TRAINING MODULES 1–5
Understanding conservation agriculture

“This technology is knowledge intensive.”
–Kofi Boa

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Conservation agriculture modular approach

• Module 1: Concept, Principles and Practices
• Module 2: Land Preparation
• Module 3: Soil Cover
• Module 4: Soil Health and Fertility
• Module 5: Weed Control
If you were to grow maize on these two fields, which would give better yield and why?

Forest / fallow land

Continuously - cropped land
The majority picked the green patch, which would have required slash and burning existing vegetation.

One voted for the brown earth and explained:

“Because **we can reclaim the brown land**, and we came here today to learn how to do that. If we don’t learn, then if we cut down the trees and green to plant, it will just become the brown.”
Concept of conservation agriculture

- Utilizes mulch to **increase water availability** to the plant in dry years
- Allows **planting of crops** – ideally, legumes such as cowpeas, which **fix nitrogen** – between rows of maize, for example
  - Provides second edible crop as the cover crop
  - Stabilizes soil and keeps it from washing away
- Helps keep (in the field) a larger number of beneficial insects that feed on destructive pests
Benefits of conservation agriculture

**Mulch** is foundational to conservation agriculture, and is defined as:

- *Plant residues* and other organic matter left on or carried to the rows in **between planted crops**

Mulch offers multiple benefits:

- Helps **soil retain moisture** and keeps **soil temperature cooler**
- Raises the **biomass** and organic matter in soil
“And from then on I became Mr. Mulch.”
–Kofi Boa
Benefits of conservation agriculture

Economic benefits
• Improves production efficiency
  – In normal rainfall years, no-till farmers obtained higher maize yields than farmers who did not use no-till
  – After adopting no-till, average family labor was reduced

Agronomic benefits
• Improves soil productivity
  – After adopting no-till, both land preparation and planting were reduced
  – Labor for weed control was reduced, based on an average of man-days per hectare
Benefits of conservation agriculture

Environmental benefits

• Protects the soil
• Makes agriculture more sustainable
“No-till (agriculture) brings increased food security to families from the larger yields and creates more time for other income–generating farming or trading activities.”
Adoption of conservation agriculture

Q: How can we improve and maintain the productivity of a field like this one?

A: Adoption of conservation agriculture
Adoption of conservation agriculture

Historically, shifting cultivation was used to bring such lands back to arable status.

This is no longer feasible as a result of increased pressure on land due to:

– Increased human population and related factors
Principles of conservation agriculture

Three key principles:
• Minimal or no soil disturbance
• Permanent soil cover
• Crop rotation / associations

“We haven’t had rain in two months, but things are still growing.”
Conservation agriculture: minimal or no soil disturbance

No soil inversion  Direct planting
Conservation agriculture: permanent soil cover

No burning

Soil covered with vegetation / mulch
Conservation agriculture: crop rotation / associations
“Conservation agriculture is serious farming. It’s about increasing yields today and protecting the soil for tomorrow.”
Discussion
Conservation agriculture modular approach

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Traditional land preparation practices

Are those still viable?
Conservation agriculture: no-tillage
Other conservation agriculture land preparation practices

Planting pits / basins

Zonal tillage
Land preparation:
The way mother nature does it

Without tools and equipment for digging and turning the soil over, Mother Nature covers the earth with plants.

We can do the same and save time, labor and cost-per-unit of land area farmed, while simultaneously producing sustainable yields and conserving soil and water.
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Characteristics of bare soil

- Prone to erosion
- Very high soil temperatures
- Accelerated evaporation
- Lack of organic matter
- Little or no soil life

The sum of the above characteristics is **poor soil productivity**
“A good farmer gives her soil some cover; only a healthy soil can produce a good crop.”
Two main types of soil cover

Living plant material – crops and cover crops

Mulch or dead plant material – crop residues and pruning from trees
What are cover crops?

Crops grown to cover the area between rows of commercial crops

Crops grown to cover the whole field when no commercial crop is growing
What cover crops are available in your area?

- Cajanus cajan
- Crotolaria spectabilis
- Lablab dolichos
- “Gyangboro”
Benefits of cover crops

- Protect the soil against high temperatures
- Minimize erosion
- Add organic matter to the soil
- Control weeds
- Promote soil life
- May reduce compaction problems
- Increase porosity and internal drainage
‘Green manure crops’ vs. ‘cover crops’

**Green Manure Crops**
- Mainly legumes
- Mainly for addition of nitrogen to the soil
- Incorporated into the soil at certain growth stages

**Cover Crops**
- Species from different plant families
  - e.g. grasses, legumes, etc.
- Grown for specific plant attributes
- Grown to cover soil and feed soil organisms
- Little market value
  - Compared to commercial crops
Considerations before choosing a cover crop

Cover crops may feature multiple benefits, for example:

- Compatibility with cropping systems
- Time of sowing and length of growth cycle
- Ease of management
- Amount of water required and / or drought resistance
- Probability of becoming a weed
How to manage cover crops

For long-term soil cover from dead mulch, kill by using:
- Knife roller
- Chain
- Herbicide

For immediate decomposition to release nutrients, kill by:
- Slashing
- Mowing
Time to kill the cover crops

Important to know when to kill, as:

- Most species can regenerate when interrupted prematurely
- Mature seeds can germinate and cause problems as weeds
- Most cover crop species at full flower = maximum accumulation of biomass
  - Legumes - first pod formed; however, not yet matured
  - Grains - milky stage
  - Woody species (e.g. Cajanus) - just before flowering because of wood development
Time of sowing the commercial crop

