Agriculture and Environmental Pollution

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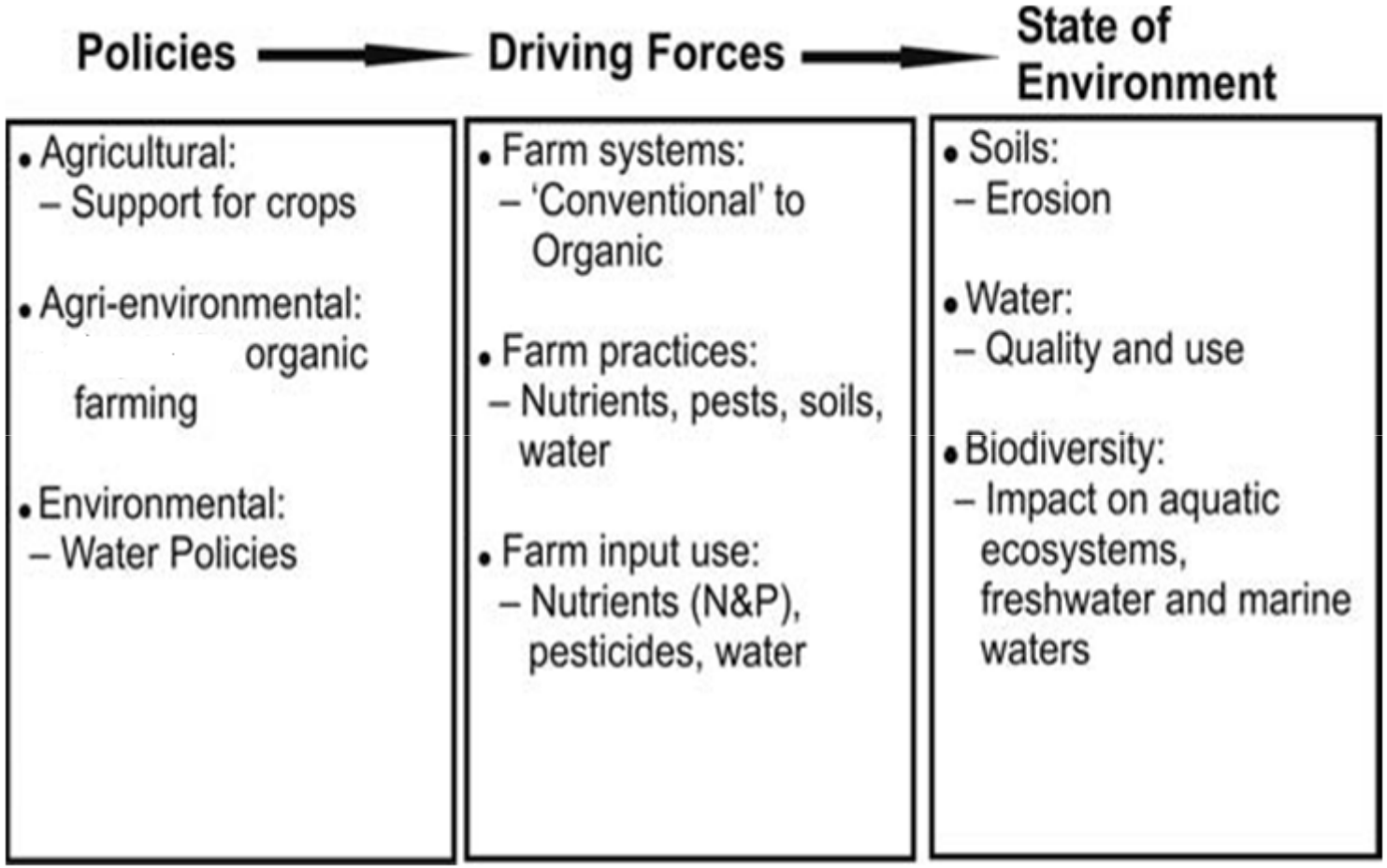
Agricultural Policy

Higher production and increased efficiency

Intensification of the farming system

Increase of pollution risks

Linkages between policies, driving forces and the state of the environment relevant to water



Source: OECD Secretariat, 2010

Agricultural Pollution

- **Contamination of the soil, air and water environments resulting from farming activities**
- **The primary agricultural nonpoint source pollutants:**
  - **nutrients (particularly nitrogen and phosphorus)**
  - **sediment**
  - **wastes**
  - **pesticides**
  - **salts.**

Effects of agricultural pollution.

1) **Public health**

In drinking water, high concentrations of nitrate can cause methemoglobinemia(blue baby syndrome), a potentially fatal disease in infants. Endosulphan Problem

2) **Fish stocks and marine biodiversity.**

Eutrophication destroys

(a) spawning areas for economically valuable fish

(b) habitats for other marine life

3) **The tourist industry**

Poisonous and odorous coastal waters discourage tourists!

Biodiversity Loss

Loss and degradation of habitat from clearing grasslands and forests and draining wetland

Fish kills from pesticide runoff

Killing of wild predators to protect livestock

Loss of genetic diversity from replacing thousands of wild crop strains with a few monoculture strains

Soil

Erosion

Loss of fertility

Salinization

Waterlogging

Desertification

Human Health

Nitrates in drinking water

Pesticide residues in drinking water, food, and air

Contamination of drinking and organisms from livestock wastes

Bacterial contamination

Air Pollution

Greenhouse gas emissions from fossil Fuel issue

Other air pollutants from fossil fuel use

Pollution from pesticide sprays

Water

Water waste

Aquifer depletion

Increased runoff and flooding from land cleared to grow crops

Sediment pollution from erosion

Fish kills from pesticide runoff

Surface and groundwater pollution from pesticides and fertilizers

Overfertilization of lakes and slow-moving rivers from runoff of nitrates and phosphates from fertilizers, livestock wastes, and food processing wastes

Fertilizers

TYPES OF FERTILIZERS

Inorganic fertilizers

Liquid fertilizers *Nitrosol and African Violet Food*

Slow-release fertilizers

Fertilizer with insecticides

Pesticides

- **Pesticide covers a wide range of compounds - insecticides,fungicides,herbicides,rodenticides, molluscicides, nematicides, plant growth regulators**
- **India - steady growth in the production of technical grade pesticides (5,000 metric tons in 1958 to 102,240 metric tons in 1998)**

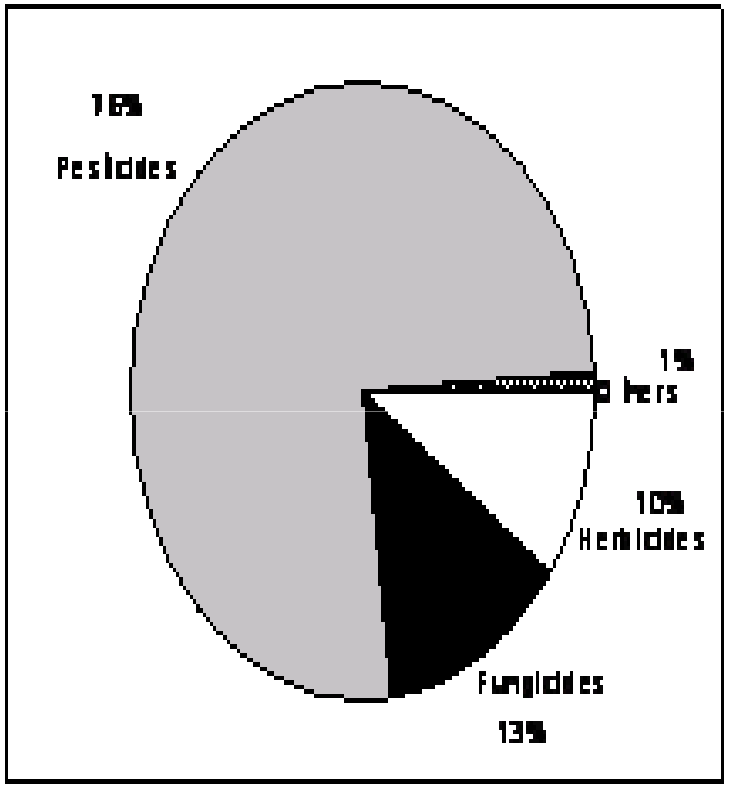
Pesticide use in India 1948 : Dichloro Diphenyl Trichloroethane (DDT) and Benzene Hexa Chloride (BHC) for malaria control.

