"Along with the probability of the extinction of mankind by nuclear war, the central problem of our age has become the contamination of man's total environment with substances of incredible potential harm……."

-Rachel Carson, Silent Spring

PESTICIDE, HEALTH AND ECONOMICS

SHISHIR ROY

VILL: NANDANKANAN, P.O. GANGANAGAR P.S. MADHYAMGRAM,
DIST: KOL-700132, WEST BENGAL, INDIA

ABSTRACT

In recent past, pesticide related issues have been extensively highlighted in the media including research journals and attracted wider debate and sharp focus among the interested group in India.

Indiscriminate and excessive application of synthetic pesticides damaged not only the environment and agriculture but also has entered into the food chain thereby affecting health and development. The main intention of the introduction of pesticide was to prevent and control insect's pests and disease in the field crops and of course, initially the use of pesticides reduced pest attack and paved the way for increasing the crop yield as expected. Simultaneously increased use of chemical pesticides has resulted in contamination the environment and the long term implications on the society are found multidimensional.IN India pests cause crop loss of more than Rupees 6000 cores annually, of which 33% are by weeds,26% by disease ,20% by insects, 10% by birds and rodents and the remaining 11% due to other reasons (Conway,1984)

INTRODUCTION

The recent research findings on the presence of pesticides particles in the packaged water are classic cases pointing out the nature and magnitude of the problem .Pesticides ,herbicides and fungicides have been introduced during the mid-sixties on a large scale along with other inputs for propagating green revolution package in Indian agriculture .we have got agricultural green revolution in India. But increasing pesticide to produce more, we have biological ill effect on our health status. So the standard of living continuously decreases than other developed countries. Sometimes we get news through media that some developed countries has denied to take Indian commodity due to excessive use of pesticides. So we get low foreign currency or low income from abroad. The farmer's faces cyclical problem. As a result, the economic growth of our country hampers. So pesticide not only hampers our health but also affect on B.O.P problem. We

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should try to search out the mathematical explanation whether pesticide is present in food or not and we will try to overcome this position and what recommendation should be made to combat the pesticide in developing nations.

OVERVIEW

Although the history of pest control likely began with the first human who swatted or picked off a tick, it was not until the emergence of organized agriculture, when pests attacked the plants we grew for food and threatened our very own survival, did the battle for the control of our planet begin. Today, underdeveloped, developing as well as developed nations have uses more for pesticides .Specially ,under developed countries and developing nations have suffering with population pressure ,needed a big amount food that pursued such nations to use high level pesticide. The economic philosophy of such country has compelled to the nations for utilizing pesticide to get more output through raising the productivity .owing to agricultural economic based country ,the nations gives importance on agriculture sector so that they can produce more agricultural good that be possible on the behalf of the nations to earn more foreign exchange or currency to meet the B.O.P problem. Pesticides are not without some risk however, but the many benefits are too often taken for granted. Consider for a moment, that we (society) accept a total and complete ban on the use of pesticides without regards for the advantages they provide, then we must be willing to accept soaring food and fiber shortages, wood shortages, and outbreaks of long –forgotten human and animal.

WHAT IS A PESTICIDE

The U.S. environment protection agency defines pesticides as: "Any substance or mixture of substances intended for preventing, destroying repelling, regulating, or controlling pests"

Simply put, pesticides are chemicals that we use to kill unwanted organisms –be they anything from insects to plants .In nature there is really no such thing as a pest ,but human have labeled any organism that endangers our food supply ,health or comfort as a pest .Example of pests includes insects ,unwanted plants(weeds),gophers, and other animals ,and disease.

1> Fungicides –pesticides that kill fungi (including blights, molds and rusts).

2> Herbicides-chemical that severely interrupts a plants normal growth process.

3> Insecticides-pesticides designed to kill insects and other arthropods.

