Agricultural Production Economics

SECOND EDITION

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2002

First Printing, 1992
Second Printing, 1993
Third Printing, 2002
Fourth Printing, 2004

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Introduction

This chapter introduces some basic concepts fundamental to the study of production economics and provides a brief review of fundamental terms used in economics. These terms are usually presented as part of an introductory economics or agricultural economics course, and provide a starting point for the further study of agricultural production economics. The fundamental assumptions of the purely competitive model and the relationship of these assumptions to agricultural production economics are outlined.

Key terms and definitions:

Economics
Wants
Resources
Theory
Model
Consumption Economics
Production Economics
Utility
Profit
Microeconomics
Macroeconomics
Statics
Dynamics
Agricultural Economics
Pure Competition

1.1 Economics Defined

Economics is defined as the study of how limited resources can best be used to fulfill unlimited human wants. Whereas the wants or desires of human beings are unlimited, the means or resources available for meeting these wants or desires are not unlimited. Economics thus deals with making the best use of available resources in order to fulfill these unlimited wants.

An entire society, an entire country, or for that matter, the world, faces constraints and limitations in the availability of resources. When the word *resource* is used, people usually think of basic natural resources, such as oil and gas, and iron ore. However, the term has a much broader economic meaning, and economists include not only basic natural resources, but a broad array of other items that would not occur to those who have not studied economics.

An important resource is the amount of labor that is available within a society. The money that is invested in industrial plants used to produce items consumers want is another basic resource within a society. A resource can be defined still more broadly. Human beings vary in their skill at doing jobs. A society consisting primarily of highly educated and well-trained individuals will be a much more productive society than one in which most people have few skills. Thus the education and skills of jobholders within an economy must be viewed as a limiting resource.

Students may attend college because they hope to obtain skills that will allow them to earn higher incomes. They view the lack of a college degree to be a constraint or limitation on their ability to earn income. Underlying this is the basic driving force of unlimited human wants. Because human wants and desires are unlimited, whereas the resources useful in fulfilling these wants are limited, the basic problem that must be faced, both by individuals and by societies, is how best to go about utilizing scarce resources in attempting to fulfill these unlimited wants.

1.2 The Logic of Economic Theory

Economists and others have made numerous attempts to define the word *theory*. A definition widely accepted by economists is that a theory is a representation of a set of relationships. Economic theory can represent either the set of relationships governing the behavior of individual producers and consumers, or the set of relationships governing the overall economy of the society or nation.

However, some scientists, including economists, also use the term *theory* as a synonym for a hypothesis, a proposition about how something operates. Some theories may be based on little if any observation. An example is a theory of how the universe was formed. Theories in physics often precede actual observation. Physicists have highly developed theories about how electrons, protons, and neutrons in atoms behave, despite the lack of actual observation. Although theories may be used as a basis for explaining phenomena in the real world, they need not be based on actual observation.

An *economic theory* can be defined as a representation of a set of relationships that govern human behavior within some portion of an economy. An economic theory can also be defined as a hypothesis or set of hypotheses about how a particular aspect of an economy operates. These hypotheses might be tested by observing if they are consistent with the observed behavior within the economy. Theory as such is not tested; rather,

what is tested is the applicability of a theory for explaining the behavior of a particular individual or group of individuals. The conclusion by a social scientist that a theory does not adequately explain the behavior of a particular group of people does not render the theory itself invalid. The same theory might be quite applicable to other people under a slightly different set of circumstances.

1.3 Economic Theory as Abstraction

The real world is highly complex. Economists spend very little time in the real world, but rather, spend a lot of time attempting to uncover fundamental theories that govern human behavior as it relates to production and consumption. If the real world is highly complex, so also is the economy of any industrialized society, or for that matter, the economy of nearly any society or nation. There is so much complexity that it is often difficult to see clearly the fundamental relationships.