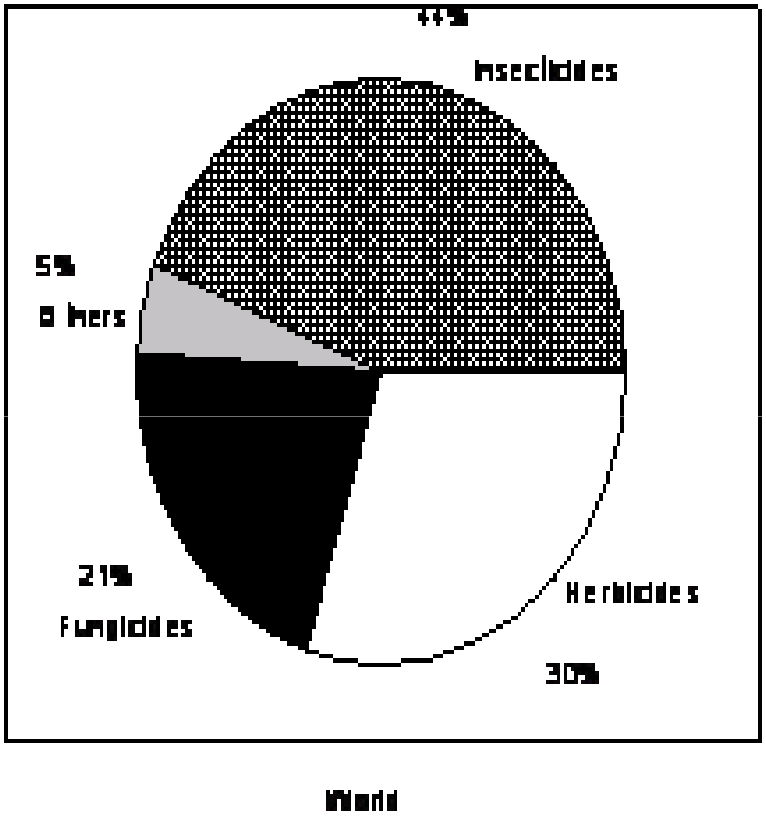
India is the leading manufacturer of basic pesticides in Asia and ranks 12th globally

Insecticides :61% of total consumption
fungicides (19%) and herbicides (17%).

54% of the total quantity of pesticides :cotton
17% : rice and 13% in vegetables and fruits.

76% of the pesticide used is insecticide, as against 44% globally





India

World

Consumption pattern of pesticides

Pesticide use in India 30% of the cropped area.
Increased from 2.4, million hectares (1950) to 137 million hectares.

Total consumption was the highest during the 1980s, post-green revolution.

The declining trend observed later may be attributed to the increased awareness on negative externalities by the farmers or the changes in policies reducing subsidies.

Consumption level of pesticides in agriculture in Kerala (1995-96 to 2007-08) 462.05 metric tonnes (MT) (2007-08) technical grade material of insecticides, fungicides, weedicides and rodenticides.

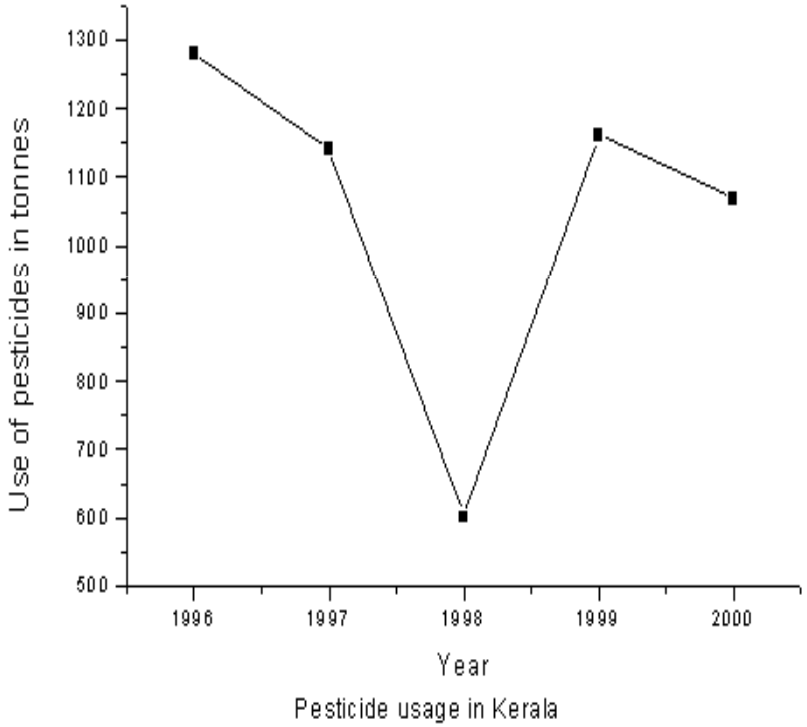
Over the past 15 years, consumption reached the highest level of 1,381.30 MT in 1994-95 and 1,328.10 in 2001-02 and was the lowest at 271.96 MT during 2003-04 and shows a gradual declining trend.

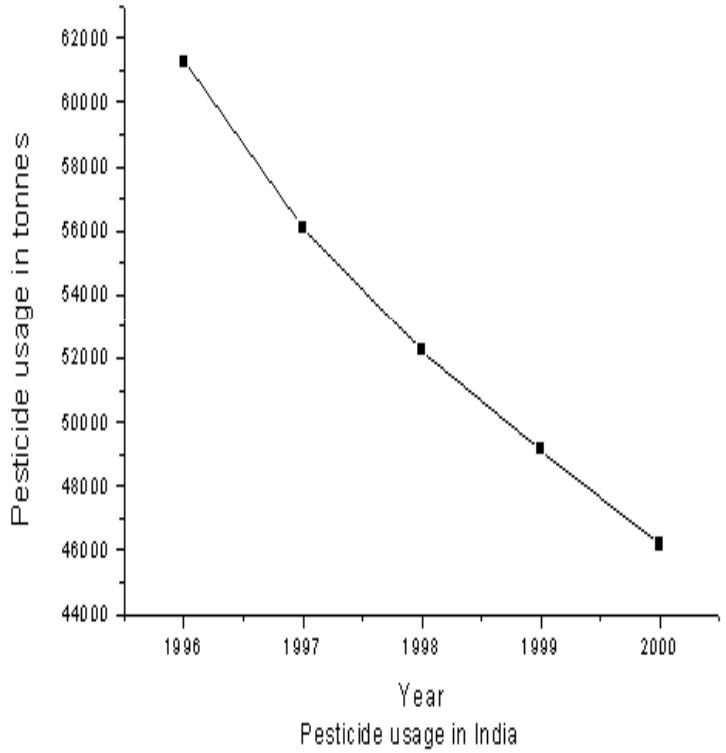
Pesticide Consumption in Kerala (Technical Grade MT)