OTHER MAJOR CLASSES OF PESTICIDES ALSO INCLUDE

i> Algaecides-pesticides used to control algae in lakes, swimming pools, and water tanks.
ii> Antifouling agents-chemical that repel organisms that attach to underwater surface.
iii> Antimicrobials and biocides-chemicals that kill microorganisms such as bacteria, fungi and virus.
iv> Disinfectants and Sanitizers-chemicals used to disable disease –producing microorganisms on inanimate objects.
v> Fumigants –a gas vapor intended to destroy pests in hard to reach areas such as the interior of buildings or soil.
vi> Matricides-pesticides designed to kill mites that feed on plants and animals.
vii>Nematicides –pesticides that kills microscope worm –like organisms that feed on plant roots (nematodes).
viii> Ovicides – chemicals used to kill eggs of insects and mites.
ix> Picicids-chemicals for the control of fish .
x> Repellents-chemicals that repel pests such as mosquitoes an animals and
xi> Rodenticides-Pesticides used to control mice and other rodents.

PESTICIDES USE IN ANCIENT TIMES

Pesticides are by no means a new intervention the first recorded intentional use of a pesticides dates back to B.C 2500 when the Sumerians rubbed foul smelling sulfur compounds on their bodies to control insects and mites in belief that the stanch would repeal the pests. Ancient Egyptians also experimented with pesticides. The eber's papyrus, the oldest known medical document (dated around 1550 B.C) described 800 recipes, many contain recognizable substances ,that were used as poisons and pesticides.

In Greece ,Homer described how odysseus "fumigated the hall ,housed and court with burning sulfur to control pests" around 1000 B.C. About the same time Chinese were using compounds made from mercury and arsenic to control body lice. The Chinese at this time had already been using predatory ants to protect citrus groves from caterpillars and wood boring beetles. They even used ropes or bamboo to help the ants more easily from place to place –perhaps the earliest form of integrated pest management(IPM).Man's concern disease is evident in the old Testament (First Kings 8:37) that lists blights and mildews as among the great scourges of mankind. In approximately 300B.C Theophrastus considered the father of modern botany, was the first to write about various pests damage .He reported killed young, undesirable trees by pouring olive oil on their roots .He also noted that certain weeds were associated with specific crops soon after cato, a censor of the Roman state who lived from 234 B.C to 149 B.C, advocated the use of a

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spray made from the oils of the hellebore plant to kill rodents and insects. During this time the Romans becomes so distresses over grain crop losses .Due to rusts that they created a special rust god Robigo, to which they sacrificed rust colored animals such as dogs and sheep each spring.
Marcus Terrentius Varro, known in his time as the most learned of all the Romans is created with discovering the first century B.C. He noted that amurca made from crushed olives was toxic to ants moles and weeds. In 800 A.D. the Chinese used and weeds. In 800A.D the Chinese used a mixture of arsenic and water to control insects in field and citrus orchards. Rotenone was used as early as 1649,in South America ,to paralyze fish ,causing them to surface Rotenone is obtained from the roots of several tropical and subtropical plant species belonging to the genus Lonchocarpus or Derris. About the same time ,extracts of tobacco were ,being used to control lace bugs on pears.

From the time of 1750 to about 1880,Europe would experience an agricultural revolution .During this time ,crop protection become more wide spread and international trade promoted the discovery and use of the insecticides pyrethrum and derris. Soon after in 1896,the first selective herbicide, iron sulfur ,was found. Second world war marked the scientific age of pesticide for it gave us DDT, BHC, Aldrin Dieldrin, endrin and phenoxy herbicides such as 2,4-D;2-4-DP(1944);and2,4,5-T(1945).

PESTICIDES AND HEALTH HAZARDS

"A healthy world for all protect humanity and the environment from pesticides promote alternatives".

Presumably ,all populations worldwide are exposed to pesticides .The ubiquitous dispersal of these substance is revealed by data on contamination of food as well as surface ,ground and drinking water.

