ENVIRONMENT FRIENDLY SYSTEM OF CROPPING

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ABSTRACT

Suitable to environment or eco-friendly means not harmful to our system of environment i.e. not harmful to land, air etc. Presently, due to agriculture a lot of pollutants are added day by day in our environment. Because of these pollutants, the soil fertility is decreasing, the fear of disease in living beings are increasing, a lot of poisonous chemicals and gases prevails in the environment. There is a great need to the use of such a cropping system which is suitable to environment i.e Eco-friendly system of cropping. The Eco-friendliness of cropping system may be viewed from two different angles i.e systems which help in soil and water conservation and system which reduce the use of pesticides, insecticides, herbicides, organic fertilizers. As far as the pesticides use is concerned at national level, it is still for below the alarming proportions. Inclusion of such crops in the cropping systems in problem areas can play a significant role in minimizing the use of agro-chemicals in the crop production.

Insecticides or fungicides use can also be minimized to a considerable extent through cropping system approach. It has been reported that sorghum ear-head fly damage is extremely rare where pigeon pea is planted in alternate rows. Intercropping of coriander in autumn planted sugarcane prevent top borer in sugarcane Sorghum helepense (L) pers (Tohagen grass) becomes predominant weed in continuous maize cultivation but can be controlled by rotating with cotton. Adoption of sugarcane wheat system in place of rice-wheat decreases philaries minor infestation to almost negligible level which is otherwise not achieved through herbicides. In maize-potato cropping system raising of pearl millet for green fodder or sesamum for green manure during summer was also found advantageous in reducing Cyprus rotundas in succeeding crop of maize and potato. Position of ground water owing to leaching of nitrates is a selectively new concern in India. Because usage of N-fertilizer is low in India, nitrate is not likely to pose serious problems in most farming situations. Choice of appropriate system and management practices helped minimizing nitrate leaching besides improving N-use efficiency.

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INTRODUCTION
The population is increasing day by day at a very fast rate. Naturally, the requirement of food grains is also increasing, therefore, the farmers are concentrating on increasing production at any cost. But it can be very dangerous to the environment. The farmers should adopt such farming practices which can enhance the production without any adverse effect on the environment. Eco-friendly means not harmful to our system of environment i.e. not harmful to land, air etc. At present, in our environment lots of pollutants are added day by day. Because of these pollutants, the soil fertility is decreasing, the fear of disease in living beings is increasing, a lot of poisonous chemicals and gases prevails in the environment. The life of the human as well as animals becomes very hard due to the use of fertilizers, insecticides, pesticides and herbicides etc. in our agriculture. There is a great need to use Eco-friendly cropping system to save the environment from further degradation. We have to adopt such type of cropping systems, from which least use of chemicals and fertilizers more production of crops and healthier environment for the living organisms can be maintained.

However, to reduce the plant protection costs, Indian scientists identified some crop varieties capable of tolerating or resisting certain disease, insect pests or needs through biological mechanisms like genetic inheritance, growth pattern or simply cultural requirements. Inclusion of such crops in the cropping systems in problem areas can play a significant role in minimizing the use of agro-chemicals in the crop production.

Objectives
1. Use of fertilizer and pesticides in comparison to the production of agricultural crops in Haryana.
2. General study of measures adopted for the Eco-friendly system of cropping.

MATERIAL AND METHODS
The secondary data was used for the objective 1. The data was collected from the Director of Agriculture, Haryana and from Statistical Abstract Haryana issued by Economic and Statistical Advisor, Planning Department, Govt. of Haryana. The data was collected for fertilizer and pesticides consumption in Haryana since 1970-71 to 2008-09 and area and production of major crops in Haryana since 1970-71 to 2009-10. Simple average method was used to find out the production tonnes/hectare, and use of fertilizer and pesticides tonnes/hectare. Based upon the production and consumption of fertilizer and pesticides in agricultural crops, the conclusion was drawn.

For the second objective general discussion of findings and articles was taken and included from India and abroad.

RESULTS AND DISCUSSION
Use of fertilizers and pesticides for the production of agricultural crops
In the year 1970-71, the consumption of fertilizer was very low as compared to present time. The total use of nitrogen, phosphorus and potassium nutrients were
60972, 6860 and 2228 tonnes, respectively in the year 1970-71. It was 187385, 31340 and 12098 tonnes in 1980-81 which shows 3.07, 4.56 and 5.43 times increase in use of Nitrogen, Phosphorus and Potassium nutrients, respectively.

