Sustainable Agriculture: Potential and Strategies for Development

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The Urgency of the Problem

We can ignore the state of global and national land and water resources only at our great peril. We tend to assume that environmental degradation is a contemporary condition, but there is historical evidence to show that cultures rise and fall on their agricultural base's ability to support the rest of society. The balance between population and agricultural productivity becomes more and more precarious as a society becomes more complex and the drive for a continuing food supply to support all the non-producers places more and more demands upon land and water resources. The histories of the Mesopotamian, the Mediterranean and the Mayan civilizations suggest that ever greater use of resources without accompanying stewardship leads to societal disintegration.

We now face a scenario in which global exploitation of resources has expanded a local environmental phenomenon into a world-scale problem. Already, 6% of the earth's surface is classified as extreme desert, and a further 29% is subject to varying degrees of desertification. Any expansion in the extent or intensity of agricultural production would require sustainable management of the land-water-vegetation system.

What is Sustainable Agriculture?

Is sustainable agriculture a philosophy, a system of farming or a management strategy? It has been called all three, and each term adds a perspective which helps explain the complexity of this multi-dimensional concept. From the difficulties evident in gaining a consensus on the definition, it is obvious the term has different meanings for different people.

Organic farmers tend to equate "natural" with "sustainable" and consider that their methods follow the tenets of a sustainable system. Their approach goes beyond methodology to embrace a philosophy of co-existing with nature rather than exploiting it. It involves benign designs and management procedures that work with natural processes to conserve all resources, minimize waste and environmental impact, and promote agro-ecosystem resilience.

Mainstream farmers would contest the claim that organic farming is the farming most closely associated with sustainable agriculture, since many of them are also using methods they consider conserve or enhance the natural resource base. The view of many experts, places organic agriculture within a broad spectrum of agricultural methodologies that

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support the environment, which range from conventional, and more intensive, methods to alternatives such as biodynamic practices.

Certainly, as one moves from broad principles to actual farming practices, the differences between approaches become less discernible. Methods of production are evolving all the time and the same ones may be practiced along a continuum of farming from mainstream to organic. Practices associated with the term "sustainable" may include crop rotation, soil and water conservation and management, annual legumes, minimum or zero tillage, or reduction of inputs.

Many pre-date the Green Revolution of the 1960s and 1970s and prompt questions about just how modern are the concept of sustainable production. For instance, some sustainable proponents stress reduction of inputs as crucial, yet in the dryland and rainfed areas of the country, fertilizers and pesticides were not relied on until the intensive cropping was introduced post green revolution. It is somewhat ironic that there may be a certain reluctance to re-introduce such things as crop rotation, shelter belts or fewer inputs, which, in an era when most farmers have embraced "high tech" production, are associated with outmoded practices. We must conclude that, while the methods may differ, the modern term "sustainable" encompasses the ability to maintain productive capability even in the face of economic and climatic setbacks.

Expectations for sustainability date from the 1987 publication of the Brundtland Report, *Our Common Future*, which popularized the term "sustainable development." The report stressed that present economic needs should not compromise future needs and that current approaches that contribute to environmental degradation do not contribute to sustainable development.

The World Commission on Environment and Development ties economic survival to the health of our natural resource endowment and the efficient use of scarce resources to benefit both present and future generations. The natural resource base remains crucial, but if the farmer is not receiving adequate returns on capital and labour, his farming operation will not be viable even in the short term. In the long term, if the economics seem right but the resource base is being depleted, the operation will not be sustainable. Efforts to ensure short-term viability must be tested against long-term durability if farming is to meet the new goal of being sustainable.

If farmers cannot switch production systems without significantly changing their attitude, pouring money into these new approaches will not bear fruit. There is no question that establishing sustainable agriculture will involve adjustments. It is fairly safe to assume that the more major these are, the greater the likelihood that their adoption will require a comparable adjustment in attitude.

To take a case in point, sustainable agriculture favours diversification over specialization. If this option turns out to have a less attractive economic return, then it must be the well-being of future generations or the well-being of the soil that motivates the choice for a diversified production method. Until non-economic values become as important as the

bottom line, a farmer is unlikely to be motivated to adopt the new approach. Consequently, stressing diversification without understanding the key motivators and what rewards farmers find acceptable, will not lead to its adoption.

