
TECHNICAL PAPER #26

UNDERSTANDING MULTIPLE CROPPING

By
Dr. Glen M. Wood

Technical Reviewers
Charles A. Francis
Armin R. Grunewald

VITA
1600 Wilson Boulevard, Suite 500
Arlington, Virginia 22209 USA
Tel: 703/276-1800 . Fax: 703/243-1865
Internet: pr-info@vita.org

Understanding Multiple Cropping
ISBN: 0-86619-228-X

PREFACE

This paper is one of a series published by Volunteers in Technical Assistance to provide an introduction to specific state-of-the-art technologies of interest to people in developing countries. The papers are intended to be used as guidelines to help people choose technologies that are suitable to their situations. They are not intended to provide construction or implementation details. People are urged to contact VITA or a similar organization for further information and technical assistance if they find that a particular technology seems to meet their needs.

The papers in the series were written, reviewed, and illustrated almost entirely by VITA Volunteer technical experts on a purely voluntary basis. Some 500 volunteers were involved in the production of the first 100 titles issued, contributing approximately 5,000 hours of their time. VITA staff included Maria Giannuzzi as editor, Julie Berman handling typesetting and layout, and Margaret Crouch as project manager.

The author of this paper, VITA Volunteer Dr. Glen M. Wood, is Agronomist and Professor of Plant and Soil Science at the University of Vermont. The reviewers are also VITA Volunteers. Charles A. Francis, international program director at the Rodale Research Center in Pennsylvania, has worked on intercropping for the past 10 years. He was previously a staff scientist at the Centro

Internacional de Agricultura Tropical (CIAT), near Cali, Colombia, and a professor at the University of Nebraska. Armin R. Grunewald bas 33 years experience as a soil scientist with the U.S. Agency for International Development and the U.S. Department of Agriculture. He has performed consultancies in several developing countries.

VITA is a private, nonprofit organization that supports people working on technical problems in developing countries. VITA offers information and assistance aimed at helping individuals and groups to select and implement technologies appropriate to their situations. VITA maintains an international Inquiry Service, a specialized documentation center, and a computerized roster of volunteer technical consultants; manages long-term field projects; and publishes a variety of technical manuals and papers.

UNDERSTANDING MULTIPLE CROPPING

By VITA Volunteer Dr. Glen M. Wood

I. INTRODUCTION

Multiple cropping, simply defined, is the growing of two or more crops on the same field during the same year. When the crops are grown one after another the term "sequential cropping" is applied. If the second or later crops are the result of regrowth of the first crop, then the term "ratoon cropping" is used. Sugar

cane (Saccharum spp.), sorghum (Sorghum spp.), and even rice (Oryza sativa L.) can be ratoon cropped. Crops that produce no regrowth, as in the case of most annuals, cannot be ratoon cropped.

When two or more crops are grown simultaneously on the same plot of land the term "intercropping" is appropriate. Such crops may be mixed planted, that is, the plants of different crops are intermingled; or they may be sole (pure stand) planted in alternating rows, that is, the plants of each crop are grown in separate rows or strips (wide rows). When one crop is interplanted with a second crop as the first crop approaches maturity, the practice is termed "relay cropping." All of these cropping practices come under the general heading of multiple cropping.

All forms of multiple cropping have the potential to utilize the soil more efficiently, resulting in greater production from a given unit of land. This is especially true in tropical or subtropical areas of the world with wet and dry seasons. Where water for irrigation is available, exploitation of the abundant solar energy in the dry season is possible. Double, triple, and even quadruple cropping has dramatically increased food production in some countries--making them exporters instead of importers of food crops. Less dramatic increases can also result from other forms of multicropping. Beans (Phaseolus vulgaris L.), for example, can complete their life cycle in dry periods, if fertilized and relay planted in corn or maize (Zea mays L.) toward the end of the wet season.

The exploding world population continues to place a severe strain on existing land resources and their ability to provide enough food. Any technology that can result in increased food production from present land holdings has great potential for easing hunger around the world. Some researchers consider multiple cropping the most important of today's agricultural practices. Both high and low technology societies can profit from greater use of multiple cropping.

