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Teaching and Educational Methods

Teaching Forward Contracts in Undergraduate Courses in Agribusiness and Agricultural Economics Programs

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Abstract

This article presents teaching materials for teaching forward contracts in undergraduate courses in agribusiness and agricultural economics programs, as well as educational materials for Extension and outreach activities. The teaching materials include: (a) an introduction to spot and forward contracts as market exchange mechanisms and an explanation of the main differences between these two types of contracts; (b) a discussion of the business rationale for using forward contracts, as compared to spot contracts; (c) a simple economic framework explaining the mechanics of forward contracts; and (d) analytical problem sets demonstrating applications of this framework in the U.S. beef, pork, and milk supply chains. The teaching note includes analytical problem sets, multiple choices questions, and answer keys for all questions.

1 Introduction

The use of various types of agricultural marketing agreements that are alternatives to traditional spot market transactions, including forward contracts, have increased in many agricultural industries in recent decades (MacDonald and Korb 2011; MacDonald 2015; Adjemian et al. 2016). Using the food supply chain perspective, forward contracts are market exchange mechanisms, which facilitate efficient movement of products and payments throughout the food supply chain. Using the perspective of firms, forward contracts are essential for proper business planning and are also important risk management tools used to manage output and input price risks, as compared to spot market alternatives.

This article presents teaching materials that can be used to teach a topic on forward contracts in undergraduate courses in agribusiness and agricultural economics programs, as well as educational materials for Extension and outreach activities. To explain economic and business aspects of forward contracts, they are compared to spot contracts. The teaching materials include (a) an introduction to spot and forward contracts as market exchange mechanisms and an explanation of the main differences between these two types of contracts (Section 2); (b) a discussion of the business rationale for using forward contracts, as compared to spot contracts (Section 3); (c) a simple economic framework explaining the mechanics of forward contracts (Section 4); and (d) analytical problem sets demonstrating applications of this framework in the U.S. beef, pork, and milk supply chains. The teaching note includes the problem sets, multiple choice questions, and answer keys to all questions. Table 1 presents a list of student learning objectives.

Table 1. Student Learning Objectives

| Student Learning Objective (SLO) | |
|---|--|
| SLO #1 | Students should be able to explain a simple market exchange mechanism and the difference between spot contracts and forward contracts using the perspectives of sellers and buyers. |
| SLO #2 | Students should be able to explain the difference between an input forward contract and an output forward contract. |
| SLO #3 | Students should be able to discuss the business rationale for using forward contracts, as compared to spot contracts. |
| SLO #4 | Students should be able to provide examples of spot contracts and forward contracts. |
| SLO #5 | Students should be able to explain an economic framework describing the mechanics of forward contracts using the perspectives of sellers and buyers. |
| SLO #6 | Students should be able to apply the economic framework in the representative agribusiness settings to evaluate economic effects of the input and output forward contracts on contract parties (seller and buyer). |

2 Spot and Forward Contracts: Economics

Spot contracts and forward contracts are alternative agreements that sellers and buyers can use to sell and purchase products. In terms of economics, spot and forward contracts are market exchange mechanisms. From a seller's perspective, these contracts are output marketing contracts because products sold are outputs for sellers. From a buyer's perspective, these contracts are input procurement (purchasing) contracts because products purchased are inputs for buyers.

This section explains the economics of spot and forward contracts using the concept of market exchange. This section further defines the key differences between these two types of contracts.

2.1 Spot and Forward Contracts as Market Exchange Mechanisms

The key elements of any market exchange are a product, a seller, and a buyer of this product. Assume that a certain quantity of the product is available now or will be available in the future. The seller has the title (ownership) of the product. To enter a market exchange, the seller and the buyer reach an agreement on product quantity and price per unit. During the market exchange, the product quantity and title are exchanged for the product price (payment). As a result of the market exchange, the seller transfers the product and its title to the buyer, and the buyer accepts the product and its title from the seller and makes the payment to the seller.

Consider a simple market exchange (either a spot market contract or a forward contract), where Q is product quantity (measured in physical units) and P is product price (measured in \$ per unit). The total \$ value of this market exchange (contract) is $P * Q$.

From the seller's perspective, the product is output. P is output price,¹ Q is output quantity, and $P * Q$ is the total revenue associated with this market exchange (contract). The revenue has a positive effect on profit. The seller has a business and economic incentive to negotiate a higher price for the product they sell.

