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AN ECONOMIC ANALYSIS OF CONTRACTING ARRANGEMENTS
USED BY THE MINNESOTA TURKEY INDUSTRY

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# AN ECONOMIC ANALYSIS OF CONTRACTING ARRANGEMENTS USED BY THE MINNESOTA TURKEY INDUSTRY

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Abstract

The objective of this report is to summarize knowledge about contracts used in the turkey industry which may be helpful in initiating contracts in other agricultural enterprises.

Characteristics common to all Minnesota contracts are described. Contracts are divided into three main categories and similarities of contracts within those categories are described.

Budgets developed at the University of Minnesota were used to calculate the return to labor and management (RLM) for each type of contract. Feed costs were set at six levels to show how risk and return are shared as feed costs change.

Historic wholesale prices were used to establish a probability distribution for effective prices paid to growers. The Agricultural Risk Management Simulator (ARMS) program used this price distribution to calculate cumulative distributions of returns to labor and management (RLM) for each level of feed costs. Contracts were evaluated at each level of feed costs using stochastic dominance techniques.

## I. PROBLEM STATEMENT

The bulk of U.S. agriculture is currently organized as sole proprietorships using debt and equity as the primary means of financing operations. The loss of equity caused by operating losses and declining asset values has created a great deal of hardship for farmers and farm communities. It has forced many farmers to file for bankruptcy. The financial stress hardship and bankruptcy is so widespread that is has been termed a "farm crisis."

As a result of the farm crisis, alternatives to the traditional structure and financing arrangements for agriculture are being examined. Some of those alternatives are leasing, limited partnerships, contracts and vertical integration. This paper examines turkey contracts used in Minnesota. The objective is to analyze the risk-returns implications of various contracting arrangements and acquire knowledge about the contracts used in the turkey industry which may be helpful in initiating contracts in other enterprises. This overall objective was divided into four areas:

1. reasons for contract coordination in the turkey industry,
2. characteristics of the contracts used,
3. evaluation of how risks and returns are shared, and
4. considerations for initiating contracts in other enterprises.

Section II reviews the changes which have occurred in the turkey industry during the past 25 years. Section III briefly introduces and describes the various types of contracts used in the U.S.; contracts prevalent in Minnesota are described in greater detail. Section IV lists the reasons given for adopting contracts in the turkey industry.

It also compares contracting in Minnesota with the rest of the U.S. Section V evaluates the sharing of risk and return for three types of contracts commonly used in Minnesota. Section VI briefly disscusses some of the factors to consider when initiating contracts for other enterprises.

## II. EVOLUTION OF THE TURKEY INDUSTRY

The turkey industry appears to be one of the most dynamic and rapidly changing segments of U.S. agriculture. Changes have occurred not only in the method by which turkeys are raised, but also in the means by which they are marketed to processors and the form in which they are consumed by households.

Traditionally, consumption of turkey meat has been in the form of ready-to-cook whole birds consumed during the Thanksgiving and Christmas holiday seasons. Now turkey is also marketed as cut-up parts (breasts, drumsticks, wings), roasts, smoked products, rolls, franks and frozen dinners, as well as other products. Per capita consumption of turkey increased from 7.4 pounds in 1965 to 11.9 pounds in 1985 (USDA, 1985b). The diversity in product type has undoubtedly had an influence on per capita consumption. Lance states, "Consumption is still heavily concentrated around the Thanksgiving and Christmas seasons, but the marketing of turkey parts and processed products has diminished the traditional seasonal consumption patterns" (Lance, 1982, p. 1).

To meet the demand for turkey in the off-season, producers have switched from a ranging system (turkeys raised on an open lot) to total confinement. They have also increased production nationwide from

105,684,000 birds in 1965 to 169,728,000 in 1983 (USDA, 1985a).