Multicropping is not a new agricultural technique. Evidence of the practice has been found in Egypt dating back to 300 B.C. The Maya Indians in Central America and the Incas in South America practiced both sequential and intercropping.

II. SYSTEMS OF MULTIPLE CROPPING

SEQUENTIAL CROPPING

Sequential cropping, to be used most effectively, requires the use of fertilizers, high yielding plant varieties, pest control, high planting rates, mechanization, and, where appropriate, irrigation. Sequential cropping of plants with relatively short growing seasons offers better total annual use of land than does a single crop system. It is particularly important to use the improved, early maturing, high yielding varieties. Unlike traditional varieties, these improved types do not lodge, or fall over to the ground, when heavily fertilized and also produce more grain per unit of fertilizer applied. Pest control, as well as irrigation and fertilizers, allows them to yield more nearly at

their full potential.

Mechanization, or the use of appropriate mechanical equipment, allows the farmer to perform promptly all the operations of soil preparation--planting, pest control, and harvesting--so that the next crop in sequence is not delayed and a portion of the growing season wasted. In the United States and other more temperate regions of the world where growing seasons are shorter, notillage planting is widely used. With the use of specially designed equipment and early maturing varieties, crops can be planted in the stubble of a previous crop without any further soil preparation. This ensures a minimum of delay and full use of the available growing season. Leaving the stubble in place also minimizes water and wind erosion and affords protection for the newly emerging seedlings.

The use of day-neutral varieties--those not requiring a specific day length to flower and set seed--allows the farmer to grow them at any time of the year, regardless of latitude, if growing conditions are favorable. The availability of water for irrigation permits full use of the dry season.

Early maturing varieties may also suffer less damage from pests. As a general rule, the most serious crop loss due to weeds occurs during the first third of the life cycle. An exception occurs where late maturing varieties compete better with barnyard grass (Echinochloa crusgalli L. Beauv.). Although crop rotation with different crops will generally result in better pest control, it may be feasible to rotate different varieties of the same crop

having different disease and insect resistance and better ability to compete with weeds. Sometimes natural predators of pests (biological control) build up to more effective levels when same crop follows same crop. The buildup of the pests with continuous cropping is perhaps more likely to happen, however, and thus rotation with different crops is preferred.

RATOON CROPPING

The principles involved in ratoon cropping, a form of sequential cropping, are different from other types of multiple cropping because of such factors as the presence of a well developed root system, earlier maturity, and the perennial nature of the plant. Although the term may be applied to perennial pasture plants, it is considered more appropriately used with respect to field crops such as sugar cane, sorghum, banana (Musa sapientum, M. caven-dishii), cotton, kodra millet (Paspalum scrobiculatum), pineapple (Ananas comosa), and rice.

The advantages of ratoon cropping include the following:

1. reduced cost of production through savings in land preparation and care for the plant;

2. reduced crop cycle: crop planted less often, so replanting cycle is longer;

3. better use of growing season;

4. higher yield per unit area in a given period of time;

5. less use of irrigation water and fertilizer than main (original) crop because of a shorter growing period; and

6. simple and effective way to provide windbreaks for vegetable production.

On the other hand, ratoon cropping has a number of drawbacks. These include:

1. later crops have lower yields than the first crop;

2. buildup of insect pests;

3. buildup of harmful weeds;

4. increased disease problems;

5. greater cost per unit produced;

6. where heavy equipment is used, the soil may become hard, causing poor drainage and lack of oxygen for roots;

7. loss of crop density (number of plants per unit of land); and

8. growth of volunteer seedlings inferior to sown variety.

INTERCROPPING

Intercropping requires only 60-80 percent of the land to equal the production of monocropping systems. Traditional farmers in many parts of the world-have practiced intercropping in various forms for many centuries. This form of multiple cropping, which generally involves the growing of rain-fed crops in mixtures, uses available resources and permits farmers to maintain low but often adequate and relatively steady production.