From the buyer's perspective, the product is input. P is input price,² Q is input quantity, and $P * Q$ is the total costs associated with this market exchange (contract). The costs have a negative effect on profit. The buyer has a business and economic incentive to negotiate a lower price for the product they buy.

¹ The output price is also referred to as selling price, price received, and price charged.

² The input price is also referred to as price paid and purchasing price.

2.2 Spot and Forward Contracts: Differences

A spot contract is an agreement between a seller and a buyer for an *immediate* delivery of a product in exchange for a payment. A forward contract is an agreement between a seller and a buyer to deliver a product in exchange for a payment at a specified *future* date.³ In the case of both spot and forward contracts, the seller transfers the product title to the buyer.⁴ From the seller's perspective, output forward contracts are also referred to as agricultural marketing contracts. According to the U.S. Department of Agriculture Economic Research Service, "Marketing contracts are agreements to exchange a specified asset for a certain price on a future date" (Prager et al. 2020, p. 3).⁵

The first difference between spot contracts and forward contracts is whether the products are available at the moment these contracts are signed (entered). Spot contracts are used when the product is already produced, and a desired quantity of this product is available to sell and to purchase immediately (on the spot). As in the case of spot contracts, forward contracts are also used when the product is produced and available to sell and to purchase. In contrast to spot contracts, forward contracts are also used when the product is not produced yet, but it will be produced by the time these contracts are to be executed, that is, when the seller delivers the product to the buyer and the buyer makes the payment.

The second difference between spot contracts and forward contracts is a time period between the moment these contracts are signed (Step 1) and the moment these contracts are executed (Step 2). Figure 1 depicts a timeline of the market exchange process, which helps explain this difference.

- Step 1 is TODAY: the seller and the buyer reach an agreement on product quantity to be sold and product price to be paid; they sign the contract.
- Step 2 is FUTURE (LATER): the seller and the buyer execute their agreement; the seller delivers the product to the buyer, and the buyer accepts the product and makes the payment. The seller transfers the product ownership to the buyer.

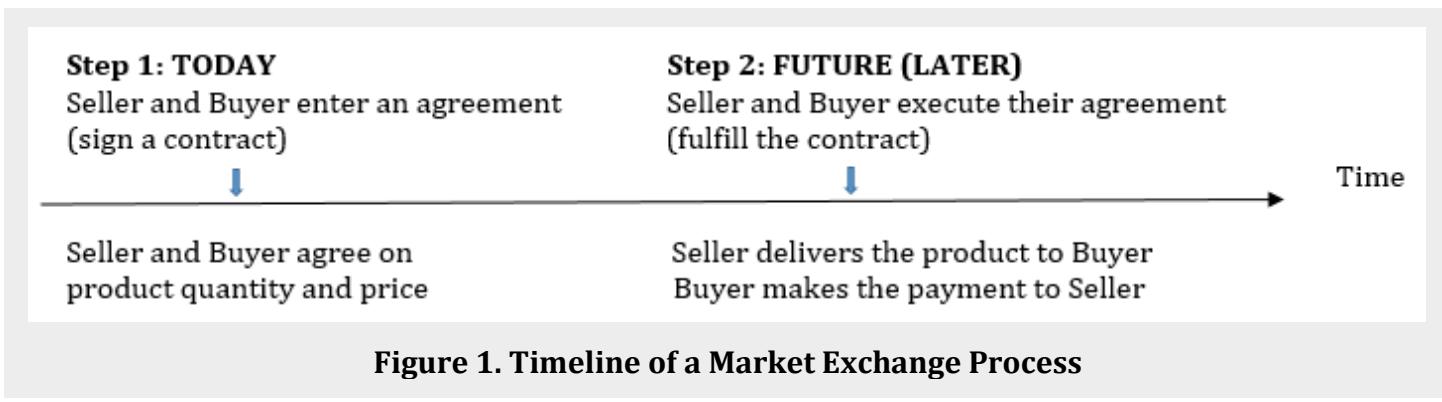


Figure 1. Timeline of a Market Exchange Process

³ Appendix 1 briefly explains legal aspects related to spot and forward contracts in light of the Uniform Commercial Code.

