
WATERSHED MANAGEMENT
Module 2 – (L5) Sustainable Watershed Approach & Watershed Management Practices
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Lecture No - 5
Agricultural Practices & Watershed Management

WATERSHED MANAGEMENT

L5–Agricultural Practices & Watershed Management

- **Topics Covered**
- Watershed Ecology and agro-ecosystems, Soil and Water conservation management practices, Sustainable land management practices, Crop management, Nutrient & Pest Management, Integrated Farming, Case Study.

Photo, A.K. Singh, 2002

- Keywords: Agro-ecosystems, agriculture management, Nutrient & pest management, integrated farming.

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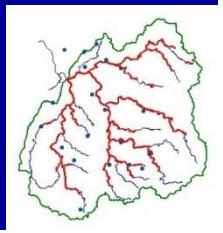


Sustainable Agriculture Management

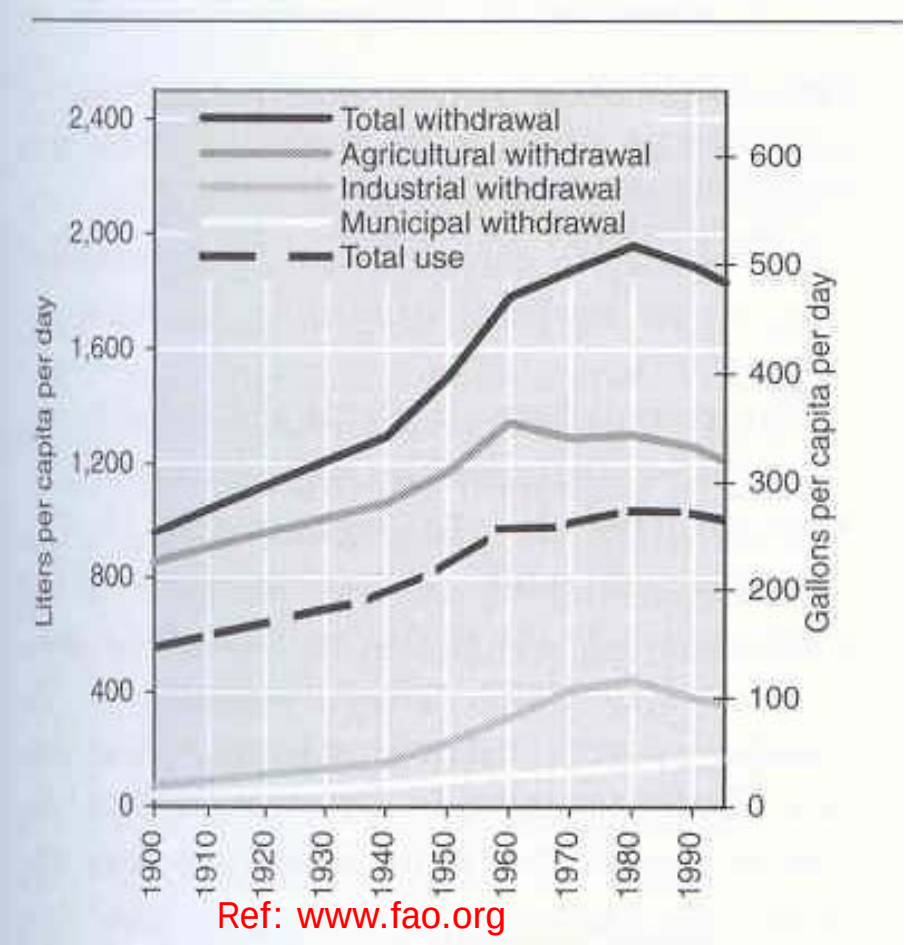
- Watersheds in many parts of world are experiencing pressure from high population growth, climate, land use change & over-exploitation of natural resources.
- To stop degradation of natural resources, understanding of Sustainable Agricultural Management Practices is necessary –
  - Dealing with upstream and downstream resources management challenges
  - To identify sustainable land use practices
  - To increase sustainable agriculture production
  - Increase opportunity of rural livelihood