The increase in production has not been uniform across all production regions in the U.S. Table 1 lists both number of turkeys raised in 1965 and 1983 and the percentage of U.S. production for each of the six regions of the U.S. Figure 1 shows how the U.S. is divided into the poultry production-marketing regions. In 1965 the South Atlantic region produced 14.59% of the total turkeys in the U.S. By 1983 their share had increased to 27.52%. Both the East and West North Central regions declined in percentage of U.S. production. The West North Central region provided 33.42% of the turkeys in 1965, but only 29.40% in 1983. The share of U.S. production for the East North Central region during these years was 14.60% and 10.62%, respectively (USDA, 1985a).

Turkey processing has become more concentrated in larger firms over the past two decades. Table 2 presents turkey slaughter by the number of firms accounting for specified percentages of slaughter (USDA, 1985a). The share of federally inspected turkey slaughtered by the four largest firms in 1960 was 22%; in 1982 it was 33%. The 20 largest firms slaughtered 50% of the turkeys in 1960, and by 1982 they slaughtered 87%.

As turkey slaughter became more concentrated in fewer firms, the number of plants processing turkeys declined. In 1962 there were 281 turkey processing plants under federal inspection. By 1981 the number had declined to 128 (USDA, 1985a).

## III. COORDINATING ARRANGEMENTS

Schrader and Lang characterized coordinating arrangements for

Table 1. Regional production of turkeys and percentage of U.S. production for 1965 and 1983.

| Region | 1985 Number raised (thousands) | 1985 Percentage of U.S. production | 1983 Number raised (thousands) | 1983 Percentage of U.S. production |
|---|---|---|---|---|
| North Atlantic | 3,265 | 3.09 | 7,434 | 4.38 |
| East North Central | 15,427 | 14.60 | 18,033 | 10.62 |
| West North Central | 35,321 | 33.42 | 49,907 | 29.40 |
| South Atlantic | 15,420 | 14.59 | 46,716 | 27.52 |
| South Central | 13,487 | 12.76 | 19,850 | 11.70 |
| West | 22,764 | 21.54 | 27,788 | 16.37 |
| United States | 105,684 | 100.00 | 169,728 | 100.00 |

Source: USDA, 1985a.

Table 2. Turkey processing firms accounting for specified proportions of federally inspected output for 1960 and 1982

| Federally inspected output | 1960 | 1982 |
|---|---|---|
| | (number of firms) | |
| 30 percent | 6 | 4 |
| 50 percent | 18 | 8 |
| 70 percent | 40 | 13 |
| 80 percent | 57 | 17 |
| 90 percent | 87 | 24 |
| 95 percent | 121 | 31 |
| 100 percent | 249 | 86 |

Source: USDA, 1985a.

turkey production into several broad categories. The following is a summary of those categories with a brief description of each category quoted from portions of their work.

1. Vertical Integration. The producer-processor owns all production facilities and hires labor to care for the birds. He internalizes all market risk at the producer-processor interface. Internal transfer pricing may be based upon the cost of grow-out or a market quote.

2. Cooperatives. Presumably these firms return net margins to their members based on patronage and equity ownership. Cooperative members internalize market risk at the producer-processor interface and assume market risk at the wholesale level.

3. Resource Providing Contracts are very much like ownership integration. In the typical resource providing contract, the processor or other contractor provides poults, feed, field supervision and other factors. An independent grower owns buildings and facilities and provides labor. Payment is on a per bird or per pound grow-out basis and may include performance incentives for feed conversion, livability and grade.

4. Cost-Plus Contracts. Under this arrangement, a producer's payment is based on estimated factor costs at a standard performance level plus a profit margin. The arrangement differs from the resource providing contract in that the cost-plus arrangement places certain production risks on the grower. Performance incentives with respect to grade may be included and producers may receive some share of price increases above a certain level. But they do not risk product market losses. Such contracts facilitate financial support from bankers for new producers and others who cannot or do not desire to bear market risk.

5. Independent Growers with Formula Pricing Arrangement (Formula Price Contract). Under a widely used arrangement, growers contract a specified number of birds to be priced by formula using a market quote on the date of slaughter or on the average quote for the week of slaughter. The amount paid to the grower is the market quote, less a specified processing fee, the remainder multiplied by a dressed-weight yield factor. Urner Barry is the most commonly used quote in such formulas, but Market News is used as well.1/ Such a formula "locks in" a processing margin and assigns market risk to the producer.

