Weeds

Plants are differentiated into

a) Crops : which met the needs of human being
b) Weeds : which compete or interfere in human affairs.

Jethrotull, is the first person to use the word WEED.

Several definitions were given on weeds and the most common ones are

A plant growing where it is not required.

Plant out of place.

Weed is an unwanted plant.

Weeds are the plants growing in place and at times when we wanted either some other plants to grow or no plants to grow at all.

Weeds are unwanted and undesirable plants that interfere with utilization of land and water resources and thus adversely affect crop production and human welfare.

Weeds compete with crop plants for water, nutrients, light, space / atmosphere (CO_2) and thus reduce the crop yields.

A plant of oat in the field of wheat can also be a weed. However, a plant which doesn't interfere with the utilization of land, water and other resources can't be considered as a weed. Hence, plants listed as weeds are qualified based on the situation.

Origin of weeds : Weeds originated together with crop plants. They have been there since the man started cultivating crops about 10,000 BC. Man during his stage of development, explored certain crop plant to suit his own taste and fancy and cultivated them as '**crops**'. The unexplored / unwanted / troublesome plants which are interfering with his activities are considered as weeds. About 30,000 plants species have been identified as definite weeds in the World. Which are infesting crop lands, water bodies, gardens, orchards, road sides, railway lines, irrigation channels etc.

It is widely known that, losses caused by weeds exceed the losses from any other agricultural pests such as insects, diseases.

In India, weeds accounts for a losses as high as 45%. While loss by other pests are : Insects – 30%, Diseases – 20%, and others – 5%. Recent estimates indicate that, weeds cause an annual loss of Rs. 2000 /- crores to Indian Agriculture.

Characteristics of weeds :

Nature has given the following characters for survival of weeds.

1. Most weeds are prolific seed producers : Annual and biennialweeds reproduce mainly through seeds. Most of these weeds produce abundant seeds (300 – 400 times higher) compared to crop plants. Further, weed seeds are smaller in size and

dispersal / spread very easily.

Table : Comparison of seed producing capacity of weeds and crop plants

Crop	No. of seeds / plant	Weed	No. of seeds / weed
Rice	100 – 120	*Echinocloa colanum*	43,000
Wheat	90 – 100	*Phalaris minor*	3,000 – 5,000
		Chenopodium album	10,000 – 15,000

2. **Dormancy :** Weed seeds undergo dormancy for few days to several years till satisfactory micro-climate prevails. This serves as a survival mechanism for weeds.

3. Some weeds **propagate vegetatively** : Herbaceous perennials propagate vegetatvively through stolons, rhizomes, tubers, bulbs, corms etc.

4. **Dispersal / spread** : Weed seeds are smaller in size and are easily spread through wind, water, animal, birds, implements, human being etc and are considered as self sown plants.

5. Weeds are **hardy** and resist to adverse climate, soil, pest and diseases scenarios. Hence they are persistent.

6. Weeds are **evasive (slippery)** in nature because of their bitter taste, disagreeable odour, spiny nature and mimicry.

7. Weeds seeds **germinate faster** and earlier to crop plants. Their seedling grow faster and compete with crop plants.

8. They have **short life span** than crop plants and mature early.

9. Weeds processes **extensive deep root** system (they can survive and grow under moisture stress condition .

10. Most weeds processes **C_4 type** of photosynthetic pathway.

11. **Mimicry** : Certain weeds express morphological similarity with associated crop plants.

Weeds are competitive and aggressive in nature attributing to their deep root system, C_4 Pathway, early sprouting and maturity, resistance to adverse conditions, evasiveness and dormancy.

Losses caused by weeds

A. Reduction in crop yield

Weeds compete with crop plants for nutrients, soil moisture, space and sunlight. In

general an increase in one kilogram weed growth corresponds to reduction in one kilogram of crop growth. The loss in crop yield varies depending on type of weed, intensity of infestation, period of infestation, the ability of crop to compete and climatic conditions.

Table : Yield losses due to weeds in some important crops

Crop	Yield loss range (%)	Crop	Yield loss range (%)
Rice	9.1 – 51.4	Sugarcane	14.1 – 71.7
Wheat	6.3 – 34.8	Linseed	30.9 – 39.1
Maize	29.5 – 74.0	Cotton	20.7 – 61.0
Millets	6.2 – 81.9	Carrot	70.2 – 78.0
Groundnut	29.7 – 32.9	Peas	25.3 – 35.5

B. Reduction in quality of farm produce

A crop may have to be rejected if it contains weed seeds when it is grown for seed purpose. For example, the wild oat weed seeds are similar in size and shape of the crops like barley, wheat, and its admixture may lead to rejection for seed purpose. Contamination by poisonous weed seeds is unacceptable and increases costs of crop cleaning and fetches low price. The leafy vegetables much suffers due to weed problem as the leafy weed mixture spoil the economic value. In tea plantation, presence of Loranthus (*Dendrophthoe falcate*) leaves impairs its quality. In cotton, dry weed fragments adhere to its lint and hinder its ginning process.

