



माता भूमिःपुत्रोऽहं पृथिव्याः



## **Agron 511- Cropping System And Sustainable Agriculture (2+0)**

**Above & Below Ground Interaction & Allelopathic Effects, Competition Relation, Multistored Cropping System & Yield Stability In Intercropping, Role Of Non-monetary Inputs & Low Cost Techniques, Research Need in Sustainable Agriculture**

***Prof. K. K. Agrawal***

**Principal Scientist**

**Mob.- 9425163385**

**Department of Agronomy, CoA, JNKVV, Jabalpur- 482004**



# Allelopathy



माता भूमि:पुत्रोऽहं पृथिव्याः

In 1996 **The International Allelopathy Society** defined allelopathy as “Any process involving secondary metabolites produced by plants, micro-organisms, viruses, and fungi that influence the growth and development of agricultural and biological systems (excluding animals), including positive and negative effects” (Torres et al. 1996).

The **term allelopathy**, was introduced by **Molisch in 1937**, and is derived from the Greek words allelon ‘of each other’ and pathos ‘to suffer’ and mean the injurious effect of one upon the other (c.f. Rizvi et al. 1992).

However, the term is today generally accepted to cover both inhibitory and stimulatory effects of one plant on another plant (Rice 1984).



माता भूमि:पुत्रोऽहं पृथिव्या:

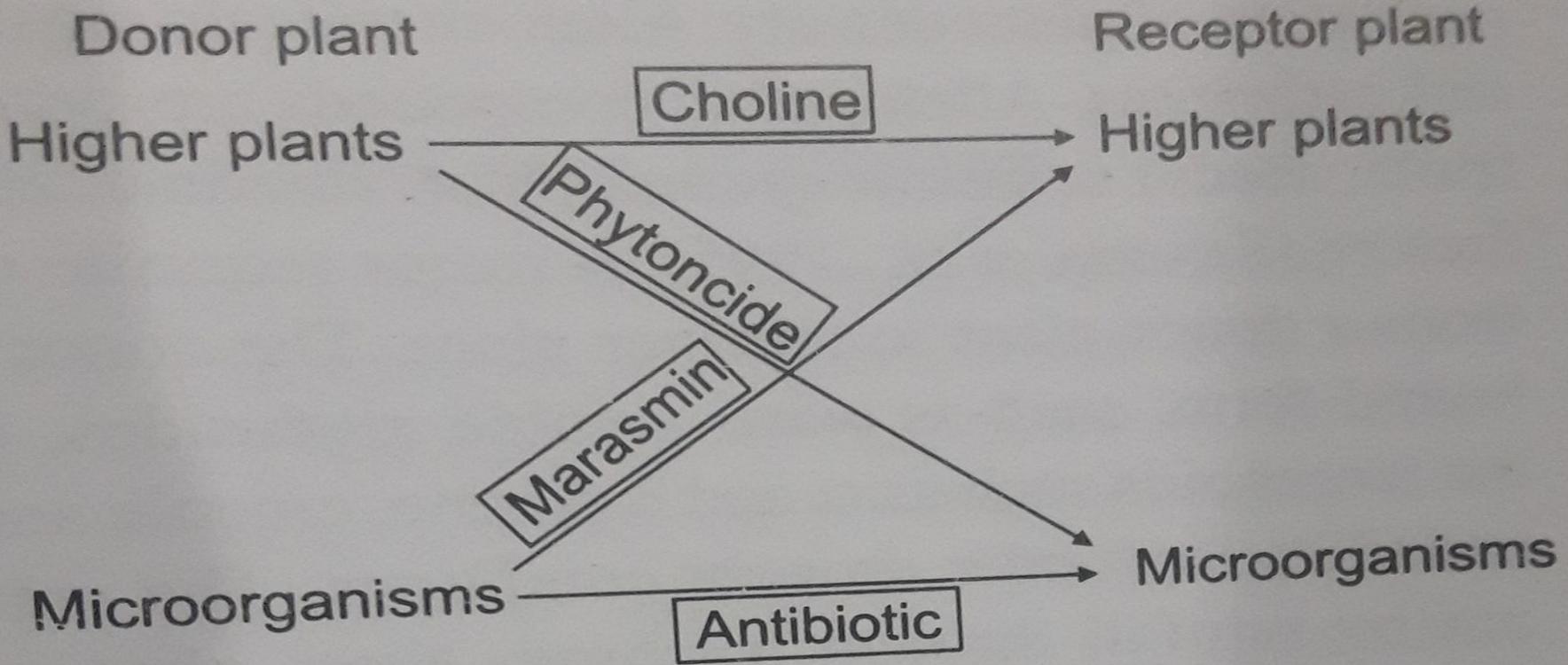


Fig. 1. Grummer's classification of allelopathic substances



# Allelo-chemicals



माता भूमिःपुत्रोऽहं पृथिव्याः

- ❖ Chemicals released from plants and imposing allelopathic influences are termed allelochemicals or allelochemics.
- ❖ Most allelochemicals are classified as secondary metabolites and are produced as offshoots of the primary metabolic pathways of the plant.
- ❖ Some allelochemicals are known to have structural functions (e.g. as intermediates of lignification) or to play a role in the general defence against herbivores and plant pathogen.
- ❖ Allelochemicals can be present in several parts of plants including roots, rhizomes, leaves, stems, pollen, seeds and flowers.
- ❖ Allelochemicals are released into the environment by root exudation, leaching from aboveground parts, and volatilisation and by decomposition of plant material (Rice 1984).



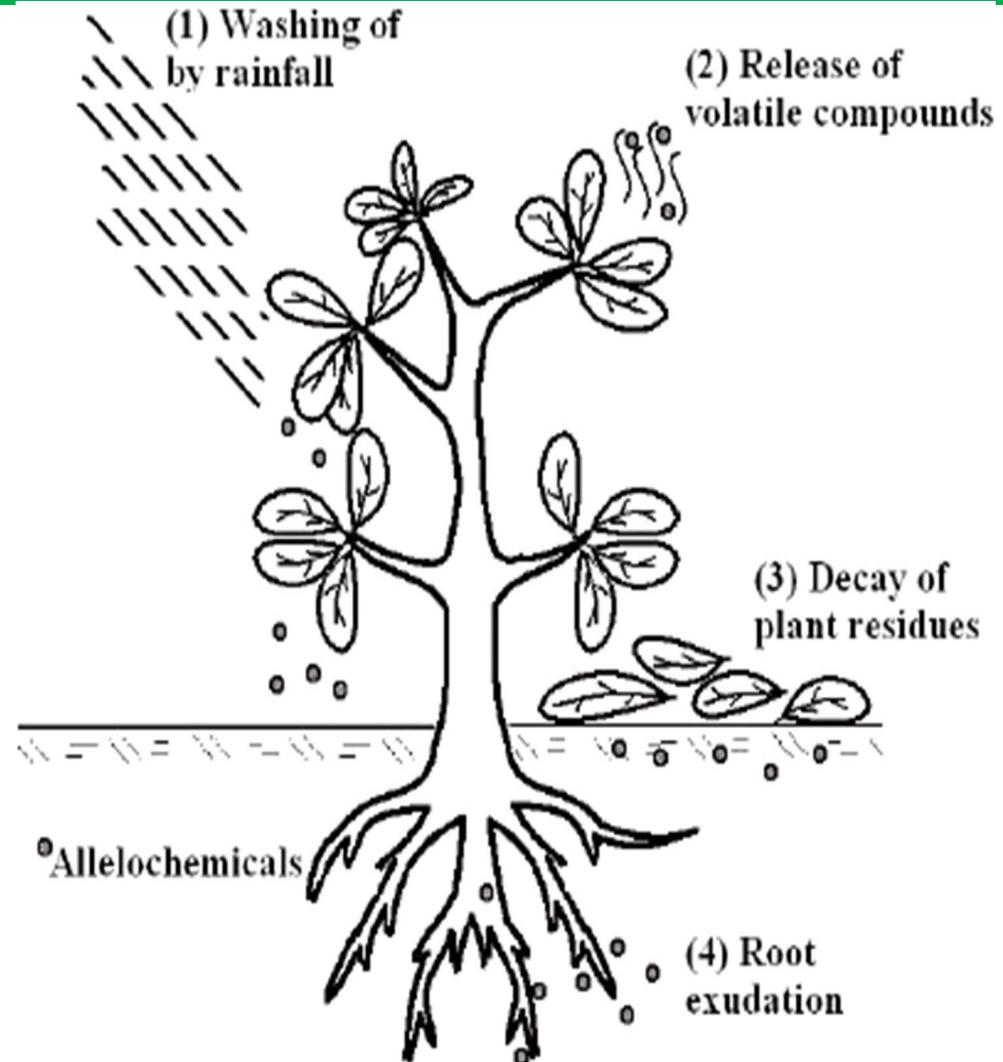
# Ways of releasing allelochemicals :



माता भूमि: पुत्रोऽहं पृथिव्याः

**Allelopathic chemicals are released from the plants as**

- ◆ Vapour-from root and leaf (through stomata)
- ◆ Foliar leachate
- ◆ Root exudate
- ◆ Breakdown/decomposition product of dead plant parts
- ◆ Seed extract