1/Urner Barry and Market News are private organizations which publish estimated wholesale prices of turkey. Their quotes are widely regarded as good estimates of turkey prices.

6. Shared Risk (Joint Venture). Under joint ventures, processors or other contractors deal with independent growers. Grower costs of production are estimated and a formula price is used to estimate market value. If market value deviates from production cost, differences are shared by producers and processors (Schrader and Lang, pp. 12-15).

Each of these types of coordinating arrangements with the exception of shared risk is known to exist in Minnesota in some form. A description of the resource providing, cost-plus and formula pricing arrangements used in Minnesota follows.

## General Characteristics of Contracts

Turkey contracts used in Minnesota have several characteristics in common. Most generally producers own the resources used in the production of turkeys -- buildings, equipment and land. As full owners they are responsible for paying real estate taxes and mortgages on the facilities and equipment.

The growers provide and pay for production inputs such as water, medication, litter, heat and utilities. The grower is also responsible for acquiring and servicing an operating loan for production inputs if one is needed. The grower is compensated for these inputs as a part of the payment plan. The method of calculating the amount of compensation will vary depending upon the contract which is used.

In some contracts the processor provides both poults and feed. Growers must meet livability and feed conversion rates as part of those contracts.

The contracts specify that growers will deliver a predetermined number of live, healthy, marketable birds on the date(s) agreed upon. Turkeys which are dead on arrival are deducted from the total pounds delivered. Birds which are dead on arrival and which can be determined

to have been the fault of the processor are not deducted from the total weight.

As flocks are processed they are inspected by the USDA. The total weight of parts condemned is divided by a contractually specified dressing percentage, appropriate for the type of birds marketed, to arrive at a total liveweight of condemnations. This amount is also deducted from the total liveweight delivered.

The grower is to provide turkeys which are fit for immediate slaughter for human consumption. All birds must meet the guidelines set forth by federal and state agencies for pesticides, herbicides, and drugs. The grower is responsible for meeting withdrawl times for growth promotants and medications.

The contract stipulates the percentage of birds which must meet grade A standards. The price paid to growers is a function of the percentage of grade A birds.

The processor provides a turkey loading machine and a skilled crew to operate it. The grower provides labor to move the birds from the barns to the turkey loader.

## Resource Providing Contracts

Resource providing contracts used in Minnesota are written for people who are contemplating the erection of turkey growing facilities. The contracts assure the grower and the financing agency that the income stream will exceed expenses and will be predictable. These contracts are generally five to ten years in length, since they are intended to aid in the procurement of financing for buildings and equipment.

The final cash settlement in these contracts is based on direct and overhead costs of raising the turkey poults. Growers must provide evidence of the actual costs of inputs.

A profit margin is paid in accordance with the terms of the contract. The summation of the actual costs plus the profit margin is the rate of payment to the grower in cents per pound of liveweight marketed.

Poult costs are adjusted by a contractually specified livability percentage to spread their cost over the total weight marketed. In some cases the grower may not have to pay for the poults. Instead he forwards the bill to the processor for payment.

The feed source is specified within the contract. Feed ingredients, preparation and delivery charges are paid based on contractually specified feed conversion rates. These conversion rates reflect the seasonality of weight gain for turkeys.

Other direct costs such as fuel, medication, vaccination, litter, interest on working capital, etc., are contractually set. Fuel costs also reflect seasonal variations.

Overhead charges such as repairs, maintenance, property insurance, real estate taxes, and labor are contractually determined. Financing costs of buildings and equipment are based on actual costs. Growers provide the processor with their amortization schedule as proof of their actual costs. These contracts state that the processor is not obligated to the third party lender if the grower defaults on his building and equipment loan. The processor is only guaranteeing a market for the birds.

