milk, etc. Increased animal stocking rates puts pressure on grazing lands, leading in some cases to soil compaction and erosion, grasslands degradation, and desertification in semi-arid areas. The concentrated manure and livestock waste contains nitrogen, phosphorous, potassium, etc deteriorate water quality as well as their fermentation is also responsible for CH_4 and N_2O emissions.

Environmental Impacts of Modren Agriculture

The different types of agricultural production systems necessitate farmers to use excess inorganic fertilizers, pesticides, irrigation systems and new seed varieties (Killebrew and Wolff, 2010). The impact of these technologies and practices has been tabulated in Table 1.

It is evident from table: 1 that modern agricultural practices have various adverse environmental impacts. The various negative environmental impacts discussed briefly here as:-

Table 1 Agricultural technologies and their impacts on ecosystem services

Sr. No.	Technology	Impacts on soils, water, biodiversity, climate and other remark
1	Monoculture	• Increase soil erosion and deplete the nutrients that every living thing in an ecosystem relies on. • Reduces habitat for insects and wildlife, require more pesticides • Minimal human input in harvesting using automation
2	Poly-culture or Intercropping	• Maintain soil fertility and needs less pesticides and fertilizers • harvesting is significantly more labor intensive • more yield than monoculture
3	Continuous Cropping	• Soil fertility declines due to nutrient mining • Reduces farmers' ability to use natural pest cycles, leading to increased need for pesticides
4.	Crop rotation	• Maintain soil fertility
5	Conventional Tillage	• Reduces soil organic matter, leading to increased erosion • Contributes to CO_2 emissions due to decomposition of soil organic matter
6	Intensive Hillside Cultivation	• Increases erosion, leading to soil degradation
7	Intensive Livestock Systems	• Increases erosion and soil compaction due to overgrazing and hoof action • Untreated livestock waste degrades water quality • Degrades grassland habitat due to overgrazing • Contributes to CH_4 and N_2O emissions due to enteric fermentation and manure management

Source: Killebrew and Wolff, 2010

Use of Inorganic Fertilizers

In India the fertilizer consumption increased to a level of 20.34 million tonnes in 2005-06 from 0.305 million tonnes in 1959-1960. Similarly, the fertilizer consumption per hector increased to 107 kg in 2005-06 from 2 kg in 1959-1960. The trend of increase in fertilizer consumption in India is shown in Table 2.

Table 2 Trend in intensity of fertilizer consumption in India.

Year	Consumption				
	kg/ha				Million tones
	N	P_2O_5	K2O	Total	
1959-1960	1.50	0.35	0.14	1.99	0.305
1979-1980	20.63	6.79	3.58	31.00	
1999-2000	61.19	25.33	8.86	95.38	
2005-2006	66.74	27.30	12.66	106.69	20.34

Source: Malik and Sekhar, 2007

The per hectare fertiliser consumption of NPK during 2004-06 (in Kg) in leading agriculture producing states are shown in Table 3.

Table 3 Consumption of NPK (kg/ha) in leading agricultural states

S. No	State/UT	2005-06	2004-05
		Consumption (kg/ha)	
1	Maharashtra	84.52	74.68
2	Gujarat	111.07	99.49
3	Uttar Pradesh	140.37	134.13
4	Haryana	166.72	155.10
5	Tamilnadu	183.67	159.07
6	Andhra Pradesh	203.61	158.57
12	Punjab	210.06	194.56
13	Pondicherry	1100.26	1086.30
	All India (average)	104.50	94.52

Source: Malik and Sekhar, 2007

The total consumption of NPK grew by more than 8%, 11.5% and 6 % per annum, in Haryana during the period 1970-71 to 2003-04. For wheat, the fertilizer use per hectare over the entire period of analysis from 1970-71 to 2003-04 increased on an average by 6.10 percent per annum while for rice the fertilizer consumption increased by about 5 percent per annum. During this period the rates of growth in crop yields of wheat and rice differed. While the crop yield in the case of wheat increased by an average of 2.9 percent per annum, the growth in yield of rice was much smaller at 1.19 percent per annum.