In an effort to see more clearly the relationships that are important, economists abstract from reality in developing theories. They leave out relationships identified as un-important to the problem, in an effort to focus more closely on the relationships which they feel are important. Economic theory often becomes a simplification of reality that may seem unrealistic or even silly to someone with no training in economics.

Moreover, economists appear to argue continually. To a person without a background in economics, economists never seem to agree on anything. The development of an economic theory as a formal set of relationships governing some aspect of an economy will invariably involve simplification. Some relationships will be included: others will be left out. The relationships included are those that the economist developing the theory felt were important and which represented the key features of the particular economic problem the economist wanted to study.

However, economists can and do engage in heated debate with regard to whether or not a particular theory (one that includes some relationships but omits others) is the correct representation. Debate is a very normal and ordinary part of the behavior of economists and is the driving force that results in a continual improvement in economic theories over time. Without it, economics as a discipline within the social sciences would not progress.

1.4 Economic Theory Versus Economic Model

Economists sometimes use the terms *theory* and *model* interchangeably. A child might think of a model as a miniature or toy version of, say, an automobile or farm tractor. This is not a bad way to think about an economic model. To be realistic, a model must have a degree of detail. The model must contain a representation of the principal parts of the real thing, or it would not be recognizable.

At the same time, the model would not be expected to perform the same functions as the real thing. Just as one would not expect to make a journey in a toy automobile, an economist would not expect to control the workings of the U.S. economy with a model of the economy. However, just as an automobile designer might construct a model of a new automobile before the real thing is built in an effort to obtain a better understanding of how the real thing might look, so might an economist construct a model of the U.S. economy to better understand how a particular government policy, if implemented, might affect individuals and firms within the economy.

Economists use models as a way to measure or simulate the effects of a policy without actually having to implement the policy. The key question is "What would happen if . . . ?" The model can be used to answer the question and to assess the impact of numerous alternative policies without actually implementing them. Hence a model can also be thought of as a set of relationships (or theory) that lends itself to answering "what would happen if" types of questions.

1.5 Representing Economic Relationships

Economic theories and models can be represented in a variety of ways. Beginning in the 18th century with Adam Smith's famous work *The Wealth of Nations*, economists have relied heavily on words to express economic relationships. Increasingly, words did not lend themselves very well to answering specific "what if" types of questions. Economists in the late nineteenth and early twentieth centuries relied increasingly on graphical tools as the major means of expressing economic relationships. Graphics could often be used to make complex verbal arguments precise, but graphical tools had disadvantages as well. For example, a graph representing a production function on a farm was limited to no more than two inputs and a single output, since it is not possible to draw in more than three dimensions.

The use of mathematics as the means of describing economic theories and models got an important boost with the publication of Paul Samuelson's *Foundations of Economic Analysis* in 1947. Since that time, mathematics has become increasingly important as a tool for the development of theory and models. Fuzzy relationships cannot be part of a theory posed in mathematical terms. Moreover, mathematics opened new doors for expressing complicated relationships. On the production side, there were no longer any limits as to the number of inputs that a production function might use or the number of outputs that could be obtained.

Concomitant with the increased use of mathematics for describing economic relationships was increased use of statistics for estimating economic relationships from real world data. An entirely new subdiscipline, econometrics—economic measurement—appeared. The relationships contained within the mathematically based theoretical model could now be measured.

The final event having an impact on economics over the second half of the twentieth century was the rapid growth in the use of the computer as a device for estimating or measuring relationships within an economy. Economists now routinely use techniques for estimating models in which the computational requirements would have been considered impossible to achieve only five or ten years ago.

1.6 Consumption Versus Production Economics

Economics involves choices. A person who faces a limited income (and no one does not) must choose to purchase those items that make him or her feel most satisfied, subject to an income limitation or constraint. Choice is the heart of consumption economics. Economists say that a person derives utility from an item from which he or she receives satisfaction. The basic consumer economics problem involves the maximization of utility (satisfaction) subject to the constraint imposed by the availability of income.

