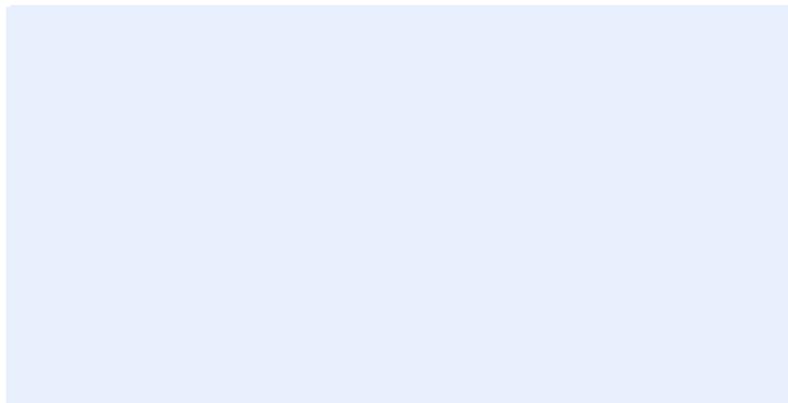


Conservation Agriculture

Facilitator's Guidebook

Season 1: Core Lessons



Conservation Agriculture Facilitator's Guidebook

Introduction

Conservation Agriculture (CA) has spread in the past 40 years to cover 105 million hectares of farmland worldwide (ACT 2008). CA's effectiveness in retaining soil moisture, improving soil quality, lowering input costs and producing stable, high yields of crops leaves little doubt that it will be central to creating food security in a world of increasing population and climate uncertainty.

Unfortunately, however, the adoption of CA among small-scale farmers has lagged far behind that of large-scale mechanized farmers. The challenges hindering the adoption of CA among small-scale farmers include the great diversity of crops and farming approaches that make standardization of CA technologies virtually impossible. Overly rigid extension methods and materials further hinder the spread of CA technologies when they promote a one-size-fits-all approach.

This *Conservation Agriculture Facilitator's Guidebook* is designed to address these challenges by building adaptation and diversity into every aspect of its production and dissemination. The materials presented herein are agronomically sound, but simple enough to be understood by farmers with little formal education. By reproducing them in electronic format only, without copyright, we hope that they will be shared widely, customized, and improved by each Project Field Officer that uses them.

How to use these Conservation Agriculture training materials

These training materials are organized in modules designed to facilitate discussions with groups of 10-25 farmers. The suggested core modules include:

1. Situation Analysis: Why CA?
2. Minimizing Tillage With Planting Basins
3. Importance of Soil Cover
4. Planting with Precision
5. Cover crops
6. Weed Management in Conservation Agriculture
7. Crop Residue Management

These core modules can create the 1st year curriculum for a CA farmer-training project. You may, however, decide that in your context, one or more of these modules is not relevant. Alternatively, you may decide that another subject needs to be added to create a sound 1st year training program. In year 2 and beyond, other subjects should be added to help farmers move beyond these basic concepts. Modules for additional subjects (e.g. CA with Animal Traction, Agroforestry, Postharvest storage, etc.) are being developed and will be posted on the ACT website: <http://caguide.act-africa.org/>.

The individual modules are designed be taught, then followed by a several weeks during which the participants will go home and put what they have learned into practice. ***Alternating training and action through the cropping cycle, is a much more effective way to teach farmers than to hold one long workshop at the beginning of the season.*** For more on building effective training cycles, see *Appendix A*.

Each module includes 3 training tools:

1. **Facilitator's Guide** – This document will guide facilitators as they lead groups of farmers. They were created in MS Word format, and do *not* carry copyright protection, so we encourage you to adapt, customize, and translate them to fit your particular training context.
2. **Poster** - The Posters are designed to help farmers visualize the concepts presented in each lesson. They are created in several formats. The .pdf files are designed to be printed on large-format (A1 size) material by a professional print shop. As such, they are more difficult for most users to edit without design software. We will gladly do this editing for you if you send us an e-mail explaining what changes you would like. The MS Word versions of the posters can be more easily edited, but they will result in poor quality images if they are printed on anything larger than A4 paper.
3. **Farmer Booklet**– For each lesson we have prepared a booklet designed to be printed and distributed to participating farmers. The core lessons have been combined in one large booklet for ease of use. The Farmer Booklets are also in MS Word format, and we encourage you to adapt, customize, and translate them to fit your particular training context. Pictures may be replaced with local ones which have more relevance. Practical exercises and discussion questions may need to be adapted to fit other crops and farming systems. Feel free to put your organizational logo on the front cover to promote your own “brand.” Although this booklet is not copyright protected, we ask you to leave the back cover unedited so that others who may be interested in using our materials will know where they came from.

Why Use a Question-Posing Approach to Training?

The user of this guidebook may be surprised to find it includes more questions than facts!! This approach grows out of a belief that the best learning comes when facilitators and participants join together in a genuine dialogue. Facilitators may bring knowledge of the scientific world, but farmers best know the reality of their community and farming system. The lecture format, where a teacher talks and the students passively receive information, is replaced by a dialogue in which all parties discuss the reality of their lives, and work together to identify solutions and action plans.

This approach, which grows out of the work of Brazilian educator, Paulo Freire, relies on asking critical “open-ended” questions, for which there are many possible answers, rather than “leading questions,” which a teacher might use to lead a student to a pre-determined answer. For this reason, it is crucial that the facilitator allow the farmer group to take time to present their ideas, and only add to them if the group doesn't have enough experience or exposure to fully understand the issue being discussed. Posters and Farmer Booklets can help these discussions by illustrating the issue at hand, but they should also be used in a question-posing mode, allowing participants to discuss and discover what they represent rather than to have the facilitator explain what they mean.

Ultimately, the question-posing process should lead the participants to develop an action plan. After putting their plan into practice, they should return and discuss what they have learned from their experiences. This cycle of reflection followed by action, followed by more reflection should be repeated throughout the training period and will result not only in profound learning, but also ownership by the farmers of the solutions which they have helped to develop. For more on Freirian training approaches, consult the resources in *Appendix C*.

A few tips on facilitating a Question-Posing Approach to training:

1. In order to allow all participants to contribute to the discussion, groups should never be larger than 25-30 farmers. An ideal group size is 15-20.
2. These lessons **MUST** be taught in the mother tongue/local language. Spend time researching and preparing terminology that the simplest villager will understand. Do **NOT** use technical terms you may have learned in another language.
3. Prepare yourself thoroughly to ask the critical questions in your outline, but be prepared for group members to take you in other directions! If they raise unexpected, but related, issues that contribute to the learning process, let the discussion flow in that direction. If, on the other hand, a participant raises an issue that distracts from the topic at hand, bring the discussion gently back on track.
4. Prepare yourself thoroughly by reading background resources and discussing with your colleagues and mentors, but be ready to say “I don’t know” when participants raise questions beyond your expertise. They will respect you more if you tell them you will return with an answer, than if you try to make something up!