⁴ Paul, Heifner, and Helmuth (1976); Heifner, Wright, and Plato (1993); MacDonald et al. (2004); and MacDonald (2015) provide detailed discussions of the use of spot and forward contracts in agriculture, as well as agricultural industry examples, which can be used to supplement the lecture materials. The terminology related to forward contracts may vary depending on agricultural industry (MacDonald et al. 2004; MacDonald and Korb 2011; Adjemian et al. 2016; Greene 2019; Prager et al. 2020).

⁵ Agricultural *marketing* contracts should be distinguished from agricultural *production* contracts; both types of contracts are common in agriculture (Roy 1963; MacDonald et al. 2004; Prager et al. 2020). Under production contracts, agricultural producers perform services for a contractor (i.e., a food processor) in exchange for a fee. The examples of services include growing crops and raising animals. Agricultural producers do not own the product they produce for the contractor. The contractor maintains the product ownership, provides selected agricultural inputs, and markets the product.

If Step 1 and Step 2 take place on the same day or within a few days, then the contract is referred to as a spot market contract. If there is a certain time period between Step 1 and Step 2 (a few weeks to months), then the contract is referred to as a forward contract.

Figure 2 depicts a timeline of spot and forward contracting in light of crop production and marketing sessions, which further clarifies the differences between spot and forward contracts. Spot contracts can be entered only immediately after the harvest (after agricultural products have been produced) and during the marketing season. In contrast, forward contracts can be entered during the pre-production, production, and marketing seasons. However, forward contracts can be executed only immediately after the harvest and during the marketing season, when agricultural products are produced and available to be delivered.