Resource providing contracts are also called "no market participation" contracts since the grower's payment bears no relation to the market price of turkeys. While the total payment to the grower may vary from flock to flock due to changes in feed costs or differences in flock size, his net return will remain stable as long as he meets the livability and feed conversion rates stipulated in the contract. This occurs because actual production costs are used by the processor to calculate total payments to the grower.

The contract quantity is specified in pounds of live heavy weight (24 to 26 pounds)2/ turkey toms marketed annually. Contracts in this category are not available for the production of light weight toms. Some contracts permit the sale of light weight hens 10-12 weeks after the flock is started. This allows growers to more fully utilize their buildings when the turkeys are younger and have lower per bird space requirements. Flock scheduling is such that a confinement system is necessary to meet the production schedule.

To qualify for resource providing contracts, growers must meet minimum net worth requirements and own the land on which they propose to build the facilities. In addition they must reveal to the processor their financial statements and income tax returns for the past several years. The grower's financial condition is reviewed periodically during the life of the contract to ascertain that it has not deteriorated. The contract is terminated if the grower becomes insolvent or declares bankruptcy.

2/The terms "heavy weight" and "light weight" are relative. Individual processors may define heavy weight birds to be slightly larger than this; however, these weights are fairly typical.

## Cost-plus Contracts

Cost-plus contracts are also available to Minnesota turkey growers. These contracts compute two values for the turkeys: base price and market value. The base price formula "locks in" a minimum price the grower will receive regardless of the market price of turkeys. Thus, the grower does not bear all the market price risk.

Calculation of the base price has two components: feed cost and an aggregate cost for other inputs. The feed component of costs is obtained by securing price quotes for corn and soybean meal from a specified source. The source is usually a local elevator or a grain terminal such as Minneapolis or Portland cash price.

These quotes are recorded weekly for the duration of the contract. The turkey production cycle is subdivided into three- to four-week periods. Quotes are averaged for the periods and then multiplied by a weighting factor to arrive at a weighted average price for the feed ingredient. The weighting factor is a reflection of the percent of total feed consumption which occurs during each period.

The method used to transform feed costs into a base price varies between the contracts. The method chosen for this analysis is easy to comprehend and specifies the factors which influence the base price.

For this analysis the weighted average price is multiplied by the pounds of the ingredient (corn or soybean meal) per ton of feed mix to obtain a cost per ton for the ingredient. Allowances for supplements and minerals, grinding, mixing and delivery are added to calculate the total cost per ton of feed. This cost is converted to a per pound basis which is multiplied by a contractually determined feed conversion

rate and results in the estimated feed cost per pound of live turkey.

The values for other growing costs are set forth in a schedule within the contract. They are not determined by the actual purchase prices of the inputs but rather are an aggregate of costs expressed in cents per pound of live turkey produced. These aggregate costs reflect seasonal fluctuations in the actual costs which underlie them.

The sum of feed costs and other growing costs is the base price per pound of live turkey. This is the minimum the grower will receive for his turkeys.

The market value is computed from a New York price quote at the time the birds are processed. Most often the Urner Barry quote is used. Processing charges are deducted from the quoted price. The remainder is multiplied in the contract to obtain the market value of live turkeys. Processing charges are set forth in a schedule within the contract. They also show seasonal variations reflecting higher charges during the Thanksgiving and Christmas seasons and lower charges at other times of the year.

If market value exceeds the base price an excess is said to exist. The amount of the excess is the market value less the base price. Both the grower and processor share in the excess according to the terms of the contract. In the Southeastern U.S. this is known as "splitting the ups."

Two types of splitting arrangements are used in Minnesota. In one, both producer and processor share all the excess. The second type limits the amount of excess which is split. In contracts with limiting clauses, the excess is split between the producer and processor until

the excess reaches a specified level; beyond that level the processor receives 100% of the excess. This limits the grower's share of the excess. The percentage of the excess each party receives varies between the contracts.

The example of Table 3 shows how prices would be calculated based on the listed assumptions. The base price of $.3375 would be the minimum a grower would receive for his birds. In this example he receives the base plus some splits an excess of $.1463 exists.