Adapted from training materials developed by:

- Canadian Foodgrains Bank
- Africa Conservation Tillage Network
- With support from Global Affairs Canada

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Situation Assessment: Why Conservation Agriculture? Facilitator's Guide

Learning Outcomes – Participants will:

1. Analyze their current situation and the factors contributing to soil infertility/low crop production/food insecurity
2. Understand what is CA and its potential to address the constraints they have identified
3. Decide whether to try CA on their own farms

Pre-Requisites: None. This lesson is used to motivate groups to begin trying CA. It is often presented to a larger group in the community, so that individuals can decide if they want to join the project and receive further training.

Timing of this Lesson: This lesson should take place 3-4 months before the time of planting so that participants have plenty of time to attend the other lessons and prepare before the rains begin.

References:

[Conservation Agriculture: A Manual for Farmers and Extension Workers in Africa](#). 2005. IIRR and ACT.

Materials Needed:

1. Flip chart or large-format paper
2. Magic markers
3. “Situation Assessment” and “Conservation Agriculture” Posters
4. An old, respected person from the community who has agreed to share about how things have changed in their lifetime
5. A successful CA farmer from the same community, or a community as nearby as possible

Preparation:

1. If possible, plan to hold this class at the farm of a current CA farmer, or else close enough to visit a nearby CA farm during the class.
2. Prepare your own testimony of how your community has changed.
3. Explain to the old, respected person what questions you will be asking them during the lesson.
4. Review all discussion questions and be prepared to guide the discussion appropriately.

Learning Activities (Total time required = 2 - 2½ hours)

I. Introduction: (30 minutes)

A. Show Poster: “Situation Analysis”

1. Ask them to describe what they see on the top picture
2. Ask them to describe what they see on the bottom picture

B. Discussion Questions:

1. What is the difference between the two pictures? Why?
2. Which of the two places would you prefer to farm? Why?
3. Which place has healthier soils? How can you tell this?
4. Why has the soil on the lower picture degraded?



II. Their Testimony (30 minutes)

A. Ask an old person who has been living in the village for a long time to share about their community.

1. Ask the following interview questions to help them explain how things have changed through their lifetime:

- a) What was the situation on your farm and in your environment when you were very young?
- b) What changes have you seen?

B. Discussion Questions (for the whole group to answer):

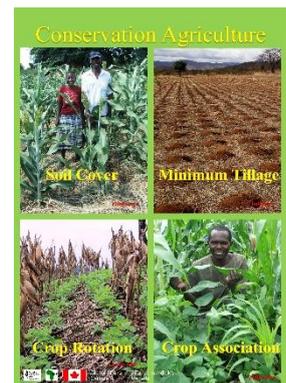
1. What have you heard? (write on a flip chart – past vs present)
2. What caused the changes they have described?
3. What will happen if these changes continue?
4. What are you currently doing to prevent these problems?
5. Do you want to learn some other ways to prevent this from continuing in your community? *This is a key question, so be sure they are interested before you move on. Don't rush through it.*

III. What is CA: (30 minutes)

A. Show the Conservation Agriculture poster

B. Discussion Questions:

1. What do you see in this field that is different from most other farms in the community?



2. Do you know anyone in the community who is using these methods?

C. Describe the Principles of Conservation Agriculture (*refer to the poster for illustration*)

1. Permanent soil cover (dry mulch and/or living plants)
2. Minimizing soil disturbance (using reduced or zero tillage)
3. Crop rotation and/or association

D. Invite the guest CA farmer to explain her/his experience with CA

IV. Why use CA? (30 minutes)

A. Discussion Questions:

1. What benefits do you expect a farmer would get from growing crops in this way?
Allow them to give their ideas first, but be sure they discuss the following potential benefits:
 - a) Less moisture stress (because of increased water infiltration and less evaporation)
 - b) Less soil erosion
 - c) Higher yields
2. Do these benefits help solve the problems we listed on the flipchart?
3. How?
4. What are some possible challenges in converting to CA?

V. Concluding Discussion (10 minutes)

1. Summarize what they have discussed.
2. Ask if they have any unanswered issues.
3. Ask if they would like to try CA on their farms. *This is a key question since they are deciding whether to join the project! Give them plenty of time to discuss and decide.*
4. If they say “yes,” decide on a time and place to return for practical training.

Minimizing Tillage With Planting Basins - Facilitator's Guide

Learning Outcomes – Participants will:

- 1) Appreciate the advantages of minimum tillage
- 2) Understand the importance of plant spacing, and decide what spacing they will use in their CA plot
- 3) Acquire the skills and techniques necessary for digging CA planting-basins with a hoe

Timing of this Lesson: This lesson should take place 2-3 months before the time of planting so that participants have time to prepare their land before the rains begin.

Pre-Requisites: In order to benefit fully from this class, participants should have already attended the following classes:

1. Situation Analysis: Why CA?
2. Contour Farming - *If most of the land in the area is sloping, rows should be planted on the contour rather than in straight lines. Participants should receive training on contour farming as part of their CA training.*

References:

[Conservation Agriculture: A Manual for Farmers and Extension Workers in Africa.](#) 2005. IIRR and ACT.

Materials Needed:

1. 2 Posters: “Situation Analysis” and “Minimizing Tillage” (basins and rippers)
2. Three maize ears: small, medium and large sized (fresh or dried)
3. A handful of maize seed
4. Hoes (*at least 1 for every 2 participants*)
5. Tape measure or ruler
6. Machete or sharp knife for cutting measuring sticks
7. 2 sticks, at least 1 meter long for each participant to cut for measuring plant spacing
8. 4 heavier wood stakes for holding the planting rope
9. Planting string or rope (enough for 2 lengths of the demonstration plot)

Preparation:

1. Research local extension service recommendations for plant spacing for all crops which will be planted in CA plots (see Appendix B for some examples).
2. Practice all demonstrations.
3. Review all discussion questions and be prepared to guide the discussion appropriately.

Learning Activities (Total time required = 3-4 hours)

I. Minimum Tillage - Introduction (1 hour)

A. Show poster from Situation Analysis class - Discussion Questions:

1. What do you remember from our discussion of the past and present last time?
2. In the old days (refer to the upper picture), did farmers plow or dig land before planting?
3. Why do people plow or dig their farms today?

B. Explain that the goal of this class is to learn a way of farming that doesn't require plowing or digging

C. Show Minimizing Tillage Poster - Discussion Questions:

1. What do you see in the upper picture that's different from how most people farm today?
2. How will weeds be controlled?
3. Will this method require more labor or less labor than digging the entire field?
4. What will happen to crops planted in this way if there is a dry period after planting? *Refer to the drawing in the Farmer's Booklet and explain the proper depth for planting basins.*
5. What do you see in the lower picture? *Explain that CA can also be done with oxen, though in this first year we will start with hand hoe dug basins.*

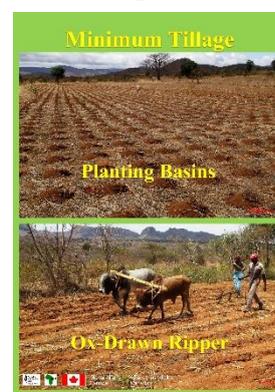
D. Discuss and decide how you will do the practical demonstration:

1. Ask which crops they would like to use for the demonstration
2. Ask what plant spacing they would like to use for these crops

II. Demonstration: Preparation of Planting Basins (1 hour)

A. Basin Digging: Work along with the participants. Don't stand by and supervise!!!

1. If land is grown up in weeds, begin by clearing with machete or a very shallow hoeing. Leave all weedy residue on the plot unless they have seeds that would cause problems after planting.
2. Stretch the planting rope along one side of plot.
3. Dig planting basins along this rope using within-row measuring stick prepared in plant population discussion (above). Basins should be 15 cm deep if the farmers will use compost or manure, or half this deep if they will use fertilizer.