In almost all parts of the world wide ,low-level poisoning of human beings due to pesticide contamination of food poses a risk of chronic illness and adverse health effects .In Germany ,the Federal office of consumer production and food safety(Bundesamt fur verbraucherschutz und Lebensmittelsicherheit) publishes an annual monitoring report on undesirable substances that constitute health risk in food.
In developing countries, the effects of acute poisoning due to exposure to dangerous levels of pesticides in food are apparently more severe than in industrialized country. Three examples: two from Africa and one from India: in 2008 Nigeria reported that 112 people had been poisoned by pesticide-contaminated food. Two children died as a result.

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Another report from Nigeria recorded 120 cases of poisoning of students who had eaten beans contaminated with indane.13 children died in west Bengal, Malda district by unripe litchis trigger toxins which prima, led to the children death. The toxin –methylenecyclopropyl-glycine (MCPC)-depletes glucose reserves in the body ,making it more total for undernourished children triggering the encephalitis –related death.

Mixing and applying pesticides can result in acute poisoning due to uptake via the respiratory organs or through direct contact with the skin or eyes .Pesticides direct poses a further hazard for the residents of rural areas.

Moreover ,pesticide are not only used outdoors ,they are also applied inside buildings to combat insects and other undesirable organisms such as mice. In many developing countries ,spraying pesticides indoors is one of the main measure undertaken against certain mosquitoes to roll back malaria.

A pesticide plant in Bhopal, India, run by an Indian subsidiary of the U.S. company Union Carbide corporations, a defective tank led to the release of about forty tons of isocyanate gas. Thousands of people were exposed ,and died or incurred serious injuries .Even today, after a long time of accident people of that region are still suffering from the long-term effects of exposure.

The many chemical substances that are collectively referred to as pesticides intervene in indifferent vital metabolic processes in various organisms .The effects of insecticides range from damage to the transmission of nerve impulses and inhibition of blood clothing to paralysis of the respiratory and circulatory centers. Based on estimates by the WHO, we then offer an impression of the global extent of pesticide poisonings. Among the typical symptoms of poisoning in humans that are relatively easy to diagnose as acute pesticide poisoning are fatigue ,headaches ,and body aches, skin discomfort ,skin rashes, poor concentration, feelings of weakness circulatory problems ,dizziness, vomiting, excessive sweating, impaired vision, tremors, panic attacks, cramps etc. and in severe cases coma and death.

Nearly 500000 illness and 20000 deaths can be attributed annually to chemical pesticides worldwide .According to an estimated made by the WHO each year 3000000 cases of pesticides poisoning including 220000 deaths are reported across the globe(DTE 2001).

CHILDREN AND PESTICIDE

The are several definitions of a pesticide ;the Food and Agriculture organization of the united Nations(FAO)defines a pesticide as any substance or mixture of substances intended for

preventing, destroying or controlling any pest, including vectors of human or animal disease, unwanted species of plants or otherwise interfering with the production, processing, storage or marketing of food ,agricultural commodities and wood products or animals feed stuffs or which may be administrated to animals for the control of insects, arachnids or other pests in or their bodies.

A number of pesticides cause concern of children. The concern for children is twofold. First, concern in children, including leukemia, sarcomas, lymphoma and brain cancer, have been associated with parents or homes that have been exposed to pesticides.Second ,people may face an increased risk of developing concern during their lifetime if they have been exposed to carcinogens in their childhood.

A weekend immune system, particularly in growing children, exacerbates the risk of infectious disease and cancer ,thus increasing mortality rates. This would be specially menacing in developing countries ,where children face greater exposures to infectious agents and may already have compromised immune system due to poor nutrition and other factors. Children are often more exposed to pesticides .For example, when a mother is exposed to pesticides, the child often becomes exposed as well. Children may even be exposed to pesticides before birth, while in the womb. This occurs when pesticides are transmitted to the fetus via the placenta.