Agriculture Water Management

- Interactions & Interplay between Food, People & Nature Sectors
- Food sector: produces bio-mass, influences eco-system positively / negatively
- Major use is consumptive: Major / micro irrigation; excess use is largely recycled.
- Fertilizers, pesticides - non-point source of pollution. Needs of people sector are relatively small. Saving of 1cm/ha/day= w/s for 1000 persons.
- Agri: Mun: Industrial:: 70: 15: 15, India - 85: 8: 7.
- For sustainable agriculture – irrigation is essential

Agriculture Water Management

- Global withdrawal of water for agriculture, industry and municipal use, and total use, in liters and gallons per capita per day, 1900-95
- Irrigated area covers about 40% of arable land in the world; Rainfed area the rest.



Ref: www.fao.org

India's agriculture & Irrigation

- India has 2% of world's land, 4% of freshwater, 16% of population, and 10% of its cattle.
- Geographical area = 329 Mha of which 47% is cultivated, 23% forested, 7% under non-agri. use, 23% waste land.
- Per capita availability of land 50 years ago was 0.9 ha, could be only 0. 14 ha in 2050.
- Out of cultivated area, 40% is irrigated which produces 55% food; 60% is rain-fed producing 45% of about 250 M t of food.
- In 40 years (ultimate), proportion could be 50:50 producing 75:25 of 500 M t of required food.

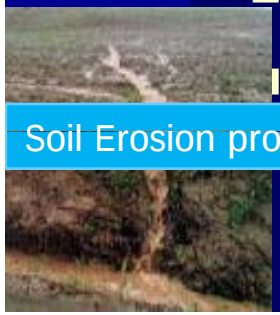
Agriculture related Issues

- Increase in agricultural growth rate in India – (0.3% - 3.5%)
- First Green Revolution (1970s)
  - Introduction of new high yielding varieties
- Second Green Revolution (1980s)
  - Concentration on genetic engg. through organized input management, farmer services & extension
- Some of the negative trends in spite of positive trends
  - * Per hectare yield is low
  - * Infrastructure facilities are poor
  - * Neglecting management aspects totally
  - * Non-mechanized & unscientific farming

Agriculture related Issues…

Major Constraints are

- Decline in per capita land availability
- Stress in water resources
- Degradation of soils
- Lack of efficient water management
- Mono-cropping
- Lack of Crop Management
- Negligence of sustainable agriculture
- People's apathy – scientific farming!



Soil Erosion problem

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Drought problem

Watershed Ecology & Agro-ecosystems

- Agro-ecosystems - subset of ecosystems that defines functional representation of coherent agricultural activity - includes interaction of living & non-living components involved.
- Agro-ecological zones - defined as land unit carved out of agro-climatic zones based on major climate super imposed on length of growing period (moisture availability)
- India has 20 agro-ecological regions & 60 agro-eco sub regions. Each agro-eco sub region has further been classified into eco unit at district level for developing long term land use strategies.

Source: http://agricoop.nic.in

Zones are delineated based on physiography, soil, length of growing season and bio-climate of the region

Nomenclature :

For example AER zone "A13Eh1"

A stands for Physiography

13 stands for soil scale

Eh stands for bioclimatic zone

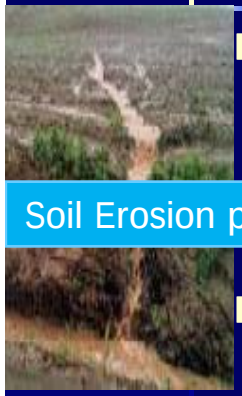
1 stands for length of growing period

AER zone A13Eh1 is referred as Western Himalayas , shallow skeletal soils, hyper arid climate with length of growing period less than 60 days