4. Move planting rope using between-row measuring stick prepared above.
5. Dig second row using first row planting basins as a guide.
6. After digging planting basins for half the plot, demonstrate more labor-efficient methods of row planting such as those in Addendum A, at the end of this lesson.

III. Concluding Discussion (30 minutes)

A. Discussion Questions:

1. What advantages do you see with this method?
2. What disadvantages do you see with this method?
3. What additional steps remain before the crop can be planted?
4. Ask if they have any unanswered issues.
5. Challenge them to dig their own minimum tillage plot at home before the next training date.
 - a) Help them set a goal for an appropriate plot size (should be at least 20 m x 20 m, but not more than 40 m x 40 m or they may have difficulty finding enough mulch).
 - b) Stress the importance of preparing an adjacent plot of the same size, using conventional farming methods, so that they have a control to compare with the CA plot.
 - c) Ask for volunteers to host the next training class.
 - d) State that you will be visiting them to encourage them, and to answer any questions which may arise.

IV. Addendum A: Labor-Efficient Methods for Row Planting by Hand *(These methods were learned from innovative farmers. Encourage your farmers to find other labor-efficient ways to plant while maintaining consistent spacing).*

A. 2 People, 2 Ropes

1. Dig planting basins in first row as outlined in lesson plan, above.
2. Have 2 people place 2 planting ropes for the next two rows (rows 2 and 3).
3. Have the same 2 people dig basins for rows 2 & 3, beginning on opposite ends of the field.
4. When they each finish their row, they move the 2 ropes to mark rows 4 & 5
5. Continue digging 2 rows at a time.

B. 1 Person, 2 Ropes

1. Stretch ropes for both row 1 and row 2
2. Dig planting basins in row 1 using measuring stick as outlined in lesson plan, above.
3. Move the nearby end of the rope in row 1 to row 3. (The rope will now sit at a diagonal angle from one end of row 1 to the opposite end of row 3).
4. Dig planting basins for row 2 following the 2nd rope. (You will cross over the diagonal rope half way down the row).

5. Move the other end of the 1st rope to row 3 so that it's now straight, and the end of the 2nd rope to the beginning of row 4 (it will now sit at a diagonal). Dig row 3, and continue digging additional rows, moving both ropes in the same manner at each end of the field.

Importance of Soil Cover – Facilitator’s Guide

Learning Outcomes – Participants will:

- 1) Understand the importance of soil cover in conserving water and soil
- 2) Identify good local sources of mulch
- 3) Understand the challenges of keeping soils covered and identify ways to minimize these risks

Timing of this Lesson: This lesson should take place 4-6 weeks before the time of planting so that participants have time to collect mulch before the rains begin. *This lesson is often taught together with the lesson on Planting With Precision.*

Pre-Requisites: In order to benefit fully from this class, participants should have already attended the following classes:

1. Situation Analysis: Why CA?
2. Minimizing Tillage With Planting Basins

References:

[Conservation Agriculture: A Manual for Farmers and Extension Workers in Africa](#). 2005. IIRR and ACT.

Information series No. 3: Crop Residue Management and Cover Crops. <http://www.act-africa.org/libmain.php?com=5&com2=20&com3=64&com4=>

Materials Needed:

1. Farm land near training site (preferably with enough slope for water to run off). If appropriate land is not available, the demonstration can be done by cutting a 20 liter jerry can in half length-wise and filling each half with soil.
2. Tape measure
3. 6 wood stakes
4. Enough mulching material to cover a 1 m x 1 m plot 2-3 cm thick
5. 8-10 liter watering can with sprinkler head
6. 16 liters water
7. Poster: “How Much is Enough Soil Cover”

Preparation:

1. Practice the mulching demonstration to be sure you can produce good results.
2. Review all discussion questions and be prepared to guide the discussion appropriately.

Learning Activities (2 ½ to 3 hours)

I. Create an Experiment: Effect of Mulch on Soil Erosion and Moisture Retention

A. Lay out the experiment (30 minutes)

1. Measure two 1m x 1m plots and mark with wood stakes (or fill 2 cut-apart 20 liter containers with soil).

2. Spread mulch on one plot.
3. Fill the watering can with 8 liters of water and sprinkle on the **unmulched** plot holding the can as high as possible so that it impacts the soil.
 - a) Note any runoff water and soil from the plot.
4. Fill the watering can with 8 liters of water and sprinkle on the **mulched** plot holding the can as high as possible in the same fashion.
 - a) Note any runoff water and soil from the plot.
 - b) Lift the mulch to examine the soil underneath.

B. Discussion Questions (30 minutes)

1. What did you see in each plot?
2. What differences will you expect to see in the 2 plots if you return in 2 days? Why?
Replace the mulch and leave the plots to dry out.

II. Follow-up (*This activity should take place several hours or up to 1 day after watering the two plots. If this lesson is being done the same day as the lesson on Planting with Precision, you can facilitate that lesson now, then come back to complete this lesson at the end of the afternoon.*)

A. Field Observations (30-45 minutes)

1. Uncover the mulched plot.
2. Have participants feel differences in soil temperature in the two plots.
3. Turn soil in center of each plot with a shovel.
4. Give each participant a handful of soil from each plot.
5. Discussion Questions:
 - a) What changes do you see since we watered the 2 plots?
 - b) What differences do you see between the 2 plots? Why?
 - c) In which soil would you rather plant a crop?
 - d) If we planted seed in each plot today, what difference would you expect to see in 1 week?

B. Discussion (1 hour)

1. What are the advantages of keeping soils covered? (**Allow participants to respond, but be sure they mention moisture retention, and soil erosion reduction.**)
2. How much cover do we need to get these benefits? **Refer to poster and/or booklet and stress the following points:**



- a) 30% cover is the minimum we need to maintain throughout the year to maintain soil health
 - b) This cover can be provided by dry mulch *and/or* green plants
 - c) 30% cover will *not* suppress weed growth. This requires 100% cover.
3. What are some good mulching materials available in your community?
 4. During which months should you gather mulch for farming?
 5. You have seen the advantages of mulching soils. Unfortunately, most good things also have some disadvantages. What disadvantages would you expect to encounter with mulched crops? (*Facilitator should be sure participants are aware of challenges of weed control, excess moisture, labor to collect mulch, competition with livestock feed, potential increase in pests like rodents, slugs, termites, etc.*)
 6. What steps can you take to minimize these disadvantages? (*Wait for participants to offer their solutions to the above problems, but be sure to discuss strategies for weed control, and competition for livestock feed.*)
 7. What is a reasonable goal for soil cover in your farming operation? 30%? 60%? 100%?
 8. End the class by visiting nearby fields and discussing the amount of soil cover present in each one.