Year	Fungicide	Insecticide	Weedicide	Rodenticide	Total Quantity of Pesticides
1991-92	374.46	325.24	20.46	4.09	724.25
1992-93	394.01	302.17	36.72	17.65	750.55
1993-94	264.50	294.64	20.46	21.10	600.70
1994-95	1,038.90	305.67	16.63	20.12	1,381.30
1995-96	1,001.90	249.37	12.76	18.74	1,282.80
1996-97	895.98	218.41	15.74	10.40	1,140.50
1997-98	359.91	192.16	31.13	13.19	596.39
1998-99	839.53	232.51	70.62	8.90	1,151.60
1999-2000	472.41	467.00	108.27	10.24	1,057.90
2000-01	497.36	144.64	98.41	7.33	747.74
2001-02	608.40	568.29	142.79	8.63	1,328.10
2002-03	157.54	112.56	8.28	3.35	281.73
2003-04	117.32	144.96	5.42	4.26	271.96
2004-05	433.17	940.48	21.36	0.36	548.94
2005-06	481.24	140.63	34.56	0.07	656.50
2006-07	380.10	130.31	32.81	0.14	
2007-08	277.26	134.68	49.56	0.55	

Source: *Economic Review*, Government of Kerala (various issues).

Kerala agriculture contributes 17.2% to Kerala's economy (as of 2002-2003).





Pesticide consumption in Kerala and India

How can Agricultural Pollution harm our environment?

How do different agricultural activities contribute to pollution, and how does this affect our ground and surface waters??

Agricultural impacts on water quality

Agricultural activity

Tillage/ploughing

Impacts

Surface water **Groundwater**

Sediment/turbidity: sediments carry phosphorus and pesticides adsorbed to sediment particles; siltation of river beds and loss of habitat,etc.

Surface water pollution

- **Direct surface runoff**
- **Seepage to ground water that discharges to a surface water outlet**
- **Various farming activities - erosion of soil particles Sediment produced by erosion - damage fish habitat wetlands , transports excess agricultural chemicals resulting in contaminated runoff**
- **Excess nutrients from nonpoint sources cause eutrophication**

Agricultural activity

Fertilizers

Impacts

Surface water

Runoff of nutrients, especially phosphorus, leading to eutrophication causing taste and odour in public water supply, excess algae growth leading to deoxygenating of water and fish kills.

Groundwater

Leaching of nitrate to groundwater; excessive levels are a threat to public health.

Groundwater pollution

- **Nitrate -most common chemical contaminant**
- **Mean nitrate levels - risen by an estimated 36% in global waterways since 1990**
- **India and Africa - 20-50% of wells in agriculture areas contain nitrate levels greater than 50 mg/l & in some cases as high as 100 mg/l**

Agricultural activity

Manure spreading

Impacts

Surface water

Carried out as a fertilizer activity;
Results in high levels of contamination of receiving waters by pathogens, metals, phosphorus and nitrogen leading to eutrophication and potential contamination.

Groundwater

Contamination of groundwater, especially by nitrogen

Agricultural activity

5. Irrigation

Impacts

Surface water

Runoff of salts leading to salinization of surface waters; runoff of fertilizers and pesticides to surface waters with ecological damage, bioaccumulation in edible fish species, etc. High levels of trace elements such as selenium can occur with serious ecological damage and potential human health impacts.

Groundwater

Enrichment of groundwater with salts, nutrients (especially nitrate).

Agricultural activity

Clear cutting

Impacts

Surface water

Erosion of land, leading to high levels of turbidity in rivers, siltation of bottom habitat, etc. Disruption and change of hydrologic regime, often with loss of perennial streams; causes public health problems due to loss of potable water.

Groundwater

Disruption of hydrologic regime, often with increased surface runoff and decreased groundwater recharge; affects surface water by decreasing flow in dry periods and concentrating nutrients and contaminants in surface water.

Agricultural activity

Silviculture

Impacts

Surface water

Groundwater

Broad range of effects:
pesticide runoff and contamination of surface water and fish; erosion and sedimentation problems.

Agricultural activity

Aquaculture

Impacts

Surface water

Groundwater

Release of high levels of nutrients to surface water and groundwater through feed and faeces, leading to serious eutrophication.