This book deals with another set of choices, however, the set of choices faced by the producer of goods and services desired by the consumer. The producer also attempts to maximize utility. To maximize utility, the producer is motivated by a desire to make money, again in order better to fulfill unlimited wants. Although the producer may have

other goals, the producer frequently attempts to maximize profit as a means of achieving utility or satisfaction. Profit is the difference between the revenues obtained from what is sold and the costs incurred in producing the goods. However, producers face constraints, too. If producers did not face constraints, the solution to the profit-maximization problem for the producer would be to produce as much as possible of anything that could be sold for more than the cost of production.

Producers may attempt to maximize something other than profit as a means for achieving the greatest utility or satisfaction. Some farmers might indeed have the objective of maximizing profits on their farms given resources such as land, labor, and farm machinery. The underlying motivation for maximizing profits on the farm is that some of these profits will be used as income to purchase goods and services for which the farmer (and his or her family) obtain satisfaction or utility. Such a farmer behaves no differently from any other consumer. Other farmers might attempt to maximize something else, such as the amount of land owned, as a means to achieve satisfaction.

The producer faces an allocation problem analogous to that faced by the consumer. The consumer frequently is interested in allocating income such that utility or satisfaction is maximized. The producer frequently is interested in allocating resources such that profits are maximized. Economics is concerned with the basic choices that must be made to achieve these objectives. Consumption economics deals primarily with the utility maximization problem, whereas production economics is concerned primarily with the profit maximization problem. However, profits are used by the owner of the firm to purchase goods and services that provide utility or satisfaction.

1.7 Microeconomics versus Macroeconomics

Economics can be broadly divided into two categories: *microeconomics* and *macroeconomics*. Microeconomics is concerned with the behavior of individual decision-making units. The prefix *micro-* is often used in conjunction with things that are small. Microeconomics deals with the behavior of the individual consumer as income is allocated and the individual firm manager (such as a farmer) who attempts to allocate his or her resources consistent with his or her goals.

The prefix *macro-* is often used in conjunction with things that are large. *Macroeconomics* deals with the big picture. For example, a person studying macroeconomics might deal with issues confronting an entire economy. Inflation and unemployment are classical areas of concern for macroeconomists. They are concerned with how producers and consumers interact in total in a society, nation, or for that matter, the world.

Macroeconomists are also concerned with the role that government policy might play in determining answers to the fundamental questions that must be answered by any society. These questions include (1) What should be produced? (2) How much should be produced? (3) How should available goods and services be allocated?

Although microeconomics and macroeconomics are often considered to be separate branches of economics, they are really very closely intertwined. The macroeconomy is made up of individual producers and consumers. Moreover, the decisions made by individual producers and consumers are not at all independent of what is happening at the macro level. Tax cuts and tax increases by the federal government influence income available to the individual consumer to spend. Prices received by individual farmers for the commodities they produce are in large measure determined by the aggregate production of all farmers in producing a particular commodity, yet to a great extent affect

decisions made by the farmer as an individual firm manager.

This text deals with production economics and the central focus is on the farm firm as an individual decision-making unit. At the same time, the individual farm firm does not operate in a vacuum, but is affected in large measure by what happens in the aggregate. Moreover, decisions made by individual firms such as farms, when taken together, can have a substantial impact in a macroeconomic setting.

1.8 Statics Versus Dynamics

Economics can also be classified as static economics or dynamic economics. *Static economics* can be thought of as one or more still snapshots of events taking place in an economy. *Dynamic economics* can be thought of as a moving picture of the economy. Economists rely heavily on what is sometimes called *comparative statics*.

The economic relationships are often represented by a graph: for example, a graph showing a supply curve and a demand curve. An event or shock affecting demand or supply is assumed to take place. For example, suppose that consumer incomes increase. A second demand curve might be drawn on the same graph to represent what happens as a result. The snapshot comparison of prices and quantities that would prevail under the old and new levels of consumer incomes is referred to as *comparative statics* (Figure 1.1).

