PRINCIPLES AND CONCEPTS OF CROPPING SYSTEMS

(Part- 1)

Dr. G. M. SUJITH
UNIVERSITY OF AGRICULTURAL SCIENCES,BANGALORE KARNATAKA
Cropping system – Cropping patterns practiced on a farm
Cropping patterns – Different crop sequences followed in a year

- Rainfall is the main & the most variable source of water for dryland crops
- Rainfall variability plays a dominant role in influencing crop growth and yield and also in crop planning
- Cropping pattern in a region is usually planned on the basis of prevailing rainfall behavior
Important climatological inputs in crop planning

- Seasonal rainfall
- Probable period of assured rainfall distribution
- Long range forecast
- Medium-range forecast

IMD forecasting of seasonal rainfall accuracy of more than 90%
Characteristics of crops / varieties for drylands

Capacity to produce a fairly good yield under limited soil moisture conditions

- Short life or yearly reproductive cycle
- Photo - insensitive
- Strong and penetrating root system
- Low water requirement
- Higher harvest index
Types of cropping systems

a) Mono cropping – A single crop is grown on a piece of land and the same crop is grown every year

Predominant mono crops in drylands
- Groundnut, Sorghum and Finger millet

b) Multiple cropping – Two or more crops are grown on the same piece of land in one calendar year
PRINCIPLES AND CONCEPTS OF CROPPING SYSTEMS

(Part- 2)

Dr. G. M. SUJITH
UNIVERSITY OF AGRICULTURAL SCIENCES, BANGALORE
KARNATAKA
Types of Multiple cropping

a) Inter cropping – Two or more crops are grown at a given time in spatial arrangement

b) Mixed cropping – Two or more crops are randomly grown at a given time without any distinct arrangement

c) Sequential cropping – Two or more crops are grown in succession one after another
Examples of predominant multiple cropping systems

- **Intercropping**: Sorghum/pigeonpea in red soils
- **Mixed cropping**: Sorghum, pigeonpea & sesame
- **Sequential cropping**: Sorghum – Safflower & Maize – Chickpea

Traditional practices

Intercropping and mixed cropping are the most common cropping systems

Finger millet + Pigeon pea (8:2)

Farmer’s practice (Mixed cropping)
Advantages of multiple cropping

- Avoid risk of total crop failure due to erratic rainfall and ensures food security
- Optimum utilization of natural resources – land, water, sunlight
- Increases the annual net yield per unit area
<table>
<thead>
<tr>
<th>Rainfall (in mm)</th>
<th>Soil type</th>
<th>Water availability period (weeks)</th>
<th>Potential cropping systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>350-600</td>
<td>Red soils &amp; shallow black soils</td>
<td>20</td>
<td>Single <em>kharif</em> crop</td>
</tr>
<tr>
<td>350-600</td>
<td>Sandy soils</td>
<td>20</td>
<td>Single <em>kharif</em> or <em>rabi</em> crop</td>
</tr>
<tr>
<td>350-600</td>
<td>Deep black soils</td>
<td>20</td>
<td>Single <em>rabi</em> crop</td>
</tr>
<tr>
<td>600-750</td>
<td>Red/Black/sandy</td>
<td>20-30</td>
<td>Intercropping</td>
</tr>
<tr>
<td>750-900</td>
<td>Sandy / deep black/ red soils</td>
<td>More than 30</td>
<td>Sequential and double cropping</td>
</tr>
</tbody>
</table>
Factors influencing choice of cropping system

1) Farm resources

Choice of the cropping system depends on land, labour and water. Amount of rainfall as well as soil type and water holding capacity influence the type of cropping system based on the length of crop growing season.
Factors influencing choice of cropping system

2) Farm enterprises

Enterprise at the farm level leads to a cropping system having specific crops eg. Fodder crops in dairy and grain crops in poultry
Factors influencing choice of cropping system

3) Farm technology

Improved technologies alter the cropping systems

In deep black soils with annual rainfall more than 750mm, dry seeding yields both *kharif* and *rabi* crops instead of only one *rabi* crop in the post rainy season.
Besides putting various measures to increase the productivity of dryland crops, efforts would also be needed to increase the cropping intensity which was generally 100% implying that a single crop was taken during the year.