C. Weeds harbour pest and diseases and in turn increase cost of production

Weeds serve as alternate hosts to several insect pests, nematodes and pathogens. Insect such as aphids, thrips, weevils etc., survive on weeds during off-season and transmit to crops in regular season and thus increase the cost of their management. Some example of weeds acting as alternate host of crop pest and diseases are

Weed Host		Insect pest / disease organism hosted	Crops affected
INSECTS	*Chenopodium album*	Stem borer	Tomato, Maize, Chilli
	Chenopodium album Amaranthus spp.&Datura spp.	Gram caterpillar	Redgram, Cotton, Okra, Pea, Tomato, Brinjal
	Digeria arvensis & *Amaranthus spp*	Caterpillars	Tobacco
	Amaranthus spp & *Salvia spp*	Thrips	Onion
DISEASES	*Cynodon doctylon* & *Digitaria spp*	Sting nematode	Vegetables
	Centurus ciliaris	Ergot	Pearl millet
	Daucas carota	Blight	Carrot
	Saccharum spontaneum	Downy mildew	Maize
	Leersia oryzoides	Bacterial blight	Rices
	Panicum repens	Blast	Rice

	Wild oat	Stem rust	Wheat, Oat, Barley

D. **Interference in crop handling**

Some weeds can make the operation of agricultural machinery more difficult, more costly and even impossible. Heavy infestation of *Cynadon dactylon* causes poor ploughing performance

E. Reduction in land value

Heavy infestation by perennial weeds could make the land unsuitable are less suitable for cultivation resulting in loss in its monetary value. Thousands of hectare of cultivable area in rice growing regions of India have been abandoned or not being regularly cultivated due to severe infestation of nutgrass (*Cyperus rotundus*) and other perennial grasses.

F. Limitation of crop choice

When certain weeds are heavily infested, it will limit the growth of a particular crop. The high infestation of parasitic weeds such as *Striga spp* may limit the growing of sorghum or sugarcane. While, *Orabanche* limits the choice of tobacco, tomato and other solanaceous crops.

G. Loss of human efficiency

Weeds reduce human efficiency through physical discomfort caused by allergies and poisoning. Weeds such as congress weed (*Parthenium hysterophorus*) causes itching. Thorny weeds like *Amaranthus spinosus, Argemone mexicana etc*. restrict the moment of farm workers in carrying out farm practices such as fertilizer application, insect and disease control measures, irrigation, harvesting etc.

H. Problems due to aquatic weeds

The aquatic weeds that grow along the irrigation canals, channels and streams restrict the flow of water. Weed obstruction cause reduction in velocity of flow and increases stagnation of water and may lead to high siltation, flooding, seepage to adjoining areas, break canal banks, and reducedcarrying capacity. Aquatic weeds form breeding grounds for obnoxious insects like mosquitoes. They reduce recreational value by interfering with fishing, swimming, boating, hunting and navigation on streams and canals.

I. Deteriorate the aesthetic value

Presence of weeds around living and working places makes the surrounding dull and

insipid.

J. Weed menace in Animal husbandry

When some hungry animals are forced to feed on weedy forage, their meat and milk get odd flavoured and tainted. Certain weeds like *Euphorbia simplex, Lepidium sativa, Cleome viscose* impart an undesirable smell to milk upon feeding to cattle. Certain weeds like *Centurus spp., Achyranrthus aspera* entangled to hairs / wool of animals (sheep) and reduce the quality of wool.

Certain weeds cause sickness in farm animals due to the presence of alkaloids, tannins, oxalates, glucosides or nitrates. Johnson grass (*Sorghum halopense*) at its tillering stage and *Xanthium pungens* at its cotyledonous stage are poisonous to animal due to their high Prussic acid content.

K. Weed menace in human health

Health, comfort and work efficiency of man are adversely affected by weeds. Numerous people are plagued year after year with hay fewer and asthama aggravated by pollens of *Ambrosia artimissifolia* and *Fraseria spp.Parthenium hysterophorus* is resposnsible for allergy. Mexican poppy *(Argemone mexicana*) seeds crushed with mustard seeds have brought death and blindness to thousands of people.

L. Weed menace to industry and public utilities

Weeds growing in industrial sites are potential source of fire hazards. Also, they block pipelines, roads line, electric poles etc reduce their easy access.

M. Other problems

Weeds are troublesome not only in crop plants but also in play grounds and road / railway sides etc. *Alternanthera echinata* and *Tribulus terresstris* occurs in many of the playgrounds causing annoyance to players and spectators.

ECONOMIC USES OF WEEDS

a. Weeds are indirectly **responsible for crop cultivation**. Crops were taken care partly through disturbing soil to manage weeds of weeds.

b. **As manure**: When weeds are ploughed, they add plenty of humus to the soil. Excellent compost can be made out of many weed plants. e.g. *Calotropis gigantea*, *Croton sparsiflorus* and *Tephrosia purpurea* are used as green leaf manure for rice.

c. **As human food**: Weeds serve as human food e.g. *Amaranthus viridis* and *Digera arvensis* used as greens.

d. **As fodder**: Most weeds are eaten by cattle and weeds like *Rynchosia aurea*, *R.*

capitata and *Clitoria terneata* are very good fodder legumes.

e. **As fuel**: *Prosopis juliflora* very invasive in nature and notorious tree weed commonly used as fire wood. People make charcoal out of it and are marketed.

f. **As soil binders**: *Panicum repens* is an excellent soil binder; keeps bunds in position and prevents soil erosion. We can also use Hariyali (*Cynodon doctylon)*.

g. **As medicine**: Many weeds have great therapeutic properties and used as medicine.