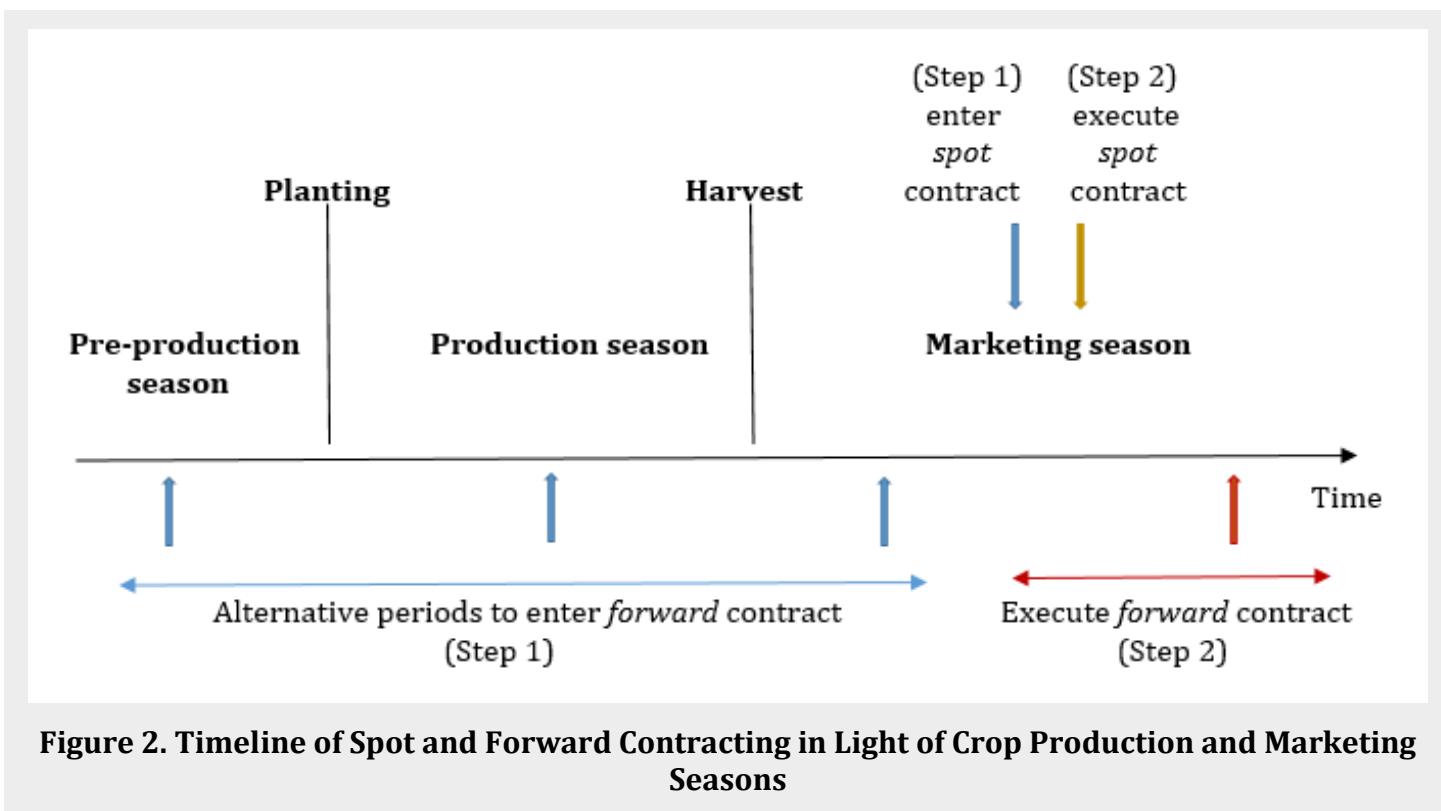


Figure 2. Timeline of Spot and Forward Contracting in Light of Crop Production and Marketing Seasons

3 Forward Contracts: Business Rationale and Risks

Why do firms use forward contracts instead of spot contracts? A general answer is proper business planning of input procurement (purchasing) and output marketing. The input quantity, quality, and timely availability from preferred geographic locations affects the output quantity, quality, and timely availability for different output distribution channels.

Input forward contracts are important for effective production planning. Input forward contracts allow to secure in advance input quantities and prices. Input purchasing (procurement) is a cost side of business. Output forward contracts are important for effective output marketing and pricing (sales). Output forward contracts allow to secure in advance output market outlets and prices. Output marketing is a revenue side of business.

Many types of food supply chain participants use forward contracts:

- Agricultural producers *purchase* some agricultural inputs from agricultural input suppliers using *input* forward contracts;
- Agricultural producers *sell* agricultural products to food processors using *output* forward contracts;
- Food processors *purchase* large quantities of agricultural products from agricultural producers using *input* forward contracts;
- Food processors *sell* large quantities of food products to food retailers using *output* forward contracts; and
- Food retailers *purchase* large quantities of food products from food processors using *input* forward contracts.

Different types of food supply chain participants use spot contracts:

- Fruit and vegetable producers (farmers) sell their products at local farmers markets to consumers shopping at these markets;
- Livestock producers sell their livestock at livestock auctions;
- Grain producers sell their grains to local grain elevators;
- Fresh fruit and vegetable producers (farmers and their cooperatives) sell their products to wholesalers and retailers at the shipping points located in large agricultural production regions;⁶
- Wholesalers sell domestic and imported fresh vegetables and fruits to other wholesalers and food retailers at large terminal markets;⁷ and
- Food retailers sell food products to consumers.

Forward contracts are also important risk management tools. Table 2 summarizes risk categories that agricultural producers face. Forward contracts may help firms manage risks (uncertainty) related to input and output quantities and prices.⁸ Using forward contracts, sellers and buyers lock in product prices and quantities today, while the product delivery and payment take place in the future.

In certain situations, there may be disadvantages to using forward contracts, as compared to spot contracts. First, there are risks related to changes in spot market prices between the moment a forward contract is signed and the moment it is executed. For a seller, the forward contract price accepted today may be lower than the spot market price in the future, meaning that the seller eventually sells the product at a lower price by using a forward contract. Had the seller not used a forward contract and used a spot market contract instead, the output price would have been higher for them. The seller loses money by using the forward contract in this situation. Similarly, for a buyer, the forward contract

⁶ The examples are open (spot) market sales by first handlers of specialty crops at the shipping points reported in the U.S. Department of Agriculture Specialty Crops Market News report available at https://www.ams.usda.gov/mnreports/wa_fv102.txt. This report presents prices associated with open (spot) market sales by first handlers of the products. Prices vary depending on the products' growing origin, variety, size, package, and grade.

⁷ The examples are open (spot) market sales of specialty crops at the terminal markets reported in the U.S. Department of Agriculture Specialty Crops Market News report available at https://www.ams.usda.gov/mnreports/aj_fv020.txt. This report presents prices associated with open (spot) market sales. Prices vary depending on the products' growing origin, variety, size, package, and grade.

