Techniques for Farming in Dry Areas

Randy Creswell heads a group in Mali called Cornerstone Enterprises. They are involved in both community agricultural development and research to enhance that work. Randy sent us a manuscript he prepared on this topic. So many of you work in regions that are dry for much of the year that I asked and received permission to print the manuscript as an ECHO Technical Note. Overseas readers working with small farmers can request a copy at no charge. Others please send $1.50 to cover postage and photocopying expenses. A condensed version of Randy's manuscript follows:

Dry farming is the profitable production of crops, without irrigation, on land with a low average or highly variable rainfall. The two basic fundamental principles are that farm practices must conserve and utilize available water and quick maturing, drought resistant crops must be grown. Dry farming techniques build upon a knowledge of general agriculture but modify them because of the significant probability that this year or next will be a drought.

Increasing Water Absorption. The greatest deterrent to a high rate of water absorption is the tendency for soils to puddle at the surface and form a seal against water intake. The beating action of raindrops tends to break down cloddiness and disperse the soil. One should till to form a rough, cloddy surface. It will take longer for the rain to break down the clods and seal the surface. Of course, small seeds need a finer bed than large seeds. After harvest create a stubble mulch on the surface. Unless water-logging is a problem, the runoff of water should be slowed.

Reducing the Loss of Soil Moisture. There are two kinds of loss: by evaporation and by transpiration.

Water in the soil exists as a continuous film surrounding each particle. As water near the surface evaporates, water is drawn up from below to replace it, thinning this film. When it becomes too thin for plants to absorb, wilting occurs. Shelterbelts of trees or shrubs reduce wind speeds and cast shadows which can reduce evaporation 10 to 30 percent (as well as reducing wind erosion). Mulching reduces the surface speed of winds and reduces soil temperatures. Shallow tilling can create a dirt mulch 2 to 3 inches deep which dries out easily but is discontinuous from the subsurface water, preventing further loss. Tillage must be repeated after each rain to restore the discontinuity. This works best where there are a few major rainfalls with relatively long intervals in between.

All growing plants extract water from the soil and evaporate it from their leaves and stems in a process known as transpiration. Weed control is critical because they not only compete for soil nutrients but also for water. Dwarf crop varieties tend to lose

less water because they have less surface area. In dry farming, the number and spacing of plants is reduced so that fewer plants compete for soil moisture. The exception to this is when allowance for insect, bird or rodent loss must be made at planting.

Where rainfall is marginal to insufficient, drought "insurance" can be had by clear fallowing. An area clear of growing vegetation with a properly maintained stubble and soil mulch can retain 20 to 70 percent of the rainfall received until the next year. Where five to six acres each year per family have been so set aside in India, the specter of famine due to drought has been eliminated.

Bunding. The first essential step in dry farming is to lay out the land and construct bunds on hillsides after each fall of two feet. Bunds are ridges about 18 to 24 inches high that serve to stop runoff from light to moderate rains. Outlets that are half the bund height are constructed with stones at intervals to permit runoff from storms.

Strip Cropping. This serves both to control erosion and increase water absorption (by slowing its runoff). Different crops are grown in the same field in strips. Crops that expose the soil to erosion alternate with those which protect the soil. Strips are planted perpendicular to either the slope of the land or the prevailing wind direction, depending upon whether water or wind presents the more serious erosion potential. The groundnut (peanut) seeded at the normal rate is an efficient crop for checking erosion. Some other leguminous crops do not provide a sufficiently dense canopy to prevent raindrops from beating the soil surface at the normal seeding rate and may need to be planted at three times the normal seed rate. [Ed: of course that uses more water]. An average effective width of contour strips for cereals such as sorghum and millet is 72 feet and for the intervening legume, 24 feet. The optimum strip width varies with slope:

SLOPE	WIDTH OF CROPS THAT PERMIT EROSION	WIDTH OF CROPS THAT RESIST EROSION
1% or less	150 feet	30 feet
1-2%	80 feet	20 feet
2-3%	45 feet	15 feet
3-5%	20 feet	10 feet
5% or more	10 feet	10 feet

Summer Fallow. If the soil depth is at least 18 inches, rainfall can be stored from one year to the next. With a depth of 10-15 feet, up to 75% of the rainfall may be retained, though 20-40% is more normal. When summer fallows are practiced in an area that averages sufficient rainfall for crop growth, it will be a rare year that the sum of the stored water and current rainfall will not be sufficient for crop production. The loss of a crop on that land in the year of fallow is offset to a great extent by a very much increased yield in the year of cropping. Such increased yield in a year of failure of the general crop in the surrounding areas has a far greater value than a normal crop in a good season! For the fallow to work, a dirt/stubble mulch must be maintained and weeds not allowed to grow.

Experience has shown that where rainfall is 10-15 inches per year (250-375 mm) a clear fallow every other year is necessary. At 15-20 inches per year (375-500 mm), a fallow is needed every third year.