It is fact that fertilizers containing synthetically derived nitrogen (N), phosphorous (P), potassium (K), calcium, magnesium, and micronutrients has allowed humans to increase per area yields dramatically. The synthetic fertilizers itself requires

natural gas and coal, contribute in CO_2 emission as well as its inefficient application impacts soil, water and air quality. The nitrogen based fertilizers are responsible for acidification when ammonium in certain fertilizers undergoes nitrification to form nitrate and then the nitrate leaches into the soil. The increase in fertilizer use in cotton growing to boost the production causes pollution of surface water as well as of ground-water. The use of phosphate fertilizers causes accumulation of heavy metals, such as cadmium, in soil as well as surface water eutrophication in context with possible leaching (Gleick, 1993).

The excessive used fertilizer accumulates in soils and further percolates into aquatic ecosystems in a number of ways. The excessive over abundant nutrient in fresh water is leading a state of eutrophication. In eutrophication state, oxygen depletion take places as well as algae grows in water. Due to lack of oxygen aquatic life come in danger or "Dead zones" develops in these areas. "The aquatic life suffered adversely in the Baltic Sea, Black Sea, west coast of India and outlet of the Mississippi River in the Gulf of Mexico due to generation of dead zones caused by eutrophication." The polluted water has numbers of health effects on human and wild animals and creates danger for biodiversity. Beside water pollution the excessive used fertilizer also responsible for air pollution and formation of smog and acid rain due to emission of NO and N_2O gases in the environment (FAO, 2006).

Pesticides and Impact on Ecosystem

Pesticides are toxic substances used for preventing, destroying, repelling and controlling the pest. The term pesticide includes- insecticides, nematocides, herbicides, fungicides, etc (Figure 1) which is used to control pests, diseases and weed competition. They control the pest by their toxic nature also has adverse affect on humans, animals or other living organisms in the environment. Due to leaching into soil and water, pesticide's creates lethal environmental impact related to biodiversity (Chaturvedi et al, 2013).

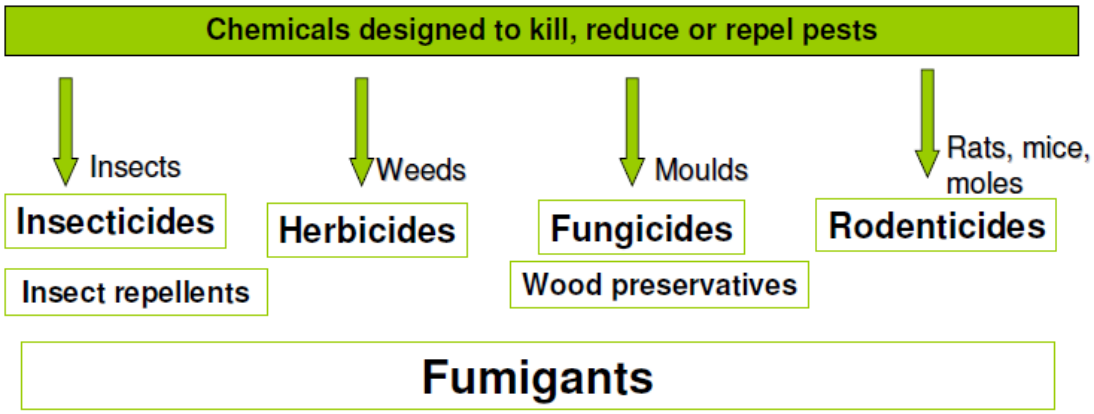

Figure 1 Pesticides Classification by use (Pesticides, 2008)

It is estimated that only less than 0.1% to 5% of pesticides applied to crops actually reach the intended pest. The excess toxic pesticide via soil, air or water interacted with micro-organisms, aquatic animals and humans (Figure 2). It harms eco-friendly arthropods, earthworms, fungi, bacteria, protozoa and other organisms that contribute to the function and structure of soils. Once in the soil they can kill the micro-organisms living in the soil that break down organic material and aid in plant growth (Arias-Estevez et al., 2008).