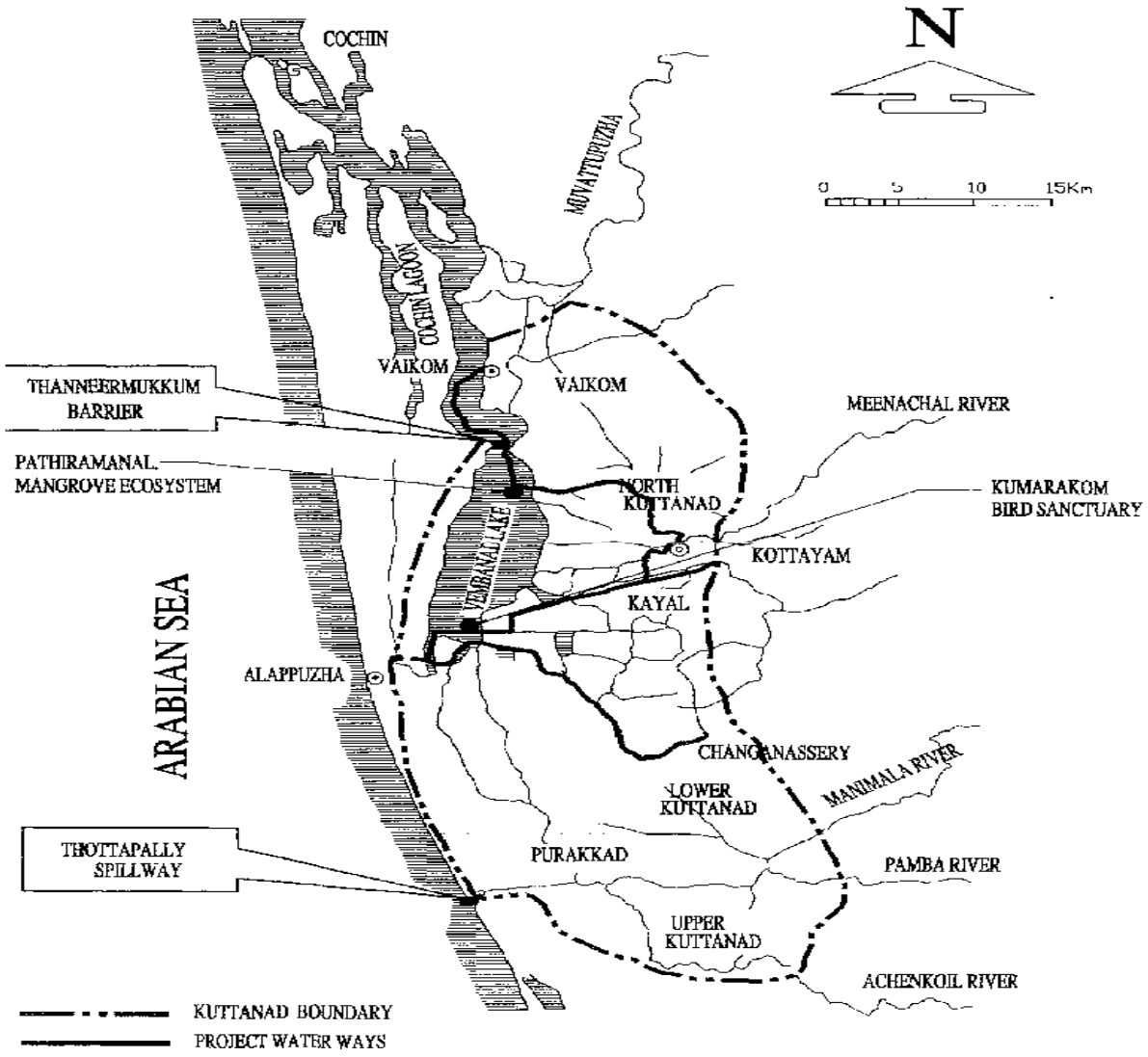
Health problems

- **Handling, storage and disposal of chemical agricultural inputs - cause cancer ,negatively influence reproduction ,disrupt the endocrine system etc.**
- **Pesticide residues in food and drinking water - cause similar adverse health effects**

Agriculture Pollution in Kerala

- **Systems of ‘Pokkali’, ‘Kuttanad’ and ‘Kole’-**
- **Irrigated as well as rain fed rice cultivation- in valleys of midlands and highlands**
- **Catchment area of Kuttand- fertilizer and pesticide consumption increased significantly over the years**
- **Plantation Corporation of Kerala -aerial spraying of Endrin (later Endosulphan) in cashew plantations -severe health problems**

Agrochemical Pollution of Vembanad Wetland System



Periyar (5,400 km2, 244 km),
Muvattupuzha (1,550 km2, 121km
Meenachil (1,250km2, 78km
Manimala (850 km2, 90km)
Pamba (2,250 km2, 176km
Achencoil (1,500 km2, 128km).

Pollution of Vembanad backwater system

- **Input of large quantities of agrochemicals and pesticides**
- **The annual usage of pesticides/fungicides/weedicides in Kuttanad -117 tones during Virippu season , 368 tones during the Mundakan and Puncha season**
- **Annual fertilizer consumption - 8409 tones of nitrogen, 5044 tones of potassium**
- **Aggressive waterweeds and water pollution**

Major Interventions in the Vembanad Wetland System

To check the floodwaters from Achenkovil, Manimala and Pamba Rivers during monsoons, a spillway was constructed at Thottapally in 1955 which divert the water to the Arabian Sea.

To prevent salt water intrusion and to promote double crop of rice in about 55000 ha of low lying fields in the area, a barrage at Thanneermukkom in the Vembanad Lake was constructed in1975 with facilities for allowing navigation and this remains closed from December to May every year.

Environmental Problems faced by Vembanad Lake

- **Agricultural practices**
- **Construction of barrages and bunds**
- **Drainage of fertilizer, pesticide residues**

Environmental Problems faced by Vembanad Lake

- **Coconut husk retting**
- **Eutrophication**
- **Aquatic weeds**

Annual Fertilizer consumption in Kutttanad

Sl.No	Crop	Fertilizers (Tonnes)		
		N	P	K
1	Paddy	6839	3666	4721
2	Coconut	914	757	1399
3	Banana	111	77	193
4	Cocoa	67	40	102
5	Vegetables	33	26	29
6	Tapioca/Cassava	18	16	64
7	Plantain	83	82	86
8	Others	344	380	192
	Total	8409	5044	6786

Agrochemicals used in Kuttanad Area

Fertilizers

Total agricultural field area in Kuttanad is 56000 ha including 30000 ha in Alappuzha and 26000 ha in Kuttanad area.

NPK requirement per ha is 90:45:45

- Factomphos - 20:20:0:15 (N: P: K: S)
- Rajphos - 22-24% rock phosphate, suited to the acid environment of Kerala
- Urea - Source of Nitrogen
- Mureto potash -Source of Potassium (400 kg/ha per season)

Aquatic Weeds

Eichornia crassipes(water hyacinth)

Salvania molesta (African Payal)

- **Anoxic conditions in the wetland**
  -deleterious to fish life

- **Can choke the drainage channels**

- **The rafts of water hyacinth obstruct the navigation and even result in the anoxic condition.**

- **Can adsorb heavy metals**

Coir Retting

Production of hydrogen sulfide and release of organic substances such as pectin, petosan, fat and tannin by the biological degradation of algae and fungi

The retting yards also act as breeding grounds for mosquitoes

Kuttanad, -157 million coconut husks are subjected to retting annually covering an area of 242 ha.

Anoxic condition, excess H_2S and increased turbidity drastically reduce the primary productivity of the lake leading considerable decline in fishery resource

Time scale changes in water quality of Vembanad Lake

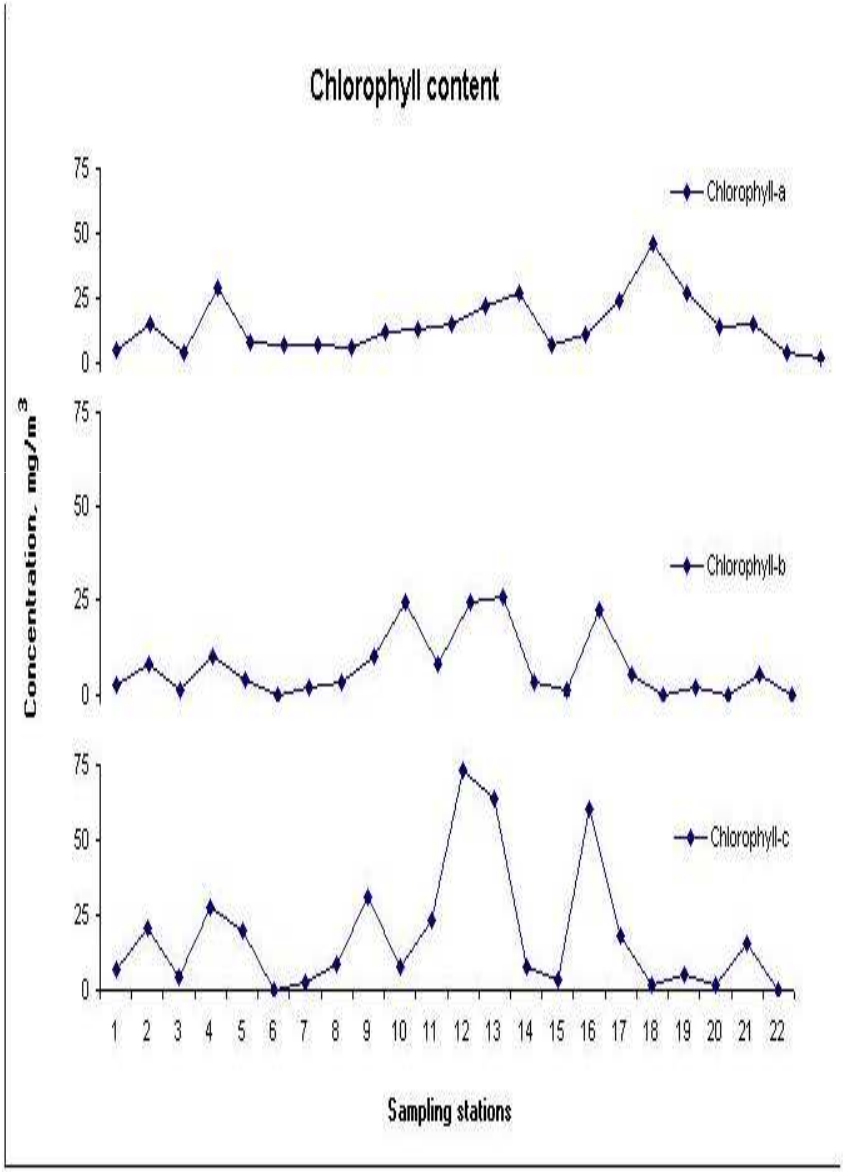
WATER QUALITY			
Sl.No:	**Parameter**	**Old Findings**	**Recent Findings (CWRDM)**
1	Nitrate-N	0-20.3 µ g/l (Lakshmanan et al., 1987)	0 – 1536.37 µ g/l.
2	Phosphate-P	18µ g/ l (Joseph, 1974)	102.75 µ g/l
3	Chloride	2500 mg/l in the north of the bund (Jacob et.al, 1987)	7300 mg/l
		300 mg/l in the south of the bund (Jacob et.al, 1987)	3700 mg/l
4	Chlorophyll	2.4 to 21 mg/ m^3 (Bijoy & Abdul Aziz, 1995)	4.33 to 45.85 mg/ m^3
		25 mg/g monsoon of 1989 (Nair et al., 1993).	62.4 mg/g