During early infancy ,children also come into contact with persistent and bio-accumulative pesticides that are posed on to them through breastfeeding .This can be a major source of exposure .Because breast milk is the best source of nutrition for infants and recommended by WTO, protecting mothers from exposure to toxic contaminants is crucial.

In the childhood ,water is required more than adult .This implies ,if the water contains residues of pesticides ,infants will receive more than double the dose of pesticide as an adult drinking the same water.

Children consume more food, per body weight than do adults .U.S data on the consumption of various foods in which persistent and bio-accumulative pesticides may be present at high levels ,such as meat ,milk, eggs and fish. Similarly pesticides on to children at high levels ,including in processed at high levels ,including in processed foods.

Poverty can put children in a number of potentially high risk situations. Children may help out on family-owned forms where pesticides are used .They may work for local concerns, carrying goods treated with pesticides. The result can be even higher exposure to pesticides. Pesticides-related illness in children employed in form work have been documented in many countries.

Litchis are sweet and juicy fruits and a particular favorite with people on hot summer days. But this fruit is deadly now because of the highly pesticides is given that has led to death of children in W.B and neighboring states such as Vietnam and Bangladesh . 13 children have died in Malda as a result of this virus.

Similar cases were reported when 47 children died in 2011 and 188 in 2012 in the litchi growing belt of Muzzafarpur. Investigators in Vietnam had blamed in on mystery virus. Bangladesh claimed it was due to pesticides

PRODUCTION AND PESTICIDES USE

PESTICIDE APPLICATION IN INDIAN AGRICULTURE FROM 1950-51 TO 1989-90.

Reference year	*Pesticide use (technical grade material) In, 000tons*
1950-51	*2.35*
1960-61	*8.62*
1970-71	*24.32*
1980-81	*45.00*
1990-91	*75.00*
1995-96	*61.26*
1998-99	*57.00**