## Ways of releasing allelochemicals :



माता भूमिः पुत्रोऽहं पृथिव्याः

- 1. Volatilization:** Allelopathic trees release a chemical in a gas form through small opening in their leaves. Other plants absorb the toxic chemicals and die.
- 2. Leaching:** When the leaves fall to the ground, they decompose and give off chemicals that protect the plant. Fall foliage tends to release more potent allelochemicals than the fresh, spring foliage.
- 3. Water-soluble phytotoxins:** may be leached from roots or above ground plant parts or they may be actively exuded from living roots. Rye and quackgrass release allelopathic chemicals from rhizomes or cut leaves.
- 4. Exudation:** Some plants release defensive chemicals into the soil through their roots. The released chemicals are absorbed by the roots of nearby trees. Exudates compounds (e.g., coumarins) that tend to inhibit development.



# Types of allelopathy



माता भूमिःपुत्रोऽहं पृथिव्याः

- 1. Alloallelopathy:** It is inter-specific chemical co-action.
- 2. Allelochemicals :** are toxic to other species other than species which release it. e.g. maize is allelopathic for *Chenopodium*, *Amaranthus etc.*
- 3. Autoallelopathy:** It is intra-specific chemical co-action. Allelochemical are toxics to same species from which they are released. e.g. wheat, alfalfa, cowpea, rice, apple etc.
- 4. True allelopathy :** It refers to the release into the environment of chemical compound that are toxic in the forms.



माता भूमि:पुत्रोऽहं पृथिव्या:

- 5. Functional allelopathy:** It refers to the release into the environment of compound that is toxic after chemical modification by micro-organisms.
- 6. Concurrent/direct allelopathy:** It refers to instantaneous direct effect of released toxins from the living plants to another growing in vicinity. It is also called 'live plant effect'. e.g. sorghum suppress many weeds growing in vicinity.
- 7. Residual allelopathy:** It is the effect obtained on the plants growing in succession from the decaying residues, leaf litters, stems, roots of the previous plants. e.g. sorghum is allelopathic to wheat and Phalaris minor and sweet potato to cowpea.



## Factors Affecting Allelopathic Effect :



माता भूमि:पुत्रोऽहं पृथिव्या:

- ❑ **Varieties:** Difference in the strength of allelopathic effects between different crop varieties.
- ❑ **Specificity:** A crop which is strongly allelopathic against one weed may show little or no effect against another.
- ❑ **Autotoxicity:** Allelopathic chemicals may not only suppress the growth of other plant species, they can also suppress the germination or growth of seeds and plant of same species.
- ❑ **Crop on Crop Effect:** Residues from allelopathic crops can hinder germination and growth of following crops as well as Weeds
- ❑ **Environmental Factors:** Several factors impact the strength of the allelopathic effect. These include insect-pests and diseases and especially soil fertility. Low fertility increases the production of allelochemicals. After incorporation the allelopathic effect declines fastest in warm wet conditions and slowest in cold wet condition



माता भूमि:पुत्रोऽहं पृथिव्या:



# 1. Effect of Weed on Crop :

- *Agropyron repens (Quackgrass)*: maize and potato. Ethylene is generated in quackgrass rhizomes due to microbial activity in soil.
- *Avena fatua (Wild oat)*: winter annuals like wheat, barley and oats.
- *Cynodon dactylon (Bermunda grass)*: Barley
- *Cyperus esculentus (Yellow nut sedge)*: maize, soybean and orchards. the effect on soybean is due to the allelopathic compounds-vanillic acid, hydroxybenzoic acid in the yellow nut sedge extract.
- *Sorghum halepense*: sugarcane, maize, soybean etc.
- *Setaria viridis (Gaint foxtail)*: maize



## 2. Effect of Weed on Weed:



माता भूमि:पुत्रोऽहं पृथिव्याः

- *Impereta cylindrical*: annual broadleaf weed i.e. *Borreria hispada*(Button weed)
- *Soghum helepense*: *setaria viridis*, *Digitaria sanguinalis* (Large crabgrass) and *Amarantus spinosusi* (Spiny amarath)

## 3. Effect of Weed on Crop :

- *Coffea Arabica* (Coffee) release 1,3,7-trimethyxanthin which *inhibits* germination on *Amaranthus spinosus* (Spiny amaranth)
- *Zea mays* root extract increase catalase and peroxidise activity of the weeds which inhibits their growth. Oat, pea and wheat suppress the growth of *Chenopodium album*



# Competition Relationship



माता भूमि:पुत्रोऽहं पृथिव्याः

**Competition occur when two or more plants present in a given area demand a particular growth factor and the instantaneous supply of that factor falls below their combined demand.**

- **In plant communities, each individual is in continuous state of war to gain in its competition for various growth factors both under-ground and aboveground.**
- **Competition is relationship between two or more plants in Which supply of growth factors falls below their combined demand. The competition does not start as long as the growth factor is abundant in supply and does not fall below their combined demand.**
- **Competition offers negative effects to both species**



# Principles in Crop Competition



माता भूमि:पुत्रोऽहं पृथिव्या:

1. Competition is most serious when the crop plants are young e.g. in seedling to tillering, branching or early flowering stage.
2. Competition is likely greater between plants of similar morphology and growth behaviour.
3. Plant competition is both under-and above-ground.

