



Indian Journal of Agriculture and Allied Sciences

A Refereed Research Journal

ISSN 2395-1109

Volume: 1, No.: 3, Year: 2015

Received: 19.09.2015, Accepted: 25.09.2015

POPULAR SCIENCE ARTICLE

IMPACT OF PESTICIDES AND THEIR EFFECT ON ENVIRONMENT

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Chemicals are becoming indispensable part in our daily life. They are related to our nutrition, medicine, and use as pesticides, fertilizers, petrol, paints, cosmetics, glue, varnish, artificial fibers,...etc. despite these enormous use and benefits of chemicals they can cause and implicate some health and environmental problems. Examples of problems associated with them they can cause diseases like cancer, kidney, endocrine disrupting, and acute poisoning or cause environmental problems like ozone depleting, effect on terrestrial and aquatic animals, contamination on environmental media (air, water, food, land). All these are making clear to every one that “chemical safety – a national challenge” is not an empty phrase.

Internationally big effort is made to safe use of chemicals which identified the elements for the sound management of the chemicals as: adequate legislation; information gathering and dissemination; capacity for risk assessment; and interpretation; establishment of risks policy; capacity for implementation and enforcement; capacity for rehabilitation of contaminated sites and poisoned persons; effective education programmes and capacity to respond to emergencies. Also legally binding instruments like Rotterdam Convention, Basle Convention, and Vienna Convention are now ratified by many countries. Beside the loophole in the existing regulations and inadequate sectoral co-ordination and collaboration, health and environment are threaten by the large quantity of obsolete and stockpiles of pesticides and other chemicals that have been piled near residential area and

scattered all over the country. Also empty containers and contaminated soils (spillage, and dumping sites) are another problems.

Pesticides

Background: The period from early sixties to late seventies witnessed progressive intensification and expansion in the cropped areas with subsequent increase in pest complexity and damage. This necessitates increase in chemical treatment with negative impact on human health and the environment. The number of applications during the season has also risen to levels to average 9-11. Organochlorines were the major group of pesticides, which flourished during this period favored by their high potency against wide range of agricultural and public health pests, cheapness and environmental persistence.

The problems arising from the increased use of pesticides coupled with the drastic change in the cotton pest complex led in the early 80s to the introduction of synthetic pyrethroids in order to replace DDT and the insecticides mixtures containing DDT which, were then banned.

Nevertheless, the use of pesticides remains an important component of crop production policy, especially after the introduction of a new generation of pesticides, which is claimed to have better biological efficiency, less negative impact on the environment and more cost-effective performance, thus complying with IPM objectives. Among these new products are the BT toxins, the neonicotinoid imidacloprid, and the phenylpyrazole, fipronil. However, only

Limited number of the registered compounds dominates the local import despite the huge number of registered products. The desirability of certain products may be attributed to their superior efficacy under local conditions, safety and cheapness.

The recent advancement in agrochemical industry with the tremendous efforts currently focused on the use of genetically modified crops is a new challenge facing crop protection policy which still stands fairly in the opposition of such technology for many logical reasons.

The Pesticides Market and Use in Various Sectors: Pesticide industry represents a significant fraction of the international trade. Herbicides constitute 44% of the manufactured pesticides while insecticides and fungicides constitute 33% and 18%, respectively. Currently there are more than 600 active ingredients and about 1000 known formulations used in the fields of agriculture, human and animal health. Developed countries consume 80% of the total production of pesticides while the developing countries consume 20%. Africa consumes about 4% of the total world production, which is worth about one billion USD per annum. The Arab world consumes about 2% of the world production which is equivalent to 0.5 billion USD per year. Several studies reported that the consumption of pesticides in developing countries may rise in the future to 35% of world production as a result of the expected horizontal and vertical expansion in the agricultural sector.

Most of the research activities were done following specific incident, or for personal interest of the scientist involved. There is no strategic research plan whether at the national or institutional level. The research done so far is very limited, sporadic with many gaps either in the topic or the area covered.