**Table 1: Fertilizer consumption in Haryana, India (Nutrients) (In tonnes)**

<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970-71</td>
<td>60972</td>
<td>6860</td>
<td>2228</td>
<td>70069</td>
</tr>
<tr>
<td>1980-81</td>
<td>187385</td>
<td>31340</td>
<td>12098</td>
<td>230823</td>
</tr>
<tr>
<td>1990-91</td>
<td>443245</td>
<td>138005</td>
<td>5042</td>
<td>586292</td>
</tr>
<tr>
<td>2000-01</td>
<td>714308</td>
<td>206319</td>
<td>9668</td>
<td>930295</td>
</tr>
<tr>
<td>2005-06</td>
<td>847427</td>
<td>252570</td>
<td>28674</td>
<td>1128671</td>
</tr>
<tr>
<td>2006-07</td>
<td>862642</td>
<td>244115</td>
<td>18217</td>
<td>1124974</td>
</tr>
<tr>
<td>2007-08</td>
<td>939502</td>
<td>257273</td>
<td>23592</td>
<td>1220367</td>
</tr>
<tr>
<td>2008-09</td>
<td>946266</td>
<td>313512</td>
<td>29361</td>
<td>1289139</td>
</tr>
</tbody>
</table>

**Source:** Statistical Abstract of Haryana and Economic Survey of Haryana

The use of nitrogen (nutrient) in the year 2008-09 was approximately 15.52 times than that of use in 1970-71. In the same fashion, the use of phosphorus and potassium nutrients in the year 2008-09 increased 45.20 time and 13.18 times, respectively than that of their use in 1970-71.

**Consumption of pesticides:** The use of pesticides was 412 tonnes for 3206 thousand hectares area in 1970-71 Table 2, but it reaches up to 4288 tonnes for 7290 thousand hectare area in the year 2008-09.

**Table 2: Consumption of Pesticides (Technical Grade)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Quantity in tonnes</th>
<th>Area cover (in 000hec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970-71</td>
<td>412</td>
<td>3206</td>
</tr>
<tr>
<td>1980-81</td>
<td>2150</td>
<td>5058</td>
</tr>
<tr>
<td>1990-91</td>
<td>5164.53</td>
<td>6420</td>
</tr>
<tr>
<td>2000-01</td>
<td>5025</td>
<td>8798</td>
</tr>
<tr>
<td>2005-06</td>
<td>4650</td>
<td>8495</td>
</tr>
<tr>
<td>2006-07</td>
<td>4600</td>
<td>8415</td>
</tr>
<tr>
<td>2007-08</td>
<td>4390</td>
<td>7555</td>
</tr>
<tr>
<td>2008-09</td>
<td>4288</td>
<td>7290</td>
</tr>
</tbody>
</table>

**Source:** Statistical Abstract of Haryana and Economic Survey of Haryana
The use of pesticides was 0.129 tonne per thousand hectares in 1970-71 and it reaches to 0.588 tonnes per thousand hectares in 2008-09. It means the use of pesticides in 2008-09 increased about 4.56 times per hectare than use of pesticides in the year 1970-71.

**Area and production of crops in Haryana:**

The production under total cereals was 3939 thousand tonnes in 1970-71. It increases to 15392 Table 3. in the year 2007-08, which is about 3.91 times of the year 1970-71. The production of total pulses was 832 thousand tonnes in 1970-71 and it came down to 99 thousand tonnes in the year 2007-08. It is absolutely due to less area shown under the pulses crop. But if we consider the total food-grain production, it was 4771 thousand tonnes in 2009-10, which is 3.25 times of that of production of 1970-71.

Similarly the production of sugarcane crop in 1970-71 was 707 and it reaches to 4654 thousand tonnes in 2009-10. And the production of cotton was 193.4 thousand tonnes in 1970-71 and it reaches to 1926 thousand tonnes in the year 2005-06. Except pulses of course there is increase in production of the crops but this increase is very little as that of increase in consumption of fertilizer and pesticides. If we add all of the crops production, it was 15929.8 thousand tonnes of 4359.4 thousand hectare area in 1970-71 but it was 18678 thousand tonnes of 5610.2 thousand hectare of area in 2007-08. The net increase in production in 2007-08 calculated was only 2.44 times than that of production of 1970-71. It is also very lesser than the increase of the consumption of fertilizer and pesticides and many other inputs used in agriculture.

**Average yield of important crops in Haryana**

The average yield of Rice and Wheat crop was 1697 and 2074 kg/hec., respectively in 1970-71, it increases to 3008 and 4335 kg/hec., respectively in the year 2009-10. The increase in average yield is less than two times of rice and approximately two times then that was in 1970-71 Table 4.