Intercropping can take any of three forms--strip planting, row planting, or mixed planting. The form chosen should be based on crops grown and such factors as ease of planting, weeding, and harvesting. Yield also may be affected. Intercropping is particularly suited to those situations where labor is abundant and land is not. If it is to be successful economically, the sum of the competition of the interplanted species should be less than when the species are grown alone. Crops of different maturities have varying peak requirements for water, fertilizer, light, and space. Thus, there may be less competition between different crops than there is in a sole planting of identical plants. Moreover, disease and insect infestation of intercropped plants tends to be less. For example, virus diseases may spread more easily through adjacent plants than to those separated by unlike, and frequently non-susceptible, neighboring plants. Insects that spread disease are also thwarted or at least slowed. Insects tend to be less attracted to plants that are intermingled with other species than to those in solid stands of the same species.

Interplanting of some crop species, however, may be harmful because of allelopathic effects. Allelopathy is defined as "any direct or indirect harmful effect that one plant has on another through the production of chemical compounds that escape into the environment."(*) The harmful compound may take varied forms such as volatile chemicals produced by roots, or leached from leaves. Dead or decaying plant tissues may also be a source of allelopathic substances. Note that the nitrogen released from legumes is not considered a form of allelopathy.

Some common combinations are maize-bean, maize-soybean (Glycine max L. Merr.) , maize-rice, maize-sorghum, sorghum-millet, sweet potato (Ipomoea batatas Lam.) in sugar cane (Saccharum officinarum L.), and cotton (Gossypium sp.) with peanuts (Arachis hypogaea L.). The net result of such combinations can vary widely from productive to unproductive compared to sole planting of the same crops. Factors such as fertilization schedule, seeding rate and spacing, selection of variety and type of plant, e.g., dwarf versus normal (maize), bush versus pole (bean), as well as many other cultural factors can markedly influence results. <see figure>

umc1x6.gif (600x600)

Figure 1. Intercropping--Maize, Cowpea, Melon, Soya

Source: R. Wijewardene and P. Waidyanatha, Conservation Farming (Peradeniya, Sri Lanka: Sri Lanka Department of Agriculture, 1984).

The overall advantages of intercropping include the following:

1. provides increased protection against erosion;

2. insures against crop failure;

3. spreads labor and harvesting more evenly during the growing season and helps minimize storage problems;

4. helps allocate space for crops required in small quantities, and facilitates production of many commodities in a limited area;

5. results in efficient use of resources by plants of different heights, rooting systems, and nutrient requirements;

6. where legumes are grown with grasses (or other non-legumes), grasses may benefit from the nitrogen fixed by the legume companion crop; and

7. inhibits the spread of diseases and pests since not all crops involved are susceptible to the same extent to the same problems.

(*) B.R. Trenbath, "Plant Interactions in Mixed Crop Communities," Multiple Cropping, Edited by M. Stelly (Madison, Wisconsin: American Society of Agronomy, 1976).

Disadvantages, on the other hand, are:

1. mechanized planting and harvesting are difficult;

2. it is more difficult to apply needed fertilizers and other chemicals as in sole cropping; and

3. experimentation with intercropping is more complex and difficult to manage than with sole cropping.

RELAY CROPPING

Relay intercropping is a common practice in wet-dry climates where the wet season is not sufficiently long for two full season crops. Generally corn is the wet season crop, with beans interplanted as the corn approaches maturity. With relay planting, greater crop density and protection against wind and water erosion are achieved. Since the first crop has reached maturity, its demands on soil moisture and fertility are minimal as natural aging and deterioration of leaves occur. The relay interplanted seedling crop likewise places small but increasing demands on the soil. As the first crop gradually fades out of the picture and is finally removed entirely through harvest, the sequential crop continues to advance and the transition is completed.

III. SUMMARY

Multiple cropping in some form can help get the maximum crop production from fixed land holdings, particularly in subtropical and tropical areas of the world. Both low and high technology societies can profit by adopting one or more of the various

multicropping techniques. Even small farmers who lack the capital to purchase inputs (e.g., equipment, fertilizers, herbicides) but generally have abundant hand labor, can find the practice of some form of multicropping to be to their benefit.