Cropping intensities of these areas could be increased by practice of intercropping and multiple cropping by way of more efficient utilization of the resources.
PRINCIPLES AND CONCEPTS OF CROPPING SYSTEMS

(Part- 3)

Dr. G. M. SUJITH
UNIVERSITY OF AGRICULTURAL SCIENCES, BANGALORE
KARNATAKA STATE
Crop interaction

Intercropping

- Interaction between the component crops may be competitive, non-competitive or complementary

- A combination of tall and short crop (millet /groundnut) or short and long duration (groundnut/pigeonpea) reduces competition for sunlight

- Water is used more efficiently by crops that extract water from different soil depths due to different rooting depths or produce more canopy thus reducing evaporation from soil surface

- A combination of cereal and legume crops reduces input of nitrogen
Crop interaction

Sequential cropping

✓ Interaction is non-competitive

✓ Some preceding crops have an allelopathic effect on the succeeding crop

✓ Soil fertility is reduced by the preceding crop

✓ Residual effect of Farmyard manure (FYM) or phosphorus (P) fertilizer can be seen on the succeeding crop
Crop management

Inter cropping

- Use less competitive crops
- Adjust time of sowing – staggered planting in aggressive & non-aggressive crop combination
- Adequate nutrient application as per requirement of component crop
- Weed control – less weed infestation compared to monocrops
- Pest & disease control – less pests and diseases due to crop diversity
Crop Management

Sequential cropping

- Use short duration & photo insensitive varieties
- Harvest the first crop at physiological maturity to avoid terminal drought of second crop
- Add additional amount of N if the preceding crop is sorghum or millet
- Reduce N quantity if the preceding crop was a grain legume
- If FYM or P fertilizer are applied to the preceding crop, reduce the input of N and p to the succeeding crop
The plant characteristics that influence cropping systems are:
Plant height, crop canopy, nutrient & water requirements, root
structure and plant products

Farm sustainability depends on the efficient use of natural
resources (soil, water, energy, and plant diversity) depending on
the requirements of the farmers

A sustainable system aims to optimize the production rather
than maximizing it
An ideal sustainable cropping system is one which includes crop combinations meeting:

- Soil and water conservation
- Efficient use of water and energy
- Enhance and maintenance of soil fertility
- Maintenance of crop yield level: and
- Farm (including crop) diversity
PRODUCTION STRATEGIES FOR CROPPING SYSTEMS

Dr. G. M. SUJITH
UNIVERSITY OF AGRICULTURAL SCIENCES, BANGALORE
KARNATAKA STATE
Tillage

- **Red soils**
  
  Shallow tillage (up to 10cm depth) in red soils immediately after harvest of previous seasons crop to improve the infiltration

- **Black soils**
  
  Deep tillage (up to 25-30cm depth) immediately after harvest of previous seasons crop to increase the soil depth and control perennial weeds
Contour cultivation

Conduct all field activities like ploughing, tilling, seeding along the contour or across the slope to increase the yield by 20 to 35%
Compartmental bunding

Usually carried out in black soils – During kharif, complete primary tillage first followed by two harrowings. Construct compartmental bunds of suitable size on lands having slopes 2 to 3%
Tied ridges and furrows

Open the furrows at 60 to 70cm apart across the slope in black soils after the completion of primary tillage. Tie at regular intervals along their length. This increases yield by 30%
Broad furrows and ridges

Lay out the land into broad furrows and ridges across the slope in medium to deep black soils of 2% slope to conserve rainwater effectively and to increase the grain yields.
Scooping
Form scoops during the second fortnight of July across the slope or along the contour to increase the infiltration rate and to reduce the erosion. Revive the scoop after each rain for better infiltration.
Mulching - Vertical mulching

Opening trenches of 30cm depth & 15cm width across the slope at vertical intervals of 30cm & stuffing crop stubbles vertically in these trenches. These guide run off water to subsoil layers.
**Multiplying - Surface mulching**

Opening ridges and furrows at suitable length prior to sowing. Perform sowing in a furrow and break the ridges during first interculturing and apply crop residues between the rows to reduce evaporation and improve water intake.
Intercultivation

Frequent deep intercultivation operations break the soil, help in closing the cracks, create dust mulch and control weeds.
Seed hardening and dry seeding

Seed hardening refers to the technique of subjecting seeds to 2-3 cycles of soaking with appropriate chemical solution and drying.

Dry seeding is the technique of placing the hardened seeds in a dry soil. It is practiced when delayed rain is forecasted.