Eg. *Phyllanthus niruri* – Jaundice
Leucas aspera – Snake bite
Centella asiatica – Improves memory
Eclipta alba - Scorpion sting
Cynodon dactylon – Asthma, piles
Cyperus rotundus – Stimulates milk secretion

h. **As mats and screens:** Stems of *Cyperus spp* are used for mat making while *Typha angustata* is used for making screens.

i. **As indicators:** Weeds are useful as indicators of good and bad soils. *E. colonum* occurs in rich soils while *Cymbopogon* denotes poor soil and Sedges are found in ill-drained soils.

j. **As pesticidal :** Incorporation of *Crotalaria, Parthenium, Calotrophis, Eichornea spp* into the soil reduce root knot nematode population.

CLASSIFICATION OF WEEDS:

Out of 2,50,000 plant species, weeds constitute about 250 species, which are prominent in agricultural and non-agricultural system. Under world conditions about 30,000 species is grouped as weeds and 18,000 species cause serious problems.

There are many ways weeds can be grouped for convenience of planning, interpreting or suggesting appropriate weed management practices. Some important classifications of weeds usedby weed scientists worldwide are discussed below.

I. Based on life span or Ontogeny

Based on life span (Ontogeny), weeds are classified as Annual weeds, Biennial weeds and Perennial weeds.

(a) Annual Weeds: Those that live only for a season or year and complete their life cycle in that season or year is called annuals.

These are small herbs with shallow roots and weak stem. Produces seeds in profusion and the mode of propagation is commonly through seeds. After seeding the annuals die away and the seeds germinate and start the next generation in the next season or year following.

Based on the growing season, annuals are further classified as

i). *Kharif* annuals : *Leucas aspera, Digitaria marginata, Eleusine indica*

ii). Winter or Rabi annuals : *Phalaris minor, Avena fetua, Chenopodium album*

iii) Summer annuals : *Amaranthus spp.* & most of *Kharif annuals*

Plants which complete their life cycle with in very short span are called **Epimerales.** Eg. *Phyllanthus niruri*

(b) Biennials: It completes the vegetative growth in the first season, flower and set seeds in the succeeding season and then dies. These are found mainly in non-cropped areas. They are easy to manage as we can control during vegetative period. Eg. *Alternanthera echinata, Daucus carota, Melilotus alba*

(c) Perennials: Perennials live for more than two years and may live almost indefinitely. They adapted to withstand adverse conditions. They propagate not only through seeds but also by underground stem, root, rhizomes, tubers etc. And hence they are further classified into

i. Simple perennials: Plants propagated only by seeds. Eg. *Sonchus arvensis*

ii. Bulbous perennials: Plants which possess a modified stem with scales and reproduce mainly from bulbs and seeds. Eg. *Allium* sp.

iii. Corm perennials: Plants that possess a modified shoot and fleshy stem and reproduce through corm and seeds. Eg. *Timothy* sp., wild garlic, agave

iv. Creeping perennials: Reproduced through seeds as well as with one of the following.

*a.***Rhizome**: Plants having underground stem – *Sorghum halapense*

b.**Stolon**: Plants having horizontal creeping stem above the ground – *Cynodon dactylon*

c.**Roots**: Plants having enlarged root system with numerous buds – *Convolvulus arvensis*

d.**Tubers**: Plants having modified rhizomes for storage of food – *Cyperus rotundus*

II. Based on ecological affinities:

a. Wetland weeds: They are tender annuals with semi-aquatic habit. They can thrive as well under waterlogged and in partially dry condition. Propagation is chiefly by seed. Eg. *Ammania baccifera, Eclipta alba*

b. Garden land weeds (Irrigated lands): These weeds neither require large quantities of water like wetland weeds nor can they successfully withstand extreme drought as dryland weeds Eg. *Trianthema portulacastrum, Digera arvensis*

c. Dry lands weeds: These are usually hardy plants with deep root system. They are adapted to withstand drought on account of mucilaginous nature of the stem and

hairiness. Eg. *Tribulus terrestris, Convolvulus arvensis*

III. Based on soil type (Edaphic):

(a)Weeds of black cotton soil: These are often closely allied to those that grow in dry condition. Eg., *Aristolochia bracteata*

(b) Weeds of red soils: They are like the weeds of garden lands consisting of various classes of plants. Eg. *Commelina benghalensis*

(c) Weeds of light, sandy or loamy soils: Weeds that occur in soils having good drainage. Eg. *Leucas aspera*

(d) Weeds of laterite soils: Eg. *Lantana camara, Spergula arvensis*

IV. Based on place of occurrence

(a) Weeds of crop lands: The majority of weeds infest the cultivated lands and cause hindrance to the farmers for successful crop production. Eg. *Phalaris minor* in wheat

(b) Plantation weeds : Occurring in plantation area Eg.: *Lantana camara, Chromelina bengalensis*,Loranthus

(c) Forest and wood land weeds

(d) Garden land weeds

(e) Weeds of Grass land or Range land or pasture lands: Weeds found in pasture / grazing grounds. Eg. *Indigofera enneaphylla*

(f) Weeds of fallow and non-cropped waste places: Corners of fields, margins of channels, industrial areas etc., where weeds grow in profusion. Eg. *Gynandropsis pentaphylla*, *Calotropis gigantea*

(g) Weeds of playgrounds, road-sides: They are usually hardy, prostrate perennials, capable of withstanding any amount of trampling. Eg. *Alternanthera echinata, Tribulus terestris*

