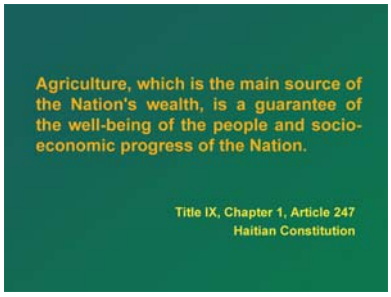
SP.721 (D-Lab) Fall 2004
Session #17 notes

Agricultural Technology Showcase Part 1

This class session will focus on technologies for food storage, processing, and cooking. In the next session (Ag Tech Showcase Part II), guest speaker Paul Polak from IDE will discuss irrigation, a fundamental challenge to growing crops in many developing countries.

Agriculture in Developing Countries

This quote from the Haitian constitution signifies that agriculture is fundamentally important and widespread in Haitian society.



Let's consider the state of agriculture in Haiti. (See the slide.) Why is the average Haitian farm so small? (A hectare is 100m x 100m – not much land!) The larger farms of several generations ago have been subdivided among the children over and over again.

In Brazil, government policies have favored large shareholders and the crops considered most economically productive – at the expense of other values.

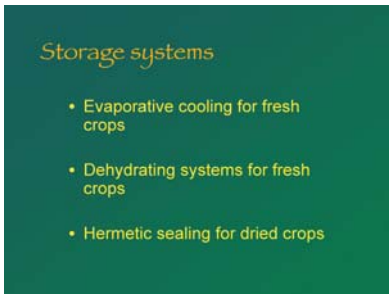
Indian agriculture has been transformed by the Green Revolution, with dramatic increases in crop yields and overall production. Yet, the 2nd bullet indicates that the livelihoods of farmers haven't necessary improved as much: very few actually own the land that they farm.

Survey of Agricultural Technologies

We'll be looking at some technologies for storage, processing, and cooking.

Storage

Recall from the World Fact Quiz (Session 1) that approximately 20% of harvested crops are lost during storage. Thus improved storage technologies can provide big benefits.



Appropriate technology storage systems take several forms, including:

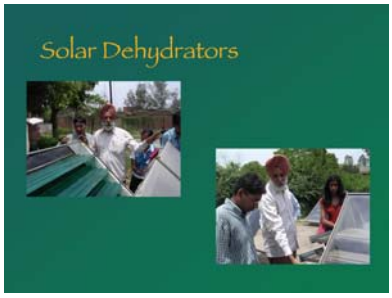
- Evaporative cooling for fresh crops
- Dehydrating systems for fresh crops
- Hermetic sealing for dried crops

The Pot-in-Pot (covered in Sessions 1 and 2) uses evaporative cooling. It's been found most effective in drier environments, although it doesn't work as well in humid environments. In other words, an appropriate solution in one place may not be appropriate in others.

A pot-in-pot is passed around the class. See photo (right). The sand layer is wet, and the inner pot is noticeably cool to the touch.

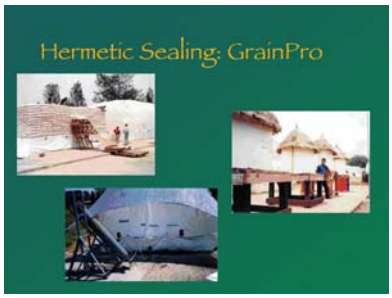
Pot-in-pots vary in size; some Nigerian pots are quite large. The technology is also being studied for room-sized cooling. A prototype Pot-in-Pot building, with 2 layers of bricks around 4 inches of sand, has been built but supplying water proved to be a challenge.

Properly dehydrated foods can be stored for long periods. For dehydration, solar-powered solutions are often favored. In the design shown in the slide, sloped walls and mesh-bottom shelves foster good air circulation.



Hermetic sealing dates back at least to ancient Egypt, where they stored food in glazed jars with wax-sealed lids. Done properly, hermetic sealing cuts off oxygen from any insects or eggs that might be in the grain – a few might hatch after storage but they'll quickly die off.

The hermetic storage system sold by GrainPro (http://www.grainpro.com) uses plastic film and specially-designed "zipper" seals. It's portable, and designed to be set up in a few hours (allowing storage at the growing locations, a benefit for areas with limited transportation capacity). They come in a range of sizes, from the five to twenty ton "cocoons" most likely to be used in developing countries, up to 100 ton silos.