Time scale changes in some sediment quality parameters of Vembanad Lake

Sl.No:	Parameter	Old Findings	Recent Findings (CWRDM)
5	Manganese	141 to 337 µ g / g in the year 2000	404.76 to 785 µ g / g.
6	Organic carbon	35 mg/g pre-monsoon of 1989 (Nair et al., 1993).	99.5 mg/g
		25 mg/g monsoon of 1989 (Nair et al., 1993).	62.4 mg/g

Distribution of Chlorophyll in Vembanad Lake

- Chlorophyll is to be having high value in the range 4.33 to 45.85 mg/ m3.
- High chlorophyll value (2.4 to 21 mg/ m3) was reported in Vembanad Lake
- Gross primary productivity shows a vertical decrease from 0.0004718 mg C/ m3/hr in the surface to zero in the bottom during monsoon season
- Luxuriant growth of plants in some parts of the lake indicates the nutrient rich condition in the lake.
- The system is found to be eutrophic in nature, especially the tourism areas where the chlorophyll content and the nutrients are found to be high and DO is found to be very less.



Agrochemicals used in Kuttanad Area

Herbicides:

- **Fernoxone, 2,4-D- (2,4-Dichlorophenoxy acetic acid, for control of broad leaved weeds and sedges.**

- **Clinchure 10/EC - Cyhalofop butyl,for control of Echinochlora sp.**

- **Sofit 30/EC - Pretilachlor and safener**

Fungicides:

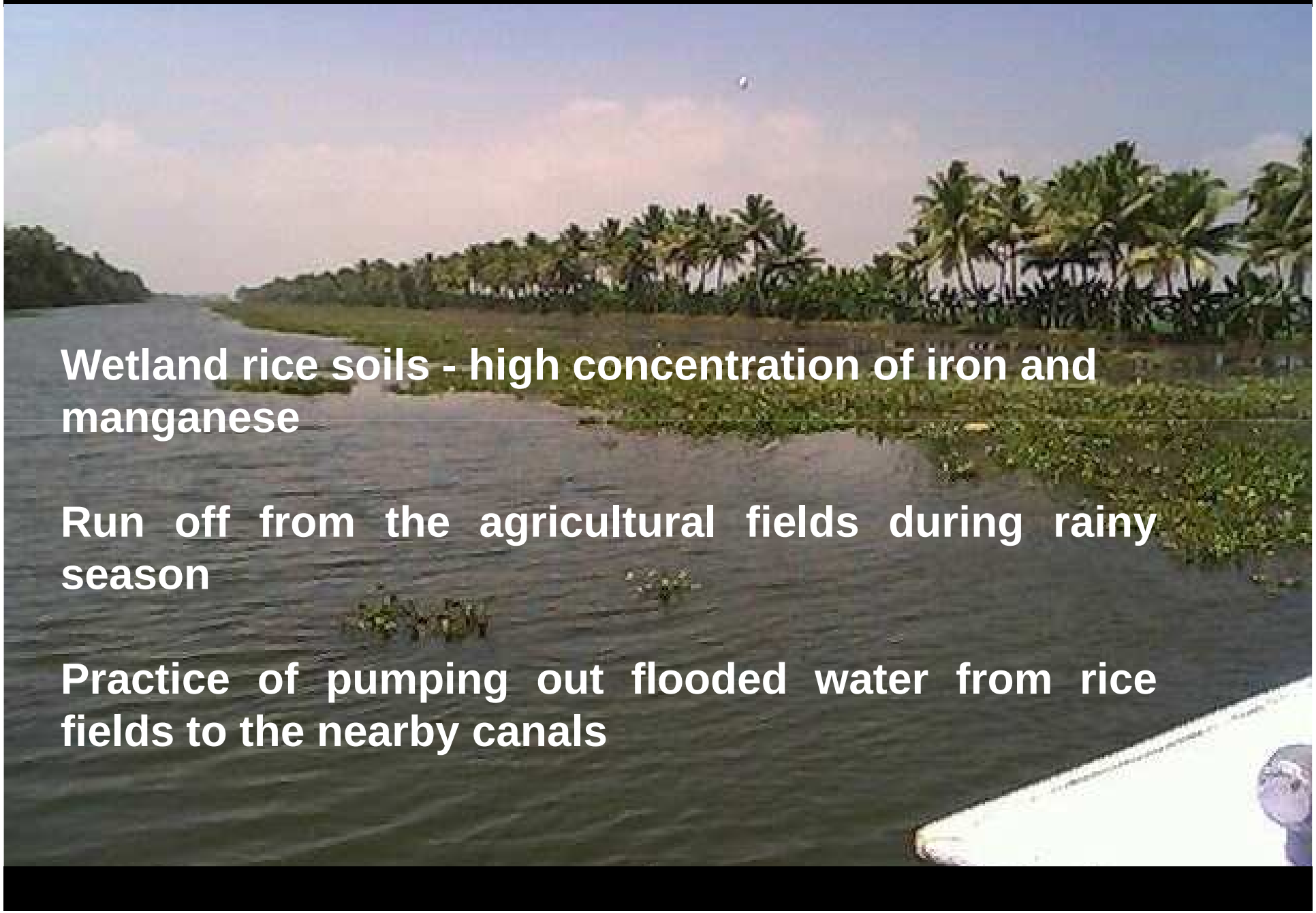
- **New generation chemicals are used and are supposed to be dissipating in 30 days and so they are not harmful.**

PESTICIDES CAN ENTER IN WATER BY

- ✓by direct sprays on water surface to kill mosquitoes and such other such vectors.