Planting With Precision – Facilitator’s Guide

Learning Outcomes – Participants will:

- 1) Understand the importance of precision placement of seed and fertility
- 2) Acquire the skills for basin planting in a CA system
- 3) Appreciate the importance of early field preparation and timely planting

Timing of this Lesson: This lesson should take place 3-4 weeks before the time of planting so that participants are prepared to plant as soon as the rains begin. *This lesson is often taught together with the lesson on Importance of Soil Cover.*

Pre-Requisites: In order to benefit fully from this class, participants should have already attended the following classes:

1. Situation Analysis: Why CA?
2. Minimum Tillage with Planting Basins
3. Importance of Soil Cover

References:

[Conservation Agriculture: A Manual for Farmers and Extension Workers in Africa.](#) 2005. IIRR and ACT.

Micro Doses, Mega Benefits <http://www.icrisat.org/what-we-do/publications/digital-publications/icrisat-publications-2008/icrisat-ebook-2008-microdoses.pdf>.

Materials Needed:

1. A farmer’s CA plot already prepared with planting basins
2. Manure, compost and/or fertilizer (preferably DAP = 18-46-0) depending on the most common local practices
3. Soil test results to know if local soils are acidic (see Appendix D)
4. Lime or wood ash if local soils are acidic
5. Measuring units (1/2 liter water bottles for manure and compost, bottle caps for fertilizer and lime/wood ash)
6. Hoes and machetes for covering seed and cutting mulch material
7. Maize seed (or seed of other crops if maize is not common)
8. “Precision Planting” poster

Preparation:

1. Practice demonstrations
2. Review all discussion questions and be prepared to guide the discussion appropriately.

Learning Activities (Total time required = 2 hours)



I. Introduction (30 minutes)

A. Show “Precision Planting” Poster - Discussion Questions:

1. What do you see in the upper picture?
2. What do you see in the lower picture?
3. Explain that in the upper picture, seed was broadcast and plowed in. In the lower picture, holes were dug, and 2-3 seeds were placed precisely in each planting basin.
4. Which field do you think will produce a better harvest of maize? Why?
5. Why is it important to plant with precision? *(Wait for participants to offer their ideas, but be sure they discuss how too shallow planting may cause the seed to dry out while too deep planting makes it hard for the plant to emerge. Also, remind them of the class on plant population and the importance of proper plant spacing).*

B. Explain that the goal of this class is to learn how to plant with precision

II. Demonstration: (60 minutes)

A. Demonstration: Precision Planting with CA *(this demonstration should take place in the field of a farmer who dug planting basins after the previous lesson)*

1. **Examine planting basins and discuss optimum basin depth:** 15 cm (the length of a hand) if they will be using manure or compost, and 10 cm (the width of a hand) if they will use fertilizer.
2. **Demonstrate placement of compost/manure or fertilizer** (1 half-liter water bottle with 1/3 of the top cut off) or fertilizer (1 heaping bottle cap) and wood ash (1 heaping bottle cap) in the bottom of the planting basin, cover with 2-3 cm of soil.
3. **Demonstrate seed placement** (2-3 seeds/basin) and cover with 3 cm soil for large-seeded crops like maize and beans, and 1-2 cm for small seeded crops like sorghum and millet.

B. Discussion in the Field:

1. Why do we cover the fertilizer/manure/compost before placing the seed?
2. Under what conditions would we want to cover the seed with more than 3 cm soil? *(Answer: If we anticipate dry weather)*
3. What other suggestions do you have for planting with precision?
4. Have each participant plant several holes, but explain that the owner of the field will wait until the rains fall to plant the remainder.
5. Finish by mulching over the planting basins which were planted.

III. Discussion: Early Preparation Allows Timely Planting Dates (30 minutes)

A. Discussion Questions:

1. When do you expect the rains will begin this season?
2. If the rains fall when expected, when is the best time to plant your crop? (*Wait for participants to offer their ideas, but be sure they discuss the disadvantages of planting too early or too late.*)
3. What might prevent you from planting at the optimum time?
4. What can we do to overcome these challenges? (*Wait for participants to offer their ideas, but be sure they talk about collecting materials and digging planting basins early, during the dry season. In areas with very uncertain rainfall, it may be best to split planting dates to reduce risk.*)
5. Reporting back: Summarize their discussion for them. Compliment them on their wisdom!
6. Encourage them to continue preparing their CA plots and gathering mulch early so that they are ready before the first rains fall. Mention that you will visit to encourage them and see how they are doing.

Cover Crops – Facilitator’s Guide

Learning Outcomes – Participants will:

- 1) Understand the importance of living plants and organic matter in maintaining soil health
- 2) Realize the advantages of growing mulch materials on location in fields versus bringing it in from outside
- 3) Decide what cover crops to plant on their farms in the coming season

Timing of this Lesson: This lesson should take place 4-6 weeks before the time of planting so that participants have time to get seed and prepare for planting before the rains begin.

Pre-Requisites: In order to benefit fully from this class, participants should have already attended the following classes:

1. Situation Analysis: Why CA?
2. Importance of Soil Cover

References:

[Conservation Agriculture: A Manual for Farmers and Extension Workers in Africa](#). 2005. IIRR and ACT.

[Green manure / cover crops and crop rotation in Conservation Agriculture on small farms](#). 2011. FAO.

[Restoring the Soil](#). 2012. Roland Bunch. Canadian Foodgrains Bank, Winnipeg.

Materials Needed:

1. Legume plants with nodules (if available)
2. Posters: “Situation Analysis” and whichever “Cover Crops” poster best fits your context
3. Green manure/cover crop seeds
4. Legume roots with nodules if available

Preparation:

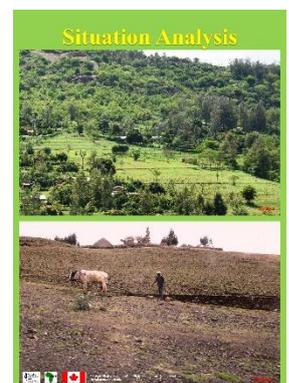
1. Practice demonstrations
2. Review all discussion questions and be prepared to guide the discussion appropriately.
3. If a field which was planted to cover crops is available, arrange to hold this lesson near enough to visit that field.

Learning Activities (Total time required = 2 – 2½ hours)

I. Introduction (30 minutes)

A. Discussion Questions: (Use “Situation Analysis” Poster to help this discussion)

1. Do you remember when we discussed how things were in the past, and how they are today?



2. What are some indicators of soil health? (*Wait for participants to give their answers, but be sure they mention color, organic matter content, water retention, and good plant growth*).
3. In the time of your great-grandmothers, when a field stopped producing well, what did they do to restore soil health?
4. During a period of fallow, what was happening that made soils become healthy again? (*Wait for participants to offer their ideas, but be sure to discuss how, when fields are fallowed, shrubs, trees and decomposing plant material rebuild soil fertility and productivity*).
5. Why can't we use fallow to restore our soils to health today? (*Allow participants to share, but be sure they mention population growth, land scarcity, etc.*)
6. What plants do you know that help to restore soil health?