⁸ Forward contracts should be distinguished from futures contracts. Both types of contracts are risk management tools and are often referred to as forward pricing methods (Paul, Heifner, and Helmuth 1976; Wolf and Olynk Widmar 2014). Futures contracts are standardized contracts with the pre-determined terms and conditions. Futures contracts are traded on the organized Exchanges. Chicago Mercantile Exchange is one of the largest Exchanges in the world (CME Group 2022).

Table 2. Categories of Risks in Agriculture

| Risk Category |
|--|
| Price Risks |
| Output price risks arise from the uncertainty related to changes in prices received for agricultural outputs. |
| Input price risks arise from the uncertainty related to changes in prices paid for agricultural inputs. |
| Production Risks |
| Output quantity (yield) risks arise from the uncertainty related to the production processes of crops and livestock, that are due to weather, diseases, pests, and other factors affecting the quantity and quality of agricultural outputs. |
| Market Risks |
| The risks arising from the uncertainty related to locating a buyer or a seller. |
| Institutional Risks |
| The risks arising from the uncertainty related to government policies and programs affecting agricultural production and/or farms or farm households' finances. |
| Financial (Repayment) Risks |
| The risks arising from changes in interest rates, credit availability, or other market conditions. |
| Human (Personal) Risks |
| The risks arising from health or personal relationship issues that can affect the farm business (accidents, illness, death, and divorce). |

Source: Adopted from Prager et al. (2020).

price accepted today may be higher than the spot market price in the future, meaning that the buyer eventually purchases the product at a higher price by using a forward contract. Had the buyer not used the forward contract and used a spot market contract, the input price would have been lower for them. The buyer loses money by using the forward contract in this situation.

Second, there are risks for agricultural producers as sellers, if they are not able to produce the needed output quantity required to fulfill a forward contract. For example, this can happen due to bad weather or a disease outbreak. In this case, agricultural producers must buy the output quantity elsewhere to fulfill the forward contract, which might lead to a loss for these producers. Third, there are risks involving nonperformance by a buyer, who fails to provide a payment on time or at all, possibly due to bankruptcy or insolvency.

4 Framework Explaining the Mechanics of Forward Contracts

Figure A2 included in Appendix 2 presents an economic framework explaining the mechanics of forward contracts.⁹ The framework focuses on economic effects (gain or loss) of the same forward contract on the contract parties: the buyer and the seller of the product. This forward contract is an output forward contract for the seller, affecting the output price they receive and consequently their revenue and profit. The same forward contract is an input forward contract for the buyer affecting the input price they pay and consequently their costs and profit. The main components of the framework are explained in the following.

⁹ This framework is conceptually similar to the mechanics of futures contracts, when the seller and the buyer gain or lose between TODAY and the FUTURE depending on the patterns of the spot and futures price movements between the moment a futures contract is purchased (or sold) TODAY and the moment this contract is sold (or purchased) in the FUTURE.

Consider a product that theoretically can be sold and purchased using a forward contract or a spot contract.¹⁰ The product is sold and purchased using a forward contract. Assume there is a seller and a buyer for this product. Now consider two points in time: TODAY and the FUTURE (LATER). Assume there is a time period of a few weeks or months between TODAY and the FUTURE. The following actions take place TODAY and in the FUTURE:

- TODAY: the seller and the buyer sign a forward contract by making (entering) an agreement on product quantity (Q) to be delivered in the FUTURE and forward price (FP) to be paid for this product in the FUTURE.
- FUTURE (LATER): the seller delivers the product to the buyer (Q), and the buyer accepts this product (Q) and makes a payment to the seller (FP in \$/unit or the total payment of $FP * Q$).

The spot market is an alternative to the forward contract. While the spot market is not used by the seller and the buyer in this situation, the spot market price for the FUTURE (SPL) is used as a reference price within the framework to evaluate economic effects of the forward contract on the seller and the buyer.

The spot market price may change between TODAY and the FUTURE. This price may increase or decrease. TODAY the seller and the buyer do not typically know whether the spot market price will increase or decrease between TODAY and the FUTURE. TODAY, when the seller decides on the forward price to accept, the seller would typically accept the forward price which covers production costs.