With an analysis using comparative statics, no attempt is made to uncover the processes that caused incomes to rise, nor is time important. This is sometimes referred to as a static, timeless environment. It is a useful means of analysis when the focus is on the impact of an economic shock, not the processes by which the shock takes place. Notice also that comparative statics can be used to shed light on either microeconomic or macroeconomic issues.

In contrast with statics, time is the important element of dynamics. Dynamic economics attempts to show the processes by which an individual consumer, firm, or economy moves from one equilibrium to another. Suppose, for example, that the price of a good or commodity decreases. Dynamic economics might attempt to uncover changes in the quantity that would be taken from the market one hour, one day, one week, and one month from the point in time in which the initial price decrease took place. Another problem in dynamics might be the path of machinery investments made by a farmer over a 20-year period.

1.9 Economics Versus Agricultural Economics

Until now, little has been said about agricultural economics and its relationship to economics. There has been a reason for this. An agricultural economist is, first, an economist, in that an agricultural economist knows economic theory intimately. However, an agricultural economist is also an economist with a specialization in agriculture. The primary interest is in applying economic logic to problems that occur in agriculture. An agricultural economist needs to know economics, but a knowledge of agriculture is also important. If an agricultural economist is to portray relationships accurately using a model of some component of an agricultural sector, the agricultural economist must know these relationships. Otherwise, the salient or important elements of the theory would be missed.

1.10 Agricultural Production Economics

Agricultural production economics is concerned primarily with economic theory as it relates to the producer of agricultural commodities. Some major concerns in agricultural production economics include the following.

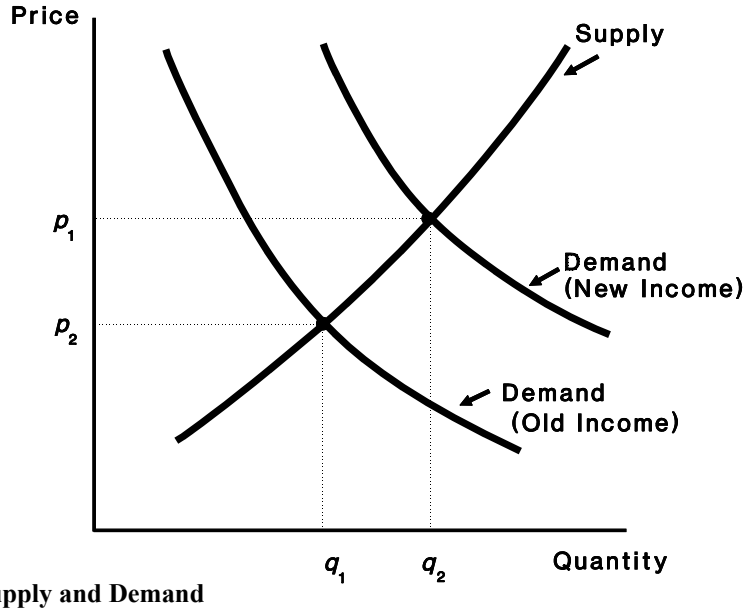

Figure 1.1 Supply and Demand

Goals and objectives of the farm manager. Agricultural economists often assume that the objective of any farm manager is that of maximizing profits, a measurement of which is the difference between returns from the sale of crops and livestock less the costs of producing these commodities. However, individual farmers have unique goals. One farmer might be more interested in obtaining ownership of the largest farm in the county. Another might have as his or her goal that of owning the best set of farm machinery. Still another might be interested in minimizing his or her debt load.

The goals and objectives of a farm manager are closely intertwined with a person's psychological makeup, and the goals selected by a particular person may have very little to do with profit maximization. Nonetheless, most economic models used for representing the behavior of farm managers assume that the manager is interested in maximizing profits, or at minimum is interested in maximizing revenue subject to constraints imposed by the availability of resources.

