

MULTIPLE CROPPING SYSTEMS

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Summary

The ancient practice of multiple cropping is increasing in importance as farmers intensify land use to remain competitive and provide the increasing world demand for food, feed, fiber, and industrial crops. Hundreds of succession and interplant multiple-cropping systems are possible. Successful management of many of these systems requires the use of conservation tillage to achieve timely planting dates and conservation of natural and nonrenewable resources. Recent emphasis on crop development of new crop varieties specifically developed through plant breeding and molecular genetics are important to the success of intensive crop production. Soil management from no-till or strip-till help to maintain or increase soil organic matter and enhance better root growth and water use efficiency. Innovations by agricultural scientists in pesticides, no-till equipment, rotation of legumes and grasses for tap-rooted and fibrous-rooted crops, and breeding crops adapted to specific systems and environments make intensified multiple cropping farming more successful.

1. Introduction

Some time in 1975, a woman gave birth to a very significant child—our planet's four-billionth (4×10^9) human being. At that time it was estimated the earth's population was on its way to the 5×10^9 level by the mid 1980s. Even though much family planning effort was implemented in an attempt to help cut birthrates, the 6×10^9 person was expected before the year 2000. Today the demand for food is steadily growing because 90 million people are added to the global population annually. This represents an annual increase equal to about one-third of the present population of the United States. More than 90% of this growth is

occurring in the developing world, where these people have the least resources needed to feed themselves.

One obvious way to increase food production is by expanding arable land. However, much of the world's arable land suitable for crop production is already in production, resulting in significant areas of marginal land being cultivated. It has been estimated that since 1975 the area of cultivated land world wide expanded by only 4% while the world's population increased by 40%. At the present and expected future rate of world population growth, expanding cultivated arable land is not a viable solution for producing a sustainable world food supply.

A second option for meeting world food demand is through improvement in technology, research, and extension of information to producers in order to improve genetics of crops, improve soil quality, and eliminate or manage pests for improved yields of traditional crops. This strategy worked well as long as enough arable land was available to sustain the existing population. For example, in the United States corn yields increased from an average of 20 bushels per acre (bu/acre) or less in the early 1900s to an average of over 100 bu/acre by the end of the century. These improvements in yield for a single crop came about because of research and education. Even with these tremendous improvements in yield of traditional crops within 100 years, without increased intensification of existing land they have not been enough to solve world hunger facing us today.

A third alternative to helping meet world demand for food is by multiple cropping. The element "multi-" can refer to many, multiple, many times over, more than one, more than two, etc. The word "crop," in terms of this article, refers to a plant species that can be grown and harvested extensively for profit or subsistence. "Cropping" then means to grow a crop. In its simplest form, multiple cropping and multicropping can be used interchangeably and, based on the above definitions, means to grow or manage more than one crop. When we use the above definitions and add space and time into the discussion, multiple cropping can have much more meaning. Restrictions are placed on both space and time. Space is restricted to the same land area where crops can be grown repeatedly. Time is restricted to 12 months in a one-year cycle of seasons. When we tie all of the above together, we can refine the definition of multiple cropping (multicropping) as "growing more than one food, feed, fiber, industrial, green manure, mulch, or rotation crop on the same land area in the course of a 12-month period." More simply stated, the production of two or more crops per year on the same land is multiple cropping (multicropping). Multiple cropping, then, is a form of farming to maximize the use of land each year. The two major categories of multiple cropping are succession cropping and intercropping.

Systems are often referred to in distinguishing one type of multiple cropping from another. System is defined as "a regularly interacting or interdependent group of items forming a unified whole," "an organized or established procedure." Because there are hundreds or perhaps thousands of different combinations of crops, uses, seasons, management inputs, etc. we use the term "multiple-cropping system" to help distinguish one, regularly interacting or interdependent, group of crops and management strategies forming a unified whole from another. The only logical key to sustainability of a wholesome food supply for the ever increasing world population is a constant supply of funding to support

development of technology for increased multiple-cropping systems on the limited supply of arable land.

2. Cropping Systems Terminology

2.1. Succession Multiple Cropping

This is the first major category of multiple-cropping systems, in which two or more crops are grown in succession on the same land per year. These forms are generally known as double cropping, triple cropping, quadruple cropping, etc. and ratoon cropping. The term “sequential multiple cropping” is used interchangeably with succession multiple cropping.

Double cropping: This is a form of multiple cropping in which two crops are grown in sequence or interplanted on the same land in a 12-month period (a year). Small grain (wheat, rye, oat, or barley) succeeded by soybean, corn, grain sorghum, forage sorghum, or sorghum x sudangrass are examples of sequential double-cropping systems.

Triple cropping: This is a form of multiple cropping in which three crops are grown in sequence and/or interplanted on the same land in a 12-month period (a year). Small grain for silage succeeded by corn for silage succeeded by forage sorghum for silage is an example of succession triple cropping in Florida, USA. An example of a widely practiced triple-cropping system in Taiwan includes growing two short-season rice crops followed in winter months with a soybean crop. In southern Taiwan these three crops can all be grown in succession. In central Taiwan two rice crops might be followed by a relay interplanted sweet potato crop or tobacco.