Pesticides such as DDT, dieldrin, endrin and chlordane are very toxic and lethal for biodiversity. Most of the toxic pesticides are not biodegradable and they remain in the environment more than decades

With prolong use of pesticides it was found that pest becomes resistant to pesticides and one estimate suggests that approximately 1,000 major agricultural pests are now resistant to most commercially available pesticides. This increased resistance of pest towards pesticides leads farmers to use stronger concentrations or more frequent pesticide applications (Wilson and Tisdell, 2001).

Status of Pesticides Consumption in Uttar Pradesh, Punjab and Haryana

Uttar Pradesh, Punjab and Haryana are leading pesticide consuming state in the country; the consumption of pesticide in few leading states is shown in Table 4. The consumption amount of leading pesticides such as monocrotophos, acephate, endosulfan and chlorpyrifos are shown in Table 5. Beside these DDT, BHC, carbamate, etc. are the most common pesticides used in India.

Table 4 Leading pesticide consuming states during 1999-2000:

Sr No.	Name of the state	Pesticides consumption, MT
1	Uttar Pradesh	7459
2	Punjab	6972
3	Haryana	5025
4	Andhra Pradesh	4054
5	Gujarat	3646

Source: Mathur et al 2005

Table 5 Leading type of pesticide consumed during 1999-2000:

Sr No.	Name of the Pesticides	consumption, MT
1	Monocrotophos	10700
2	Acephate	6400
3	Endosulfan	5600
4	Chlorpyrifos	5000

Source: Mathur et al 2005

Pesticides have become integral part of villagers in Punjab and Haryana. In study at Bhatinda district in Punjab, an important cotton and rice cultivation belt of the country, it was found that farmers are using excessive pesticides. The used pesticide is 5-6 times more than required optimum quantities. In several studies it was found that DDT residues

are present in the environment even 20-25 year later to the application. Due to this reason several studies have shown pesticide residues in breast milk (Kalra et al, 1994), bovine milk, fruits and vegetables from Punjab and a few reports of high incidence of cancer have been coming from certain areas of Punjab since last few years. It is very pathetic that pesticides which have been banned in developed courtiers are dumped into developing countries. It is needed for policy makers to take early decision and bane the lethal pesticides.

The Effects of Pesticide on Humans

Pesticides can be toxic to humans and lower animals. It can take a small amount of some toxins to kill. And other toxins that are slower acting, may take a long time to cause harm to the human body. The pesticides can enter the body through skin, eyes, mouth and nose and causes temporary as well as permanent health effects such as

- Asthma
- Birth Defects
- Neurological Effects
- Cancer

People exposed to pesticides feels uneasy and have breathing problem. Long exposure of pesticides creates asthma and birth defects. When people are exposed to neurotoxins they may feel dizzy, lightheaded, confused and may have reduced coordination and ability to think. Beside these long terms exposure can result in reduced IQ and learning disability, associated with permanent brain damage. Basically pesticides hamper the working of neural cells by which it affecting signals transmission and their processing at brain. The phenoxy herbicides are associated with increased risk for non-Hodgkin's lymphoma, soft tissue sarcoma and prostate cancer (Potential Health Effects May, 2015). Endometriosis, undescended testicles, precocious puberty in girls, reduced sperm counts, fertility problems, etc are some other symptoms occurred due to hormone disruption via pesticides.

Hazard depends on the toxicity of the pesticide and the amount of exposure to the pesticide and is often illustrated with the following equation:

$$\text{Hazard} = \text{Toxicity} \times \text{Exposure}$$

By understanding the difference in toxicity levels of pesticides, a user can minimize the potential hazard by selecting the pesticide with the lowest toxicity that will control the pest. It is analysed that more than 95 percent of all pesticide exposures come from dermal exposure, primarily to the hands and forearms. Hence by reducing pesticide consumption and with only bare minimum exposure by using proper safety clothing such as chemical-resistant gloves, mask, apron, shoes and eye protecting glasses this type of toxicity hazards can be nearly eliminated.