Choice of outputs to be produced. A farm manager faces an array of options with regard to what to produce given available land, labor, machinery, and equipment. The manager must not only decide how much of each particular commodity to be produced, but also how available resources are to be allocated among alternative commodities. The farmer might be interested in maximizing profits but may have other goals as well. Often other constraints enter. For example, the government may permit the farmer to grow only a certain number of acres of a particular commodity. The farmer may have a particular knowledge of, or preference for, a certain commodity. The farmland may be better suited for certain types of crops or livestock than for other types.

Allocation of resources among outputs. Once decisions have been made with regard to what commodity or commodities are to be produced, the farmer must decide how his or her available resources are to be allocated among outputs. A simple question to be answered is which field is to be used for the production of each crop, but the questions quickly become far more complex. The amount of farm labor and machinery on each farm is limited. Labor and machinery time must be allocated to each crop and livestock activity, consistent with the farmer's overall objective. The greatest share of this text is devoted to dealing with issues underlying the problems faced by farm managers in the allocation of resources or inputs across alternative outputs or enterprises.

Assumption of risk and uncertainty. Models in production economics frequently assume that the manager knows with certainty the applicable production function (for example, the yield that would result for a crop if a particular amount of fertilizer were applied) and the prices both for inputs to be purchased and outputs to be sold. However, in agriculture, the assumption of knowledge with respect to the production function is almost never met. Weather is, of course, the key variable, but nature presents other challenges. Cattle develop diseases and die, and crops are affected by insects and disease. Most farmers would scoff at economic theory that assumes that a production function is known with certainty.

Although farmers may be fully aware of the prices they must pay for inputs such as fuel, fertilizer, and seed at the time each input is purchased, they are almost never aware at the beginning of the production season of prices that will prevail when outputs are sold. Price uncertainty is a result of the biological lag facing the producer of nearly any agricultural commodity, and production in agriculture takes time.

Economists have often made a simplifying assumption that production takes place instantaneously ! that inputs are, upon acquisition, immediately and magically transformed into outputs. The transformation does not instantaneously take place in

agricultural production. Production of most crops takes several months. The time may be measured in years from when a calf is conceived to when the fattened steer is placed on the market. Hence farmers must make production decisions with less than perfect knowledge with regard to the price at which the product will sell when it is actually placed on the market.

The competitive economic environment in which the farm firm operates. Economists often cite farming as the closest real ! world example of the traditional model of pure competition. But the competitive environment under which a farmer operates depends heavily on the particular commodity being produced.

1.11 The Assumptions of Pure Competition

Economists often use the theory of pure competition as a basic model for explaining the behavior of firms in an industry. At this point, it is useful to review the assumptions of the classical economic model of pure competition and assess the degree to which these assumptions might apply to farming in the United States. The model of pure competition assumes the following.

A large number of buyers and sellers in the industry exist. Few would feel that there are not a large number of sellers in farming. The United States Department of Agriculture (USDA) reported over 2.4 million farms in the United States in 1980, but farm numbers are far fewer for selected agricultural commodities. Only a few farms supply the entire nation's parsley needs, for example.

The assumption of a large number of buyers may be met to a degree at a local livestock auction market or at a central grain exchange in Minneapolis or Chicago, but many agricultural products move in markets in which only a comparatively few buyers exist. The tobacco producer may face only buyers from the three or four major cigarette manufacturers, and prices are determined in an environment that is not very competitive. In the livestock sector, broiler production has been dominated in recent years by only a few major producers. Production of hogs and cattle in the United States is often closer to a purely competitive environment in which a large number of farm firms take prices generated by overall supply and demand for hogs and cattle. However, there are a relatively small number of buyers for hogs and cattle, which again means that the model of pure competition does not strictly apply.