Using a proper business planning perspective, both contract parties will gain from using the forward contract. Using a risk management perspective, one contract party will gain, and another contract party will lose from using the same forward contract, as compared to the spot market alternative. In the latter case, the key thing is whether the forward price accepted today will be higher or lower than the spot market price in the future. The price difference ($FP-SPL$) affects who loses and who gains from using the same forward contract. The two scenarios are explained in Figure A2 in the FUTURE (LATER) section (Appendix 2).

The first scenario is that the forward price accepted today is higher than the spot price in the future (Figure A2: FUTURE (LATER) section Scenario 1). In this scenario, the seller gains because by using the forward contract the seller increases the output price, relative to the spot price, which consequently increases revenue and profit. In contrast, the buyer loses because by using this forward contract, the buyer increases the input price, relative to the spot price, which consequently increases costs and decreases profit.

The second scenario is that the forward price accepted today is lower than the spot price in the future (Figure A2: FUTURE (LATER) section Scenario 2). In this scenario, the seller loses because by using the forward contract, the seller decreases the output price, relative to the spot price, which consequently decreases revenue and profit. In contrast, the buyer gains because by using this forward contract, the buyer decreases the input price, relative to the spot price, which consequently decreases costs and increases profit.

5 Forward Contracts in the U.S. Beef, Pork, and Milk Supply Chains

The analytical problem sets included in the teaching note demonstrate applications of the economic framework in the U.S. beef, pork, and milk supply chains. The main decision maker is an agricultural producer: cattle farmer, hog farmer, or dairy farmer. This agricultural producer uses an input forward contract to purchase feed from an animal feed supplier and an output forward contract to sell output

¹⁰ Spot contracts are associated with spot markets, which examples include a local livestock auction, a shipping point, and a terminal market.

(cattle, hogs, or milk) to a food processor. The decision maker uses a fixed price forward contract. They know the level of the forward price when they sign the forward contract.

In a real-world industry setting, many forward contracts used in the food supply chain have deferred pricing systems. A deferred pricing means that the product price is to be determined later using a price formula or another price determination method. Forward contracts with deferred pricing specify a base price and a price differential reflecting differences in the value of the seller's product from the one associated with the base price (Paul, Heifner, and Helmuth 1976). In addition to the product price and quantity-related provisions, forward contracts include provisions related to product quality, delivery conditions, dispute resolution, and others. The agricultural product quality in forward contracts is typically specified by referring to the U.S. Department of Agriculture Agricultural Marketing Service Grades and Standards (2022).

Using the terminology common to the livestock industries, the category of forward contracts with differed pricing used in these industries includes forward and formula contracts (Adjemian et al. 2016; Greene 2019). Both forward and formula contracts establish a price determination method for the price to be determined later, when fed cattle and hogs are delivered to the meat packing plants. Forward contracts use the Chicago Mercantile Exchange cattle and hog futures contract prices as a base (or a reference price) to determine the actual price to be paid to fed cattle and hog producers later. Formula contracts use a spot market price as a base (or a reference price) to determine the actual price to be paid to fed cattle and hog producers later. The spot (cash) market prices used in the formula contracts are typically spot (cash) prices reported by the U.S. Department of Agriculture Agricultural Marketing Service (Adjemian et al. 2016; Greene 2019).

Beef and pork packers (meat processors) benefit from using forward and formula contracts ("input procurement practices" for packers) because they can secure the constant flow of the required quantity of fed cattle and hogs with the essential quality characteristics to their meat processing (packing) plants. Fed cattle and hog producers (farmers) also benefit from using forward and formula contracts, because they can secure in advance a market outlet for their fed cattle and hogs and reduce market and price risks (Table 2).

Similarly, dairy farmers benefit from using forward contracts. The milk marketing arrangements that many dairy farmers have with dairy cooperatives (who market milk on behalf of farmer-members) and milk processors are designed as forward contracts (Ling and Liebrand 1996; Shields 2011; Wolf 2012; Wolf and Olynk Widmar 2014). The design of milk pricing systems used in forward contracts may be as simple as a fixed forward price or more complex when forward prices are tied to the Chicago Mercantile Exchange futures prices for manufactured dairy products (forward contracts with deferred pricing).