Stubble Mulch. This aims to disrupt the drying process by protecting the soil surface with a mulch from the crop residue. To be effective at least one ton per hectare must cover the surface. Maximum benefit per unit of residue is obtained at two tons per hectare. The mulch can reduce wind speed right at the soil surface by up to 99%, significantly reducing losses by evaporation. Residues can improve water penetration and reduce runoff losses by a factor of two to six times and reduce wind and water erosion by a factor of four to eight relative to a bare field. [Ed: Mulches also absorb much of the sun's energy and dissipate it into the surrounding air, keeping soil temperatures lower].

There are two disadvantages to stubble mulch farming. Crop residues provide a breeding ground for plant disease organisms, insects and rodents. Use of a mulch not related to the succeeding crops will minimize much of the disease and insect effects. Use of a stubble mulch only in the dry season will minimize all biological activity.

Because crop residues tend to be very low in nitrogen, their incorporation into the soil can temporarily deplete soil nitrogen. [Ed: soil microorganisms quickly go to work breaking down the residue, but must get much the nitrogen to do this from the soil. It is later returned when the microorganisms themselves die]. A stubble mulch should only be used during a biologically active period such as the rainy season if (1) soil nitrogen is very high, (2) plant nitrogen needs are very low, such as cassava, (3) a nitrogen-containing fertilizer is used, (4) the land is fallow, [Ed: (5) or if the residue is left on top of the ground and not incorporated].

Dirt Mulching. As stated earlier, this slows the soil drying process by separating the upper layer of soil from the lower layers, making the soil moisture film discontinuous. Effectiveness increases with increasing depth to a limit of 3-4 inches (75-100 mm). Increasing the dirt mulch depth decreases the available fertile soil. Dirt mulch decreases in efficiency with age and must be re-created by shallow tillage each month or after each rain. A mulch composed of particles larger than 1 mm (crumb form) is more effective and resists wind erosion more than the dust form. Dirt mulches can only be properly made when the soil is moist. WARNING: If there is a "rainy" growing season and a hot, windy dry season, dirt mulching should only be done during the rainy season and with a growing crop present. Improper use of dirt mulching led directly to the "dust bowl" in the United States.

Time of Tillage. In the arid and semiarid tropics, proper moisture conditions are likely to occur only at the beginning of the rainy season and should be done on the same day. It should be planted immediately with the seed row centered on the furrow slice. A crosswise harrowing will cover seeds and close air spaces and create a dirt mulch.

The usual test for proper condition for plowing is to squeeze a handful of soil. If it sticks together in a ball and does not readily crumble under slight pressure by the thumb and finger, it is too wet for working. If it does not stick into a ball it is too dry. Samples should be taken both at and a few inches below the soil surface. Soil that sticks to the tools is usually too wet. A shiny, unbroken surface of the turned furrow is another indication of excessive soil moisture. Soils with a lot of sand or organic matter can be worked at higher moisture contents than heavy clay soils.

The soil will probably be too dry to plow after harvest time, so the field should be harrowed and crop residue left to form a stubble mulch.

Depth of Plowing. Heavy clay soils need to be plowed deeper than light, sandy soils in order to promote bacterial activity and circulation of the air. Plowing sandy soils too deep tends to speed soil drying by too free a circulation of air in the soil. In semi-arid climates, the greatest advantage from deep plowing (5-8 inches) is the development of a large moisture reservoir. If it is not plowed more than 3-4 inches for some years, a hard pan develops which roots and rain can penetrate only with difficulty. Deep plowing need not be done every year. A deep plowing every 2-5 years is satisfactory. Deep plowing in some soils will reduce yields for one or two seasons as a result of bringing to the top an acidic subsoil. If liming is not possible, this can be dealt with by varying the depth of plowing slowly so as to expose the subsoil a little at a time.

Planting Density. Wider row spacing and lower seeding rates (by one-half to two-thirds) are necessary with low rainfall. Planting 2-4 rows and skipping one sometimes further increases yield. In general, with limited rain, higher seed rates produce more straw and stubble at the expense of grain. [Ed: Remember too that fertilizer will increase growth and hence use of water].

Time of Sowing. Sowing after a dry season starts at the moment that there has accumulated more than 60 mm of rainfall in less than 30 days.

Unique Aspects of Crop Rotations for Dry Farming. Crop rotation practices in more humid regions are not necessarily recommended in semi-arid lands. (1) Only a limited number of crops are adapted to the climate, so the farmer must sow the crop that is best suited to the moisture conditions. (2) Because moisture is the most limiting factor by far, soil improving crops are much less effective than in more humid areas. (3) Success with rigid or complex sequences is difficult.

Crop and Variety Selection. Short-stemmed varieties with limited leaf surface minimize transpiration. Deep, prolific root systems enhance uptake of moisture. Quickly maturing varieties develop prior to the hottest and driest part of the year and before moisture is exhausted.

Martin speaking now: Did you find this discussion helpful? You may know of special techniques or plants for arid regions that might likewise help our other readers. The quality of EDN is greatly increased as our readers share their best ideas with us. If you want to write to Randy, his address is Centre de Formation Agro-Industriel, Kouroukoula, B.P. 211, Kayes, Mali, West Africa. Thanks a million Randy!

 http://edn.link/w6txzk