- ✓Kuttanad area has a practice of pumping out water from the agriculture field to the water bodies to avoid flooding. During this process there is a chance of pesticide to join the water course

WATER HYACINTH



Wetland rice soils - high concentration of iron and manganese

Run off from the agricultural fields during rainy season

Practice of pumping out flooded water from rice fields to the nearby canals

Environmental Features of Vembanad Lake

- **The concentration of the nutrients, shallow nature, lower secchi depth values (average 1.50m) and chlorophyll concentration higher than 30μg/l indicate that the water column of the lake is in euphotic zone.**

- **The analysis of the water and sediment also reveals the extent of eutrophication at the southern part of the lake.**

- **The eutrophication is also determined to be influenced by operation of the Thaneermukkom barrage an intervention constructed to prevent salinity intrusion during summer months.**


Eutrophication of Vembanad Lake

Water column of the lake is in euphotic zone

- **concentration of the nutrients**
- **shallow nature**
- **lower secchi depth values (average1.50m)**
- **chlorophyll concentration higher than 30 μg/l indicate**

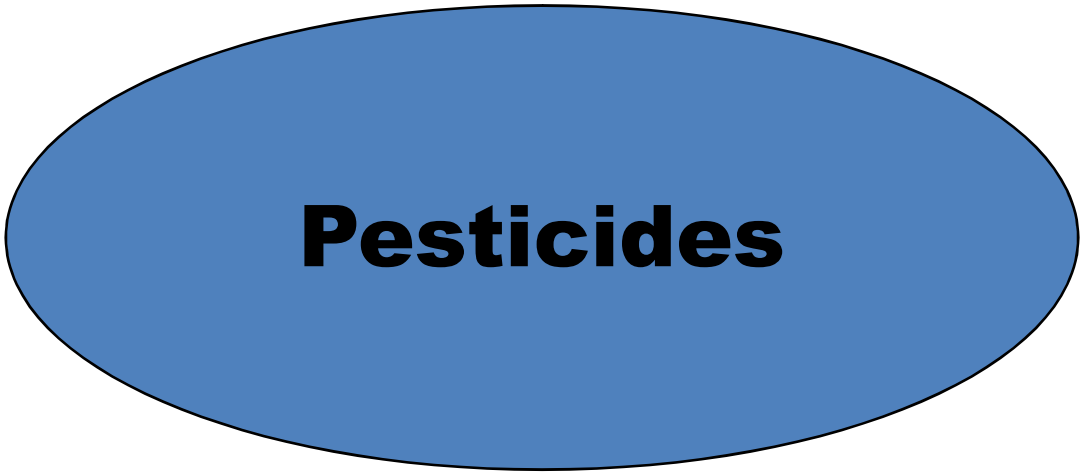
Extent of eutrophication at the southern part of the lake

When the barrage is closed the nutrients have the tendency to concentrate in the lake

Bottom turbulence and tidal influence
phosphorous to the epilimnion section (average phosphorous
20 mg/kg)

Habit	Species
‘Free’ floating	***Eichornia crassipes*** ***Salvania molests***
Rooted and floating	***Nymphaea stellata*** ***Nymphoea nouchali*** ***Nymphoides cristatum*** ***Nymphoides indicum***
Rooted and submerged	***Hydrilla verticellata*** ***Najas minor*** ***Limnophila heterophylla*** ***Aponogeton crispium*** ***Potamogeton pectinatus***
Emergent/littoral	**Scripus validus** **Cyperus corymbosus** **Ischaemum barbatum**

The results indicate that a reduction of 12.5 % of the existing load of phosphorous may be necessary to achieve the targeted reduction in chlorophyll value <10 so as to bring the lake to mesotrophic/oligotrophic level