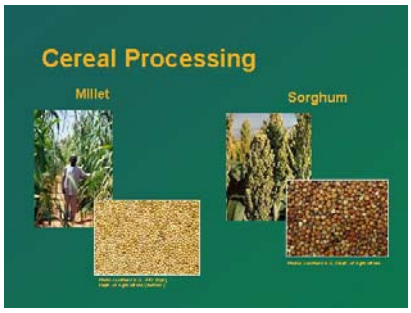


Images courtesy of GrainPro, Inc. Used with permission.

Processing

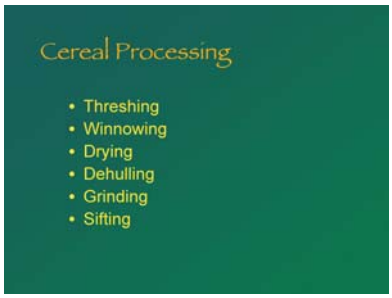
Processing technologies help turn raw grains, vegetables, fruits and other products into edible food.

Cereal processing is particularly important in developing countries. Cereals like millet (left two photos) and sorghum (right two photos) are staples in many diets.



Images courtesy of USAID (upper left) and U.S. Department of Agriculture.

Class discussion: What does it take to turn the raw plant into a bowl of porridge? The class brainstormed this list, gradually filling all the steps with the instructor's prompting.



1. Harvesting
2. Threshing (removing grains from the stalk) – indigenous solutions include beating the grains with sticks and having livestock walk on it.
3. Winnowing
4. Cleaning
5. Drying

6. Storage
7. De-hulling or de-corticating
8. Grinding
9. Sifting by particle size (coarse becomes grits, fine becomes flour)
10. Cooking

The class also notes that once outside a completely localized subsistence agriculture, transportation goes across all these steps.

The slide photo (below) shows labor-intensive de-hulling with mortar and pestle, from Senegal. Grain mills are a favored intermediate technology solution for improved food processing.

A mortar and pestle from Botswana is shown in class (right).

Grain Milling Technology

Grain mills come in several forms, including:

- Roller Mills
- Burr Mills
- Hammer Mills

The roller mill tends to be large and complex to maintain and configure. It's not well suited to small-scale operations.

The burr mill is often used in villages. However, its expensive grinding plates must be replaced too often.

The problems with roller and burr mills have led Amy Smith and others to develop an appropriate technology solution based on the Hammer Mill.

Existing hammer mills have their own issues. The separating mesh is prone to breaking, and the mesh cannot be made locally. (A mother would send their child to the miller with a bag of grain and a few coins. Inevitably, the coins wind up in the bag with the grain, and they damage the mill.)

About 10 years ago, an inventor in Vermont was trying to make a hammer mill that didn't rely on the separating mesh. He brought this problem to a class at MIT for which Amy was a TA. She developed a design that uses aerodynamics and a carefully placed slot in the outside rim to separate the grain. This design became her Master's thesis.

One of Amy's hammer mills is wheeled into class and demonstrated. Photos show Amy and Kurt describing the mill, with two students holding a red bag to collect the milled grain; pouring the raw grain into the running mill; detail of the blade (front of the mill with plexiglass cover removed); and the milled grain, white flour to left and yellow grits to right.

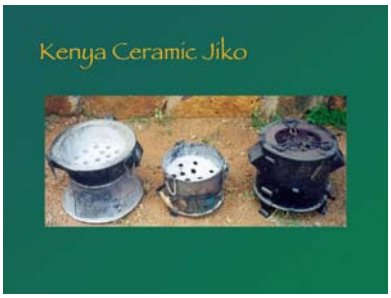
Energy to power the mill is a concern. Human powered (i.e. using bicycle technology) would be great, but the mill needs to operate above 3600 rpm, and with 1-2 horsepower. Thus current designs still use an electric motor.

The latest design has driven the cost way down, to about ¼ the cost of the original designs in Senegal, and about 1/8 the alternatives in Haiti. It uses a simpler blade, lower power motor, and a direct drive connection between blade and motor.

How would the mill be used in a village? Different scenarios exist, but typically there might be one or two mills in the village, each with several machines for milling, de-hulling, etc. Customers come by with bags of grain and pay a little money for milling. Typically, the miller runs the machines, not the farmers.

Cooking

(Covered quickly, running out of class time…)



Cooking is a fundamental need, and one that comprises a significant share of a family's energy expenses. An improved cookstove design like the Jiko offers great improvements in efficiency. The ceramic lining is key, requiring the right composition of clay and the right firing procedures.

Examples of a traditional cookstove and a Jiko are passed around the room. See photos below (traditional – left; Jiko – right).