Treat the seeds with 0.2% calcium chloride for eight hours and subsequently shade dry till it attains less than 10% moisture content for seed hardening. Practice dry seeding.
Seed hardening

Dry seeding
MANAGEMENT PRACTICES FOR EARLY SEASON DROUGHT

Land configurations
Formation of tied ridges & broad furrows and ridges

Crop management
Seed hardening and Dry seeding
Transplanting - community nurseries
Resowing - instead of maintaining poor plant stand

Management of biotic stress
Insect pests diseases – Chemical, biological and cultural measures
MANAGEMENT PRACTICES FOR MID-SEASON DROUGHT

- Top dressing and foliar spray of urea at 2%
- Reduce the leaf area index by removing every alternate or third row of crop
- Close the soil cracks by repeated deep interculturing
MANAGEMENT PRACTICES FOR LATE SEASON DROUGHT

- Supplemental irrigation
- Use of surface mulches
- Avoid cracks by forming thin soil mulch using a blade hoe
The need for modifying and introducing new technologies for increasing and sustaining yield in dryland areas should be emphasized.

To mitigate some of the abnormal weather situations, farmers should make changes in the normal cropping schedule and adopting technologies for getting some production in place of total crop failure.
INTEGRATED NUTRIENT MANAGEMENT FOR DRYLANDS

Dr. G. M. SUJITH
UNIVERSITY OF AGRICULTURAL SCIENCES, BANGALORE
KARNATAKA STATE
INTEGRATED NUTRIENT MANAGEMENT FOR DRYLANDS

- Use of mineral fertilizers is the quickest way to increase crop production
- High cost, unavailability and risks and soil related problems

INM strategy

* Soil fertility & plant nutrient supply
* Cropping system approach
* Does not preclude the use of chemical fertilizers
* Optimal use of renewable nutrient sources & minimal use of fertilizers
Sources of nutrients for crop production

- Soil organic matter (SOM)
- Biological Nitrogen Fixation
- Mineral fertilisers
- Soil reserves
- Organic manures
- Precipitation
BIOLOGICAL INPUTS FOR NUTRIENT MANAGEMENT

Biological process

- Decomposition of plant and animal residues
- Nutrient flow (immobilization) & mineralization

Beneficial microorganisms

- Symbiotic N fixer
- Non-Symbiotic N fixer
- PGPR
- Phosphate solubilising Mos
- Vesicular Arbuscular Mycorrhiza (VAM)
BIOLOGICAL INPUTS FOR NUTRIENT MANAGEMENT

Use of bio-fertilizer by seed inoculation

- Rhizobium inoculation is practiced to ensure adequate N nutrition of legumes instead of fertilizer nitrogen
- Select the right type of inoculant as different crops require different rhizobia
- Prepare inoculum slurry using sticky agent (jaggery)
- Mix seeds with inoculum slurry, dry the seeds and sow seeds within 48 hours after inoculation

Legumes, grown in rotation or as intercrops, increase crop yields of succeeding non-legume crop 0.5 to 3t/ha saving up to 120kg N/ha compared to sequential cropping of non-legume crops.
ORGANIC INPUTS FOR NUTRIENT MANAGEMENT

- Organic manures: FYM & Composts – Oil cakes
- FYM most used organic manure & crop residues can be recycled by composting
- Combination of crop residue restitution, fallowing or green manuring can be used to maintain organic matter levels in the soil

**Increases biological activity in soil**
**Reduces nitrogen losses through immobilization**
**Improves performance of microorganisms**
MINERAL FERTILIZERS FOR NUTRIENT MANAGEMENT

- Use appropriate mineral fertilizers to meet the demand for necessary nutrients
- Ensure that efficiency of applied fertilizers is optimized through adoption of suitable practices

Form or type – as recommended for the crop
Method – furrow placement & covering with soil
Time – split N doses instead of one application
Quantity – just sufficient to meet plant demand
ON-FARM PRODUCTION OF BIOMASS & COMPOST

Planting of green manure trees on field bunds for on-farm production of biomass and compost and modifying the microclimate

- During the rainy season plant a mixture of 2-4 species of green manures on the earthen bunds of the farm field
- Add leaves obtained from the prunings of trees to the compost pit
- Use the compost as manure after four to six months of decomposition
- Leaves obtained can also be incorporated into the soil by suitable methods
ON-FARM PRODUCTION OF BIOMASS & COMPOST

Advantages

- Increases soil fertility and the microbial activity in the soil
- Reduces the soil erosion
- Increases the water holding capacity of the soil
- Improves the micro-climate
Since soil moisture is limiting in drylands, the availability of nutrients becomes limited. For this, a proper mixing of organics and inorganics would be desirable. So, INM practices holds key for nutrient management in drylands.