The forward prices for feed in input forward contracts used by dairy farmers also have deferred pricing systems. The feed forward prices in these contracts are typically tied to the Chicago Mercantile Exchange futures prices for grains, such as corn and soybean meal (Shields 2011; Wolf 2012; Wolf and Olynk Widmar 2014).

6 Conclusion

Given the increasing use of forward contracts in the food supply chain, teaching economic and business aspects related to forward contracts, mechanics of forward contracts, and industry applications in undergraduate courses in agribusiness and agricultural economics programs gains more importance. The teaching materials presented in this article and teaching note were used to teach forward contracts in a junior level "Economics of Agricultural Marketing" course and a junior level "Agribusiness Management" course at a land-grant university. As for teaching approaches, it is suggested to allocate two class sessions to this lecture topic. The first class session is to be allocated to economic and business aspects related to spot and forward contracts. The second class session is to be allocated to the economic framework

explaining the mechanics of forward contracts and an in-depth explanation of one of the industry applications (the instructor solves one of the problem sets on the blackboard).

The teaching note includes analytical problem sets demonstrating industry applications, which can be used for in-class explanation, assigned as homework, and included in exams. The teaching note also includes multiple-choice questions and answer keys to all questions. The teaching materials are also suitable for educational Extension and outreach activities.

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Appendix 1. Spot and Forward Contracts: Legal Aspects

The Uniform Commercial Code (UCC)¹¹ establishes rules regulating contracts for sale of goods. Spot and forward contracts are contracts for sale of goods in light of UCC because agricultural commodities and food products are “goods.” Goods are things that are movable, including unborn animals and growing crops.¹²

The UCC defines “contract for sale of goods” as the one that “includes both a **present sale** of goods and a **contract to sell goods at a future time**.” “A sale consists in the **passing of title** from the seller to the buyer **for a price**.¹³ “A ‘present sale’ means a **sale which is accomplished by the making of the contract**.”

In light of UCC, spot contracts may be interpreted as present sales, and forward contracts may be interpreted as future sales. Spot contracts and forward contracts are legally binding agreements between sellers and buyers of the products. To be enforceable in court, these contracts must be in writing, if for \$500 or more.¹⁴

¹¹ <https://www.law.cornell.edu/ucc>

¹² <https://www.law.cornell.edu/ucc/2/2-105>

¹³ https://www.law.cornell.edu/ucc/2/2-106#Contract%20for%20sale_2-106

¹⁴ <https://www.law.cornell.edu/ucc/2/2-201>

Appendix 2. Framework Explaining the Mechanics of Forward Contracts

| SPOT MARKET | FORWARD CONTRACT (FC) | |
|--|--|--|
| | Seller Sells the product (output). Output price received affects revenue. | Buyer Buys the product (input). Input price paid affects costs. |
| TODAY Spot Price = \$XX/unit “SPT” | Seller and Buyer sign a forward contract: Agree on product Quantity (Q) to be delivered in the FUTURE and Forward Price (FP) to be paid in the FUTURE . Q is in physical units, and FP is in \$/unit. Forward contract \$ value = $FP * Q$. | |
| FUTURE (LATER) Spot Price = \$YY/unit “SPL” | Seller delivers the product to Buyer and receives price (FP). To evaluate economic effects (gain or loss) of the forward contract on Seller and Buyer: compare Forward Price (FP) and Spot Price LATER (SPL), and calculate the price difference (PD). | Buyer accepts the product from Seller and pays price (FP). <u>Scenario 1: $FP > SPL$ and $PD = FP - SPL > 0$.</u> Seller Gains Seller has increased the output price by using FC. Seller's revenue and profit increase . Buyer Loses Buyer has increased the input price by using FC. Buyer's costs increase and profit decreases . |
| | <u>Scenario 2: $FP < SPL$ and $PD = SPL - FP > 0$.</u> Seller Loses Seller has decreased the output price by using FC. Seller's revenue and profit decrease . Buyer Gains Buyer has decreased the input price by using FC. Buyer's costs decrease and profit increases . | |

Figure A2: Framework Explaining the Mechanics of Forward Contracts

Note: Seller: Total Gain/Loss (\$) = Price Difference (\$/unit) * Quantity (Units).

Buyer: Total Gain/Loss (\$) = Price Difference (\$/unit) * Quantity (Units).

Forward Contract \$ Value = Forward Price (\$ per unit) * Quantity (Units).

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