The firm can sell as much as it wants at the going market price, and no single firm is large enough to influence the price for the commodity being produced. For many agricultural commodities, the farmer can sell as much as he or she wants at the market price. Farmers are price takers, not price setters, in the production of commodities such as wheat, corn, beef, and pork. However, for certain commodities, the sparcity of farms means that the producers might exert a degree of control over the price obtained.

The product is homogeneous. The homogeneity assumption implies that the product produced by all firms in the industry is identical. As a result, there is no need for advertising, for there is nothing to distinguish the output of one firm from another. For the most part, this assumption is true in farming. There is little to distinguish one producer's number 2 corn from another's number 2 corn. For a few commodities, there have been some attempts at product differentiation ! for example, Sunkist oranges by the growers' cooperative, and branded chicken by the individual broiler producer.

There is free entry and exit, and thus free mobility of resources (inputs or factors of production) exists both in and out of farming. The free-mobility assumption is currently seldom met in agriculture. At one time it may have been possible for a farmer to begin with very little money and a lot of ambition. Nowadays, a normal farm may very well be a business with a million dollar investment. It is difficult to see how free entry end exit can exist in an industry that may require an individual firm to have a million dollars in startup capital. Inflation over the past decade has drastically increased the startup capital requirements for farming, with resultant impacts on the mobility of resources.

Free mobility of resources in linked to an absence of artificial restraints, such as government involvement. There exist a number of artificial restraints in farming. The federal government has been and continues to be involved in influencing production decisions with respect to nearly every major agricultural commodity and numerous minor commodities as well. Agricultural cooperatives have had a significant impact on production levels for commodities such as milk and oranges.

Grain production in the United States is often heavily influenced by the presence of government programs. The wheat and feed grain programs are major examples. In milk production, the government has largely determined the prices to be received by dairy farmers.

The government is involved not only in major agricultural commodities, but is also heavily involved in the economic environment for many commodities with limited production. For example, the hops producer in Washington state, or the burley tobacco producer in central Kentucky, produces in an environment in which the federal government largely determines both who will produce as well as how much each grower will produce. This is anything but competitive.

All variables of concern to the producer and the consumer are known with certainty. Some economists distinguish between *pure* competition and *perfect* competition. These economists argue that *pure competition* can exist even if all variables are not known with certainty to the producer and consumer. However, *perfect competition* will exist only if the producer knows not only the prices for which outputs will be sold, but also the prices for inputs. Moreover, with perfect competition, the consumer has complete knowledge with respect to prices.

Most important, with perfect competition the producer is assumed to have complete knowledge of the production process or function that transforms inputs or resources into outputs or commodities. Nature is assumed not to vary from year to year. Of course, this assumption is violated in agriculture. The vagaries of nature enter into nearly everything a farmer does, and influence not only output levels, but the quantity of inputs used as well.

1.12 Why Retain the Purely Competitive Model?

As has been indicated, the assumptions of the purely competitive model are not very closely met by farming in the United States The next logical question is: Why retain it? The answer to this question is simple. Despite its weaknesses, the purely competitive model comes closer to representing farming than any other comprehensive model of economic behavior. An individual farm is clearly not a monopoly if a *monopoly* is thought of as being a model in which a single firm is the industry. Nor, for most commodities, do farmers constitute an oligopoly, if an *oligopoly* is defined as a model in

which only a few firms exist in a competitive environment where price and output decisions by one firm a strongly affected by the price and output decisions of other firms. Nor does farming usually meet the basic assumption of monopolistic competition, where slight differences in product prices can be maintained over the long term because individual producers are somewhat successful in slightly differentiating their product from products made by a rival firm.

In summary, the purely competitive model has been retained as the basic model for application within agricultural production economics to farming because it comes closer than any of the remaining models of competitive behavior. This does not mean that other models of competitive behavior are unimportant in the remainder of the text. Rather, reliance will be placed on the purely competitive model as the starting point for much of our analysis, with modifications made as needed to meet the particular features of the problem.