The average yield of cotton was 400 kg/hec. In 1990-91 and it was only 664 kg/hec. in the year 2007-08, which is a very less increase (1.66 times of 1990-91) in average yield production of cottons. However, the use of fertilizer and pesticides etc. is usually more in this crop.

**Study of measures adopted for the eco-friendly system of cropping:**

**Organic Farming:** It is defined as production system, which avoids or largely excludes the use of synthetically compound-ed fertilizers, pesticides, growth regulators and livestock feed additives. For maximum extent feasible, organic farming systems rely upon crop rotations, crop residues, animal manures, legumes, green manures, off-farm organic wastes, mechanic-cal cultivation mineral-bearing socks, and aspects of biological pest control to maintain soil productivity and to supply plant nutrients, and to control insects, weeds and other pests. This system is a production system which favours maximum use of organic material as crop residues, animal excreta, legumes on and off farm organic wastes, growth regulators, bio-pesticides etc. and discourage use of synthetically produced agro-inputs, for maintaining soil productivity and fertility and pest management under conditions of sustainable natural resources and healthy environment.
Table 3: Area and production of crops in Haryana, (India)

(Area in 000 hec.)
(Production in 000 tonnes)

<table>
<thead>
<tr>
<th>Year</th>
<th>Total cereals</th>
<th>Total pulses</th>
<th>Total food-grains</th>
<th>Total oilseeds</th>
<th>Sugar-cane</th>
<th>Total cotton</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970-71</td>
<td>2708.8</td>
<td>3939</td>
<td>1158.9</td>
<td>832</td>
<td>3867.7</td>
<td>4771</td>
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<tr>
<td>1980-81</td>
<td>3167.7</td>
<td>5533</td>
<td>794.8</td>
<td>502.5</td>
<td>3962.5</td>
<td>6035.5</td>
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<td>1990-91</td>
<td>3337.7</td>
<td>9017</td>
<td>742</td>
<td>541.7</td>
<td>4079.3</td>
<td>9558.7</td>
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<td>2000-01</td>
<td>4186.5</td>
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<td>157</td>
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<td>43435</td>
<td>13294.8</td>
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<tr>
<td>2005-06</td>
<td>4116.1</td>
<td>12894</td>
<td>195.3</td>
<td>111.8</td>
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<td>2006-07</td>
<td>4178.3</td>
<td>14627</td>
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<td>136.0</td>
<td>4347.6</td>
<td>14763.0</td>
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<tr>
<td>2007-08</td>
<td>4305.0</td>
<td>15392</td>
<td>172.0</td>
<td>99.0</td>
<td>4477.2</td>
<td>15294.1</td>
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<tr>
<td>2008-09</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>4609.0</td>
<td>16166.0</td>
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<tr>
<td>2009-10*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4537.0</td>
<td>15528.0</td>
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</table>

Source: Statistical Abstract of Haryana and Economic Survey of Haryana, (India)

*Data Provisional.
Total Cereals:  Rice + Jowar + Bajra + Maize + Wheat + Barley + Others
Total Pulses:  Gram + Urd + Lentil + Others
Total Oilseeds:  Groundnut + Rapeseed Mustard + Sesamum + Linseed + Others
Total Cotton:  American + Desi Cotton
Table 4: Average yield (kg/ha) of important crops in Haryana, (India)

<table>
<thead>
<tr>
<th>Year</th>
<th>Rice</th>
<th>Jowar</th>
<th>Bajra</th>
<th>Wheat</th>
<th>Gram</th>
<th>Moong</th>
<th>Masher</th>
<th>Ground-nut</th>
<th>Sesame</th>
<th>Rape-seed Mustard</th>
<th>Cotton</th>
<th>Sugar-cane</th>
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<tbody>
<tr>
<td>1970-71</td>
<td>1697</td>
<td>277</td>
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<td>2074</td>
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<td>854</td>
<td>347</td>
<td>678</td>
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<td>4504</td>
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<td>1980-81</td>
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<td>2360</td>
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<td>1990-91</td>
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<td>864</td>
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<td>771</td>
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<td>798</td>
<td>688</td>
<td>295</td>
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<td>424</td>
<td>5713</td>
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<tr>
<td>2005-06</td>
<td>3051</td>
<td>272</td>
<td>1117</td>
<td>3844</td>
<td>554</td>
<td>431</td>
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<td>764</td>
<td>352</td>
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<td>300</td>
<td>1649</td>
<td>4232</td>
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<td>751</td>
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<td>2007-08</td>
<td>3361</td>
<td>450</td>
<td>1841</td>
<td>4158</td>
<td>505</td>
<td>439</td>
<td>746</td>
<td>761</td>
<td>363</td>
<td>1202</td>
<td>664</td>
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<td>2726</td>
<td>-</td>
<td>4614</td>
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<td>-</td>
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<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2009-10</td>
<td>3008</td>
<td>-</td>
<td>4335</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Statistical Abstract of Haryana and Economic Survey of Haryana (India)