(h) Aquatic weeds : Eg : *Eicorrnea crossiptes*

E. Based on Origin

F. **(a) Indigenous weeds:** All the native weeds of the country are coming under this group and most of the weeds are indigenous. Eg. *Acalypha indica, Abutilon indicum*

(b) Introduced or Exotic weeds: These are the weeds introduced from other countries. These weeds are normally troublesome and control becomes difficult. Eg., *Parthenium hysterophorus, Phalaris minor, Acanthospermum hispidum*

Invasive weeds:

Weeds (Plants) that do not occur naturally in a region but proliferate in the area they have been introduced into, and causeseveral negative impacts (such as affecting native biodiveristy, causing economic losses and harming human health) in these new habitats, are called invasive weeds (plants).

VI. Based on cotyledon character

Based on number of cotyledons it possess it can be classified as dicots and monocots.

(a) Monocots Eg. *Panicum flavidum, Echinochloa colona*

(b) Dicots Eg. *Crotalaria verucosa, Indigofera viscosa*

VII. Based on soil pH

Based on pH of the soil the weeds can be classified into three categories.

(a) Acidophile – Acid soil weeds eg. *Rumex acetosella*

(b) Basophile – Saline & alkaline soil weeds eg. *Taraxacum stricta*

(c) Neutrophile – Weeds of neutral soils eg *Acalypha indica*

VIII. Based on morphology

Based on the morphology of the plant, the weeds are also classified in to three categories. This is the most widely used classification by the weed scientists.

(a) Grasses: All the weeds come under the family Poaceae are called as grasses which are characteristically having long narrow spiny leaves. The examples are *Echinocloa colonum, Cynodon dactylon*

(b) Sedges: The weeds belonging to the family Cyperaceae come under this group. Stems are solid and triangular in cross section. The leaves are mostly from the base having modified stem with or without tubers. They are distinguished from grasses by having no joints in the stem. They grow in marshy or swampy areas. The examples are *Cyperus rotundus, Fimbrystylis miliaceae*

(c) Broad leaved weeds: All dicotyledonous weeds are broad leaved with netted venation. The examples are *Flavaria australacica, Digera arvensis*

IX. Based on nature of stem

Based on development of bark tissues on their stems and branches, weeds are classified as woody, semi-woody and herbaceous species.

(a) **Woody weeds:** Weeds include shrubs and undershrubs and are collectively called brush weeds. Eg. *Lantana camera, Prosopis juliflora*

(b) **Semi-woody weeds**: eg.*Croton sparsiflorus*

(c) **Herbaceous weeds**: Weeds have green, succulent stems are of most common occurrence around us. Eg. *Amaranthus viridis*

X. Based on specificity

Besides the various classes of weeds, a few others deserve special attention due to their specificity. They are;

a. Poisonous weeds:

b. Parasitic weeds

c. Aquatic weeds

a. Poisonous weeds: The poisonous weeds cause ailment on livestock resulting in death and cause great loss. These weeds are harvested along with fodder or grass and fed to cattle or while grazing the cattle consumes these poisonous plants. Eg. *Datura fastuosa, D. stramonium* and *D. metel* are poisonous to animals and human beings. The berries of *Withania somnifera* and seeds of *Abrus precatorius* are poisonous.

b. Parasitic weeds: The parasite weeds are either total or partial which means, the weeds that depend completely on the host plant are termed as total parasites while the weeds that partially depend on host plant for minerals and capable of preparing its food from the green leaves are called as partial parasites.

Those parasites which attack roots are termed as root parasites and those which attack shoot of other plants are called as stem parasites. The typical examples of different parasitic weeds are;

1. Total root parasite – *Orabanche cernua* on Tobacco

2. Partial root parasite - *Striga lutea* on sugarcane and sorghum

3. Total stem parasite - *Cuscuta chinensis* on leucerne and onion

4. Partial stem parasite - *Cassytha filiformis* on orange trees and *Loranthus longiflorus* on mango and other trees.

c. Aquatic weeds: Unwanted plants, which grow in water and complete at least a part of their life cycle in water are called as aquatic weeds. They are further grouped into four categories as submersed, emersed, marginal and floating weeds.

1. Submersed weeds*:* These weeds are mostly vascular plants that produce all or most of their vegetative growth beneath the water surface, having true roots, stems and leaves. Eg. *Utricularia stellaris, Ceratophyllum demersum,*

2. Emerged weeds: These plants are rooted in the bottom mud, with aerial stems and leaves at or above the water surface. The leaves are broad in many plants and sometimes like grasses. These leaves do not rise and fall with water level as in the case of floating weeds. Eg. *Nelumbium speciosum, Jussieua repens*

3. Marginal weeds*:* Most of these plants are emerged weeds that can grow in moist shoreline areas with a depth of 60 to 90 cm water. These weeds vary in size, shape and habitat. The important genera that come under this group are; *Typha, Polygonum, Cephalanthus,etc.*

4. Floating weeds: These weeds have leaves that float on the water surface either singly or in cluster. Some weeds are free floating and some rooted at the mud bottom and the leaves rise and fall as the water level increases or decreases. Eg. *Eichhornia crassipes, Pistia stratiotes, Salvinia, Nymphaea pubescens*.