In any event, the economic incentive proves to be a fickle indicator of commitment to change. When prices are low, interest in reducing costs is high and may lead to a reduction in inputs or conservation tillage in order to save money. A turnaround in prices may, however, result in an increased use of inputs, or more cultivation of marginal land. A sustainable approach should go beyond short-term considerations; nevertheless, a system which does not return enough income for the farmer to stay in business is obviously not sustainable.

Is the Resource Base Sustainable?

It has been established that, on a global basis, there is not sufficient land capable of producing food to meet the world's requirements. Not only is this arable land base limited, its quality has been rapidly deteriorating as a result of wind and water erosion, soil salinization, acidification, soil compaction and loss of soil organic matter. Wind and water erosion along with salinization affects million hectares of land across the country. Other factors are: Loss of organic content of the soil, and/or compaction, over-fertilization, acidification, and erosion. Concerns about soil degradation and water quality are typical to some states in India , while the coastal region is trying to address water erosion and quality, and soil acidity.

Each of these factors is heavily influenced by the individual farmer's choice of cropping system and soil management. In many cases, soil salinity and acidity are natural problems with which the farmer must contend.

From the farmer's point of view, it would be useful to know to what extent it has been possible to maintain production only at the expense of the resource base. The market economy tends to emphasize the value of current production over the value of the land resource for future production. This ties the farmer, particularly during adverse periods, to production practices that have historically met the short-term test of profitability and minimized risk, but that may fly in the face of long-term soil fertility. Yet it pays farmers to respect the soil as a precious natural resource, since they are so dependent on its fertility. Indeed, most farmers have a deeply ingrained sense of stewardship for their land and would be unwilling to sacrifice its quality for the sake of short-term gains. It makes little sense for any producer to exploit the land resource for short-term profit if this is likely to compromise long-term food production capability.

The impact of soil degradation on production yields and costs may not be immediately apparent, given changing cultivation practices or technological improvements. Soil erosion is pervasive, rather like an unrelenting fatal disease that is not immediately recognized but, once entrenched, is difficult to eradicate. While soil degradation may be found in farming operations all across the country, factors such as quality and type and composition of the soil, amount and distribution of rainfall, and other natural phenomena obviously affect the amount and rate of deterioration. That is why human impacts on the soil are difficult to

quantify and solutions must be farm-based. What may be acceptable practice on one farm may not be so across the farm boundary or county line. Farm practices largely determine whether an agricultural system is sustainable.

Losses due to soil degradation are not confined to the farm. Off-farm costs include water pollution, sedimentation and flooding. Soil degradation may also result from any land disturbance, contamination, sewage disposal and conversion of high-quality agricultural land to non-agricultural uses. Those losses that stem from urban and industrial growth will be dealt with separately later in the paper.

Farm Practices

The three approaches covered in this section represent two extremes of farming systems and a possible compromise. Farming techniques are in a continual state of evolution so that what is a typical methodology in one period is not necessarily so a few years down the road. Sustainable farming is high-quality farming, and does not depend on specific practices. The criterion is potential for continuous viability, which may have to vary from farm to farm in response to a particular situation.

A. High-Tech Farming

After World War II, the drive to increase food efficiency led to an energy-intensive agriculture, based on inexpensive oil. The use of herbicides, pesticides and synthetic fertilizers expanded, bringing about a corresponding increase in production. Because much of this farming was done on a much larger (and probably more mechanized) scale than formerly, it is sometimes referred to as "industrial" farming. Many farmers continue to farm this way; however, some components of this method are emerging as unsustainable. For instance, in the dryland or rain shadow areas, essential parts of this system were intensive tillage and summer fallow. Research studies now show that, used together; these two farming methods encourage loss of water and organic matter, and leave the soil in a high-risk condition.

Consequently, the annual returning of crop residues to the soil is now being advocated in order to improve soil organic matter. Chemical fallow is being suggested as an alternative to intensively-tilled fallow for conserving the soil and its water content. Other adaptations to increase the sustainability of this type of agriculture are diversification of crops and livestock, better weed and fertilizer management, more careful capture of snow water, and return of cover crops, shelter belts, woodlands and wetlands.