*Data provisional.
Herbicide use: Sorghum halepense (L) Pers (Johnson grass) becomes predominant weed in continuous maize cultivation but can be controlled by rotating with cotton. Similarly, a change from rice-wheat and rice-potato system to any other system season tends to reduce population of small canary grass in wheat considerably. Adoption of sugarcane-wheat system in place of rice-wheat, decrease Philaris minor infestation to almost negligible level which is otherwise not achieved through herbicides. In maize potato cropping system, raising of pearl millet for green fodder or sesame for green manure during summer was also found advantageous in reducing Cyprus rotundites in succeeding crop of maize and potato. It was reported that intercropping systems based on sorghum reduced weed growth by 25% that intercropping of pigeon-pea in sorghum has fewer weeds than sole crop of pigeonpea. Sorghum, intercropping of many short-duration legumes like green gram and black gram with pigeonpea smoother weeds to 60-70%.

Pesticide use: Besides minimizing herbicide use for weed control, insecticides or fungicides use can also be minimized to a considerable extent through cropping systems approach. It has been reported that sorghum ear-head fly damage is extremely rare where pigeonpea is planted in alternate rows. In another study, it was observed that incidence of root-rot of cotton caused by Rhizotonia solani fungus is appreciably reduced by inter-cropping of dew gram. The dew gram inter-cropping caused moderating effect on soil temperature of the fungus. Inter-cropping of coriander in autumn-planted sugarcane prevent top-borer attack in sugarcane. Garlic in diennel inter-cropping also reduces incidence of top-borer in sugarcane. It was concluded that top-borer in sugarcane inter-cropped with these spices crops.

Use of bio-pesticides for insect-pest and disease management

Bio-pesticides are natural plant products which belong to the secondary metabolites, which includes alkaloid, terpenoids phenolics and minor secondary chemicals. Every plant species has developed in built unique chemical complex structure that protects it from pests.

Integrated Pest Management (IPM)

IPM is a pest control strategy that uses an array of complementary methods; mechanical devices, physical devices, genetic, biological, legal, cultural management and chemical management. These methods are done in three stages: prevention, observation and intervention. It is an ecological approach with a main goal of significantly reducing or elimination the use of pesticides. In working of the IPM system, it is designed around six basic components. First is to decide on what constitutes acceptable pest levels and apply controls, if those levels are exceeded; secondly, adoption of preventive cultural practices i.e. removal of diseased plants to prevent spread of infection; thirdly, monitor the degree days of an environment to determine when is the optimal time for a specific insect’s outbreak. Fourthly, mechanical control i.e. simple hand picking, erecting insect barriers, using traps, vacuuming and tillage to disrupt breeding. Fifth, natural biological processes and materials can provide control, with minimal environmental impact, and often at low cost. The main focus here is on promoting beneficial insects that eat target pests. Biological insecticides, derived from naturally occurring micro-organisms i.e. Bt,
entomopathogenic fungi etc. Lastly, the chemical control in which many of the newer pesticide groups are derived from plants or naturally occurring substances i.e. nicotine, pyrethrum, and further, ‘biology-based’ or ‘ecological’ techniques are used.

Water management and soil fertility for improved yields

The 21st century is being called the ‘Century of Water’. Soil fertility is governed by soil physical and chemical properties. Today many fertilizers are being applied in the field and water is being contaminated; consequently there is a thrust towards the development of environmentally safe and sustainable agricultural practices that maintain soil and water health. The Industrial waste materials have to be well managed and mineral and organic fertilizers must be applied appropriately to each field plot after soil testing. To maintain water availability in adjacent surrounding areas, irrigation water should be managed efficiently.

Integration of elements of a farming system for sustainable weed and pest management

Diversification of agricultural activities that links farm-based enterprises with cultivation of field crops helps the resource-poor farmers in tropics to generate additional income, gainful employment and improve their dietary standards. A farming system approach has been found to be a resource management strategy for achieving economic and sustainable agricultural production, catering to the diverse needs of topical farm household while preserving the resource base and ensuring high environmental quality. A judicious combination of any one or more of the farming enterprises like poultry rearing, duckery, fish culture, cattle rearing, green manuring and culture of bio-fertilizers contribute significantly for weed and pest management in field crops. Cropping system strategies like rotation of crops in sequence, inter-cropping and mulching do influence the weed pest complex of crops. Due to these the weed flora in cropped fields through their feeding habits, allelopathic or allelome dietary principles in their excreta, suppression through physical interference like shading and altered ecology. Some of these elements also supplement pest management directly by virtue of their predatory behaviour or indirectly through suppression of weeds that serve as alternate hosts and by inducing fast and robust crop growth.