The period between:
• The slashing / management of the cover crop, and
• The seeding of the commercial crop
• Defines the production level of the crop

Related to:
• Allelopathy, and
• Nitrogen immobilization
Time of sowing the commercial crop

For direct seeding over the cover crop, allow:

• 8–12 days for cover crop; low-to-medium carbon:nitrogen ratio
  – Carbon:nitrogen ratio of 12–22
  – e.g. legumes

• 12 - 20 days for cover crop; high carbon:nitrogen ratio
  – Carbon:nitrogen ratio of > 24
  – e.g. grasses
Consequences of poorly-managed residue

**Properly Managed**
- Adds organic matter to the soil
- Retains carbon in the soil
- Buffers soil pH & facilitates availability of nutrients
- Captures rainfall
- Reduces evaporation & increases soil moisture content

**Poorly Managed**
- Provokes uneven drying of soil
- Interferes with seeding and fertilizing activities
- Hinders the emergence of crop seedlings
- Allows weed species to emerge
Two major threats to soil cover in Africa

Over grazing

Bush fire

How can we reduce their effects?
Challenges for maintaining soil cover

• Semi-arid areas
  – Minimal rain
    • Crops, shrubs and trees produce less residue
  – Utilized for feed, fuel and wood (for building)
    • Difficult to maintain soil cover for the entire year
    • Best to depend on crop residue and tree/shrub prunings as the main source of soil cover

• Pests and disease
  – May attack the cover crop requiring special attention
  – Fire is utilized to destroy pests and disease
    • Rotate crops – versus burning - to control pests and disease
    • Consider using pesticides, if necessary
Challenges for maintaining soil cover

• Rats
  – A dense crop cover may attract rats; rats attack crops
    • Prior to planting, slash the live cover crop as close to the ground as possible
    • Bait and / or traps may be used
    • Rotate crops to:
      – Interrupt rats’ food supply
      – Disturb rats’ living conditions
Challenges for maintaining soil cover

• Termites
  – Soil cover attracts termites
    • Termites are important
      – Break down plant material on the surface; carry it into the soil, adding organic matter
      – As a result, soil is aerated
      – Infiltration is improved
    • Most termites are beneficial
      – Some attack crops by eating the stem or damaging the grain
      – Timing is harvest
      – Trick termites by leaving plant material (mulch) on the surface; termites then attack this versus crop itself
Challenges for maintaining soil cover

• Fire
  – Bushfires or uncontrolled fires can spread into a CA field and destroy its soil cover
    • Leave a buffer zone around the field
    • Once CA is more practiced, burning will be minimized
    • Education and bylaws will help reduce damage by fire
Challenges for maintaining soil cover

• Livestock
  – Uncontrolled grazing destroys soil cover
    • Keep animals out by:
      – Planting living fences
      – Spraying field boundaries with cattle urine
      – Planting cover crops not eaten by cattle
    • Create “community-agreed upon” grazing area and fodder production
Understanding the conservation agriculture system

Farmers who do not yet understand the importance of adequate mulch coverage DO NOT yet understand the conservation agriculture system.
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What makes soil sick

- “Mining agriculture”
- Soil erosion
- Loss of organic matter
- Compaction of the soil
- Bare soil exposed to rain and sun
Effects of sick soil

Bare and productively dead soil

Low crop yields; high levels of fertilizer needed to produce good crop
What is healthy soil?

“Healthy soil is living soil.”

- High in organic matter
- Rich in nutrients
- Surface is always protected
  - By crops or mulch
- Not compacted
- Good internal drainage

“Healthy soil supports good crop growth; try to keep your soil healthy.”
Effects of conservation agriculture on soil properties

• Biological
  – Organic matter

• Physical
  – Water
  – Temperature

• Chemical
  – Nutrients from decomposing organic matter
Nutrient availability
in conservation agriculture

• Phosphorus and Potassium
  – Relatively immobile
  – Bit more stable
  – Accumulate in top soil

• Nitrogen
  – Some soil processes may hinder availability of nitrogen to plants
  – Avoid lack of nitrogen by:
    • Allowing some time for organic matter to decompose before sowing
    • Applying it (nitrogen) as band placement during sowing
Types of fertilizer

• Soil tests show high levels of available potassium
  – NPK sources could be 20-20-0
  – MAP (12-61-0)
  – DAP (18-46-0)

• Nitrogen source
  – Urea is less acidifying (soil acidity / acidification)
  – Bit more difficult to manage
Farming practices for soil health management systems

- Crop rotation
- Cover crops
- No-tillage
- Mulch tillage
- Mulching
- Nutrient management
- Pest management
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Importance of weeds

- Compete with crops for resources
  - Water, nutrients and light
- Host pests and diseases
- (Weed seeds) contaminate crop produce
- Reduce crop yields and farmers income

“Controlling weeds can be a lot of work; DO NOT allow weeds to take over your farm.”
Weed control methods

• Cultural
  – Crop rotation, cover crops, mulches, etc.

• Physical
  – Manual
    • Pulling by hand
    • Slashing and hoeing
  – Mechanical
    • Animal and tractor drawn equipment

• Chemical
  – Use of herbicides
Agronomic practices in conservation agriculture favor weed reduction
Discussion