B. Organic Farming

An earlier section described the applicability of some organic methods to sustainable agronomic practices. This section explores the evolution of organic farming in North America in view of the controversy about its connection with sustainable agriculture. A 1980 United States Department of Agriculture (USDA) study provided information on the characteristics of organic farming. Practitioners were generally experienced farmers who owned their land.

In many cases, they had shifted from chemical to organic farming for such reasons as considerations of soil health, food safety, environmental protection, and soil and water conservation. They were generally seen as good managers dedicated to responsible husbandry of their soil, crops and livestock. With few exceptions, they were following acceptable soil, water, and energy conservation practices. Most had systematically, and largely through their own efforts, developed crop and/or animal management systems well adapted to their specific conditions, including climate, soil, available capital, and accessible organic materials for recycling.

Early research evidence suggests organic agriculture has the potential to be profitable, given a receptive market, in that premium prices and lower input costs tend to offset the impact of lower yields. In Canada, although there is some organic grain farming, most organic farmers are in niche marketing of organically grown vegetable and fruit produce.

For many farmers, the term "organic" has a distasteful ring, associated with the rejection of time-honoured "high tech" farm practices. Such farmers also resent the inference that somehow the latter practices are less safe than organic ones.

C. Alternative Farming Systems

Although there will continue to be farmers who, for philosophical or other reasons, refrain from using synthetically compounded fertilizers, pesticides, growth regulators and livestock feed additives, many other farmers, for practical reasons, are adjusting their techniques to suit today's requirements. Confronted with low prices, reported off-farm pollution impacts, degraded soil, and high production costs, contemporary farmers are seeking new ways to reduce production costs and any perceived negative impacts of their methods of farming. The term "alternative agriculture" has been coined to describe these new practices.

Many components of alternative agriculture are derived from conventional agronomic practices and livestock husbandry. According to the U.S. National Research Council, the hallmark of an alternative farming approach is not the conventional approaches it rejects but the innovative ones it includes. The Council goes on to say that, in contrast to conventional farming systems, alternative systems more deliberately integrate and take advantage of naturally occurring beneficial interactions. Alternative agriculture is not, however, a single system; it covers a spectrum ranging from systems that use no synthetic chemical inputs, to systems involving the prudent use of pesticides or antibiotics to control specific pests or diseases.

Successful alternative farmers do what all good managers do they apply management skills and information to reduce costs, improve efficiency, and maintain production levels. In the U.S., use of components of alternative systems was found to be quite widespread, despite a lack of R&D support for developing practical solutions. Most farmers had adopted these practices gradually as they became more knowledgeable about pest management, plant nutrition, the genetic and biological potential of cultivars and livestock, and better management techniques.

Practices and principles emphasized in alternative systems include: crop rotation, integrated pest management, management systems that improve plant health and the ability of crops to resist insect pests and diseases, soil and water conservation tillage, and genetic improvement of disease-resistant crops and crops that use nutrients more effectively. Many of these practices are already part of high-quality farming in India, even though the term "alternative" in this sense is not yet a household word. Certainly, alternative farming includes elements similar to those stressed in various studies on Environment Sustainability as being necessary if Indian agriculture is to become more sustainable.

The Indian Experience: In Sustainable Agriculture

Implications of WTO for Indian Agriculture: The Case of Intellectual Property Rights and Emerging Bio-safety Protocol

Globalisation in trade and investment through harmonisation of national laws, particularly dealing with intellectual property rights is one of the major impacts of GATT/WTO. The contribution of knowledge as a factor of production is being increasingly given central importance in economic development. The tension between public need and private control are the first challenge before the planners and advocates of sustainable development in the country. The conflict between chemical intensive agriculture (despite declining productivity of inputs) and the non-chemical sustainable technological innovations generated by farmers as well as firms (national or international) will pose second challenge.

The increasing trend towards larger areas under fewer varieties and the need for food security through diversified biological systems will be the third source of conflicts. Production, protection, commercialisation and incorporation of intellectual property in development of national developmental strategies, will be crucial in defining the role India will play in world markets on one hand and overcoming deprivation and hunger with in the country on the other.