XI. Classification according to association

According to association, weeds are grouped into 3 types

a. Season bound weeds : These weeds grow in specific season disregard to the crop species cultivated. These weeds may be either summer annuals (Eg. *Sorghum halepence)* or winter annuals (*Circium arvensis).*

b. Crop bound weeds : are those species of weeds which are usually parasitize the host crops. They depend upon the host plants for nutrition.

c. Crop associated weeds : Non-parasitic weeds associated with specific crop Ex. *Phalaris minor* in wheat. They may be associated with crop plants for one or more of following reasons.

i) **Need for specific micro-climate :** Weeds like *Circium intybus* (Chichory) require shady, cool and moist habitat which is amply available in crops like berseen and Lucerne.

ii) **Mimicry** : Wild rice in paddy and *Phalaris minor* in wheat survive because of their morphological similarity with host plants. So is true for Loranthus in Tea. This mechanism is called mimicry.

iii) **Ready contamination of crop seed :***Alliums spp,* Wild garlic, *Phalaris minor* mature and spread their seeds same height and time of main crop and thus easily contaminate with crop seeds at harvesting time.

XII. Based on association with human affairs

a) Facultative weeds : are those weed species that grow primarily in wild communities but often escape to cultivated fields associating themselves with human affairs. Eg. Wild onion.

b) Obligate weeds : Occur only in cultivated field. They can't withstand competition from volunteer vegetation in a closed community (dominant weeds). Eg. *Convolvulus arvensis*

XIII. Noxious and Objectionable weeds :

The Noxious weeds are very difficult to control because of their high competitive nature. The weeds persist in adverse conditions and reduce the crop yield even at very low density. The following are considered as the 10 worst weeds of the world.

1. *Cyperus rotundus* - Purple nut sedge
2. *Cynodon doctylon* - Bermuda grass
3. *Echinocloa crusgalli* - Jungle rice
4. *Sorghum halepense* - Johnson grass
5. *Eichornia crassipes* - Water hyacinth
6. *Imperata cylindrica* - Quack grass
7. *Lantana camera* - Lantan
8. *Parthenium hysteroporus* - Parthenium
9. *Echinocloa colanum* - Barn yard grass
10. *Convolvulus arvensis* - Field bind weed

An objectionable weed is a troublesome weed whose seeds are difficult to separate, once mixed with crop seeds.

WEED DISSEMINATION: Dispersal of weeds

Dispersal of mature seeds and live vegetative parts of weeds is nature's way of providing non-competitive sites to new individuals. If they had not dispersed naturally, we would not have seen them today in such widely spread and vigorous forms. In the absence of proper means of their dispersal, weeds could not have moved from one country to another.

An effective dispersal of weed seeds and fruits requires two essentials

(1) A successful dispersing agent

(2) An effective adaptation to the new environment

Common weed dispersal agents are

(a) Wind, (b) Water, (c) Animals and (d) Human

(a) Wind: Weed seeds and fruits that disseminate through wind possess special

organs to keep them afloat. Such organs are

1. Pappus – It is a parachute like modification of persistent calyx into hairs. Eg. Asteraceae family weeds - *Tridax procumbens*
2. Comose - Some weed seeds are partially or fully covered with hairs Eg. *Calotropis*
3. Feathery, persistent styles - Styles are persistent and feathery Eg. *Anemone* sp.
4. Baloon - Modified papery calyx that encloses the fruits loosely along with entrapped air. Eg. *Physalis minima*
5. Wings - One or more appendages that act as wings. Eg. *Acer macrophyllum*

(b) Water: Aquatic weeds disperse largely through water. They may drift either as whole plants, plant fragments or as seeds with the water currents. Terrestrial weed seeds also disperse through irrigation, rainfall and drainage water.

(c) Animals: Birds and animals eat many weed fruits. The ingested weed seeds are passed in viable form with animal excreta, which is dropped wherever the animal moves. This mechanism of weed dispersal in called endozoochory Eg., *Lantana* seeds by birds. *Loranthus* seeds stick on beaks of birds. Farm animals carry weed seeds and fruits on their skin, hair and hooves. This is aided by special appendages such as Hooks (*Xanthium strumarium*), Stiff hairs (*Cenchrus* spp), Sharp spines (*Tribulus terrestris*) and Scarious bracts (*Achyranthus aspera*). Even ants carry a huge number of weed seeds. Donkeys eat *Prosophis julifera* pods.

(d) Man: Man disperses numerous weed seeds and fruits with raw agricultural produce. Weeds mature at the same time and height along with crop, due to their similar size and shape as that of crop seed man unknowingly harvest the weeds also, and aids in dispersal of weed seeds. Such weeds are called “Satellite weeds” Eg. *Avena fatua*, *Phalaris minor*.

(e) Manure and silage: Viable weed seeds are present in the dung of farm animals, which forms part of the FYM. Besides, addition of mature weeds to compost pit as farm waste also act as source.

(f) Dispersal by machinery: Machinery used for cultivation purposes like tractors can easily carries weed seeds, rhizomes and stolons when worked on infested fields and latter dropping them in other fields to start new infestation.

(g) Intercontinental movement of weeds: Introduction of weeds from one continent to

another through 1. Crop seed, 2. Feed stock, 3. Packing material and 4. Nursery stock. Eg. *Parthenium hysterophorus*

WEED ECOLOGY

Knowing weed biology such as seed production capacity, germination dormancy and their ecological adaptations will help in formulating suitable weed management measures.