**Estimated demand source: GOI (1999)*

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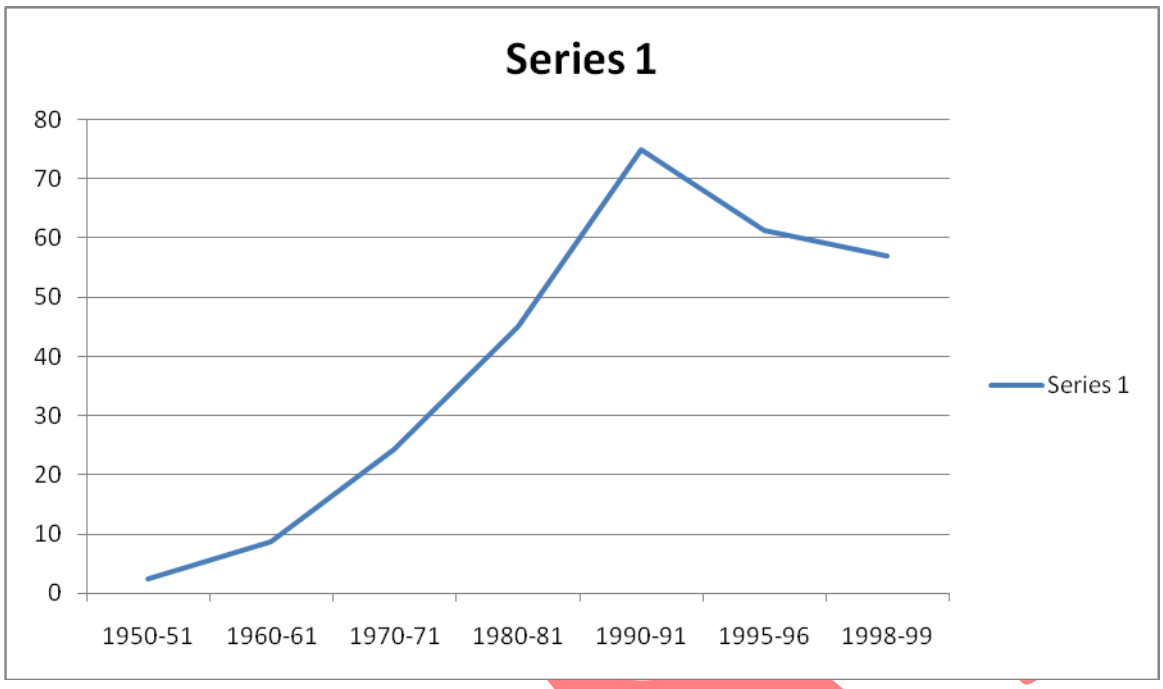
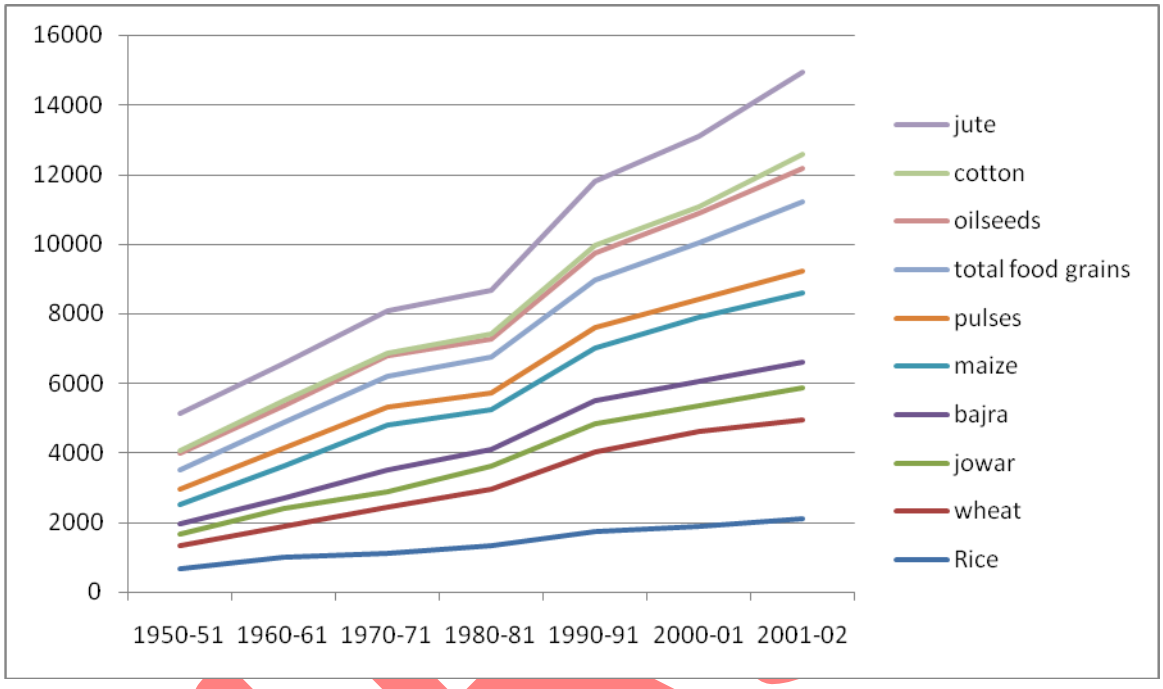


YIELD PER HECTARE OF MAJOR CROPS

CROP	*1950-51*	*1960-61*	*1970-71*	*1980-81*	*1990-90*	*2000-01*	*2001-02*
Rice	*668*	*1013*	*1123*	*1336*	*1740*	*1901*	*2130*
Wheat	*655*	*851*	*1307*	*1630*	*2281*	*2708*	*2830*
Jower	*353*	*533*	*466*	*660*	*814*	*764*	*911*
Bajra	*288*	*286*	*622*	*458*	*658*	*688*	*728*
Maize	*547*	*926*	*1279*	*1159*	*1518*	*1822*	*2002*
Pulse	*441*	*539*	*524*	*473*	*578*	*544*	*625*
Total food grains	*552*	*710*	*872*	*1023*	*1380*	*1626*	*1798*
**Oilseeds*	*481*	*507*	*579*	*532*	*771*	*810*	*955*
Cotton	*88*	*125*	*106*	*152*	*225*	*190*	*395*
Jute	*1043*	*1049*	*1186*	*1245*	*1833*	*2026*	*2358*