The strategy proposed is aimed at making Indian agriculture not only globally more competitive but also domestically more progressive by using knowledge as a strategic resource so that agriculture sustains livelihoods of millions of households dependent upon it in an environmentally sustainable manner. The major contention is that India should not view the challenges posed by WTO as if it will remain always an importing country and that it has no substantive intellectual property to offer to world market. There must be a registration system for encouraging protection of local land races and incentive system must be generated for *in situ* conservation.

The provision of TRIPs need to be strengthened to include:
(a) Micro organisms but exclude life forms,
b) Registration system of grassroots innovations (unlike utility patent system, this registration system should be like product patent for ten years just as proposed in Australian Innovation patent system)
(c) Widespread patent search facility for educational and entrepreneurial networks and centres so that quality of research and education can be competitive,

(d) Just as a global registry has been proposed for wines under TRIPS, India must insist that similar global registry must exist for green small innovations too.

This will help link innovation, investment and enterprise each vector of which may be in different parts of the world. The global trade regime has to deal with several related issues in regard to biosafety such as ability of the importing country to assess the risks and deal with them, regulations for labelling or GMO products so that consumers can make informed choice, restrict GMOs which may pose hazard to the very viability of the food security, for example, through terminator gene technology, etc. Prior informed consent of farmers must be ensured while pursuing on farm trials on transgenic.
The reciprocity in effective protection must exist i.e.,

(a) those who access farmers varieties must disclose, acknowledge and undertake to provide reasonable share of their revenue with germplasm providers/conservators through appropriate institutions, and
(b) PVP/patent claimant should unambiguously prove that the materials, in which improvements have been made, had been obtained lawfully and rightfully.

The National Agriculture Policy clearly mentions the following in terms of Sustainable Agriculture in the country

- The policy will seek to promote technically sound, economically viable, environmentally non-degrading, and socially acceptable use of country's natural resources – land, water and genetic endowment to promote sustainable development of agriculture. Measures will be taken to contain biotic pressures on land and to control indiscriminate diversion of agricultural lands for non-agricultural purposes. The unutilized wastelands will be put to use for agriculture and afforestation. Particular attention will be given for increasing cropping intensity through multiple-cropping and inter-cropping.

- The Government accords abiding importance to improving the quality of the country's land and soil resources. Reclamation of degraded and fallow lands as well as problem soils will be given high priority to optimize their productive use. Special emphasis will be laid on conserving soils and enriching their fertility. Management of land resources on watershed basis will receive special attention. Areas of shifting cultivation will also receive particular attention for their sustainable development. Integrated and holistic development of rainfed areas will be promoted by conservation of rain water by vegetative measures on watershed basis and augmentation of biomass production through agro and farm forestry with the involvement of the watershed community. All spatial components of a watershed, i.e. arable land, non-arable and drainage lines will be treated as one geo-hydrological entity. Management of grazing land will receive greater attention for augmenting availability of animal feed and fodder. A long-term perspective plan for sustainable rainfed agriculture through watershed approach will be vigorously pursued for development of two thirds of India's cropped area which is dependent on rains.

- Rational utilization and conservation of the country's abundant water resources will be promoted. Conjunctive use of surface and ground water will receive highest priority. Special attention will be focused on water quality and the problem of receding ground-water levels in certain areas as a result of over-exploitation of underground aquifers. Proper on-farm management of water resources for the optimum use of irrigation potential will be promoted. Use of in situ moisture management techniques such as mulching and use of micro overhead pressured irrigation systems like drip and sprinkler and green house technology will be encouraged for greater water use efficiency and improving productivity, particularly of horticultural crops. Emphasis will be placed on promotion of water harvesting structures and suitable water conveyance systems in the hilly and high rainfall areas for rectification of regional imbalances. Participatory community irrigation management will be encouraged.

- Erosion and narrowing of the base of India's plant and animal genetic resources in the last few decades has been affecting the food security of the country. Survey and evaluation of genetic resources and safe conservation of both indigenous and exogenously introduced genetic variability in crop plants, animals and their wild relatives will receive particular attention. The use of bio-technologies will be promoted for evolving plants which consume less water, are drought resistant, pest resistant, contain more nutrition, give higher yields and are environmentally safe. Conservation of bio-resources through their ex situ preservation in Gene Banks, as also in situ conservation in their natural habitats through bio-diversity parks, etc., will receive a high priority to prevent their extinction. Specific measures will also be taken to conserve indigenous breeds facing extinction. There will be a time bound programme to list, catalogue and classify country's vast agro bio-diversity.