Most research activities executed fall within the pesticide category only, research on other chemical groups is currently lacking as well as there is no future plans to cover such area at national, institutional or personal levels. The distribution of pesticide residues in the various environmental compartments received the lion share of the research done though it is incomplete and lack many important details. Specific environmental compartments such as soil, human blood and milk as well food received much of these efforts. Little or no research was done to study environmental fate, trends in human and the environment.

The findings of many of these research efforts were published in local reports, thesis, proceedings of local meetings and seminars, therefore they are of limited access to analyzers, policy makers or international community. Most of the studies were done in 1980's and are highly accredited due to the availability of best analytical instruments and quality assurance at that time. However methodologies followed in some of the later studies although quite acceptable but were executed with old equipments of low sensitivity and capacity and therefore they might underestimate the residue levels in the analyzed samples. This could be attributed to economic and political sanction placed against the country. The fact that there is no national strategic plan caused overlapping of many of these research efforts and some degree of repetitions. Levels detected based on these fragmented studies were not high compared to other developing countries.

Suggested Measures to Improve the Situation

- Setting of national and strategic plan for continuous monitoring of hazardous chemical residues in various environmental compartments;
- Similarly a national plan for research should set forward and follow the strategic goals of the whole country and research activities should serve the specific goals set-out in the development plan;
- Laboratories should equipped with advanced research facilities and including necessary equipments, trained staff, good access to international literature and data bases as well as validated methodologies;
- Training and availability of technical and logistic support to monitoring activities which adhere to the endorsed monitoring plans;
- Following integrated pest management program utilizing all available methods in integrated manner to reduce the use of pesticides in various sectors;
- Similarly releases of other hazardous chemicals in the environment have to be managed and reduced to the minimum;
- Enforcement of laws and regulations as well as other guidance in area of chemical safety during handling and use;
- Awareness raising in the whole community addressing the hazards of chemicals and how the humans and environment can be protected.

Application of Pesticides and Exposed Population in Various Sectors: Various methods

of application were known. However some methods greatly dominate the use. The common methods can be listed below-

- Mixing grains with protectants of low mammalian toxicity to control stored products pests.
- Baiting for the control of locusts, grasshoppers and rodents.
- Dusting for the control of agricultural and public health pests (restricted use).
- Fumigation for the control of stored products pests, seeds and goods moving through ports.
- Granular application for the control of soil and seedling pests.
- Treatment of water for the control of aquatic weeds, disease vectors (snails) and ectoparasites of animals (dipping).
- Seed-dressing against soil and seed borne pests and diseases using various crude and sophisticated equipment and devices.
- Spraying of liquid preparations by manual and motorized equipment, tractor mounted sprayers (herbicides) and aerial application for the control of pests of field crops and migratory pests.
- Aerosols.

Since insecticides has great health concern, it may be of great value to elaborate more in their quantities used, method and time of application in various sectors and exposed human population.

Public Health: Public health workers and public also get fare share of exposure to pesticides which were used as adulticide or larvicide of mosquitoes, the vector of malaria pathogen. Other vectors of humans and/or animal diseases such as sand fly tsetse fly ...etc were also subject to control operations. The important exposed population includes the malaria control workers and residents. Although the control operations in this sector are under government control, yet some workers perform the application of pesticides with minimum precautionary measures of personal protection and/or proper body and equipment decontamination procedures. Previous work indicated a depressed cholinesterase activity of various types of workers involved in mosquito control campaigns.

Plant Protection Directorate (Locust and Other National Pests): Plant protection directorate (PPD) is the federal body responsible for the control of desert locust and other national pests. Beside this it also host the pesticide registrar office with its director general being the

registrar of pesticides in the country. PPD has its own team which involved in the control of desert locust and other national pests. Although personal protection equipments were made available to the working team, yet many workers do not follow the correct procedure and are quite careless in using protective measures. The hot weather conditions make protective clothes uncomfortable. Previous work indicated a depressed cholinesterase activity among various categories of workers.