Weed ecology: Ecology is the interrelationship between organisms and their environment. The organism in weed ecology refers to the unwanted / undesired plant. We concerned with growth characteristics and adaptations that enable weeds to survive the change in the environment. Man plays an important role in changing the environment by altering the crop husbandry practices.

Survival mechanism: The seed is the primary means of survival mechanism of annual weeds while the vegetative parts such as buds, rhizomes tubers and bulbs offer on additional mechanism for perennial weeds.

a. Sexual reproduction: Through sexual reproduction abundant and small seeds are produced. Annual and biennial weeds depend on seed production, as the sole means of propagation and survival of perennial weeds are less dependent on this mechanism.

The seed production capacity of some of the weeds is

Ontogeny	Seeds/plant	Name of weed	Seeds/plant
Perennials	16,629	*Amaranthus retroflexus*	1,96,405
Biennials	26,600	*Solanum nigrum*	1,78,000
Annuals	20,832	*Chenopodium album*	72,000
		Trianthema portulacastrum	52,000

A few weeds may produce seed through apomixis i.e without fertilization. Eg. Ferns reproduce by spores.

b. Vegetative reproduction: Vegetative structures normally rely upon parent for their plant nutrient conferring their competitive advantage but has disadvantage also owing to their genetically identical nature and as such may not well adapted to change in environment. The vegetative structures include stolons, rhizomes, tubers, bulb, corms and roots.

Seed dormancy as survival mechanism

Weed seeds possess a variety of special germination mechanisms**(Self regeneration)**adapted to changes in temperature, moisture, aeration, exposure to light, depth of burial of seeds *etc*., When conditions are unfavourable for germination, they can remain dormant or delay germination.

Conditions favourable for weeds seed germination are

a. Seeds of many weeds require an exposure to light for germination. This is regulated by bluish-green protein pigment called phytochrome.

b. Many weed seeds germinate under aerobic conditions while some require anaerobic condition. Soil turnover during ploughing and other operations exposes the seeds to light and induces germination.

c. Periodicity of germination is another specialized germination mechanism. *Amaranths* spp have a definite pattern of peaks of germination at regular intervals.

d. Summer annuals favour higher temperature & winter annuals germinate at lower temperatures some weeds germinate freely throughout the year.

Seed Dormancy: Dormancy is a state of seeds and buds in which they are alive but not germinated. If all weed seeds were to germinate at one time, their seedlings could be destroyed.

Dormancy allows storage of millions of weed seeds in soil and enables them to grow in flushes over years. In this context, the old gardeners saying "*One year Seeding seven years Weeding*" is very appropriate. In fact, weed seeds have been found viable even after 20-80 years of burial in soil.

Types of dormancy.

(1) Enforced Dormancy : It is due to deep placement of weed seeds in soil during ploughing of the field. Weed seeds germinate readily when they are restored to top 3 to 5 cm. Enforced dormancy is a non-specific character of seed. Cultivation encounters enforced dormancy by bringing the weeds to surface where they are exposed to light besides better aeration. High soil temperature and NO_3 content of surface soil may further help in breaking seed dormancy.

(2) Innate dormancy: It is a genetically controlled character and it is a feature of specific weed seeds which fail to germinate even if they are present in the top 3-5 cm soil and adequate soil moisture and temperature provided to them. The possible reasons are the presence of

(i) Hard seed coats e.g., *Setaria*, *Ipomoea*, *Xanthium* spp.

(ii) Immature embryos e.g., *Polygonum*

In certain weed seeds particularly of Xerophyttic origin, presence of inhibitors is responsible for innate dormancy. It can be overcome with passage of time, or under the influence of some climatic pressure.

(3) Induced Dormancy: Induced dormancy results from some sudden physiological change in normally non-dormant weed seeds under the impact of marked rise in temperature and or CO_2 content of soil, low O_2 pressure, water logging etc.

Wild oat (*Avena fatua*) seeds exhibit all three kinds of dormancy.

Persistence of weeds (Adaptation)

Persistence is an adaptive potential of a weed that enables it to grow in any environment. In an agricultural situation, the cropping system with its (associated habitat) management practices, determines the persistence of weed species. It is largely influenced by climatic, edaphic (soil) and biotic factors, which affect its occurrence, abundance, range and distribution.

FACTORS AFFECTING PERSISTENCE

A. Climatic factors

The important climatic factors are light, temperature, rainfall, wind and humidity.

Light: Light intensity, quality and duration are important in influencing the germination, growth, reproduction and distribution of weeds. Photoperiod governs flowering time, seed setting and maturation and on the evolution of various ecotypes within a weed species. Tolerance to shading is a major adaptation that enables weeds to persist.

C_4 pathway: Most of warm season grasses like barnyard grass and yellow foxtail have C_4 pathway. In addition, a few broadleaf weeds, including redroot pigweed and purslane have the C_4 pathway.

Temperature: Temperature of atmosphere and soil affects the latitudinal and longitudinal distribution of weeds. Soil temperature affects seed germination and dormancy, which is a major survival mechanism of weeds.

Rainfall: Rainfall has a significant effect on weed persistence and distribution. More rainfall or less rainfall determines reproduction & survival.

Wind: Wind is a principal factor in the dissemination of weeds.