Pesticides

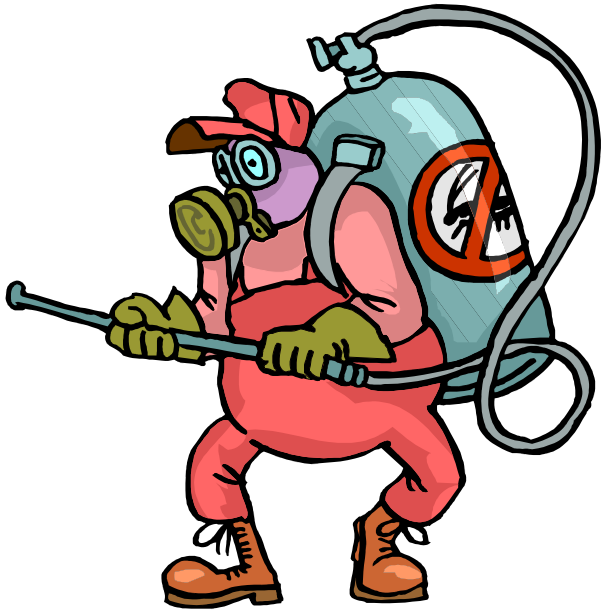
Pesticides in Drinking-Water

Conflicting uses of pesticides
- **agricultural and domestic**

Two methods of classifying pesticides

a) according to chemical class
b) according to their intended use

Health Effects of Pesticides



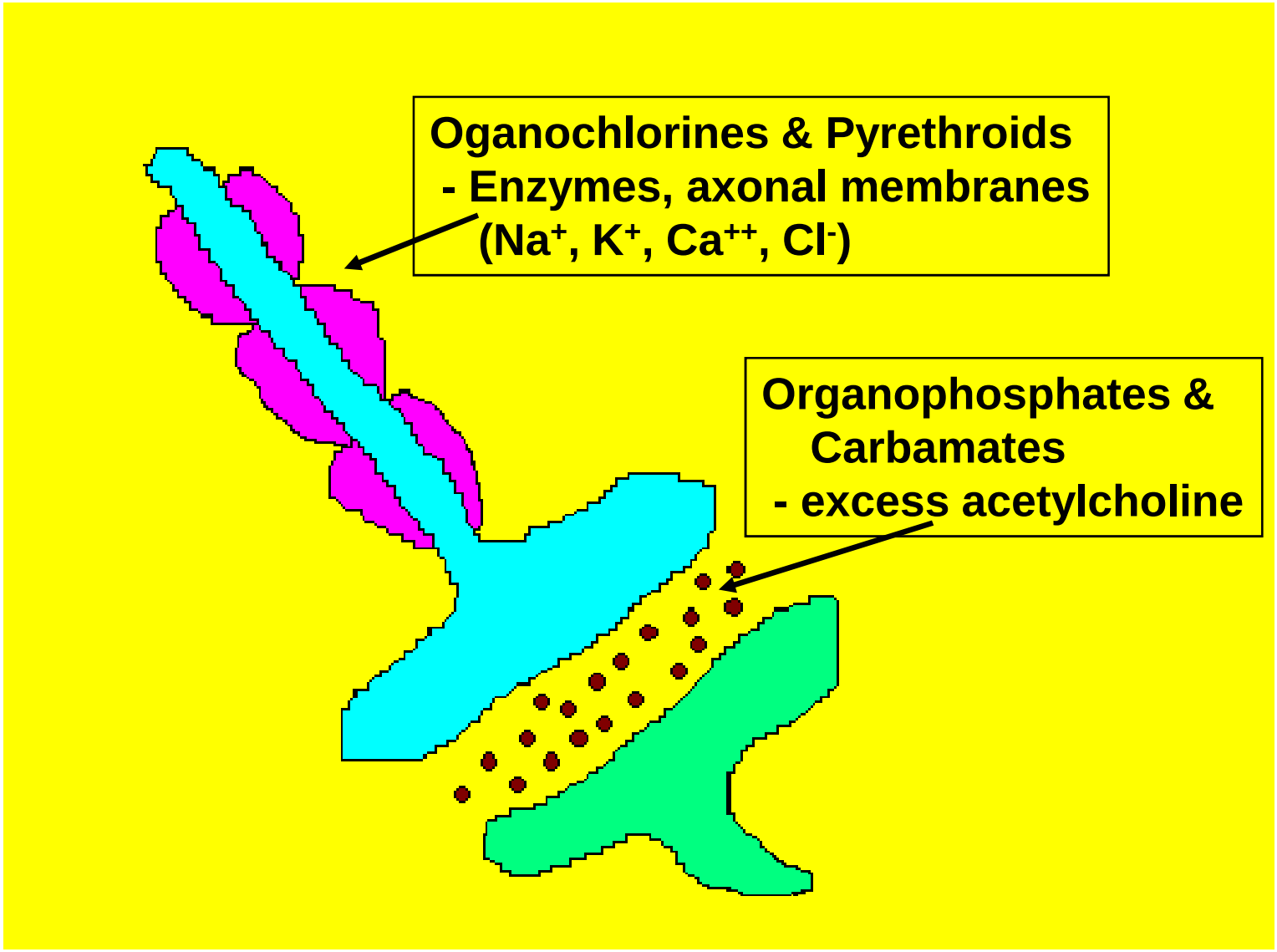
Absorption

Ingestion
Inhalation (lung)
Skin (dermal)

Insecticides

- **Insecticides (kill insects)**
  - **Organochlorines**
  - **Organophosphates**
  - **Carbamates**
  - **Synthetic Pyrethroids**

Mechanism of Action



Pesticide Analysis Vembanad

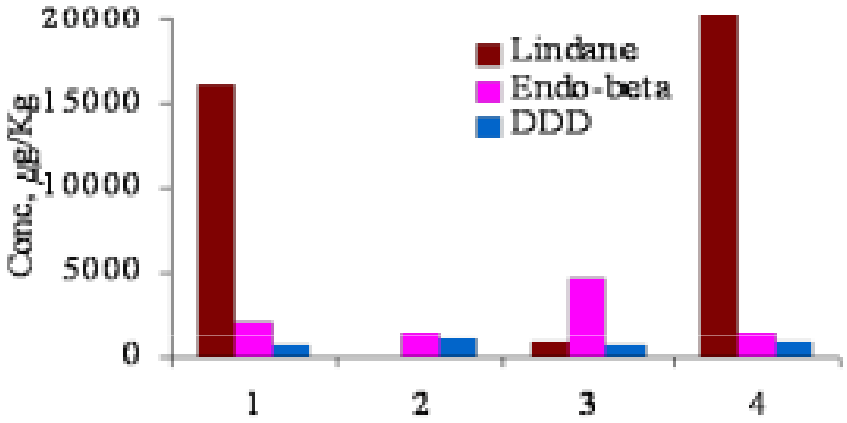
- **DDE (1,1-dichloro-2, 2-bis (P-chlorophenyl) Ethylene) - Changanacherry.**

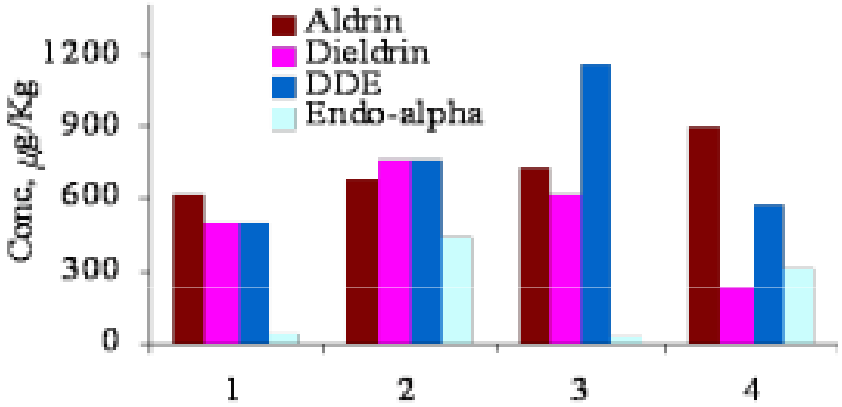
- **BHC**

The concentration range from a maximum of 38.35 mg/kg to a minimum of 6.35 mg/kg.

Core sediment samples

Lindane(16.15mg/Kg), aldrin endo-alpha, dieldrin, DDE, endo-beta (2.02 mg/Kg)and DDD (1.06mg/Kg)





Variation of organochlorine pesticides in the sediment core of Vembanad Lake

Study on the Persistence of Endosulfan in Water, Soil and Sediment Samples of Kasargod District

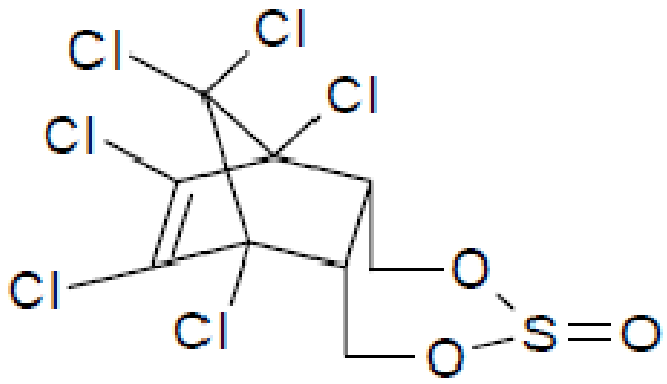
Toxicity Classification

- Endosulfan - a Persistent Organic Pollutant (POP)
- Recognized by UNEP to be a Persistent Toxic Substance.
- U S Environmental Protection Agency (EPA) has classified endosulfan as Category 1b – Highly Hazardous.