*includes groundnuts ,rapeseed, and mustered ,sesamum, linseed and castorseed for columns (2) and (4)and four other oilseeds for columns (5)and(8) also in the case of the above table.

Source: (1)Economic survey, 1980-81,(Delhi,1981). Statement 17, p.77 (2) Economic survey ,2007-08(Delhi,2008) Appendix Table 1.14,p-19 and(3) Economic Survey, 2010-11(Delhi,2011),Appendix Table 1.14 p.A-19



In the above line diagram we get all ten agricultural goods production increase over time. we get that after 1991 pesticide use decreases .but agricultural production increases beyond the year 1991.so it proves 75 000 tons pesticide is the maximum amount used.

AVERAGE GDP GROWTH RATES OF AGRICULTURE AT 1999-2000 PRIES(%)

	PERIOD	*AGRICULTURE AND ALLIED*
Pre green revaluation	*1951-52 to1967-68*	*2.5*
Green revaluation	*1968-69 to 1980-81*	*2.4*
Wider technology	*1981-82 to 1991-91*	*3.5*
Dissemination period Early reform period	*1991-92 to 1996-96*	*3.7*
Ninth and Tenth plan	*1997-98 to 2006-07*	*6.6*

SOURCE: Economic survey ,2007-08(new Delhi,2008)Table 7.1 p.155

So there is a negative relationship between pesticide use and agricultural production. so the production function first will rise and then downward sloping .

CONSUMPTION

Consumption is a major concept in economics and is also studied by many other social Sciences. Economists are particularly interested in the relationship between consumption and income, and therefore in economics the consumption function plays a major role .IN our model, we are consuming fruit with pesticide. Now the very important question is that whether pesticide is multiplicative with fruit (Litchi).The assume is no because pesticide is not fertilizer ,it is used to protect the pest .So pesticide does not include into the fruit and pesticide can eliminated from without any chemical reaction. So we take pesticide incautiously. So our utility function is-

$U = U(F, P, L)$ utility $(u_{F>0}, U_{FF<0}; U_{P<0}, U_{PP<0}, U_{L>0, U_{ll>0}})$

So people consume fruit, pesticide and leisure to get utility. But people get disutility from pesticide consumption.

Estimated Overall Annual Public Health Impact 3000000

APPROACHES TO THE PREVENTION OF PESTICIDE POISIONING

From the above analysis we can say that a major effort is required to prevent the millions of cases of pesticide poisoning that occur every year. For the reduction of unintentional poisoning, a number of different approach are needed.

PARTICULAR PROBLEMS OF PESTICIDES SAFETY IN DEVELOPING COUNTRIES

Hazards arising during the application of pesticides are mainly due to lack of information ,knowledge and awareness , poor supervision during spraying ,absence of proper legislation or of enforcement of legislation and sale on the open market of highly toxic pesticide. Compliance with the available guidelines for the safe use of pesticides (eg, ILO,1977; WHO,1985; FAO,1985A) would control most of these hazards.

The ultimate responsibility to control the use of pesticides so as to minimize health hazards develops to national government. They must continue and whenever necessary strengthen ,health education program among pesticide among pesticide users, particularly to ensure safe practices.