Climate can effect variations in cuticle development, pubescence, vegetative growth, vigour, competitiveness *etc*. Climate thus has a profound effect on the persistence of weeds which can adapt to a wide variety of climates.

B. Soil factors:

Soil factors are soil water, aeration, temperature, pH and fertility level and cropping system.

Some weed species are characteristically alkali plants, known as basophils (pH 8.5) which can grow well in alkali soils and those grow in acidic soil is known as Acidophiles.

Basophiles	Acidophiles	Neutophiles
Alkaligrass – *Puccinalia* spp Quack grass – *Agrophyron repens*	*Cynodon dactylon* *Digitaria sanguinalis*	common weeds

Several weed species of compositae family grow well in saline soils. A shift in soil pH, towards acid side due to continuous use of Ammonium sulphate as a 'N' source could cause a shift in the weed spectrum.

Many weeds can grow well in soils of low fertility level however, can adapt well

to soils of high fertility also. Weeds also has adaptation to moist soil, drought condition etc.

C. Biotic factors: In a cropping situation, the major effects on weeds are those exerted by the crop as it competes for available resources. Once, a particular weed species is introduced, its persistence is determined by the degree of competition offered by the crop and also the agricultural practices associated with the growing of a crop may encourage or discourage specific weeds.

Eg. Ponding of water – *Cynodon* dies
Repeated cultivation – discourage nut sedge.

Crops that serve as hosts to parasitic weeds, (Sorghum – Striga) crop-induced stimulants are examples of other biotic factors.

CROP-WEED INTERACTIONS

Competition and allelopathy are the main interactions, which are of importance between crop and weed. Allelopathy is distinguished from competition because it depends on a chemical compound being added to the environment while competition involves removal or reduction of an essential factor or factors from the environment, which would have been otherwise utilized.

CROP WEED COMPETITION

Weeds appear much more adapted to agro-ecosystems than our crop plants. Without interference by man, weeds would easily wipe out the crop plants. This is because of their competition for nutrients, moisture, light and space which are the principle factors of production of crop. Generally, an increase in one kilogram of weed growth will decrease one kilogram of crop growth.

The competition for nutrients, moisture, space, light between crop plants and weeds are referred as Crop-Weed Competition.

1. Competition for Nutrients

Weeds usually absorb mineral nutrients faster than many crop plants and accumulate them in their tissues in relatively larger amounts. For instance, *Amaranthus* sp. accumulate over 3% N on dry weight basis and are termed as "nitrophills". *Achyranths aspera*, a 'P' accumulator with over 1.5% P_2O_5, *Chenopodium* sp &*Portulaca* sp. are 'K' lovers with over 1.3% K_2O in dry matter. Further, the nutrient content of our dominant crops varies between 0.33 – 1.33% N, 0.19-0.59% P_2O_5 and 0.67 – 1.44% K_2O.

Mineral composition of certain common weeds on dry matter basis

Sl. No.	Species	N	P_2O_5	K_2O
1.	*Achyranthus aspera*	2.21	1.63	1.32
2.	*Amaranthus viridis*	3.16	0.06	4.51
3.	*Chenapodium album*	2.59	0.37	4.34
4.	*Cynodon dactylan*	1.72	0.25	1.75
5.	*Cyperus rotundus*	2.17	0.26	2.73
Crop plants				
1.	Rice	1.13	0.34	1.10
2.	Sugarcane	0.33	0.19	0.67
3.	Wheat	1.33	0.59	1.44

The associated weed is responsive to nitrogen and it utilizes more of the applied 'N' than the crop. Eg. The 'N' uptake by *Echinochloa crusgalli* is more than rice. Nutrient removal by weeds leads to huge loss of nutrients in each crop season, which is often twice that of crop plants. For instance at early stages of maize cultivation, the weeds found to remove 9 times more of N, 10 times more of P and 7 times more of K.

2. Competition for moisture

In general, for producing equal amounts of dry matter, weeds transpire more water than do most of our crop plants. It becomes increasingly critical with increasing soil moisture stress, as found in arid and semi-arid areas. *Cynodon dactylon* had almost twice as high transpiration rate as pearl millet.

The amount of water required to produce unit quantity of dry matter is known as transpiration co-efficient (T_Q). The weeds have 2-3 time higher T_Q than crop plants.

Table : Transpiration coefficient (T_Q) of crops and weeds

Weed	T_Q	Crop plant	T_Q
Cynodon doctylon	813	*Zea mays*	352
Tridox procumbens	1402	*Sorghum bicolor*	394

Weeds consume valuable stored moisture in the fallow field to the extent of 7-12 ha-cm which is sufficient to produce 1500-2000 kg sorghum. Further, weeds penetrate roots to greater depth (up to 2.5 m) to exploit moisture compared to crop plants (1 m).

In weedy fields soil moisture may be exhausted by the time the crop reaches the fruiting stage, i.e. the peak consumptive use period of the crop, causing significant loss in crop yields.

3. Competition for light

Generally weeds grow faster and shade the plants if not checked. Even in case of shorter weeds, the lower leaves of crop plants are shaded and deprived of light for photosynthesis. Unlike competition for nutrients and moisture once weeds shade a crop plant, increased light intensity cannot benefit it. The crop plants become thin and

pale green.

4. Competition for CO_2

Crop-weed competition for CO_2 may occur under extremely crowded plant community condition. A more efficient utilization of CO_2 by C_4 type weeds may contribute to their rapid growth over C_3 type of crops. Also, weeds can thrive well even under low CO_2 concentration.