B. Explain that the goal of this lesson is to find ways to restore soil health using plants.

II. Demonstrations: (45 minutes)

A. Discussion: Use which ever “Cover Crops” poster best fits your context (*If a field with a good cover crop is available, take the group to visit it for this discussion rather than using the poster*).

- Explain that cover crops can be planted together with the main crop, or in rotation depending on the species.
- Examine the leaf litter underneath the cover crop.

1. What did you see? (*Allow participants to make observations, but be sure they discuss the leaves covering the soil, soil moisture, and lack of weeds*)
2. What benefits do we get from having plants like this growing on our soils?
3. Do you remember when we discussed the Importance of Soil Cover?
4. What did we decide was the minimum soil cover we need to maintain throughout the year?
5. Why?
6. How can planting cover crops help us to maintain that soil cover?

B. Demonstration 2: Legume Nodules (*if no good plants are available, use “Cover Crops” poster*)

1. Carefully dig up a plant with a shovel, and gently wash off the roots.
2. Point out the nodules

C. Discussion Questions

1. Have you seen nodules like this before?



2. On what plants?
3. What do these nodules do for the plant?
4. What will these nodules provide for a crop which is planted in the next season?
 - If they are not familiar with legume nodules, explain that these nodules produce free fertilizer, both for this plant, and for the crop which will be planted after it. Many cover crops can produce the equivalent of up to 1-3 bags of fertilizer per hectare.

III. Action Planning and Discussion (45 minutes)

A. Describe 2-3 cover cropping systems you think have high potential for their farming system. *Use your experience, and the information in Appendix E to present 2-3 cover crops which are most likely to be successful:*

1. ***If their main crops are maize or early-maturing millet or sorghum:*** The best cover crops are slow-growing, late-maturing legumes that cover the soil and keep producing after the main crop is harvested:
 - a) Lablab
 - b) Pigeon pea
 - c) Late-maturing cowpea
 - d) Others? Ask if they know of other local plants that could serve as cover crops
2. ***If their main crops are cassava, late maturing millet or sorghum:*** The best cover crops are quick-growing, early-maturing legumes which cover the soil quickly:
 - a) Cowpea
 - b) Groundnut
 - c) Soybean
 - d) Jackbean (sometimes planted after the early-maturing legumes)
 - e) Others? Ask if they know of other local plants that could serve as cover crops
3. ***If their main crops are small grain cereals like wheat, barley or teff:*** The best cover crops are legumes which can be grown in rotation:
 - a) Fava bean
 - b) White lupin
 - c) Climbing common beans
 - d) Vetch
 - e) Others? Ask if they know of other local plants that could serve as cover crops

B. Discussion & Action Planning:

1. Which of these cover cropping systems do you think would be most beneficial in your farming system? Why?
2. What steps do we need to take in order to test these systems in the upcoming season? ***Help them write down their action plan including:***

- a) Where will they get seed?
- b) What will be the timing of planting and plant spacing in relation to the main crop?
- c) How will they protect the crop from pests, including livestock grazing?

IV. Concluding Discussion (15 minutes)

A. Discussion Questions:

1. Ask if they have any unanswered issues.
2. Offer to return for further training if they so desire.

Weed Management - Facilitator's Guide

Learning Outcomes – Participants will:

- 1) Understand the challenges and multiple methods of controlling weeds under CA
- 2) Learn how to use mechanical weeding methods while minimizing soil disturbance
- 3) Appreciate the importance of early-season and post-harvest weed control

Timing of this Lesson: This lesson should take place as soon after planting as possible so that participants can start weeding early.

Pre-Requisites: In order to benefit fully from this class, participants should have already attended all the initial core CA lessons (Situation Analysis, Minimum Tillage with Planting Basins, Importance of Soil Cover, Planting with Precision & Cover Crops).

References:

[Conservation Agriculture: A Manual for Farmers and Extension Workers in Africa](#). 2005. IIRR and ACT.

Information series No. 8: Weed Management in Conservation Tillage Systems. 2013. ACT.
http://www.act-africa.org/lib.php?com=5&com2=20&com3=64&com4=41&res_id=79.

Materials Needed:

1. Fresh weed samples: Alert participants to bring weed samples from their farms. In addition, collect 2-3 weeds that you know are a problem in local farms.
2. Flip chart or large-format paper
3. Magic markers
4. “Weed Management in CA” Poster
5. Hoes (one for each participant)
6. Herbicide sample (if available in local Agro-Vet supply stores)

Preparation:

1. Verify that the host farmer has a field with appropriate weed growth for the demonstration.
2. Alert Participants to bring fresh samples of their most troublesome weeds. If this is not possible, the facilitator should collect and bring 2-3 fresh weed samples.
3. Review all discussion questions and be prepared to guide the discussion appropriately.

Learning Activities (Total time required = 2.5 to 3 hours)

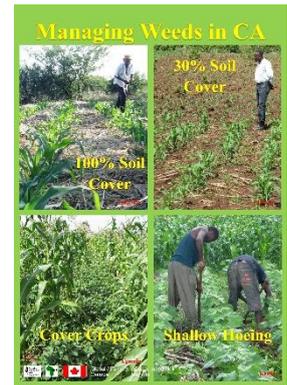
I. Introduction (45 minutes)

A. Weed Samples

1. Ask Participants to present the weed samples they brought, give their names, and how they affect crop plants.
2. On a flipchart write the names of these weeds (in their local language).
3. What other weed species are particularly damaging in your crops?

4. What methods do you use to control weeds like these? How often do you typically hoe to control these weeds?

B. Show poster - Discussion Questions:



1. How does **minimizing tillage** affect your ability to control these weeds?
2. How does **soil cover** affect your ability to control these weeds? *(Allow participants to give their ideas. Use the poster to illustrate that, while heavy mulch will suppress weed growth, light mulch will not suppress weeds, and may even make it more difficult to control them with a hoe).*
3. How do **intercropping and crop rotation** affect your ability to control these weeds? *(If they have difficulty answering, explain that intercropping covers the ground more completely and suppresses weeds by giving them more plants to compete with. Crop rotation suppresses weeds by breaking up their life cycle).*
4. How do **cover crops** affect your ability to control these weeds? *(Use the poster to illustrate how cover crops can suppress weed growth, especially after harvest of the main crop).*
5. Explain that **shallow hoeing** is often necessary in CA. Refer to the drawings in the Farmer Booklet and discuss how shallow hoeing minimizes soil disturbance, and uses weeds to create soil cover.
6. Do you know anyone in your community that uses **herbicides**? *Explain that these are chemicals that can kill weeds, but stress that they need to be used carefully in order to protect human health and the environment.*
7. *Explain that in the first few years of using CA, weed control can be a major challenge. Eliminating tillage by itself may result in more weed growth. However, CA methods like mulching, intercropping, cover crops, and shallow hoeing combine to suppress weeds.*