- Sensitization of the farming community with the environmental concerns will receive high priority. Balanced and conjunctive use of bio-mass, organic and inorganic fertilizers and controlled use of agro chemicals through integrated nutrients and pest management (INM & IPM) will be promoted to achieve the sustainable increases in agricultural production. A nation-wide programme for utilization of rural and urban garbage, farm residues and organic waste for organic matter repletion and pollution control will be worked out.

- Agro forestry and social forestry are prime requisites for maintenance of ecological balance and augmentation of bio-mass production in the agricultural systems. Agro-forestry will receive a major thrust for efficient nutrient cycling, nitrogen fixation, organic matter addition and for improving drainage. Farmers will be encouraged to take up farm/agro-forestry for higher income generation by evolving technology, extension and credit support packages and removing constraints to development of agro and farm forestry. Involvement of farmers and landless labourers will be sought in the development of pastures/forestry programmes on public wastelands by giving financial incentives and entitlements to the usufructs of trees and pastures.

- The history and traditional knowledge of agriculture, particularly of tribal communities, relating to organic farming and preservation and processing of food for nutritional and medicinal purposes is one of the oldest in the world. Concerted efforts will be made to pool, distill and evaluate traditional practices, knowledge and wisdom and to harness them for sustainable agricultural growth.

Organic Farming and Sustainable Agriculture

It is possible to farm using methods that are better for the environment. For example, allowing animals to grass feed (graze in pastures) can actually improve the soil. First, manure fertilizes the pastures. And, second, if farmers were to switch from grain-based or confined feeding to grass-feeding systems, they would save on farm equipment and fuel and prevent soil erosion by not cultivating fields.

There are other, more humane farming methods. Organic farming doesn't use synthetic pesticides, herbicides, fertilizers, or employ veterinary drugs except to treat specific, observed illnesses in animals. Sustainable agriculture is environmentally conscious farming that uses ecologically sensitive farming methods and food processing systems that ensure our ability to feed future generations.

Farmers who use organic and sustainable methods must be careful not to overwork their land or rob the soil of its fertility. They should use rotational grazing techniques that circulate animals between pastures, and they match the number of animals they raise with the land's carrying capacity (the number of animals a pasture can hold without environmental damage). They ought to practice crop rotation, plant cover crops to restore nutrients to fields and reduce soil erosion, and use compost or decayed organic material as fertilizer.

Choosing products from animals raised under more humane, organic, and sustainable systems will protect our country's environment. In your own neighborhood, buying locally raised products will not only support smaller family farms but also foster a sense of community and environmental concern. As the demand for humanely produced food increases, producers around the world will find it profitable to turn to humane, organic, and sustainable agriculture.

Dangers posed by Excessive Pesticidal Use

The problem of pests on agricultural crops was known to man since adoption of crop husbandry in a systematic way. This awareness f problem led methods for their control. The current annual loss due to insect, pests and diseases in the agricultural sector is around Rs.15,000 crore and over 20 million man days are lost due to the vector borne diseases. The country is in no position to accept the loss of food grain caused by pests in the agricultural fields as well as the damage caused to stored grain of which losses by insects and pests are of most economic importance. Chemical means of plant protection occupy the leading place as regards their total volume of application in integrated pests management and diseases of plants. But pesticides cause toxicity to humans and warm-blooded animals. Therefore, there is a need to develop bio-pesticides which are effective, biodegradable and do not leave any harmful effect on environment.

Agriculture is the back-bone of Bihar's economy and up to 80% of the population is engaged in farm sector directly or indirectly. Growing population needs sufficient farm produce. Farming and the agriculture crops are susceptible t attacks by various kinds of pests in form of insects, fungus, bacteria or virus or weeds and control of these has become necessary to reduce losses to a minimum. Heavy use of synthetic chemicals for pest control started from 1940s. Till then we were using natural insecticides namely rotenone from the roots of derris plant, and pyrethrum from the flower heads of a species of chrysanthemum. After twenty years it was found that the level of synthetic pesticides were building and were not biodegradable and their harmful effects started coming out.