1.13 Concluding Comments

The *purely competitive* model provides the basic starting point for much of the remainder of the text. The assumptions of the purely competitive model are fundamental to the microeconomic or firm oriented models of agricultural production processes.

The *factor-product* model is used in instances where one input is varied in the production of a single output. Key features of the factor-product model are outlined in detail in chapters 2 to 4.

The *factor-factor* model deals with a situation in which two inputs are varied in the production of a single output. The fundamental technical relationships underlying the factor-factor model are presented primarily with graphics in Chapter 5. The mathematics of maximization and minimization are developed in Chapter 6. Chapters 7 and 8 introduce prices and present the complete factor-factor model using the graphical presentation developed in Chapter 5 as well as the mathematics outlined in Chapter 6 as a basis. Linkages between graphical and mathematical presentations are stressed. Chapter 9 provides some extensions of the basic factor-factor model using two inputs and a single output.

Chapter 10 is devoted to the Cobb Douglas production function, which is perhaps the best known algebraic form used to represent agricultural production processes. Chapter 11 is devoted to some other closely related functional forms which are perhaps more closely linked to traditional production theory and provide better representations of true agricultural production processes, but are more difficult to work with algebraically.

Chapter 12 introduces the concept of the elasticity of substitution between input pairs. The chapter makes use of the constant elasticity of substitution, (*CES*) production function as the means for illustrating this concept.

Chapter 13 shows how the demand functions for inputs or factors of production can

be derived from the profit maximizing conditions for the firm. These input demand functions are derived under varying assumptions with respect to the characteristics of the production function underlying the profit-maximizing conditions.

Chapter 14 relaxes some of the assumptions of the purely competitive model and illustrates how the relaxation of these assumptions can affect profit-maximizing conditions for the firm. Models in which product prices and input prices are allowed to vary are considered.

Chapters 15 and 16 are devoted to the *product-product model*, in which a single input or resource is used to produce two different products. Linkages to the production possibilities curve are outlined. Profit maximization conditions for the firm are derived.

Chapters 17 and 18 extend the factor-factor and product-product models to situations in which many different inputs are used in order to produce many different outputs. The conditions required to maximize or minimize the manager's objective function subject to limitations in the availability of resources are formally derived using mathematics for many different inputs and outputs in Chapter 18.

Some linkages between marginal analysis and enterprise budgeting are discussed in Chapter 19. Chapters 20 and 21 are devoted to topics that involve dynamic as well as static theory. Chapter 20 presents models that take into account risk and uncertainty. Models in Chapter 21 include time as an explicit element.

Chapter 22 shows how linear programming might be used as a tool for operationalizing concepts related to the factor-factor and product-product models presented in the earlier chapters. Specific applications to agriculture are presented.

Chapter 23 poses some questions and unsolved problems in agricultural production economics which provide the basis for research in agricultural economics. These are used as a vehicle useful as a basis for further study in agricultural production economics.

Questions for Thought and Class Discussion

1. Discuss the role of microeconomics versus macroeconomics in agricultural economics. Does microeconomics have a greater impact than macroeconomics on the farm manager? Explain.

2. If pure competition is not an adequate representation of the economic model that underlies farming in the United States, why do the assumptions of pure competition continue to be important to agricultural economists?

3. Nowadays, is mathematics essential for understanding economic principles?

4. The real world is dynamic. If so, why do agricultural economists continue to rely so heavily on comparative statics?

5. Agricultural economists are frequently accused of spending too little time in the real world. A preoccupation with abstract theoretical issues means that agricultural economists are sometimes unable or unwilling to look at the fundamental issues linked to the production and marketing of agricultural commodities. Do you agree or disagree?

6. To become an agricultural economist, is it more important to know agriculture or to know economic theory?

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