Nutrients like potassium help to increase drought tolerance by affecting plant-soil-water relationship besides yield advantage.

Management of legumes in crop sequences/intercropping for their residual effect should be encouraged.

INM is essential to maintain soil fertility and increase food production without harming the environment.
TILLAGE & MULCHING FOR DRYLAND SOILS

Dr. G. M. SUJITH
UNIVERSITY OF AGRICULTURAL SCIENCES, BANGALORE
KARNATAKA STATE
Clean Tillage methods

**Primary Tillage**
Primarily carried out to prepare smooth seed bed

**Secondary tillage**
Operations during the cropping period to reduce weeds & to increase water intake

**Deep tillage**
Ploughing soil up to 25 -30cm depth

**Shallow tillage**
Ploughing soil up to 25 -30cm depth
Conservation Tillage

Tillage system that leaves at least 30% of the soil surface covered with crop residues after the crop is planted
Stubble mulch Tillage

Tillage system that accomplished with implements that undercut the soil surface, thereby retaining most crop residues on the surface.
Disk tillage

Tillage system that is carried out with the help of a disk to bury 30 to 70% of surface residues. It provides good weed control.
TILLAGE REQUIREMENTS FOR BLACK AND REDSOILS
BLACK SOILS - VERTISOLS

Properties:
* High clay content
* Low infiltration rate
* Deeper soil depth
* pH more than 7.5

Problems:
Hard when dry, sticky and not trafficable when wet
Optimum soil moisture range for tillage very narrow
High draft requirement when dry
BLACK SOILS - VERTISOLS

Management practices

- Deep tillage upto 30cm depth once in three years with 5t/ha of FYM
- Fall ploughing immediately after the harvest of *rabi* crop
- Shallow tillage upto 10cm depth with blade harrow (2 to 3 times)
- Shallow tillage with intercultivators (2 to 3 times) during cropping
RED SOILS - ALFISOLS

Properties:
- Low clay content
- High infiltration rate
- Shallow to medium soil depth
- Neutral soil pH (6.5-7.5)

Problems:
- Surface crust formation within 2 to 3 days of rains
- Crusting after seeding results in poor seedling emergence, more so in small seeded cereals
RED SOILS - ALFISOLS

Management practices

- Deep tillage every year to break crust & pulverize soil
- Interculturing 2 to 3 times during cropping period
- Dead furrow opening at 3m during sowing & repeated at 30-40DAS
- Use of rotary type spiked roller on crusted soil to break crusts
MULCHING FOR DRYLAND SOILS

MULCHING

Multi-pronged approach to conserve soil and water and manage weeds. Mulches are commonly used in areas subject to drought and weed infestation.

Categories of mulches

*Surface mulching  *Vertical mulching  * Live vegetative barrier

Advantages of mulching

- Intercepts raindrops & reduces run-off and soil loss
- Suppresses weeds and reduces weeding costs
- Increases soil organic matter
- Improves soil physical & chemical properties
- Increases soil water holding capacity & regulate soil
TILLAGE & MULCHING FOR DRYLAND SOILS
SURFACE MULCHING

Organic materials / residues

Stubbles, crop residues and other organic residues are spread on the surface to reduce evaporation & increase soil moisture
TILLAGE & MULCHING FOR DRYLAND SOILS
SURFACE MULCHING

Soil / dust mulch

It includes opening ridges and furrows at suitable lengths and seeds are sown in the furrows and ridges are broken during first interculturing. This results in an adequate dust mulch.

Followed in vertisols where long breaks in rainfall result in deep and wide cracks on the soil.
TILLAGE & MULCHING FOR DRYLAND SOILS

VERTICAL MULCHING

It involves opening of trenches of 30cm depth and 15cm width at regular vertical intervals. Stubbles are stacked in these trenches & are made to protrude up to 10cm above the ground.

These mulches act as intake points and divert run-off water to sub-soil layers.
TILLAGE & MULCHING FOR DRYLAND SOILS

LIVE VEGETATIVE BARRIERS

Under this mulching method, suitable plant species are planted on the contour key lines and they act as vegetative barriers and effective mulch.
Different types of tillage operations may be adopted in dryland areas depending upon the situation of the farm to get more benefit.

General theory of tillage in dryland areas is to reduce the tilling operations as far as practicable.

Pre-monsoon tillage and maintaining of crop residue (mulch) at the time of tillage is another factor to be considered in dryland areas.