**Mechanisms of competition : Soil resources reach the root surface through three general processes**

1. Root interception
2. Mass flow of water and nutrients
3. Diffusion.



## Mechanisms of competition



माता भूमि:पुत्रोऽहं पृथिव्या:

- 1. Root interception** is the capture of water and nutrients as the root grows through the soil, physically displacing soil particles and clay surfaces. In general, root interception accounts for less than 10% of resource uptake by roots and is the least important of the three processes.
- 2. Mass flow of water** and dissolved mineral nutrients is driven by plant transpiration and is a function of the rate of water movement to the root and the concentration of dissolved nutrients in the soil solution.
- 3. Diffusion of nutrients** toward the root occurs when nutrient uptake exceeds the supply by mass flow, creating a local concentration gradient. Diffusion is especially important for nutrients with large fractions bound to the solid soil matrix, such as potassium and phosphate, whereas mass flow is often more important for nitrogen, particularly nitrate.

**Department of Agronomy, CoA, JNKVV, Jabalpur- 482004**



# Different factors of production



माता भूमि: पुत्रोऽहं पृथिव्याः

- 1. Competition for nutrients :** Allowing weeds to compete with sorghum for 4 weeks when N was applied resulted in a 23% yield loss compared to keeping the crop weed free all through the season. However, if N applied, this period of competition caused a 69% yield loss.
- ❖ *Amaranthus viridis* accumulates 3.16% N apart from containing very high level of K<sub>2</sub>O (4.51%) in their dry matter and is thus a nitrophilus weed, whereas *Achyranthus aspera* and *Digitaria sanguinalis* are *P-accumulators* with P<sub>2</sub>O<sub>5</sub> content of 1.6% and 3.36%, respectively.
  - ❖ It is apparent that weeds absorb considerable amount of nutrients sometimes higher than the crop associated. This is mainly due to fact that crops are broadcasted or sown in rows with required density determined by seed rate, while weeds grow around the crop plants and there is no limit population.



## 2. Competition for water :



माता भूमि:पुत्रोऽहं पृथिव्या:

- ❑ Weed removed moisture evenly from 90 cm soil depth, while the major uptake of moisture by heat was limited to top 15cm of soil.
- ❑ For producing equal dry matter, weeds transpire more water than do most of our crop plants.
- ❑ C4 plants having higher water use efficiency are better competitor with crop plants than C3 plants.
- ❑ Water competition is more in rainfed areas compare to humid or well irrigated areas.
- ❑ If there is very high density of plants than there is higher competition for limited water.
- ❑ A plant have good root development and deeper rooting habit is more competitive than one which have shallow root system



### 3. Competition for light :



माता भूमिः पुत्रोऽहं पृथिव्याः

Light constitute a key external variable of the photosynthesis process of plants.

- ✓ It varies in duration, intensity and quality and regulates many aspects of plant growth and development. The sites for light competition are leaves.
- ✓ The leaves that first intercept light may reflect it, absorb it, convert it into photosynthetic products and heat or transmit it. Once a leaf is shaded by another leaf, there starts competition for light.
- ✓ Neighbouring plant reduces light supply by direct interception and shading.
- ✓ Plant architecture, especially height, location of branches and height of maximum leaf area determine competition for light and influence crop yield.
- ✓ Competition for light may even begin at the very early stage of crop if there is a smothering effect by dense and crowd growth of weeds.



माता भूमि:पुत्रोऽहं पृथिव्या:

**It may become more severe, if moisture and nutrient in soil are plentiful and weeds have an edge over crop plants in respect of height.**

- ✓ **Plant height and vertical leaf area distribution define effective components of the competitive struggle for light. Tall and dwarf cultivars of rice and wheat vary widely in their competitive abilities for light.**
- ✓ **Tall cultivars because of their greater height are normally superior to dwarf cultivars in competition against weeds.**
- ✓ **Broad-leaved plants, on the contrary, being normally short stature than other plants, weaker competitor of light. There is varietal difference in response to competition for light.**
- ✓ **Straw yield is primarily influenced by root competition, whereas grain yield is most affected by light.**



## 4. Competition for space :



माता भूमि:पुत्रोऽहं पृथिव्या:

The competition for space increases when plants starts growing both above-and below-ground.