II. Demonstration: Shallow Hoeing Weeds in CA (1 hour)

A. Field visit

1. Visit a field of the host farmer.
2. Explain that, while enough soil cover can suppress weed growth completely, often hand pulling, hoeing, or herbicides will also be needed to keep weed growth to a level where they won't affect crop yields.
3. Demonstrate shallow hoeing, minimizing soil disturbance and returning the weeds to the soil surface as mulch.
4. Invite participants to continue weeding while minimizing soil disturbance: Using hand pulling and shallow hoeing. Work along with the participants. ***Don't stand by and supervise!!!***

III. Concluding Discussion (30 minutes)

A. Discussion Questions:

1. Which weeds do you think will be most difficult to manage under CA? (*Hint: perennial weeds tend to be the hardest to control*).
2. How long after planting should a farmer begin weeding? (*Allow the participants to give their ideas. Answers may vary from 2 to 4 weeks. Be sure they discuss the fact that the ideal timing varies depending on the crop, on the number and species of weeds, and on how much land a farmer has to weed*).
3. Do you ever weed your fields *after* harvesting?
4. How can slashing the weed growth in your fields after harvest help to control weeds in the following season?
5. Summarize their discussion for them. *Compliment them on their wisdom!*
6. Ask if they have any unanswered issues.
7. Challenge them to get an early start on weeding when they go home.

Crop Residue Management – Facilitator’s Guide

Learning Outcomes – Participants will:

- 1) Revisit the importance of keeping soils covered
- 2) Understand how to manage crop residue to meet the needs of *both* livestock and soils
- 3) Develop an action plan for maintaining a minimum 30% soil cover throughout the dry season

Timing of this Lesson: This lesson should take place 4-6 weeks before the beginning of harvest so that participants are ready before the busy harvest season begins.

Pre-Requisites: In order to benefit fully from this class, participants should have already attended the following classes:

1. Importance of Soil Cover

References:

[Conservation Agriculture: A Manual for Farmers and Extension Workers in Africa](#). 2005. IIRR and ACT.

Information series No. 3: Crop Residue Management and Cover Crops. <http://www.act-africa.org/libmain.php?com=5&com2=20&com3=64&com4=>

Residue Retention and Mulching in CF.

[http://conservationagriculture.org/uploads/pdf/RESIDUE_RETENTION_VERSUS_MULCHING - 7.2012.pdf](http://conservationagriculture.org/uploads/pdf/RESIDUE_RETENTION_VERSUS_MULCHING_-_7.2012.pdf).

Materials Needed:

1. 2-3 Maize ears (cobs) at green roasting stage and 2-3 mature maize ears
2. Sharp knife
3. Maize field near maturity (black layer stage – see description below)
4. Poster: “How Much is Enough Soil Cover?”
5. Poster: “Give Livestock the Best, Give the Soil the Rest”

Preparation:

1. Practice demonstration of maize ear maturity to be sure you know what you’re doing!
2. Review all discussion questions and be prepared to guide the discussion appropriately.

Learning Activities: (Total time required = 2 1/2 hours)

I. Review the Importance of Soil Cover (20 minutes)

A. Describe the experiment they did with mulched and unmulched soil during the lesson on “Importance of Soil Cover”:

1. One plot was mulched, the other had bare soil.
2. Both were watered, then left in the sun for a day or two.

B. Discussion Questions

1. What do you remember learning from this experiment?
2. Which plot created a better environment for plants to grow?
3. Have you experienced the benefits of soil cover in your fields during the past season?

II. How much soil cover is enough? (30 minutes)

A. Explain minimum 30% soil cover goal using poster and/or farmer booklets

1. For good soil health, we need to maintain at least 30% cover even through the dry season
2. This cover can be provided by dry mulch *and/or* green plants
3. This is enough to keep soils cool, and minimize wind and water erosion
4. It's *not* enough to control weeds (to do this, you need nearly 100% cover)



B. Discussion Questions:

1. What is a reasonable goal for soil cover in your farming operation? 30%? 60%? 100%?
2. What challenges will you face in maintaining soil cover throughout the dry season?"

III. Demonstration: Maize residue management (30 minutes) *If maize is not a major crop in your area, replace the following section with a different demonstration of residue management for the predominant crop.*

- A. Discussion Question:** What part of the plant has the most value as livestock feed? *If they have trouble answering, help them understand that it is the top part, with green leaves.*
- B. Break a maize ear at green roasting stage and cut several kernels length-wise with a sharp knife.** The inside tip of the kernels (closest to the cob) should be milky, while the outside edge is drier and harder. Explain that these kernels are still being filled by the plant. Over the next few weeks, the milky area will get smaller until the entire kernel is hard. At this point the plant has finished filling the kernel.
- C. Break another maize ear which is mature, and show them the black layer at the tip of each kernel.** This black layer forms when the milky part of the kernel is gone, and the plant has finished filling this grain.
- D. Explain that if the tops of maize plants are cut, dried and stockpiled at black layer stage, they will have much higher feed value for livestock than the dried maize stover after the ears have dried completely. The bottoms of the plants have very little feed value, and should be left in the field.**
- E. Visit a nearby maize field** (or use poster) to illustrate how to do this.

IV. How Can We Maintain Soil Cover Through The Dry Season? (1 hour)

A. Explain the slogan: “Give livestock the best, Give the soil the rest” (create your own slogan in the local language)

1. We need to assure that livestock are well fed
2. We need to maintain a *minimum* of 30% soil cover

B. Discussion Question: What strategies can we use to achieving these goals?

1. Allow the group to brainstorm widely, but help them to be realistic and think about the details. For example:
 - a) *If they have planted cover crops*, discuss how they need to manage them in order to maintain soil cover.
 - b) *If they mention collecting mulch*, ask them what mulching materials are available? During which months should they gather mulch for farming?
 - c) *If they mention collecting and stock piling fodder*, discuss what materials are available and how they can best be stored.
 - d) *If they mention growing fodder for livestock*, discuss options and availability of seed.
 - e) *If they mention fencing*, help them identify which fencing is most effective. Will they need outside materials to build fences?
 - f) *If they mention controlled grazing of crop residues*, help them discuss how to avoid over grazing fields.
 - g) *If they mention enforcement of grazing bylaws*, help them identify which local officials will be most receptive to their concerns.
 - h) Etc.



C. Action Planning

1. Help the group decide which of these strategies they will work on in the coming dry season.
2. Have the group secretary record the following:
 - a) Their % soil cover goals for the coming dry season.
 - b) The strategies they identified for achieving these goals, including a time table for when they will complete them.
3. Explain that you will be visiting to help them achieve these goals. If they would like further training (e.g. on fencing, fodder storage, etc.) set a date to return and do this.

Appendix A – Building an Effective Training Curriculum and Follow-Up Schedule

As noted in the introduction, adults learn best when they participate in a cycle of training sessions followed by practical applications. This *praxis*, as it is known in English, allows the learner to master and adapt one idea before moving onto something new. In a CA curriculum, this means we should spread the training process throughout the cropping cycle rather than to hold one long training session before the rains start falling.

The first step in designing such curriculum is to map out the cropping cycle. Once you've identified the appropriate time for field preparation, planting, weeding, etc. you can place each lesson in its proper place (usually a week or two before they need to put the lesson into practice).