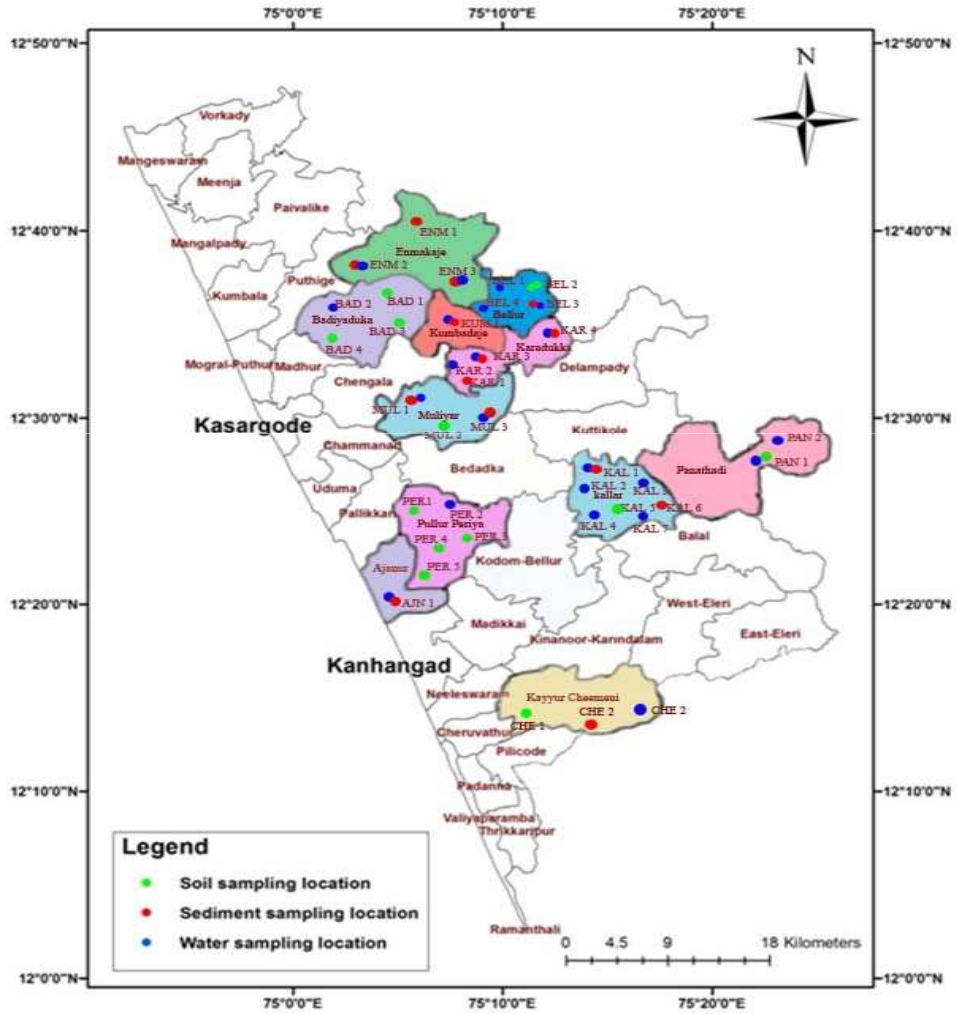
Endosulfan-chemical Identity

- Chemical formula- $C_9H_6Cl_6O_3S$
- Registered trade name(s)- Thiodan; Thionex; Thionate Malix; Cyclodan; Thifor; Beosit; etc.

➢ Chemical structure



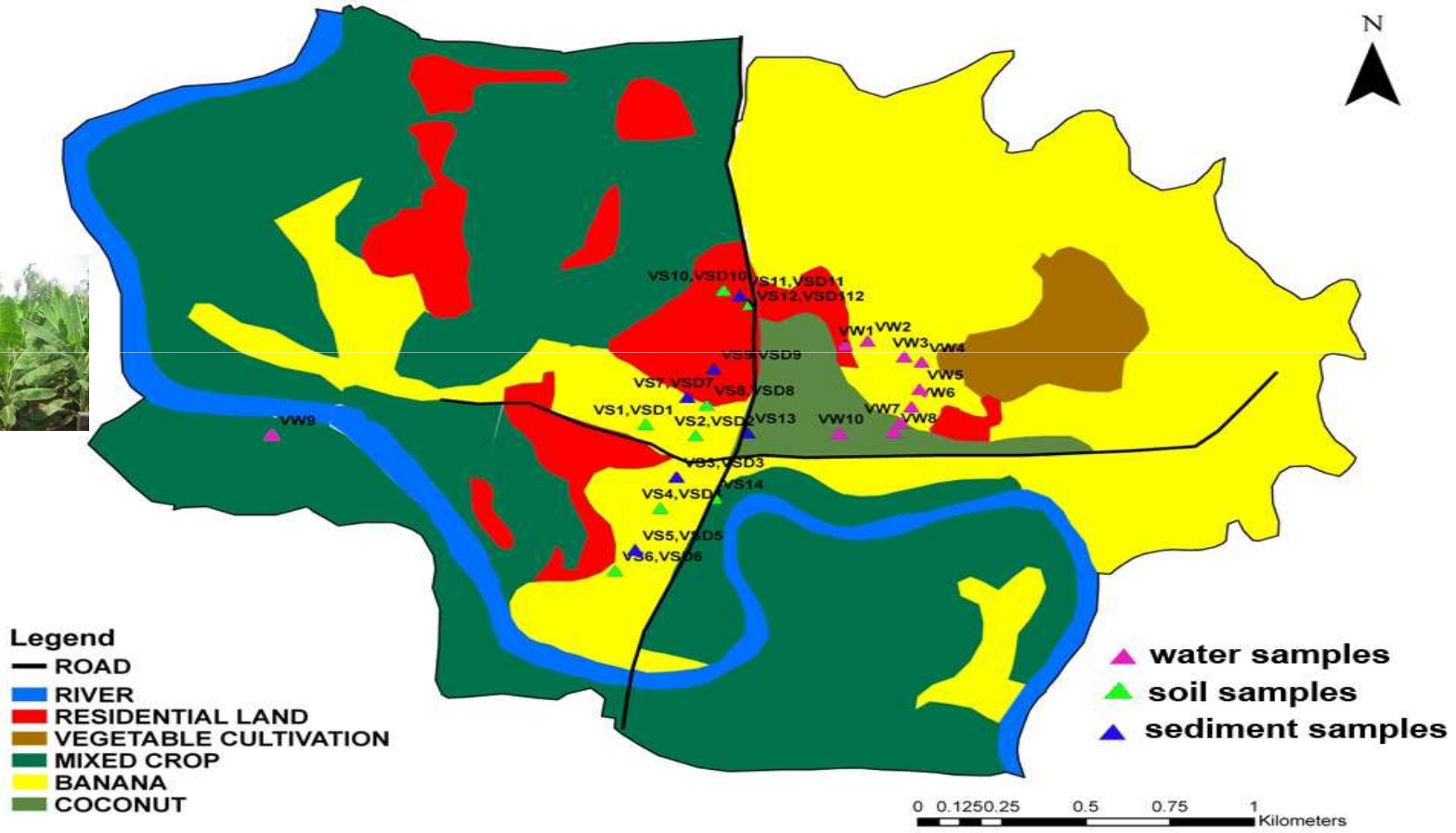
Endosulfan Prone Areas in Kasargod district



Panchayaths Selected for Sampling

1	Kumbadaje	7	Kayyur Cheemeni
2	Bellur	8	Kallar
3	Muliyar	9	Panathadi
4	Badiyadukka	10	Ajanur
5	Enmakaje	11	Pullurperiya
6	Karadukka		

Study on the impacts of agrochemicals on a Micro Watershed in Kozhikode District



VELLANUR WATERSHED MAP

Management measures

- **Sediment/erosion control**
- **Confined animal facility**
- **Nutrient management**
- **Livestock grazing**
- **Effective irrigation system**
- **Control of phosphorus from point and diffuse sources**
- **Integrated Pest Management**

Integrated pest management (IPM)

- **Combines biocontrol, chemical, and other methods**

  Involve:

  - **Biocontrol**
  - **Pesticides**
  - **Close population monitoring**
  - **Habitat modification**
  - **Crop rotation**
  - **Transgenic crops**
  - **Alternative tillage**
  - **Mechanical pest removal**

Biological control

- **Synthetic chemicals can pollute and be health hazards.**
- **Biological control (biocontrol) avoids this.**
- **Biocontol entails battling pests and weeds with other organisms that are natural enemies of those pests and weeds.**
- ***(“The enemy of my enemy is my friend.”)***


Thank You