Irrigation Systems

The crop like rice needs excess water in cultivation, the excess used water in irrigation increases water table. Salt residue accumulates in to the soil due to continual evaporation of water. The increased salinity in soil reduces productivity as in this condition absorption of water become difficult for plants and beyond certain limit of salinity soil becomes unsuitable for cultivation. "In the southern Indus valley in Pakistan, Punjab, Haryana or other rice cultivation area for instance, extensive rice irrigation caused water tables to rise from a depth of 20 to 30 meters to one to two meters within 20 years. Increased soil salinity reduces yields in the short-term, and may lead to abandonment of paddy fields over time." India has lost approximately seven million hectares of cultivated land due to salinization. These results show that there is alarming need for crop rotation with crop like rice (FAO, 1997; Killebrew and Wolff, 2010).

Numbers of dames, canals and artificial water routs have been constructed in past centuries to coup up the agricultural needs and drinking water supply. No doubt that these developments were fruitful for agricultural production and appeasement of hunger of large population across the globe but adversely affected the ecosystem and biodiversity.

According to some estimates, the ground water accounts for nearly 80 per cent of the rural domestic water needs and 50 per cent of the urban water needs in India. But, In India, where groundwater is used intensively for irrigation and industrial purposes, a variety of land and water-based human activities are causing pollution of this precious resource due to leaching of chemicals from agriculture farms. Due to this reason it was found that Nitrate concentration is above the permissible level of 45 ppm in 11 states, covering 95 districts and two blocks of Delhi (Kumar and Shah, 2015).

Genetically Modified Seeds

Over the past half century genetic improvement of crops, combined with complementary agronomic practices have benefited billions of poor people in developing countries (Toenniessen et al 2003). The majority of the transgenic lines have transgenes for traits, such as virus resistance, that can significantly benefit poor farmers who cannot afford more expensive disease control strategies and currently suffer significant crop losses (Toenniessen, 1999). These transgenic seeds can contain coding for a number of desirable characteristics, such as herbicide resistance, disease resistance, drought tolerance, frost tolerance as well as having enhanced human nutrition.

The "Genetic engineering approval committee (GEAC)" a regulatory authority for transgenic crop India approved the commercial use of certain variety BT cotton in March 2002. These varieties were developed by Monsanto in collaboration with Indian agency. As per statistics 1 million hectare was cultivated with Bt. Cotton in 2005, which account around 11% of total cultivation area of cotton (Gandi and Namboodiri, 2009).

These improved seed variety have high crop output with high input requirements of fertilizer, pesticide and water negatively impact soil conditions and water quality. The

deteriorate water and soil conditions affect plant, human, wild and aquatic life and not fruitful for biodiversity. Now more farmers are sowing monoculture fields of improved seed varieties of rice, cotton, maize, etc decreasing genetic diversity in landraces, further.