Each module in this Facilitator's Guidebook provides suggested timing for each lesson, but you will need to adjust this timing according to your local cropping cycles. A typical Year 1 CA training schedule might look like this:

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Year 1 CA Training Schedule												
Field Operations	Plant minor crops		Field Prep	Field Prep	Plant main crops	Weed - ing	Weed - ing		Har-vest	Har-vest		Minor field prep
Training Workshops												
Situation Analysis/ Introduction to CA		X										
Minimum Tillage with Planting Basins			X									
Importance of Soil Cover			X									
Planting with Precision				X								
Cover Crops				X								
Weed Management with CA					X							
Crop Residue Management								X				
Follow-up Visits			X		X	X			X			

Note that in this schedule follow-up visits are also planned throughout the year. It is not necessary to visit every farmer every month. However, each participant should be visited by an Extension Agent, Field Officer or Lead Farmer at critical times when they are implementing the training on their farms. These visits help to encourage participants and clarify misunderstandings. They also provide an opportunity for field staff to learn from the experiences and insights of the farmers.

Multi-year projects should plan a multi-year curriculum in which farmers learn progressively more each year (just like a school curriculum where each year builds on the previous year). Project staff and farmer-participants should work together to identify these subjects. A 2nd and 3rd year training schedule might look like this:

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
												
Field Operations	Plant minor crops		Field Prep	Field Prep	Plant main crops	Weed - ing	Weed - ing		Har-vest	Har-vest		Minor field prep
Second-Year Participants												
CA Refresher		X										
Minimum Tillage with Oxen (Ripping)			X									
Manure Management	X											
Herbicide Use					X							
Grain Storage									X			
Open for Other Subjects??												
Follow-up Visits		X		X		X				X		

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Third-Year Participants												
CA Refresher		X										
Fencing			X									
Insect Management					X							
Marketing								X				
Open for Other Subjects??												
Open for Other Subjects??												
Follow-up Visits				X			X		X			
Graduation											X	

Note that in later years, training time should be left open for unanticipated subjects which arise and are of interest to participants. Training materials for many subjects can be found at: <http://caguide.act-africa.org/additional-training-modules/>. As you develop your own training materials, feel free to contribute them to this same website for others to use.

Appendix B – Plant Spacing Recommendations

Plant spacing is critical to increasing crop production, especially for crops like maize which do not spread or send up productive side shoots (tillers). Optimum plant spacing depends on many factors, including rainfall, soil moisture holding capacity, soil fertility, crop varieties, intercropping, etc. Farmers should be encouraged to experiment with different plant spacing and to learn from each other. Some general guidelines for countries in the continent of Africa include:

Maize Plant Spacing Recommendations

Country	Conditions	Between rows (cm)	Within rows (cm)	Plants per station	Plants per hectare
Ethiopia ¹	Early maturing varieties	75	25	1	53,000
	Full season varieties	75	30	1	44,444
Kenya ²	High production areas	75	25	1	53,000
	Standard production areas	75	30	1	44,000
	Marginal production areas	90	30	1	37,000
Tanzania ³	Early maturing varieties	75	40	2	66.666
	Full season varieties	75	60	2	44,444
Rwanda ⁴		70	30	1	47,619
CIMMYT ⁵ (southern Africa)	>1000 mm rainfall/season	75	25	1	53,300
	600-1000 mm/season	75	30	1	44,444
	<600 mm rainfall/season	75	38	1	36,000
Malawi ⁵	600-1400 mm rainfall	75	25	1	53,333
	500-800 mm rainfall	75	60	2	44,444
Zambia ⁵	500-800 mm rainfall	90	60	3	44,444
	600-1200 mm rainfall	90	25	1	55,555
Mozambique ⁵		90	50	2	44,444
Zimbabwe ⁵	500-800 mm rainfall, planting basins	90	50	2	44,444
	600-1200mm rainfall, other methods	90 90	25 30	1 1	44,444 36,000

1. Debele., T. 1996. *Determination of varietal combination and plant density for maize/haricot bean intercropping at Bako – western Ethiopia.*
2. National Farmers Information Service: <http://www.nafis.go.ke/agriculture/maize/establishment-of-maize/>.
3. National Maize Research Programme recommendations as reported in Kaliba, *et al.* 1998. (CIMMYT)
4. Ministry of Agriculture and Animal Resources. 2009. *Farmer's Diary.*
5. Thierfelder, C. Personal Communication

Plant Spacing Recommendations for other Crops

Cotton ⁵		90	60	2-3	36,000-55,555
Sunflower		90	25	1	40,000-60,000

Other crops that spread (like beans and squash) or produce multiple shoots (like rice or millet) can compensate for variations in plant spacing. Thus, achieving an optimum planting density is much less important in maximizing yields.

Appendix C - Additional Resource Materials

- **Conservation Agriculture**

African Conservation Tillage Network: <http://www.act-africa.org/>.

Conservation Agriculture (FAO): <http://www.fao.org/ag/ca/>.

Conservation Agriculture Global Research and Resources (Cornell University):

<http://conservationagriculture.mannlib.cornell.edu/>.

Conservation Agriculture (Wageningen University):

<http://www.wageningenur.nl/en/Expertise-Services/Chair-groups/Plant-Sciences/Plant-Production-Systems-Group/Conservation-Agriculture.htm>

Conservation Farming Unit (Zambia) <http://conservationagriculture.org/conservation-farming-information>.

C2Africa (CIRAD): <http://ca2africa.cirad.fr/>.

Farming God's Way: <http://farming-gods-way.org/home.htm>.

Foundations for Farming: <http://www.foundationsforfarming.org/>.

The Conservation Agriculture Academy: <http://www.ca-academy.net/index.html>.

- **Green Manure/Cover Crops**

Lablab.org: <http://www.lablablab.org/html/origin-distribution.html>.

N2Africa: <http://www.n2africa.org/>.

Tropical Forages: An Interactive Selection Tool:

<http://www.tropicalforages.info/key/Forages/Media/Html/Overview.htm>.

- **Question-Posing Training Approaches**

Freire, P. 1970. *Pedagogy of the oppressed*. New York: The Continuum Publishing Corporation.

The Freire Institute: <http://www.freire.org/paulo-freire/concepts-used-by-paulo-freire>

Global Learning Partners: <http://www.globallearningpartners.com/resources>

- **Extension Methods**

The Farmer's Field and Business School Toolkit. <http://www.care.org/work/world-hunger/farmers-field-and-business-school-toolkit>

Farmer-to-Farmer Extension: Issues in Planning and Implementation:

<https://dl.dropboxusercontent.com/u/15810717/Technical%20Notes/MEAS%20TN%20Farmer%20to%20Farmer%20-%20Simpson%20et%20al%20-%20May%202015.pdf>.

- **Pest Management**

Africa Soil Health Consortium: <http://africasoilhealth.cabi.org/materials/>.

InfoNet Biovision Farmer Communication Programme: <http://www.infonet-biovision.org/>.

Appendix D – Soil Testing Resources

Testing soils for fertility status should be a routine part of every CA program. Soil testing helps to identify fertility issues (e.g. pH problems) that may be limiting production. This information should inform your guidelines on application of manure/compost, fertilizer, and lime or wood ash. For guidelines on how to take a proper soil sample, consult this [Agricultural Soil Analysis Sampling Guide](#).