A study of the pesticides-use pattern in the country has revealed that cotton, which accounts for just 5 per cent of the cropped area, consumes about 52 to 55 percent of the pesticides. Rice grown over 24 per cent of the cropped area uses about 18 per cent, vegetables raised over 3 per cent area, about 14 per cent plantation crops covering 2 per cent of the area, 8 per cent and cereals, millets and oilseeds extending over 58 per cent of the area, 7 per cent. Sugarcane uses 2 per cent of pesticides and other crops grown over 6 per cent of the cropped area account for another 2 per cent. Though the per hectare consumption of pesticides in the country is far lower than that in some of the developed countries. But the number of chemicals that are sold in the country and the indiscriminate use of plant protection chemicals are matter of grave concern.

Although, demand for pesticides will continue to grow for agricultural production cannot be cut down but alternatives will have to be developed before pesticides targets human beings. Pesticides management has become very important and they should only be applied when either cultural or biological control means may not be effective or pests population have reached to a high level. Other components like presentation, cooperative efforts, rotation of crops, timing of sowing have been mentioned which all form the overall control scenario. Changing pests' scenario with respect to environment, pesticides have been discussed.

To make out necessity for biological control, some of the harmful effects, so far noticed have been compiled including build up of BHC, DDT residue. The report of various agencies has been included to emphasize the need for biological control. The chapter also contains average dietary intake of DDT and BHC residues in various countries (expressed as mg/person/day).

The Magnitude of Misuse

In the process of development of agriculture, pesticides have become an important tool as a plant protection agent for boosting food production. But there indiscriminate use, apart from being an occupational hazard in the developing world, has been posing a serious threat to human health. There is a great concern over the growing incidence of cancer due to their excessive use. Some of these agricultural chemicals being poisonous leave behind residue in food and thereby produce ill-effects when the concentration exceeds the safe tolerance level.

Pesticide Use Pattern in India

India currently uses about 60 000 t of pesticides, a decline of one-third since 5 years ago. Worldwide, there has been a 44% increase in the use of herbicides over the past decade, with a concomitant reduction in insecticides by 30%. Since insecticides still account for 70% of total pesticide use in India, it is likely that insecticide residues will continue to be an issue for at least another decade, even if the declining trend in use continues.

Notorious Chemicals

Among the pesticides that have acquired notoriety, DDT and BHC (=HCH, =Gammaxane, =Lindane) are particularly important. In India DDT and BHC were the two major chemicals used in agriculture and public health programs. Although now partially banned, they are still very much in use because of their wide spectrum of activity and ready availability at low cost. Our biggest concern is that these molecules are stable in the environment. More than 600 000 t of HCH (Hexa choloro cyclo hexane) and 270 000 t of DDT have been added to the environment since their respective introductions in 1949 and 1952. It is suspected that most of our water bodies and soils are contaminated with these chemicals or with their degradation products. DDT persists with a half life of about 10 years, with only minor conversion to p, p' DDT, DDE, TDE, o, p DDT, etc. The uptake and accumulation of DDT and its metabolites in different plants and animal species varies considerably.

Here is a list of some common pesticides that affect humans, animals and the environment in adverse ways. They can be found in practically every food source today. To know about the usual contaminants in the food you eat, click here.

Trade name	**Long-term effects**
Camphechlor	Cancer suspect, toxic to fish, very persistent
Chlordane/Heptachlor	Leukemia suspect, toxic to wildlife, very persistent
Chlordimeform	Cancer suspect, bladder damage, toxic to wildlife
DBCP	Cancer risk, male sterility, persists in water
DDT	Cancer causing, damage to liver, nerve, brain, extremely persistent, toxic to wildlife
Aldrin/Dieldrin/Endrin	Cancer suspect, birth defects, very persistent, toxic to wildlife
EDB	Potent cancer cause, birth defects, lung, liver damage, very persistent
BHC/Lindane	Proven cancer cause, miscarriage, leukemia suspect, very persistent, toxic to fish
Paraquat	No antidote, lung scarring
Endosulfan	Nervous system damage
	Nervous system damage, liver damage, skin disease
2,4,5-T	Potent cancer cause, birth defects, toxic to fish, very persistent