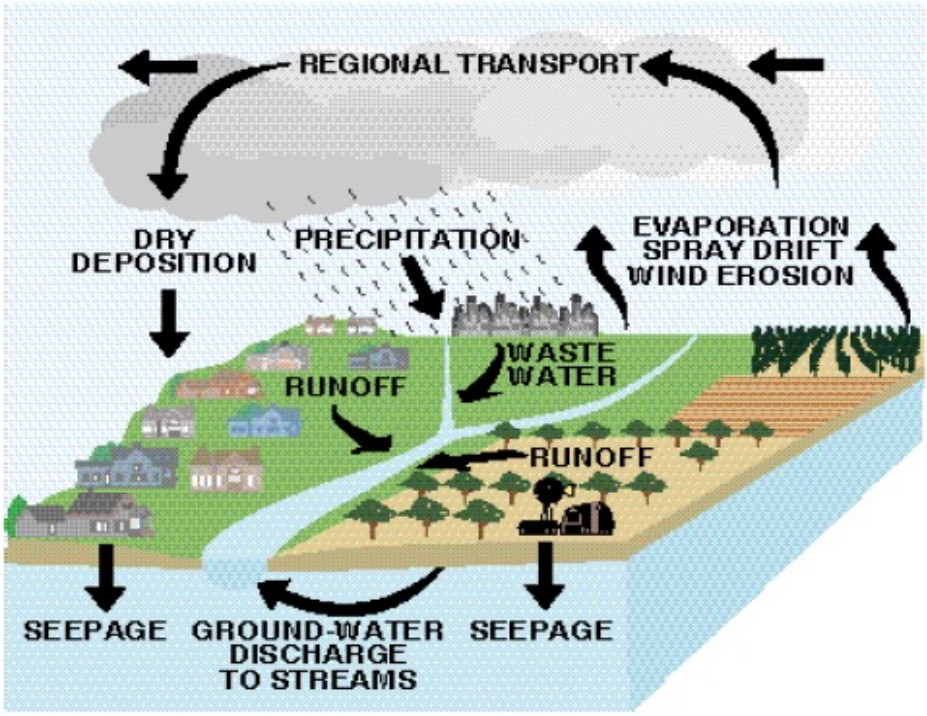

Figure 2 Pesticide in the atmosphere and water (Pesticides, 2008 and USGS)

Effect of Mass Cultivation of Cotton or other agricultural fibres

As per survey the total fibre production was 67.7 million tons in 2007 which was increase to 69.7 million tons in 2010. As per World apparel fibre consumption survey 2013, cotton has more than 32% share of fibre consumption as shown in figure 3.

India is the second largest producer of cotton in the world after China accounting for about 6.05 million tons which share approx. 18% of total the world cotton production. It has the distinction of having the largest area under cotton cultivation in the world ranging between 12.2 million hectares and constituting about 25% of the world area under cotton cultivation (National Cotton Scenario). Cotton covers around 7% of the total crop coverage and is second to rice in India. Cotton textile is one of the largest industries in India. It provides livelihood of 60 million people depend on cotton cultivation, processing trade and textiles (Barik, 2010).

The cotton is one of the main fibres used for clothing since pre historic time due to its aesthetic appearance, moisture/perspiration absorption properties, comfort and biodegradability. It is assumption that agricultural based cotton like biodegradable fibres such as linen, hemp, jute, etc are eco-friendly in nature. But in factual condition the mass

cultivation technologies of these fibres polluting the environment and disturbing the biodiversity at the great extent due to excess use of synthetic fertilizer, pesticides and water resources.

The inventory calculations proved that cotton fibre production consumes about 40% less energy than polyester fibre production. Cotton growing requires, however, huge amounts of water: irrigated amounts vary from 7 to 29 tons per kg of raw cotton fibres (Kalliala, and Nousiainen1999).

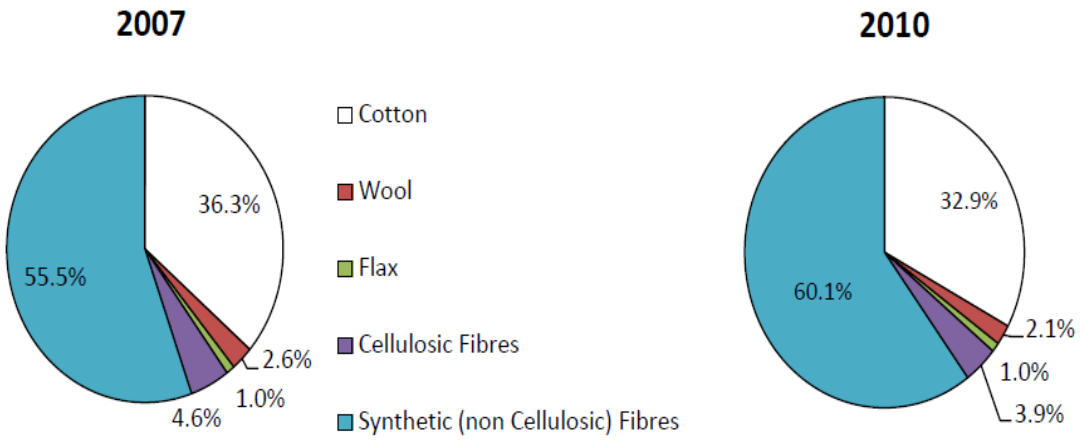

Figure 3: Composition of World apparel fibre consumption by fibre type, in percentage