Soil testing can objectively measure changes in soils over time. However, in order to document the impact of CA, it is important to sample the same fields, at the same time of year, over several years. An additional approach may be to sample pairs of fields, one which has been managed under CA and a similar field which has remained under conventional cultivation.

Be sure the laboratory which analyses your soil tests for soil carbon or soil organic matter in addition to the standard nutrient testing. Other measures of soil quality include bulk density, biological activity, etc. These measures generally require specialized equipment and/or handling procedures.

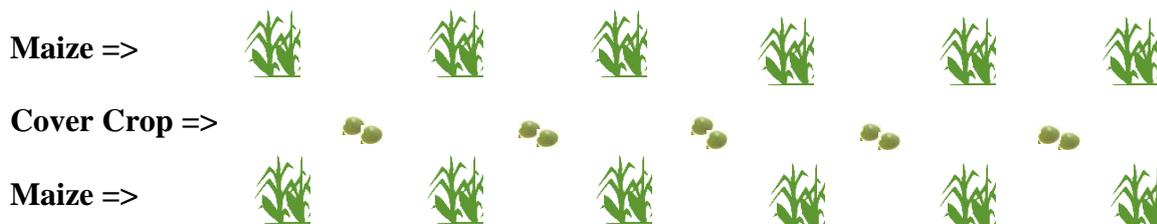
If you are having trouble finding a reliable soil testing laboratory in your country, Crop Nutrition Services (<http://www.cropnuts.com/soil-analysis>) based in Nairobi Kenya, can import and analyze soil samples from other countries. Their Basic Soil Analysis (CNSA031) costs around \$25 US per sample, and their Soil Life Test (CNSA040), around \$28 per sample, measures soil biological activity, a good indicator of soil health.

Appendix E – “Best Bet” Green Manure/Cover Crop Species

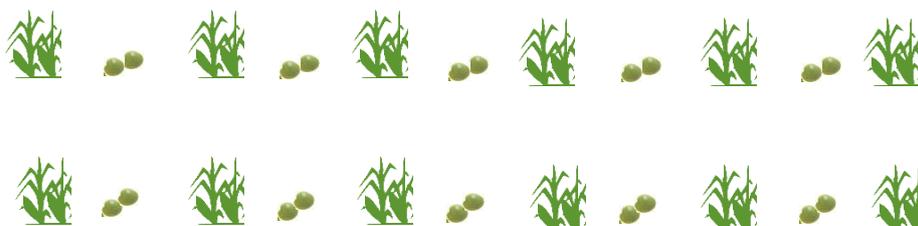
Cover Crops for Intercropping with Early-Maturing Crops (maize, early millet & sorghum)

	Lablab	Pigeon Pea	Cowpea	Velvet Bean
Scientific Name	<i>Lablab purpureus</i>	<i>Cajanus cajan</i>	<i>Vigna unguiculata</i>	<i>Mucuna pruriens</i>
Timing of planting	0-2 weeks after main crop	together with main crop	together with main crop	4 weeks after main crop
Planting rate (seeds/sq meter)	4-5	4-5 (tall var's) 8-10 (dwarf var's)	5-6 (vining var's) 10-20 (bush var's)	2-3
Planting rate (kg per ha)	8-10	4-6 (tall var's) 10-14 (dwarf var's)	8-12 (vining var's) 20-30 (bush var's)	14-20
Edible seed	yes	yes	yes	no
Edible leaves	yes	no	yes	no
Livestock feed	yes	yes	yes	yes
Altitude	<1800 m	<1800 m	< 1500 m	< 1500 m
Drought tolerance	high	very high	high	moderate
Fertility requirement	Moderate (may need inoculant 1 st time)	low	moderate	moderate
Other uses		firewood		
Notes:	Plant early-maturing varieties in short rains. Late-maturing varieties maintain better cover through long dry seasons. Can ratoon.	Late-maturing varieties maintain better cover through long dry seasons. Varieties readily cross-pollinate. Can ratoon.		Varieties differ widely in seed color, but plant growth doesn't vary much.

Intercropping Pattern: If maize is in planting stations with 2 seeds per station, plant most cover crops between the maize.



Some cover crops, like pigeon pea can be planted in the same row as the main crop, which makes weeding easier, and allows a 2nd intercrop of an early-maturing legume such as beans or green gram.



Adjust these seeding patterns according to the desired cover crop planting rate as outlined in the table, above.

Best-Bet Cover Crops for Intercropping with Late-Maturing Crops (cassava, tall millet, tall sorghum, etc.)

	Cowpea	Groundnut	Soybean	Jackbean
Scientific Name	<i>Vigna unguiculata</i>	<i>Arachis hypogaea</i>	<i>Glycine max</i>	<i>Canavalia ensiformis</i>
Timing of planting	together with main crop	together with main crop	together with main crop	together with main crop or late relay crop
Planting rate (seeds/sq meter)	5-6 (vining var's) 10-20 (bush var's)	5-6 (vining var's) 20-30 (bunching)	50-100	5-7
Planting rate (kg per ha)	8-12 (vining var's) 20-30 (bush var's)	90-140 (vining) 50-100 (bunching)	70-150	40-60
Edible seed	Yes	Yes	Yes	No
Edible leaves	Yes	No	No	No
Livestock feed	Yes	Yes	Yes	No
Altitude	< 1500 m	<1500 m	< 2000 m	< 1300 m
Drought tolerance	high	moderate	moderate	very high
Fertility requirement	moderate	moderate	moderate	low
Notes:			Respond well to rhizobium inoculation. Don't tolerate shade.	Avoid climbing varieties

Best-Bet Cover Crops for Rotation with Small Grain Cereals (wheat, barley, teff, etc.) and other crops at higher altitudes

	Fava Bean	Lupin	Climbing Beans	Vetch
Scientific Name	<i>Vicia faba</i>	<i>Lupinus albus, L angustifolius</i>	<i>Phaseolus vulgaris</i>	<i>Vicia spp.</i>
Timing of planting	Long rains (<i>maher</i>)	Short rains (<i>belg</i>) Long rains (<i>maher</i>)	Short rains (<i>belg</i>) Long rains (<i>maher</i>)	Short rains (<i>belg</i>)
Cropping system	Sole or intercrop (e.g. with maize)	Sole crop	Sole crop	Sole crop
Planting rate (seeds/sq meter)	20-40	30-40	15-25	55-70
Planting rate (kg per ha)	120-200	50-90	60-100	25-35
Edible seed	Yes	Yes (some white lupins are <i>not</i> edible)	Yes	No (unless highly processed)
Edible leaves	No	No	No	No
Livestock feed	Yes	Yes	no	Yes
Altitude	>1500 m	>1500 m	>1500 m	>1500 m
Drought tolerance	moderate	high	moderate	moderate
Fertility requirement	moderate	Very low (tolerates acid soils)	moderate	moderate
Notes:		Very good at restoring fertility of depleted soils	Respond well to rhizobium inoculation. Need to be staked.	Seed can be broadcast without incorporation if moisture is adequate