Health Effects Associated with Pesticide Exposure

- Organophosphate pesticides have gained popularity worldwide in preference to organo-chlorines, which are persistent and more damaging to the environment.
- Organophosphates are associated with well-known acute health problems such as nausea, dizziness, vomiting, headaches, and abdominal pain, and skin and eye problems.
- Pesticide exposure is associated with chronic health problems or health symptoms such as respiratory problems, memory disorders, dermatologic conditions, cancer, depression, neurological deficits, miscarriages, and birth defects.
- Studies have established links between pesticide exposure and cancer in children.
- Recent reviews have examined the link between pesticide exposure and neurological outcomes and cancer, arguably the two major end points examined in organophosphate-exposed workers.
- In these extensive reviews, it has been pointed that carcinogenicity and neurotoxicity reflect different mechanisms of toxicity that require different epidemiologic investigations to assess the effects.
- Non-Hodgkin lymphoma (NHL) has been one of the most extensively studied cancers, with more than 30 studies in the scientific literature. Associations between NHL and exposures to phenoxyacetic acid, organochlorine, and organophosphate compounds have been reported.
- Leukemia has also been studied extensively, again with more than 30 studies showing associations with insecticide and herbicide use.
- Similar associations have been shown with prostate cancer, multiple myeloma, and soft tissues sarcomas.
- There is less supportive literature of an association between pesticides and other types of cancer, although there is some literature of an association between chlorinated compounds and breast and testicular cancer and Hodgkin disease.
- In the review by Kamel and Hoppin (2004) of the health effects of pesticide exposure, the authors report that chronic pesticide exposure is associated with a broad range of nonspecific symptoms, including headache, dizziness, fatigue, weakness, nausea, chest tightness, difficulty in breathing, insomnia, confusion, and difficulty concentrating.
- Many of the studies indicate that pesticide exposure is associated with deficits in cognitive function.
- There is also extensive literature supporting the association of Parkinson's disease and other neurological diseases and pesticide exposure. Kamel and Hoppin (2004) point out studies to date have been unable to identify specific associations between pesticide exposure and Parkinson disease risk.
- Occupational exposures to pesticides and adverse reproductive effects have also been reviewed (Hanke and Jurewicz 2004).
- Many pesticides known to have reproductive effects are no longer used in the United States, but employment in agriculture appears to be associated with specific morphologic abnormalities in sperm, and studies suggest that parental employment in agriculture could increase the risk of congenital malformations in offspring, particularly orofacial cleft, as well as musculoskeletal and nervous system defects.

Thus, the dangers posed by these chemical poisons to human and animal life, and their environmental pollution and persistence of residues in air, water, soil and food material have become a global phenomenon.

Why Organic Farming?

India is faced with a rapidly growing population and a limited amount of land. Already, most of its cultivatable land is used for agriculture and many of its forests have disappeared. To get the most out of their often poor soils, farmers typically use as much artificial fertilizer and pesticide as they can afford, and without any protective gear. In many regions the "Green Revolution" of the sixties initially increased yields — but in the long run it has caused erosion, severe water pollution, and ground water depletion.

Poor farmers who cannot afford expensive fertilizers and pesticides have no knowledge about natural, organic farming. One farmer at Alice Project was very surprised when he learned that the ladybugs on his aphid-infested mustard plant are good, that they eat the aphids. He said he had always killed them, thinking they were eating the plants. Such lack of knowledge leads to very poor yields. If a poor farmer has many children (the average in the area is about five kids per family), this means he will not be able to feed them properly. Consequently, many of the children who come to People First and Project Alice schools have skin infections from a lack of vitamins.

Sustainable, organic farming is ideal for these poor areas: it is environmentally sound, requires very little money, and is labour intensive (a good match in regions where unemployment is high). Done right, organic agriculture can bring high yields and provide the people and their children with healthy, nutritious food.

Organic Farming and Choice of Crops

The objective of sustainability lies at the heart of organic farming. The term 'sustainable' is used in its widest sense, to encompass not just conservation of non-renewable resources (soil, energy, minerals) but also issues of environmental, economic and social sustainability. The aim of organic farming is to create integrated, humane, environmentally and economically sustainable agricultural production systems. Maximum reliance is placed on locally or farm-derived renewable resources and the management of self-regulating ecological and biological processes to enhance yields.