Dawson (1965) opined that critical time of interference would occur among neighboring plants based on the time of emergence and physiological factors governing growth.

If the measure are taken for controlling weeds, it should be exercised when there is enough space available for capture so that crop can translate/convert the benefit of weed control/weeding into its growth and yield. inter-specific/intergeneric competition, intra-specific competition or both competition together may occur based on density of crop and weeds, initial canopy coverage and how fast is the available space getting occupied by them.

The severity of competition, however, depends on the time of their emergence, nature of weeds total plant density, growth and development pattern of weeds and crop.



# Factors affecting plant competition



माता भूमि:पुत्रोऽहं पृथिव्याः

- 1. Weed factors:** Weed species, density, dry weight, onset and duration of weed association with crop, plant architecture (height and growing habit, nature and orientation of leaf, tillering/branching, root system) total growing duration etc.
- 2. Crop factors:** Crop species, variety, density and seedling vigour, plant architecture, total growing duration etc.
- 3. Environmental factors:** Climate (temperature, light, rainfall, humidity, cloudiness), soil (fertility, pH, moisture, texture, structure, topography), biotic stress (insect pest, diseases, nematodes etc.).
- 4. Human/crop management factors:** Tillage, time, method, rate and depth of planting, spacing, cropping pattern, fertilization, irrigation, insect pests and diseases control.

**Department of Agronomy, CoA, JNKVV, Jabalpur- 482004**



# Annidation



माता भूमिःपुत्रोऽहं पृथिव्याः

It refer to the complementary interaction which occur both in space and time

**A. Annidation in space :** The canopies of component crops may occupy different vertical layers with taller component tolerant to strong light and high evoparative demand and the shorter component favouring shade and high relative humidity. Multistoreyed cropping in coconet and planting shade trees uncooca and tea plantation use this principle.

**B. Annidation in time :** When component crops of widely varying duration are planted there peak demand for light and nutrients are likely to occur at different of periods thus reducing competition. In a combination having early and late maturing crops when early maturing crops are harvested condition become favorable for the late maturing crop to put forth its full vigour.



# Multi-story/Multi-tier Cropping:



माता भूमि:पुत्रोऽहं पृथिव्या:

It is a system of growing together, crops of different heights at the same time on the same piece of land and thus using land, water, and space most efficiently and economically i.e coconut + pepper + pineapple + grass.



**Department of Agronomy, CoA, JNKVV, Jabalpur- 482004**



माता भूमि:पुत्रोऽहं पृथिव्याः

# Advantages of Multistorey cropping



- **Better use of growth resources including light, nutrient and water.**
- **Suppression of weeds reduced plant and disease incidence yield stability.**
- **Ecological stability i.e improvement of soil health and agro-ecosystem.**
- **Other e.g. spreading of labour, physical support of one crop to another and home gardening leading to amore pluriform food supply is a good example of realization of multistory advantages.**



माता भूमि:पुत्रोऽहं पृथिव्याः

# Disadvantages of Multistory cropping



- Labor intensive.
- Control of pest and disease or chemical weed control may be difficult.
- Mechanization is difficult to realize.
- Disadvantages caused by adverse competitive effect or by allelopathy



माता भूमि:पुत्रोऽहं पृथिव्या:

# Yield stability in intercropping system Sorghum based systems



Photo 1 . SORGHUM+ PIGEONPEA



Photo 2. GROUNDNUT +SORGHUM

**Department of Agronomy, CoA, JNKVV, Jabalpur- 482004**



# Role of Non-Monetary Inputs in Crop Production



माता भूमि:पुत्रोऽहं पृथिव्याः

1. **Variety**
2. **Planting time**
3. **Biofertilizers**
4. **Farm Yard Manure**
5. **Vermicompost**
6. **No-till farming**
7. **Mulching (crop residue obtained from field)**
8. **Irrigation (rainfall)**
9. **Use of neem leaves for cereal crop storage**
10. **Sun drying**
11. **Panchgavya (made by curd + ghee + cow urine+ cow milk+ cow dung)**
12. **Agronomic practices**
13. **Timely sowing**
14. **Optimum plant**



# Research needs in sustainable agriculture :



माता भूमि:पुत्रोऽहं पृथिव्या:

**Sustainability rests on the principle that we must meet the needs of the present without compromising the ability of future generations to meet their own needs.**