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Though many countries have enacted legislation, enforcement remains insufficient .As an immediate corrective measure it may be appropriate to consider selective enforcement or selective legislation to control those pesticides considered to be most hazardous .For this purpose the WHO document recommended classification of pesticides by hazardous and guidelines to classification would be most useful –pesticide classified extremely hazardous and highly hazardous should be identified for stricter controls.

The manufacturer ,formulator, or person responsible for labeling and registering a pesticide with the appropriate national authority, should ensure that the product offered for sale or otherwise distributed bears a label written in the language of the region, giving comprehensive instructions for safe use ,warning of possible hazards ,specifying the active ingredient and giving guidelines for first aid in case of poisoning (including antidotes).

The Food and Organization of the united nations(FAO) ,in consultation with appropriate United nations agencies and other organizations has prepared a code of conduct on the distribution and use of pesticides, based on internationally agreed technical guidelines .This code was adopted by the twenty –third session of the FAO conference in November 1985(FAO,1986A).It defines the responsibilities of and establishes voluntary standards of conduct for, the, various sector of society (including government and industry) in order to reduce the hazards associated with the introduction ,distribution ,and use of pesticides.

The world Bank has recommended that projects involving pesticides of the highest hazard level should not be supported unless suitable precautions are guaranteed(W.B,1985)

IMPROVING PESTICIDE USE ,AND ALTERNATIVE STRATEGIES FOR PEST CONTROL

Good agricultural practice(GAP) in the use of pesticides is defined by FAO as*" the officially recommended or authorized usage of a pesticide under practical conditions at any stage of production storage transport ,distribution processing of food and other agricultural commodities, bearing in mind the variations in requirements within and between region , and which takes into account the minimum quantities necessary to achieve adequate control , the pesticide being applied in a manner so as to leave a residue which is the smallest amount practicable and which is toxicologically acceptable. "*

LEGISLATION

In the developed countries stringent legal requirements regarding toxicological ecological effects have to be satisfied before the importation and use of any particular pesticide is permitted .The

casts of satisfying these requirements ,when a new pesticide is being developed ,are very high, running into millions of dollars.

Before approving the use of a specific pesticide ,the reasonable government agency may require that the manufacturer provides data from standard animal toxicity tests and from field studies of ecological effects and environmental transfer.

RECOMMENDATIONS

* Control of acute pesticides poisoning.

Efforts are needed on the part of national authorities, non-governmental organizations and industry to control the major problem of acute pesticide poisoning, particularly in the developing countries .To this end the following steps should be taken.

* Training and information activities on pesticides safely should be established and strengthened

* Legislation to control the use of pesticides and to set up the infrastructure for enforcement should be established and harmonized.

* System need to be developed for obtaining descriptive epidemiological data on acute pesticide poisoning to be used as baseline information for the setting of health priorities and the identification of the need for intervention.

* Intervention programs for the control of acute pesticide poisoning (including Suicide attempts) should be established ,monitored ,and evaluated.

* International agencies should provide support and guidance for the above action.

* In the developing nations, local government should be more careful to combat the highly use of pesticide in agricultural commodities.

MODEL

The utility function is:

$U=U(F,P,L)$;*F=fruit,P=Pesticide,L=leisure*

$\frac{du}{df}>0$ =>*Marginal utility from consuming fruit is always positive.*

$\frac{du}{dp}<0$ =>*Marginal utility from consuming pesticide is always negative.*

$\frac{du}{dl}$>0 =>*Marginal utility from consuming leisure is always positive.*

Total labor endowment is divided into three broad categories: Fruit cultivation, Health purpose, and leisure. So the labor constraint is $H=L_{f+}L_h+L$

L_f= *labor devoted in the fruit farming,*

L_h=*labor devoted in the health capital formation,*

L=A part of the labor time is spend on leisure purpose.