The Food and Agriculture Organization of the United Nations (FAO) wrote in an article in 1999:

"Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs (...) This is accomplished by using, where possible, agronomic, biological, and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system."

"Organic farming is one of several approaches to sustainable agriculture. Indeed, many of the techniques used in organic farming - such as inter-cropping, mulching, and integration of crops and livestock - are practiced under various agricultural systems."
"What makes organic agriculture unique is that, under various laws and certification programmes, almost all synthetic inputs are prohibited, and "soil building" crop rotations are mandatory. Properly managed, organic farming reduces or eliminates water pollution and helps conserve water and soil on the farm. A few developed countries (e.g. Germany, France) compel or subsidize farmers to use organic techniques as a solution to water pollution problems."

"Although still only a small industry, organic agriculture is becoming of growing importance in the agriculture sectors of many countries, irrespective of their stage of development. In Austria and Switzerland, organic agriculture has come to represent as much as 10% of the food system, while USA, France, Japan and Singapore are experiencing growth rates that exceed 20% annually."

"The demand for organic products has also created new export opportunities for the developing world. Since demand for a variety of foods year-round makes it impossible for any country to satisfy all its organic food needs domestically, many developing countries have started to tap lucrative export markets for organically grown products - for example, tropical fruit to the European baby food industry, Zimbabwe herbs to South Africa, African cotton to the European Community, and Chinese tea to the Netherlands and soybeans to Japan."
There are several different organic farming methods. We are intending to use traditional organic, bio-dynamic, and/or bio-intensive farming techniques.

The key characteristics of organic farming include:

- Protecting the long term fertility of soils by maintaining organic matter levels, encouraging soil biological activity, and careful mechanical intervention;
- Providing crop nutrients indirectly using relatively insoluble nutrient sources which are made available to the plant by the action of soil micro-organisms;
- Nitrogen self-sufficiency through the use of legumes and biological nitrogen fixation, as well as effective recycling of organic materials including crop residues and livestock manures;
- Weed, disease and pest control relying primarily on crop rotations, natural predators, diversity, organic manuring, resistant varieties and limited (preferably minimal) thermal, biological and chemical intervention.

Bio-dynamic farming was originally developed by the scientist-philosopher Rudolph Steiner in the 1920s. Literally meaning "forces of life," biodynamics considers the soil to be the foundation of health for plants, animals, and humans. Special compost preparations and sprays are used to enhance the biological life of the soil. In Europe, biodynamically grown food is considered to be among the best. The shelf life and flavor of vegetables is better, and animals have a preference for biodynamically grown grain when given a choice. Biodynamic methods have been used to regenerate over 1 million acres of farm and ranch land in Australia.

Bio-intensive farming methods were developed in the United States by Alan Chadwick. They are a cross between Rudolph Steiner's biodynamic method and the intensive market-garden systems used around Paris at the turn of the 20th century. Raised, cultivated beds are used to grow a lot of food in a small area-two to ten times more than what conventional mechanized agriculture can grow. To grow food this way takes one-third to one-thirtieth the water.

The Crops

In Bihar the possibility to plant a variety of crops is almost unlimited. In the winter season it should be possible to plant spinach, potato, tomato, eggplant, chilli peppers, coriander, garlic, cauliflower, turmeric, cucumber, and other types of herbs and vegetables. In the hot season, crops could include other Indian vegetables, and in the monsoon season, rice. Also possible may be the cultivation of guava, papaya, banana, and other fruit-bearing trees. The organic farming expert will work with staff and local farmers to establish which the most suitable crops are for them.

Many private sector players including Reliance, Wal-Mart in association with Bharati group, ITC, Pepsi Foods, Chambal from K.K.Birla stable and many more are now showing interest to source their requirements from Bihar and are ready to enter in to contract farming of organic fruits and vegetable, thus providing ready market to the growers from Bihar, it the high time that the farmers were organized into groups, and federated into Commodity based Organizations to take the benefit of the changed scenario within and outside the country. ATMA in association with other such organization can play a major role in bringing the farmers and industry together, and help farmer in getting markets for their organic products.

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