Need for Agro-ecological Classification

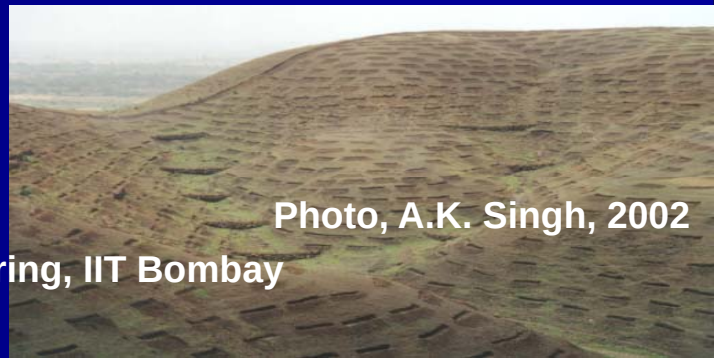
- To assess yield potentialities of different crops, crop combination in agro ecological regions/zones.
- To formulate future plan of action involving crop diversification.
- To disseminate agricultural research and agro-technology to other homogenous areas.
- To determine the crop suitability for optimization of land use in different agro-ecological regions/zones.

Soil and Water Conservation measures



Soil Erosion problem

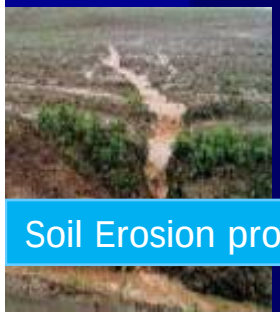
- Soil Conservation- principles
  - Rainfall of high intensity - erodes top fertile soil of land - need to be stopped by scientific measures.
- Biological Measures
  - Conservation tillage
  - Deep tillage
  - Conservation farming
- Mechanical Measures
  - Terracing
  - Water Disposals
  - Other low cost measures



Photo, A.K. Singh, 2002

Water conservation

- Principle (according to rainfall state)
  1. Where precipitation is less than crop requirements: strategy includes land treatment to increase run-off onto cropped areas, following water conservation, use of drought- tolerant crops -suitable management practices.
  2. Where precipitation is equal to crop requirements: strategy is local conservation of precipitation, maximizing storage within the soil profile, & storage of excess run-off for subsequent use.
  3. Where precipitation is in excess of crop requirements: strategy is to reduce rainfall erosion, to drain surplus run-off and store it for subsequent use.



Soil Erosion problem

Sustainable Land Management Practices (SLM)

- SLM -knowledge based system - helps to integrate land, water, biodiversity & environmental management to meet rising food & fiber demand while sustaining eco-system services and livelihood to meet requirement for growing population.
- SLM – Enhances productive capabilities of land in cropped and grazed areas
- Action to stop reverse degradation or at least to mitigate adverse effect of earlier misuse

Objectives - SLM practices

- **To increase land productivity**
  - Replenish soil nutrient by liming and organic inputs
  - Maintain soil cover - cover crops & residue recycling
- **To provide adequate quantity of water**
  - Use crop, forage or tree species with higher water use efficiency
- **To maintain water quality**
  - Protect vegetative filter areas in the riparian zone to remove excess sediment and nutrients
- **TO reduce flooding and flood damage**
  - Plant deep rooted vegetation to enhance infiltration and water consumption by the plants

Sustainable Agriculture – Crop Husbandry

- Crop Husbandry - practice of growing & harvesting crops- scientific principles - careful management & conservation of resources
  - Includes Soil enrichment, usage of hybrid and improved seeds and better cropping pattern
- Techniques for improved crop production are
  - Soil enrichment by bio-fertilization
  - Introduction of micro-nutrient management
  - Usage of hybrid seeds
  - Achieving optimum plant population
  - Timely and effective weed control
  - Pest management

SA - Nutrient Management

- Nutrient management is important to-
  - Tackle problems- use of inorganic fertilizers
  - Stop weed growth
  - Avoid crop diseases
  - Improve crop yield
- Nutrient management includes-
  - Disseminate knowledge of nutrient & its function to plant growth
  - Assessment of nutrient availability
  - Nutrient management - supply deficient nutrient to soil - also avoid excess use -to protect environment