Soil-rhizosphere system for efficient crop production and fertilizer use

Good soil-rhizosphere system is the basic condition to ensure good crop production and quality. To maintain good growth condition, soil scientists, plant nutrition scientists, and microbiologists have spent much time in establishing theories and practical technology in monitoring and identifying the condition of soil-rhizosphere system and the optimum fertilizer use.

Pollution of ground water

Pollution of ground water owing to leaching of nitrates is a relatively new concern in India. Because usage of N-fertilizer is low in India, nitrate leaching is not likely to pose serious problems in most farming situations. However, the increased NO$_3$-N content of well-waters has been registered in the areas, heavily fertilized and irrigated cropping systems predominate. In Ludhiana (Punjab), average (geometrics mean) NO$_3$-N content of shallow wells increased from 0.42 to 2.29 mg/liter during 1975-88. Choice of
Appropriate cropping systems and management practices helped minimizing nitrate leaching besides improving Nitrogen use efficiency, legume cropping in cereals grown with wider row spacing reduces nitrate leaching improving N-use efficiency, legume intercropping in cereals grown with wider row spacing reduces nitrate leaching. Although benefits of fertilizer use to agricultural production in majority of crop lands far out weigh the possible detrimental effects on environment, a close monitoring of fluctuations in ground water nitrate level is necessary in intensively cultivated area.

**Plan for future**: Cropping system research is not old but relatively new and a lot of work is to be done on this system. In future ecologically suitable, economically profitable and resource-efficiency agro ecological cropping systems will require concentrated efforts as follows:

1. Identification of efficient cropping system zone in the country.
2. Development of energy efficient tillage and crop establishment techniques for rice-based cropping system in Indo-Gangatic plains.
3. Identification, quantification and evaluation of locally available bio-organic including crop residues and by-products as a source of nutrient supply.
4. Possibilities and potentialities of crop diversification for integrated management of weeds, disease and insect pest to minimize ecological hazards of pesticide use in agriculture.
5. Development of more efficient and co-friendly nutrient carriers, amendment, bio-additions and culture techniques for improved fertilizer use efficiency.
6. Appropriate policies and strategies need to be development for multi-disciplinary approach of research through inter-institutional or inter organizational collaboration programmes for real success of cropping system research.

**CONCLUSION**

At present, position of soil fertility environment, health of living beings and of course water is decreasing day by day and finally will reach to its maximum to breakout of diseases, starvation etc. The population of the country is also increasing at a very high rate that’s why there is pressure on farmers to produce more and more by hook or crook, mean to say on high cost by use of more fertilizers without being seeing the position of land, water and environment. If all this didn’t come in control well in time then it was too late even to think.

In Haryana the use of fertilizer is increasing at a very high rate. The use of fertilizers (N, P, K) was 70069 tonnes in 1970-71 and it increases 18.4 times in 2008-09 and it was 1289139 tonnes. The use of pesticides was also increased from 0.13 tonne per hectare in 1970-71 to 0.58 tonne per hectare in 2008-09, and this increase is about 4.56 times than that of in 1970-71.

But the production of food-grain in the year 2009-10 increases only 2.77 times of production in 1970-71. It was 4771 thousand tonnes from 3867.7 thousand hec. area in 1970-71 and it reaches 15528 thousand tonnes from 4537 thousand hec. area in 2009-10. Similarly, the average yield of important crops in Haryana shows a little increase in their production. There is only 1.5 to 2 times increase in average yield (kg/hec.) from that of average yield in 1970-71. It may be concluded that the consumption of
fertilizer and pesticides are increasing at very high rate as compared to the production of the crops.

For increasing the production or average yield of the crops and to decrease the consumption of organic fertilizer, pesticides, insecticides etc., we have to adopt the Eco-friendly system of cropping. In Eco-friendly system of cropping organic farming, use of Bio-pesticides, use of bio-fertilizer, integrated pest management, water management, soil-rhizosphere system, integration of elements of a farming system are the main systems, if may be adopted that may results in high productivity with minimum of chemical usage. We have to make some of the future plans for avoiding deterioration and pollution of land, environment and of course water etc.

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INVITATION TO AUTHORS

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