- ✓ **Stewardship of human resources includes consideration of social responsibilities such as working and living conditions of laborers, the needs of rural communities, and consumer health and safety both in the present and future.**
- ✓ **Stewardship of land and natural resources involves maintaining or enhancing this vital resource base for the long term.**
- ✓ **Sustainable agriculture integrates three main goals-**
  - 1.Environmental Health**
  - 2.Economic Profitability**
  - 3.Social and economic equity.**



# Strategy for Research on Sustainable Agriculture



माता भूमिः पुत्रोऽहं पृथिव्याः

## The 4 main components are :

1. A facility to capitalise on the achievements of DFID's current and past investment in RNR research.
2. Four regional research programmes (East, West and Southern Africa and South Asia).
3. International agricultural research to deliver high quality and effective international public goods to tackle poverty reduction and achieve sustainable growth. The majority of this support is channeled through the 15 centres and 4 challenge programmes of the Consultative Group on International Agricultural Research (CGIAR).
4. A responsive programme in partnership with UK research councils to support long-term basic/fundamental research linked to applied research in southern based organizations



*Thank you*



माता भूमिःपुत्रोऽहं पृथिव्याः



## **Agron 511- Cropping System And Sustainable Agriculture (2+0)**

**Crop diversification for sustainability, role of organic matter in maintenance of soil fertility, crop residue management, fertiliser use efficiency and concept of fertiliser use in intensive cropping system**

***Prof. K. K. Agrawal***

**Principal Scientist**

**Mob.- 9425163385**

**Department of Agronomy, CoA, JNKVV, Jabalpur- 482004**



# Concept of crop diversification



माता भूमि:पुत्रोऽहं पृथिव्याः

**In agriculture diversification refers to the addition of new crops or enterprises with or without the addition a shift from one crop or enterprise in a production system.**

- ❖ **Crop diversification needs to sustain the production system of the region by enhancing the soil health, reducing biotic and abiotic stresses and increasing employment generation.**
- ❖ **Crop diversification also refers to bringing about a desirable change in the existing cropping patterns towards a more balanced cropping system to meet the ever increasing demand for food.**
- ❖ **The changes suggested should be technologically feasible and economically viable.**



**Lack of diversification in our crops and cropping system has posed never ending problems of significance, that mainly include :**



- **Excessive use of water resources (as in case of rice) leading to poor water use efficiency**
- **Deterioration in soil health**
- **Multiplication of diseases, pests and weeds**
- **Unplanned consumption of energy**
- **Reduction in the availability of other protective food and high value crops**
- **Pollution of the ecosystem**



# Crop diversification can be approached in two ways



## 1. HORIZONTAL CROP DIVERSIFICATION :

Cultivation of field crops in rice fields or growing various types of other crops in uplands have been defined as crop diversification. This type of crop diversification means the broadening of the base of the system, simply by adding more crops to the existing cropping system utilizing techniques such as multiple cropping techniques coupled with other efficient management practice.

## 2. VERTICAL CROP DIVERSIFICATION:

In which various other downstream activities are undertaken. This could be illustrated by using any crop species, which could be refined to manufactured products, such as fruits, which are canned or manufactured into juices or syrups as the case may be. Vertical crop diversification will reflect the extent and stage of industrialization of the crops.



## Advantages of crop diversification



माता भूमिःपुत्रोऽहं पृथिव्याः

**Crop substitution and adjustment are linked to the main concept of crop diversification and are strategies often used to maximize profit of growing varieties of crops.**

- ◆ • **Comparatively high net return from crops**
- ◆ • **Higher net returns per unit of labour**
- ◆ • **Optimization of resource use**
- ◆ • **Higher land utilization efficiency**
- ◆ • **Increased job opportunities**



माता भूमि:पुत्रोऽहं पृथिव्याः

# Need for diversification



**The main goal of crop diversification is to stabilize farm income and promote better farm linkages among primary, secondary and tertiary sectors of economic activity. The major reasons which highlight to need for adopting diversification are as under**

- 1. Conservation of natural resources**
- 2. Combat ill-effects of aberrant weather**
- 3. More income to marginal farmers**
- 4. Provide employment opportunities**
- 5. Diversify food basket**
- 6. Withstand price fluctuations**
- 7. Reduce dependence on outside supply**
- 8. Promote export possibilities**



माता भूमिः पुत्रोऽहं पृथिव्याः

# Factors affecting diversification



- a) Climatic features of the area
- b) Crop physiology
- c) Suitability of the crop in rotation
- d) Effect on employment
- e) Local demand of the new crop
- f) Proper utilization of the natural resources
- g) Crop adaptability in the introducing area
- h) Market availability for newly introduced crop
- i) Utilization of the by-products



माता भूमि:पुत्रोऽहं पृथिव्या:

**The major problems and constraints in crop diversification are primarily due to the following reasons with varied degrees of influence:**

- 1. Over 117 m/ha (63 percent) of the cropped area in the country is completely dependent on rainfall.**
- 2. Sub-optimal and over-use of resources like land and water resources, causing a negative impact on the environment and sustainability of agriculture.**
- 3. Inadequate supply of seeds and plants of improved cultivars. Fragmentation of land holding less favoring modernization and mechanization of agriculture.**
- 4. Poor basic infrastructure like rural roads, power, transport, communication**



माता भूमि:पुत्रोऽहं पृथिव्या:

4. **Inadequate post-harvest technologies and inadequate infrastructure for postharvest handling of perishable horticultural produce.**
5. **Very weak agro-based industry.**
6. **Weak research - extension - farmer linkages.**
7. **Inadequately trained human resources together with persistent and large scale illiteracy amongst farmers.**
8. **Host of diseases and pests affecting most crop plants.**
9. **Poor database for horticultural crops.**
10. **Decreased investments in the agricultural sector over the years.**



## Advantages:



### Role of organic matter in maintenance of soil fertility and Crop residue management

- (1) They supply plant nutrients including micronutrients.
- (2) They improve soil physical properties like structure, water holding capacity etc.
- (3) They increase the availability of nutrients.
- (4) Carbon dioxide released during decomposition acts as a CO<sub>2</sub> fertilizer.
- (5) Plant parasitic nematodes and fungi are controlled to some extent by altering the balance of microorganisms in the soil.



माता भूमिः पुत्रोऽहं पृथिव्याः

**Effect of Soil Organic Matter on Physical properties of soil :** Yin-Po Wang and Chen- Ching Chao (1995) reported that the bulk density, total porosity and aggregate stability of surface soil improved by the organic farming and this can be attributed to the higher organic matter levels of the organic farming soil.

**Soil Chemical properties:** application of green manure continuously after four cropping cycles, the soil pH of the organic farming increased to as high as 7.6 to 8.3 than conventional farming (pH 5.7 to 6.6).

**Soil Microbial Population :** Organic farming have direct contribution to soil organic matter levels thereby increase the microbial population. Scullion and Ram Shaw (1987) showed that earth worm populations increased due to FYM application. Application of poultry manure encourages costing and burrowing to the surface whereas application of inorganic fertilizers of high rates discouraged these activities.



## Effect on Organic Carbon and micronutrients:



माता भूमि:पुत्रोऽहं पृथिव्या:

**Biswas *et al* (1971) earlier and Kanwar and Prihar (1992) reported that continuous application of FYM increased the organic carbon content as well as nitrogen contents.**

- ❖ **Yadav (1995) reported that press mud application increases the organic carbon content.**
- ❖ **Continuous application of FYM at 15 t ha<sup>-1</sup> for 3 years increased zinc level from 0.48 to 0.87 percent (Radhav and Takakar. 1975).**
- ❖ **Biogas slurry poultry manure compost and pressmud have been found to be superior sources of Zn a compared to Zinc sulphate particularly in Zn deficient calcareous soil (Prasad *et al.* 1981, 1984, 1985).**
- ❖ **Azolla incorporation increased the availability of Fe and Mn in soils (Sing 1992).**



# Advantages of Crop residue management on physical properties of soil



- 1. Soil structure:** Favor the formation of aggregates due to addition of organic matter to the soil structural stability increase due to straw addition & better aggregate size distribution occurs due to a reduction in soil disturbance crop residues.
- 2. Bulk Density & porosity:** Low bulk density so incorporation of straw with FYM reduces the bulk density of soil & increase the porosity of the soils.
- 3. Hydraulic conductivity:** Crop residues increase hydraulic conductivity by modifying soil structure microspores & aggregate stability
- 4. Soil temperature:** Mulching with plant residues raised the minimum soil temp. in winter due to reduction in upward heat flux from soil & decrease soil temp. during summer due to shading effect.



माता भूमि:पुत्रोऽहं पृथिव्या:



**5. Soil Moisture : Reduces evaporation rate due to increase in amount of residues on the soil surface.**

## **Advantages of residue management on chemical properties of soil**

- 1.Organic carbon: Increases with continuous O. M. addition**
- 2. Soil pH: Increases soil pH significantly by decarboxylation of organic anions an exchange & addition of basic cations.**
- 3. C.E.C.: Soil O.M. as reservoir for plant nutrients essential prevents leaching of elements, required for growth.  
Addition of residues increases C.E.C.**



माता भूमि:पुत्रोऽहं पृथिव्या:

## Advantages of crop residue management on Biological properties of soil :



It provides energy for growth & activities of microbes & substrates for microbial biomass.