Setting lagrangian methodology,

$$\max_{F,P} U = U(F,P,L)$$

Subject to $H=L_{f+}L_h+L$

$Z=U(F,P,L) -\mu[L_{f+}L_h+L]$

$\frac{dz}{dL_f}=\frac{du}{dL_f}$ $- \mu=0$……..1

$\frac{dz}{dL_h}=\frac{du}{dL_h}$ $- \mu=0$……..2

$\frac{dz}{d\mu}=L_{f+}L_h+L-H=0$……3

From equation 2 we get,

$\frac{du}{df}\frac{df}{dp}\frac{dp}{dL_h}+\frac{du}{dp}\frac{dp}{dL_h}=\mu$……..4

From equation 1 we get,

$\frac{du}{df}\frac{df}{dL_f}=\mu$……..5

Equating 4 and 5 we get,

$\frac{du}{df}\frac{df}{dp}\frac{dp}{dL_h}+\frac{du}{dp}\frac{dp}{dL_h}=\frac{du}{df}\frac{df}{dL_f}$

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$$\frac{du}{dp}\frac{dp}{dL_h} = \frac{du}{df}\frac{df}{dL_f} - \frac{du}{df}\frac{df}{dp}\frac{dp}{dL_h}$$

$$\frac{du}{dp}\frac{dp}{dL_h} = \frac{du}{df}\left(\frac{df}{dL_f} - \frac{df}{dp}\frac{dp}{dL_h}\right)$$

$$\frac{\frac{du}{dp}}{\frac{du}{df}} = F'/\frac{dp}{dL_h} - F_p \; ; F' = \frac{df}{dL_f}; \; F_p = \frac{df}{dp}$$

$$U_p/U_F = F'/P_h - F_p$$

$$MRS_{p,F} = MRTS_{L_H,L_F} - F_p$$

F_p = *Effect of pesticide on Food.*

$MRS + F_p = MRTS$

MRS=The slope of an indifference curve is known as the marginal rate of substitution (MRS).The name comes from the fact that the MRS measures the rate at which the consumer is just willing to substitute one good for the other .

MRTS=It measures the rate at which the firm will have to substitute one input for another in order to keep output constant.

General equilibrium requires the condition is :MRS=MRTS. But when we consider pesticide with fruit ,then the general equilibrium violates. Here we get a extra item F_p.

P_h*=>Labor endowment is required for health purpose due to excessive pesticide use.*

F_p *=> this is the biological term.*

CONCLUSION

Total population (2012)	1,240,000,000
Gross national income per capita (PPP international $, 2012)	3,910
Life expectancy at birth m/f (years, 2012)	64/68
Probability of dying under five (per 1 000 live births, 2012)	56
Probability of dying between 15 and 60 years m/f (per 1 000 population, 2012)	242/160

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Total expenditure on health per capita (Intl $, 2012)	157
Total expenditure on health as % of GDP (2012)	4.1

SUMMARY

Since the 1940s, the amount of synthetic chemical pesticides used annually worldwide has increased, resulting in considerable human health hazards. Particularly at-risk are people employed in agriculture because they are directly exposed to pesticides and frequently suffer from acute as well as chronic poisoning symptoms. Moreover, especially in developing countries, a large number of highly hazardous pesticides are easily available, many of which are used in agriculture, often even without appropriate protective clothing. Many hospital records show that a high proportion of severe acute pesticide poisonings are in fact suicides, especially in Asia. The WHO estimates that there are about 2 million pesticide suicides and suicide attempts worldwide every year. However, these statistics do not reflect the fact that cases of non-suicidal pesticide poisoning among farm workers are generally poorly documented, in particular in developing countries. Poisonings with milder symptoms that generally subside rather quickly are often not registered, so that such cases are presumably underestimated. In 1990, the WHO assumed that one million severe cases of unintentional pesticide poisoning occurred annually. What is remarkable is another, much higher WHO estimate from the same year that is rarely cited in the relevant literature. This figure refers to 25 million unintentional poisonings annually of farm workers in developing countries alone, with on average 3% of agricultural workers in developing countries suffering an episode of pesticide poisoning per year.

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