Nutrient and its Functions

- Two basic types of nutrient –
  - Macro nutrient – Available in soil in larger %(ex. Nitrogen, Phosphorous, Potassium, Sulphur, Ca, Mg)
  - Micro nutrients – available in soil in minute % (eg. Fe, Cu, Zn, Mn, Cl etc.)
- Functions of nutrient
  - Involvement in photosynthesis and produces carbohydrates
  - Early root formation and growth
  - Helps plants to survive in bitter environmental conditions
  - Increasing water use efficiency
  - Important role in reproduction of plants

Assessment of Nutrient

- Traditional soil tests
  - Tests like pH, nitrogen, phosphorous, potassium, electric conductivity etc. Should be performed every 3 to 5 years
- Nitrate test
  - Pre-plant nitrate test- for additional nitrogen
  - Deep nitrate test-how much nitrogen has already leached below the crop rooting zone
- Traditional Plant Tests
  - Chlorophyll meter: to quickly determine nitrogen status (without destroying any plant tissue)
- Irrigation Water Tests
  - Electric conductivity and pH tests

Pest Management

Objective of Pest Management:

- How pest management interrelates with climate, water, crop & soil management – for producers understanding
- Incorporating them into pest management decision making process

Necessity

- Critical component of conservation practices
- Negative impacts of pesticides
- Ground and surface water deterioration due to non point source pesticide contamination
- Environmental risks, Ex: burning crop residue for disease and insect control

Integrated Pest Management (IPM)

- IPM- approach to pest control that combines biological, cultural & other alternatives to chemical control with the judicious use of pesticides
- IPM- To maintain pest levels below damaging levels

Goals of IPM:

1. Maximum use of naturally occurring control forces in the pest's environment
2. First focus on non-chemical measures
3. Use of chemical pesticides only for preventing severe damage

Sustainable Agricultural Practices

- Biomass management – (eg. Crop rotation)
- Better conservation practices (land & water)
- Conservation buffers: forest buffers, grassed waterway, filter strip, vegetative barriers, conservation barrier for wind etc
- Crop husbandry
- Nutrient management
- Integrated pest management
- Use of molecular biology
- Use of genetic engineering – hybrid & improved seeds

Integrated Farming System -IFS

- Mixed farming system that combines crop and livestock enterprises in a supplementary and/or complementary manner.
- Integration of various agricultural enterprises *viz*., cropping, animal husbandry, fishery, forestry etc. - great potentialities in the agricultural economy.
- Components: Crops, livestock, birds and trees
- Crop may have subsystem - monocrop, mixed/intercrop, multi-tier crops of cereals, legumes (pulses), oilseeds, forage etc.
- IFS – Maximize food production – Overall development of a watershed

Integrated Farming System…

- **Inter, Mixed & Strip Cropping**
- **Inter Cropping:** Crops grown in space available in b/w plants:
  - Ex: Turmeric can be grown in Mango gardens – improves soil fertility.
- **Mixed cropping:** Alternative rows of different crops – improve crop yields, preserve soil fertility
- **Strip Cropping:** Long strips are used for growing crops on leveled beds

WATERSHED MANAGEMENT

Watershed Based - Sustainable Agriculture Management – Case Study

- **Adarsha Watershed** -Kothapally village, Shankarpally, Rangareddy, Andhra Pradesh, India, spread over 465 ha, developed by ICRISAT.
- **Objective:** link strategic research in Natural Resource Management (NRM) with development research - to increase productivity of rain fed agriculture, through enhanced efficiency of natural resources while maintaining the resource base.
- To increase systems productivity through adoption of improved soil, water, nutrient & pest management.

*www.icrisat.org/journal/agroecosystem/v2i1/v2i1**adarsi*

Case study: Strategy

- Linking strategic research with watershed development to enhance effectiveness of community participation.
- Multi-disciplinary & multi-institutional consortium approach for watershed based development projects.
- "Islanding approach" - micro-watersheds as upfront demonstrations managed by farmers with technical backups.
- On-farm strategic research conducted in partnership with farmers and NGO's
- **Watershed Details:** 270 farmers out of which 136 are small landholding (up to 1 ha), 60 are medium (1-2 ha) and 74 large land holding (above 2 ha) farmers.