India is ranked first on the basis of cultivation area of cotton but it is amongst the countries having lowest yield per hector. As per estimate approximately 50 % of cotton fibres production is lost in India due to pest and diseases compared to 24.5% average of world over. The losses incurred due to this reasons is approximately Euro 300 million per year (Bio-Scop Org., 2004; Gandi and Namboodiri, 2009).

As per the estimate "About 54% of the total pesticides used in Indian agriculture are consumed on cotton alone, though it accounts for only 5-7% of the total cultivated area" (Puri et al, 1999). Beside these crop like cotton, rice, etc required huge amount of water. Due to exploitation water in irrigation, number of natural reveres, ponds or water resources dried up or ground water is decreasing simultaneously. As per the data even the Aral Sea in central Asia has been reduced to a small percentage of its original size due to over-extraction for irrigation of cotton, resulting in an almost complete loss of biodiversity in the region (FAO. 2005). The other agricultural fibres also affect the environment too in the similar way.

Sustainable Farming

There is dire need to shift towards the sustainable farming which include eco-friendly fertilizers or soil nutrient systems with utilising natural pest cycle or by application of natural pesticides. India has traditionally been a country of organic agriculture, but the growth of modern scientific, input intensive agriculture as discussed in earlier section of the paper has pushed sustainable organic farming it to wall. In today's terminology organic farming is a method of farming system which primarily aims at cultivating the land and raising crops in such a way, as to keep the soil alive and in good health by use of organic wastes (crop, animal and farm wastes, aquatic wastes) and other biological materials along with beneficial microbes (bio-fertilizers) to release nutrients to crops for increased sustainable production in an eco-friendly pollution free environment. The entire system is based on intimate understanding of nature's ways. The soil's living population of microbes and other organisms are significant contributors to its fertility on a sustained basis and they are protected and nurtured at all cost in organic farming (Yadav).

As per the definition of the USDA study team on organic farming "organic farming is a system which avoids or largely excludes the use of synthetic inputs (such as fertilizers, pesticides, hormones, feed additives etc) and to the maximum extent feasible rely upon crop rotations, crop residues, animal manures, off-farm organic waste, mineral grade rock additives and biological system of nutrient mobilization and plant protection".

The following are the important issues which should be considered for the concept of organic farming:

- Management of temperature
- Self reliance in inputs
- Application of untreated seeds having no GMO (genetic modified organism)
- Crop rotation: Adoption of Crop rotation system to increase organic matter in soil. To keep the soil healthy and to allow the natural microbial systems working, crop rotation is must. Crop rotation is the succession of different crops cultivated on same land.
- Multiple cropping: Mix cropping is the outstanding feature of organic farming in which variety of crops are grown simultaneously or at different time on the same land. Mix cropping promotes photosynthesis and avoids the competition for nutrients because different plants draw their nutrients from different depth of soil.
- Conversion of soil to organic by banning of chemicals, physical removal of pest rather than chemical destruction or use of natural available pesticides. Maintains balance between pests and their natural predators i.e. integrated pest management. Integrated Pest Management (IPM) is a procedure to manage pest populations by harmonizing control methods such as natural enemies and cultural practices without harm on environment and biodiversity.
- Instead of synthetic toxic pesticides farmer can adopt organic pesticides which are made of minerals or other plant materials that keeps pests away and they themselves biodegradable. Cayenne pepper spray, soap spray, tobacco powder,

pyrethrin, neem, bt (bacillus thuringiensis) powder etc are example of eco friendly and biodegradable pesticide.