Critical period of weed competition:

Critical period of weed competition is defined as the shortest time span during the crop growth when weeding results in highest economic returns.

The critical period of crop-weed competition is the period from the time of sowing up to, which the crop is to be maintained in a weed free environment to get the highest economical yield. The weed competition in crop field is invariably severe in early stages of crop than at later stages. Generally in a crop of 100 days duration, the first 35 days after sowing should be maintained in a weed free condition. There is no need to attempt for a weed free condition throughout the life period of the crop, as it will entail unnecessary additional expenditure without proportionate increase in yield.

Critical period of weed competition for important crops

1. Rice (Lowland)	- 35 days	7. Cotton	- 35 days
2. Rice (upland)	- 60 days	8. Sugarcane	- 90 days
3. Sorghum	- 30 days	9. Groundnut	- 45 days
4. Finger millet	- 35 days	10. Soybean	- 45 days
5. Pearl millet	- 35 days	11. Onion	- 60 days
6. Maize	- 30 days	12. Tomato	- 30 days

It becomes clear that weed free condition for 2-8 weeks in general are required for different crops and emphasizes the need for timely weed control without which the crop yield gets drastically educed.

FACTORS AFFECTING CROP-WEED COMPETITION

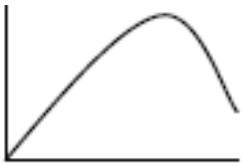
A. Type of weeds species: The type of weeds that occur in a particular crop influences the competition. Occurrence of a particular species of weed greatly influence the competition between the crop & weed. Eg. *E. crusgalli* in rice, *Setaia viridis* in corn and *Xanthium* sp. In soybean affects the crop yield.

B. Type of crop species and their varieties: Crops and their varieties differ in their competing ability with weeds e.g., the decreasing order of weed competing ability is as: barley, rye, wheat and oat. High tolerance of barley to competition from weeds is assigned to its ability to develop more roots that are extensive during initial three weeks growth period than the others.

Fast canopy forming, tillering and tall crops suffer less from weed competition than the slow growing, non-tillering and short stature & crops. Dwarf and semi-dwarf

varieties of crops are usually more susceptible to competition from weeds than the tall varieties because they grow slowly during initial stage. When we compare the crop-weed competition between two varieties of groundnut viz., Bunch and Spreading, bunch type incurred a loss of over 30% pod yield under uncontrolled weed – crop competition while spreading type lost only about 15% in its yield. The main reason is due to the spreading nature, which smothered weeds. Longer duration cultivars of rice have been found more competitive to weeds than the short duration ones.

C. Density of weeds: Increase in density of weed decrease in yield is a normal phenomena. However, it is not linear as few weeds do not affect the yields so much as other weed does and hence, it is a sigmoidal relationship



D. Plant density: Increase in plant population decreases weed growth and reduces competition until they are self competitive. Crop density and rectangularity are very important in determining the quantum and quality of crop environment available for the growth of weeds. Wide row spacing with simultaneous high, intra-row crop plant population may induce dense weed growth. In this respect, square planting of crops in which there are equal row and plant spacing should be ideal in reducing intra-crop plant competition

E. Soil factors: Soil type, soil fertility, soil moisture and soil reaction influences the crop weed competition. Elevated soil fertility usually stimulates weeds more than the crop, reducing thus crop yields. Fertilizer application of weedy crop could increase crop yields to a much lower level than the yield increase obtained when a weed free crop is applied with fertilizer.

Weeds are adapted to grow well and compete with crops, in both moisture stress and ample moisture conditions. Removal of an intense moisture stress may thus benefit crops more than the weeds leading to increased yields. If the weeds were already present at the time of irrigation, they would grow so luxuriantly as to completely over power the crops. If the crop in irrigated after it has grown 15 cm or more in a weed free environment irrigation could hasten closing in of crop rows, thus suppressing weeds.

Abnormal soil reactions often aggravate weed competition. It is therefore specific weed species suited to different soil reactions exist with us, our crops grow best only in a specified range of soil pH. Weeds would offer more intense competition to crops on normal pH soils than on normal pH soils.

F. Climate: Adverse weather condition, Eg. drought, excessive rains, extremes of temperature, will favour weeds since most of our crop plants are susceptible to climatic stresses. It is further intensified when crop cultivation is stratified over marginal lands. All such stresses weaken crops inherent capacity to fight weeds.

G. Time of germination: In general, when the time of germination of crop coincides with the emergence of first flush of weeds, it leads to intense Crop-Weed interference. Sugarcane takes about one month to complete its germination phase while weeds require very less time to complete its germination.

Weed seeds germinate most readily from 1.25 cm of soil. Few weeds even from 15cm depth. Therefore, planting method that dries the top 3 to 5 cm of soil rapidly enough to deny weed seeds opportunity to absorb moisture for their germination usually postpones weed emergence until the first irrigation. By this time the crop plants are well established to compete with late germinating weeds.

H. Cropping practices: Cropping practices, such as method of planting crops, crop density and geometry and crop species and varieties have pronounced effects on Crop-Weed interference

I. Crop maturity: Maturity of the crop is yet another factor which affects competition between weeds & crop. As the age of the crop increases the competition for weeds decreases due to its good establishment. Timely weeding in the early growth stages of the crop enhances the yield significantly.