Multiple cropping places heavy demands on the soil and cannot be successful unless the crop is supplied with adequate fertilizer. Where the extra fertilizer is not available, a few crops with low fertilizer needs may be planted (such as cassava [Manihot sp.] and plantain [Plantago sp.]). Many marginal farmers find the purchase of inorganic fertilizers beyond their means, even if obtainable, and should not consider intensive multicropping systems. More limited multicropping can be practiced where substantial amounts of animal manure and/or composted plant materials are available. Minerals provided by burning cleared land have only temporary value. On the other hand, many systems of multicropping originated under subsistence farming and can be made to work using available sources of fertilizer. Placing fertilizer in bands between plants or directly in the planting hole are two ways of making more efficient use of fertilizer at hand. Where possible, legumes should be planted for their ability to obtain nitrogen from the air and convert it into forms available to plant roots.

The advantages of multicropping include greater use of available solar energy in the dry season, improved pest control, greater insurance against crop failure, better nutritional balance for families because a wider variety of foods is produced, and a more stable farm income.

As in any departure from traditional methods, some cautions and hazards may be encountered in switching from mono- to multicropping. Farmers should consider their options carefully and seek help if necessary from local extension agencies or from technical assistance services such as VITA.

BIBLIOGRAPHY/SUGGESTED READING LIST

Allen, L.H., Jr.; Sinclair, T.R.; and Lemon, E.R. "Radiation and Microclimate Relationships in Multiple Cropping Systems." In Multiple Cropping, p. 171. Edited by M. Stelly. Madison, Wisconsin: American Society of Agronomy, 1976.

Andrews, D.J., and Kassam, A.H. "The Importance of Multiple Cropping in Increasing World Food Supplies." In Multiple Cropping. Edited by M. Stelly. Madison, Wisconsin: American Society of Agronomy, 1976.

Beets, Willem C. Multiple Cropping and Tropical Farming Systems. Boulder, Colorado: Westview Press, 1982.

Litsinger, J.A., and Moody, K. "Integrated Pest Management in Multiple Cropping Systems." In Multiple Cropping, p. 299. Edited by M. Stelly. Madison, Wisconsin: American Society of Agronomy, 1976.

Metcalf, D.S., and Elkins, D.M. Crop Production, Principles and

Practices. New York, New York: MacMillan Publishing Co., Inc., 1980.

Nasr, H.G. "Multiple Cropping in Some Countries of the Middle East." In Multiple Cropping, pp. 117-118. Edited by M. Stelly. Madison, Wisconsin: American Society of Agronomy, 1976.

Oelsligle, O.D.; McCollum, R.E.; and Kang, B.T. "Soil Fertility Management in Tropical Multiple Cropping." In Multiple Croppping, p. 281. Edited by M. Stelly. Madison, Wisconsin: American Society of Agronomy, 1976.

Okigbo, B.N., and Greenland, D.J. "Intercropping Systems in Tropical Africa." In Multiple Cropping, p. 63. Edited by M. Stelly. Madison, Wisconsin: American Society of Agronomy, 1976.

Pinchinat, A.M.; Soria, J.; and Bazan, R. "Multiple Cropping in Tropical America." In Multiple Cropping, p. 53. Edited by M. Stelly. Madison, Wisconsin: American Society of Agronomy, 1976.

Pluknett, D.L.; Evenson, J.P.; and Sanford, W.G. "Ratoon Cropping." In Advances in Agronomy, p. 285. Edited by N.C. Brady. New York, New York: Academic Press, 1970.

Rice, E.L. Allelopathy. New York, New York: Academic Press, 1974.

Thomas, G.W.; Curl, S.E.; and Bennett, W.F. Food and Fiber for a Changing World. Danville, Illinois: Interstate Printers and Publishers, Inc., 1976.

Thomas, G.W., and Phillips, S.H. "Multiple Cropping--Ace in the Hole." In The 1981 Yearbook of Agriculture--Will There Be Enough Food?, p. 68. Edited by J. Hayes. Washington, D.C.: U.S. Government Printing Office, 1981.

Trenbath, B.R. "Plant Interactions in Mixed Crop Communities." In Multiple Cropping. Edited by M. Stelly. Madison, Wisconsin: American Society of Agronomy, 1976.

Wrigley, G. Tropical Agriculture: The Development of Production. London, England: Faber and Faber, 1969.

==========
==========