Quadruple, Quintuple, etc. cropping: In this form of multiple cropping four (quadruple), five (quintuple), six (sextuple), seven (septuple), etc. crops are grown in sequence and/or interplanted on the same land in a 12-month period (a year). Numerous quadruple multiple-cropping systems are routine in Taiwan with some of the four crops growing in succession, usually rice, and others, usually vegetables, being relay interplanted into the second rice crop. In the latter case, overlapping of the final growth stages of the rice crop and the germination and early growth stages of the vegetable crop is described as the relay intercrop period. These types of systems require extensive hand labor and close attention to water management and protection of the vegetables from shading by the rice crop. In subtropical Florida it is not unusual for radish farmers in the south to produce as many as seven crops in succession per year. This type of farming is highly mechanized so that about every 35 to 40 days a crop of radishes is planted and harvested on the same land.

Ratoon cropping: Ratoon is a form of succession cropping in which regrowth occurs from root or stem stubble of the original crop, that has been planted and harvested, and is grown and harvested one or several times in the course of a 12-month period. Grain sorghum for grain succeeded by regrowth (ratoon) grain sorghum for grain is an example of ratoon succession multiple cropping.

Monoculture: Monoculture is a form of multiple cropping succession involving the same crop on the same land in a 12-month period. Double cropping of corn after corn, sorghum after sorghum, or radishes succeeding radishes for seven crops on the same land in 12

months are examples of multiple cropping monoculture systems that have been practiced in Florida.

Duoculture: Duoculture is A form of multiple cropping succession that involves successions of the same types of crops, such as one kind of grain crop grown for grain succeeding a different grain crop grown for grain, or one kind of forage crop succeeding another kind of forage, or one kind of vegetable crop succeeding another kind of vegetable crop. Examples include rice for grain followed by wheat for grain or wheat for grain followed by millet for grain. Several years of research in Florida has shown great success with growing an early maturity corn crop for grain followed by a crop of soybean for grain.

Ployculture: This is a form of multiple cropping succession that includes combinations of different types of crops and for different purposes. Examples include grain crops followed by cotton, forages succeeded by grain crops, wheat forage succeeded by watermelon, or watermelon succeeded by millet. Polyculture is extensively practiced in Florida, where several combinations of vegetables are followed by agronomic crops for grain or forage.

2.2. Intercropping

The second major form of multiple cropping, in which two or more crops are grown simultaneously for all or part of their growth cycle in a 12-month period, is intercropping. In the tropics more than one crop—in some cases dozens—is planted together on the same piece of land. The various crops can be planted at the same or different times. The term “interplanting” is used interchangeably with intercropping.

Relay intercropping: This form of intercropping is where two or more crops are grown simultaneously for only a part of their life cycle. The term actually means an overlapping of growth periods of two or more crops on the same piece of land in a 12-month period. A second crop is usually planted after the first crop has reached its reproductive stage of growth but before it is ready for harvest. Thus the crops may overlap for a short period, say a few weeks. This practice is frequently necessary to fit the multiple cropping pattern into the available growing season. Aerial seeding of small grains into soybean just before soybean defoliation is an example of relay intercropping that has been practiced in the USA and Argentina. Numerous relay intercropping systems are practiced in Taiwan, but essentially they are used all over the world.

Mixed intercropping: This is an intercropping system of growing two or more crops simultaneously without distinct row arrangements. A grass–legume mixture for grazing ruminant animal forage is an example of mixed intercropping. Millions of acres of white clover and fescue grass in this mixed intercropping system is practiced in the southern USA on an annual basis to help sustain the large production of beef cattle in this region. The author has observed as many as seven human food crops in a mixed intercropping system in Bolivia. He also saw mixed intercropping of corn and cassava in Ghana West Africa, a system of routine food production, especially by poor land owners.

Row intercropping: This is an intercropping system in which two or more crops are planted in the same row. An in-row mixture of corn and forage sorghum for forage is an

example of row intercropping. Other old systems practiced in the southern USA and in South America and Africa include simultaneously planting a vining type of snapbean, cowpea, or velvetbean in the row with corn. Corn intercropped with climbing bushbean has been a family tradition in the author's family for 100 years or more in the southwestern highland rim of Tennessee, USA. In this system the corn serves three purposes: to provide 1) roasting ears for human consumption, 2) fresh snapbean for human consumption and 3) the remaining dried corn grain for making hominy or corn meal for human consumption or for animal feed. The author also routinely observed this system on farms in Costa Rica and Nicaragua. Generally, shading by the corn is not a big problem because the vining crops can climb the corn stalks in order to compete. Interplantings of corn with low-growing crops like some varieties of cowpea or soybean don't work as well, unless the corn population is heavily reduced to allow more sunlight to reach the low-growing crops in the system. Interplanting of pumpkin with corn is another old row-intercropping system in the southern USA.

Strip intercropping: Growing two or more crops simultaneously in different strips wide enough to permit independent crop management but narrow enough for the crops to interact agronomically is called strip intercropping. Alternating strips of a forage grass sod with strips of corn for grain or other agronomic crops is an example of strip intercropping. This system is widely used in the USA on sloping land as a means of controlling erosion. Grass strips act as a buffer to slow down water movement during periods of heavy rainfall.

Monocropping: This is the growing of only one crop on the same land in the course of a 12-month period.

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Biographical Sketch

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