- a) Provide suitable environment for Biological N – fixation,
- b) Enzymes \*Microbial biomass, dehydrogenase & alkaline phosphatase activities increase in sandy loam soil.
- c) Microbial population: Increase microbial biomass & it can enhance nutrients availability in soil as well as the microbial biomass act as sink & source of plant nutrients.

The importance of SOM for sustainable maximum economic production through INM can never be underestimated.

- O.M. is a dynamic material changing physical, chemical & biological properties, fertility & productivity.
- Organic inputs are essential for promoting organic farming. Therefore, it is essential to regularly monitor the changes in soil health for sustained productivity.



# Fertilizer use efficiency and concept of fertilizer use in intensive cropping system



## Management Practices to increase FUE

1. Best fertilizer source
2. Adequate rate & diagnostic techniques
3. Proper method & right time of fertilizer application
4. Balanced fertilization
5. Nutrient interrelationships
6. Integrated nutrient management
7. Time of seeding of crops
8. Utilization of residual nutrients



# Best fertilizer source :



1. Nitrogen : Ammoniacal vs Nitrate
2. Phosphorus : Water soluble vs Citrate soluble
3. Potassium : Muriate of Potash
4. Sulphur : Sulphate vs Elemental S
5. Multinutrient : MAP,DAP,SSP, Sulphate vs Elemental S fertilizers
6. Multinutrient mixures : Several combinations of NPK
7. Fortified fertilizers :Neem coated urea,zincated urea, boronated SSP,AP+S,NPKS mix



माता भूमि:पुत्रोऽहं पृथिव्याः

# Adequate rate and diagnostic technique



## Soil-test based fertilizer recommendations (STRD)

### i. Soil-test crop response based recommendation (STCR)

### ii. Plant analysis for diagnosing nutrient deficiencies

### iii. Chlorophyll meter and Leaf color charts

#### Balanced fertilization

a) Adequate supply of all essential nutrients

b) Nutrient interrelationships

c) Proper method of application

d) Right time of application

**Department of Agronomy, CoA, JNKVV, Jabalpur- 482004**



# Appropriate time of fertilizer application



माता भूमि: पुत्रोऽहं पृथिव्याः

<b>Upland crops</b>	<b>2 splits</b> <b>(seeding, 3-5 wk)</b>
<b>o Flooded rice</b>	<b>3 splits</b> <b>Transplanting</b> <b>3 and 6 wk</b>

## Proper method of fertilizer application

- N, K - Broadcast, band placement
- P - WSP as band placement in neutral & alkaline soils
- CS as broadcast in acidic soils
- S - Sulphate as broadcast/band,
- Elemental, pyrite as broadcast
- Micronutrients – Foliar sprays



# Balance fertilization and nutrient use efficiency



Crop	Soil type/ Location	N recovery (%)			P recovery	
		N	NP	NPK	NP	NPK
Maize	Inseptisol/ Ludhiana	16.7	23.5	36.4	10.3	21.4
Wheat		32.0	50.6	63.1	20.6	30.7
Maize	Alfisol/ Palampur	6.4	34.7	52.6	21.8	35.6
Wheat		1.9	35.6	50.6	10.7	15.2
Rice	Mollisol/ Panthnagar	37.5 4	40.7	44.4	18.2	23.3
Wheat		42.4	46.1	48.4	11.2	10.4



# INM of fertilizer, green manure and crop residues in rice



माता भूमिः पुत्रोऽहं पृथिव्याः

Treatment	Rice Yield t/ha	Denitrification losses Kg/ha	N <sub>2</sub> O Emission Kg/ha	Nitrate Leaching Kg/ha	Soil organic C g/kg
Control	3.4	18	6.9	59	3.7
120 kg N/ha	5.6	58	12.4	94	3.7
GM20 + 32 kg N/ha	5.9	50	11.8	78	4.1
CR6 + GM20 + 32 kg N/ha	5.9	52	11.8		4.9
LSD (0.05)	0.2	6	3.4	12	0.4



माता भूमि:पुत्रोऽहं पृथिव्या:

## Strategies for efficient utilization of residual nutrients



- Climatic conditions & carry-over effects
- Cereal-legume rotations
- Shallow-deep rooted crop rotations

# For Improving Nutrient Use Efficiency and Sustaining Soil Health



माता भूमि:पुत्रोऽहं पृथिव्याः



- ⇒ **Soil-test based fertilizer use**
- ⇒ **Appropriate source, time & method**
- ⇒ **Balanced use of fertilizers**
- ⇒ **Integrated nutrient management**
- ⇒ **Recycling of crop residues and agricultural waste**



*Thank you*