Human Poisoning by Pesticides: The work done in this issue is limited to few sporadic reports on poisoning cases. Even these reports were incomplete, poor and limited to pesticides only. On the other hand reports were completely lacking in case of industrial chemicals. All cases reported were confined to acute poisoning while no reports or studies on chronic or sub-chronic poisoning. Until recently, poisoning by pesticides or other chemicals attracted little public or medical attention. Poisoning may sometimes goes unrecognized, undiagnosed or unreported and hence the registration of poisoning cases is very poor. The only partially documented cases can be extracted from the record of the National Chemical Laboratories of the Ministry of Health where samples of food stuff and sometimes biological samples were sent for laboratory diagnosis and evidence. However it had been quoted by the laboratory authority that preliminary investigation and tackling of the poisoning incidents is also poor. In most cases the consumed food is sent without biological samples from the victims such as; blood, urine, vomitus..etc. Postmortem examination in cases of death is rarely done for social believes and habits. Cases of wrong sampling sometimes happen and as a result laboratory analysis may be not be in consistent with observed symptoms. Sometimes cases were treated locally and local authority does not seek any further analysis especially if cases are mild.

Animal Poisoning: Documented cases include farm animals and fishes. As mentioned by reports and documentation of farm animal poisoning in Gezira scheme, where aerial spraying of pesticides is heavily practiced for more than four decades, are very poor as the administration of the scheme accept no responsibility of compensation and farmers are warned to keep their animals out of the treated area. Their report mentioned that cases of animal poisoning were very common as a result of direct exposure to spray or grazing on treated crops.

Further the seen of floating dead fishes in canal water of irrigated schemes following aerial spraying with of chlorinated insecticides, particularly enodsulfan and endrin is very common. In 1957 the application of DDT in the Blue Nile for control of mideges resulted in considerable fish mortality. Other cases of mass fish poisoning due to an identified organochlorine insecticide were reported.

Resistance to Pesticides: Resistance to pesticides was studied in four major cotton pests; *Bemisa tabaci*, *Aphis gossypii*, *Earias inulana* (Boisd) and *Podagrica puncticolis*. The resistance of field strains of *B. tabaci* to seven insecticides including DDT was studied in the growing season of 1981/1982. The results reported slight resistance to DDT which ranks among the last group of tested chemicals. Seven subsequent studies were conducted by the Agricultural Research Corporation (ARC) and University of Gezira on *B. tabaci* resistance to pesticides.

Cotton aphid was known as a late season pest in cotton. It gains importance in 1987 when severe infestation occurred throughout the season. Some authors attributed this to the successful control and removal of the competitive *B. tabaci* and *J. lybica* and to the suppression of the natural enemies through the use of broad-spectrum and persistent pesticides. The first study on the resistance of this pest was done in 1988 followed by two later studies.

The Third pest is the spiny boll worm which was reported as important pest of cotton in 1908. By 1976 it was spread allover the cotton growing areas. The first work on resistance to this pest was reported in 1984 who studied the susceptibility of this pest to three insecticides, including DDT, through four generations of larval selection. He reported that the insect started to develop resistance to these pesticides in the third and forth generations. DDT ranked the second in susceptibility.

On the other side the use of DDT was still authorized for public health purposes, although was under consideration by the National Pesticide Council (NPC). Application of DDT in this sector is under the authority of the National Malaria Control Program (NMCP) and criteria for selecting a geographical area for indoor application of DDT are; malaria endemicity and vector susceptibility. The timing of application depends on malaria endemicity, season (more vector during rainy season), and availability of budget. Resistance and susceptibility of vectors of human diseases to

DDT was studies and monitored regularly by the National Administration for Malaria, Schistosomiasis and Leishmaniasis (NAMSL), Federal Ministry of Health (MOH). According to July 2004 report of the NAMSL, monitoring of resistance to DDT is carried out regularly all over the country. The standard WHO adult susceptibility test kit and methods were used. Four practical doses are used for insecticides under use in Sudan; DDT (4%), malathion (5%), fenitrothion (1%),deltamethrin (0.05%) and permethrin (0.75%). A total of 65 sentinel sites representing the various epidemiological strata in 16 states of northern Sudan (the remaining 10 states are excluded for security reason) are regularly monitored every three years. According to the NAMSL report of July 2004 the malaria vector (*Anopholes arabiensis*) is still susceptible (mortality range; 41-100%) to DDT in 16 states (tested by the WHO standard procedure and test kits).