- Maximum reliance on renewable energy sources, such as solar power and animal power
- Rely on natural water management system by conservation of rain water.
- Integration of animals and its manure as bio-fertilizer. The vermicompost and bio-fertilizer have great potential in replacing the synthetic fertilizers and seems great future in coming years.
- Combination of aquaponics (raising aquatic animal in symbiotic environment), agroforestry (growing trees and shrubs along the crops), etc with agriculture.

The organic farming is environment friendly as well as have less negative impacts on ecology due to use of sustainable resources. The organic farming provides good quality of food as well as is based on self reliance in inputs hence insures debt free, profitable livelihood option. As per the literature available the sales of organic food market is growing at the approximately 20 % annual rate in the U.S. (Organic Trade Association, 2007).

In case of organic cotton, it production reached to 145,865 tonnes in the 2007/08 at an average annual growth rate of 185 percent over the past three years (OTA, 2008; Foglia and Ferrigno, 2009). It is also very enthusiastic that India is leading top producer of organic cotton and produced about half of world organic cotton during 2007-2008. Despite this strong growth, organic cotton represented only 0.6 percent of the world market for cotton in 2007/08. There are certain certifying agencies which encourage the producers, textile industries as well as the end users to utilise organic/sustainable based textile products at maximum extent. Name of the few certifying agencies/ standards are as follows:

- Global Organic Textile Standard (GOTS): International quality symbol for sustainable textile product (http://www.global-standard.org/).
- EU Eco-label: This Eco-labelling is to minimize impacts on the environment and our health from products. (http://www.neutral.com/; http://ec.europa.eu/environment/ecolabel/)
- Fairtrade certified cotton: Addresses the Human Ecology component of textile products (http://www.fairtrade.net/cotton.html)
- Indian Standard for Organic Textile (ISOT): This standard is for a social and environmental responsibility and to guarantee the traceability. http://www.ecocert.in/Indian%20Standard%20for%20Organic%20Textiles%20(ISOT)%20standards.pdf
- OE Blended and OE 100: Both standards use transaction certificates and mass balance calculations to track and verify the movement of certified organic cotton through the supply chain. (http://textileexchange.org/)
- OEKO-Text standard 100: Addresses the human ecology component of textile product. It is an independent testing and certification system for textile raw materials, intermediate and end products at all stages of production. (http://www.neutral.com/;

https://www.oeko-tex.com/en/manufacturers/concept/oeko_tex_standard_100/oeko_tex_standard_100.xhtml).

With increase in ecological concern definitely organic cotton has tremendous growth potential in future (Ellen Pay, 2009). The prospects of sustainable organic farming of food as well as fibre crops seems also really encouraging as there is rise in demand of organic farming products as consumers become more ecologically and health conscious. The sustainable organic farming is only remedial solution for way ahead for greener eco-friendly environment with full of biodiversity.

Conclusions

It is fact that different types of advance agricultural technologies benefited in mass agricultural production to fulfil the needs of huge population across the globe. But the increase use of fertilizers, pesticides, water and gene modified seeds imbalanced the ecosystem and biodiversity. They have numbers of health consequences in human, animal and other living organisms. The health consequences such as asthma, birth defects, neurological effects, hormonal disorder, cancer and numbers of deaths have been observed due to use of pesticide. Many water resources have been dried up due to agriculture use and beside that due to exploitation of pesticide and fertilizer application remaining water resources are also polluted and not safer for use. There is dire need to educate the farmers towards the safer use fertilizer, pesticides and water optimally. The sustainable organic farming seems best solution of adverse effects of toxic consequence of pesticides and fertilizers and way ahead for safer global ecosystem.

Authors' contributions: Dr. Lalit Jajpura (Associate Professor) and Dr. Bhupinder Singh (Assistant Professor) have equally contribution in manuscript. Dr. Lalit Jajpura is also corresponding author.

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