*www.icrisat.org/journal/agroecosystem/v2i1/v2i1**adarsha**.pdf*

Case study: Watershed Details

- Annual rainfall - about 800mm (85% of it occurs during June-Oct.).
- Soils are predominantly(90%) black soils.
- Soil depth varies from 30-90 cm.
- General slope of the land is about 3%.
- Crops grown - Sorghum, Maize, Cotton, Sunflower, Pigeon-pea, Soybean in rainy season & Sorghum, Sunflower, Vegetables in post rainy season under rain fed condition. Some area under Turmeric, Onion and Rice cultivation under well irrigation.

*www.icrisat.org/journal/agroecosystem/v2i1/v2i1**adarsha**.pdf*

Case study: Watershed Interventions

- Continuous weather monitoring – automatic weather stations
- Scientific soil analysis – classification – suitability to crops
- Cropping system analysis- crop yield & cost analyzed
- Cropping according to soil, cost effective, better crop yield
- Inter cropping
- Use of Nitrogen fixing plants
- Vermi composting, organic farming
- Integrated pest control
- Capacity building & training to farmers

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Case study: Impacts

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- Crop yield considerably improved
- Considerable improvement in water availability including groundwater
- Integrated nutrient & pest management
- Continuous monitoring – satellite – RS & GIS
- Holistic watershed management – land, water, agriculture & people
- Role model of Integrated sustainable watershed management through Sustainable agriculture management

Capacity building and training – People participation – Socio economic upliftment

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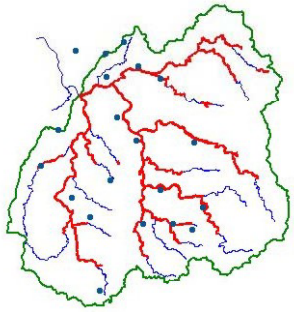
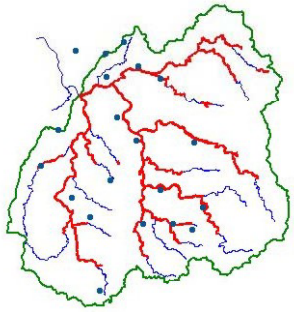


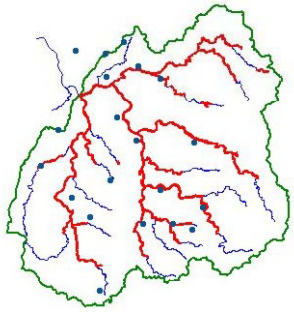
Tutorials - Question!.?.

- **Illustrate necessity of sustainable agriculture management practices.**
- Identify the components
- Scientific interventions
- Identify the problems
- Identify role of molecular biology & genetic engineering.
- Importance of nutrient management.
- Role of integrated pest management.



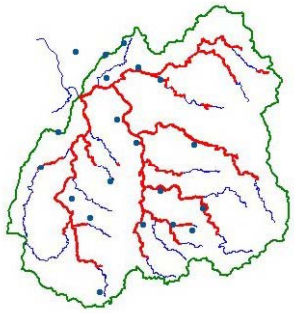
Self Evaluation - Questions!.

- Discuss agriculture water use and compare World and Indian Scenarios.
- What are the major constraints in achieving watershed based sustainable agriculture management?.
- Discuss the agro-ecological classification in India and its importance.
- Illustrate sustainable land management practices.



Assignment- Questions?.

- Discuss Indian Agriculture & Irrigation scenarios.
- Explain watershed ecology & agro-systems.
- Explain important issues in soil and water conservation.
- Discuss the importance of nutrient and integrated pest management and related issues.



Unsolved Problem!.

- For your Watershed area, study the scope for Integrated Farming Systems (IFS).
- Identify suitable IFS practices for the area for Integrated Sustainable Agriculture Management?.
  - Carry out stakeholder analysis
  - Consider traditional practices of farmers
  - Suggest scientific methods
  - Identify soil/ water conservation measures
  - Identify proper monitoring and evaluation strategy and involve local people

THANK YOU

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