Effects on Non-target Organisms: As in other areas few fragmented studies were done in this area for personal interest of some researchers or following specific accident. There are no plans of monitoring such effects. The non-target organisms studied include mainly arthropods such as pollinators and natural enemies. Toxicities to such organisms were reported under field or experimental plots or in the laboratory.

Health and Environmental Impact of Chemicals: There are many problems associated with chemical production, trade and use in the country. World wide it is estimated that chemical exposure at work alone is responsible for about 4% of all deaths from cancer. Many studies showed that the chemical pollution of the environment has long-term effects on human life. It is therefore essential that chemicals manufacture, use, storage, transport and disposal should be controlled. Recently there are international and national growing interest to reduce chemicals adverse effects in human life and their impact in the environment. Surveyed data about pollution of Sudan's coast line of the Red Sea revealed that:

- The degree oil spreading and pollution along the Sudanese coast is still not so serious.
- The most polluted area is the harbor due to the direct discharge of oil from the power station, shipping activities and the oil terminal.

Surface water comprises the River Nile and its tributaries, wades, dams and irrigated

canals were generally free from pollution. However, eminent threat from increase use of fertilizer, pesticides application and miss use and some industrial activities cannot be ignored in the future. Regular monitoring is lacked.

Groundwater (surface wells and boreholes) in some parts of the country have high concentration with certain elements such as sulphate, sodium, fluorides and nitrates which present as natural compounds of the groundwater. However, the authority to shut down the wells and boreholes in which such elements exceed the seted limits.

Food contamination with chemicals, especially for residue, is not well monitored within the country. Only information available are those for sporadic cases of poisoning by pesticides and datura seeds.

Hazardous wastes of real concern are pesticides, industry and biomedical activities. Some studies reveal the presence of small quantities of analytical and confiscated chemicals at Custom custody. The wastes, which need a prompt action, are the huge quantities of stockpiles and obsolete pesticides and the asbestos wastes. Health problems related to production, import or uses of chemicals are dealt with in general patients hospitals and clinics. No separate specialized clinic or centres are established in the country. Dioxins and Furans (PCDD/PCDF) are toxic compounds and act as endocrine disruptors and immune suppressors. An adverse effect of PCDD/PCDF includes e.g. developmental neurotoxicity, reproductive toxicity, immunotoxicity, endometriosis and cancer.

Recommendations

1. Establishment of sound chemicals management system involving all concerned parties from government, agricultural workers, industry, research institutes, non-governmental organizations and academia through multi-stakeholder committee.
2. Overarching legislation should be developed or at least develop legislation to fill the gaps which are identified in the following areas:
 - Industrial and consumer chemicals—legislation which per se: their importation, use, packaging, labelling etc.
 - Hazardous products
 - Fertilizers
 - Sited standards and acceptable limits for chemicals release in environmental

media (including water, air, soil) and in food and consumer goods

- Compliance scheme to monitor, enforce and promote observance of legislative provisions
1. Building the capacities and capabilities of the institutions concerned with chemicals management. This should include:
 - Education and training and awareness
 - Availability of resources needed
 - Sufficient safety information about chemicals (e.g. MSDS and labeling)
 - Development of infrastructure for regulatory system (e.g. accredited laboratories)
 - Development of PRTR
 2. Development of awareness programme which cover all health and environmental impact of chemical and their judicious and safe use
 3. Establishment of poison control centres with sufficient clinical and analytical capacities in addition to functions of treatment and prevention
 4. Incorporation of the provisions of the international conventions in which the country is party, in policy and programmes of chemicals management
 5. Establishment of pesticides use surveillance and monitoring programme to obtain information on use conditions and their impact on the environment
 6. Evaluation of obsolete and unwanted chemicals, especially obsolete pesticides and their environmental risks (inventory survey, and risk assessment)
 7. Establishment of mandatory or voluntary pesticide containers procedure
 8. Development of monitoring programme for reduction of unintentionally produced chemicals like dioxins and furans
 9. Development of programme to remove use all electrical transformers and capacitors which contain PCBs as cooling agents.