The grower receives $.4106 per pound of live turkey when he has a contract with unlimited splitting. A grower with a contract limiting splits to the first ten cents would receive five cents as his share of the excess. Adding this amount to the base price of $.3375 yields a price of $.3875 per pound of live turkey.

These arrangements are limited market participation contracts. Price signals from the market place are passed to the grower only when an excess exists. With an unlimited splits contract, the producer is in market participation whenever an excess exists.

When splitting is limited, growers are in market participation only while an excess exists which is less than the limit. In this latter case, the grower receives a constant price regardless of the Urner Barry price once the excess surpasses the level which limits splitting.

Thus, with cost-plus contractual arrangements the producer's downside price risk is limited to the price calculated by the base price formula. Their upside potential is limited by their share of the excess.

Table 3. Calculating turkey price

| | | | |
|---|---|---|---|
| Assume: | | | |
| Feed cost/lb. | $.0681 | Conversion rate | 2.90 |
| Other cost/turkey | $.1400 | Urner Barry price | $.80 |
| Processing charge | $.21 | Yield | .82 |
| Share of excess | .50 | Limit on splits | $.10 |

DETERMINING BASE PRICE

| | | |
|---|---|---|
| Feed cost/lb. | | $.0681 |
| Conversion rate | * | 2.9 |
| | | $.1975 |
| | | $.1975 |
| Other costs | + | .1400 |
| Base price per lb. of live turkey | | $.3375 |

DETERMINING MARKET VALUE OF TURKEY AT THE FARM GATE

| | | |
|---|---|---|
| Urner Barry price | | $.80 |
| Processing charge | - | .21 |
| | | $.59 |
| | | $.59 |
| Yield factor | | .82 |
| Market value | | $.4838 |

DETERMININT SHARE OF EXCESS

| | | |
|---|---|---|
| Market value | | $.4838 |
| Base price | - | .3375 |
| Excess | | $.1463 |

| | | |
|---|---|---|
| Unlimited splitting | | |
| Excess | | $.1463 |
| Share factor | * | .50 |
| Share of excess | | $.0732 |

| | | |
|---|---|---|
| Limited splitting | | |
| Excess | | $.1463 |
| Limit | | $.1000 |
| Since the excess is larger than the limit, the sharing factor is applied to limit only. | | |
| Limit | | $.1000 |
| Share factor | * | .50 |
| Share of excess | | $.0500 |

PRICE RECEIVED

| | | |
|---|---|---|
| Unlimited splitting | | |
| Base price | | $.3375 |
| Share of excess | + | .0732 |
| Price received per lb. of live turkey | | $.4106 |

| | | |
|---|---|---|
| Limited splitting | | |
| | | $.3375 |
| | + | .0500 |
| | | $.3875 |

There are fewer restrictions on the type of turkeys which may be contracted with these cost-plus arrangements. The type of turkeys contracted will depend upon the anticipated needs of the processors. Growers may use any type of growing system including ranging to produce birds.

Cost-plus contracts are typically in effect for three years or less. The longer term contracts tend to specify heavier birds and to contain limited splits clauses. Settlement prices are determined by a formula and not by actual cost of production. Because the cost of facilities is not reimbursed on an actual cost basis, growers are not contractually obligated to share their financial statements with the processor. The costs of buildings and equipment are expected to be recovered in the aggregated other costs component of the base price formula.

Formula Price Contracts

Formula price contracts allow growers to "lock in" a processing charge. They also guarantee that the processor will have space available on the processing line when the grower's turkeys are ready for market. Growers with these contracts are said to be in full market participation; they have no guaranteed minimum price but will receive all the returns above their expenses.

The market value is again computed from the Urner Barry price quote at the time the birds are processed. Processing charges are deducted from the quoted price. The remainder is multiplied by a yield factor appropriate for the type of birds specified in the contract to obtain the market value of live turkeys. The processing charges are

set forth in a schedule within the contract. These charges again exhibit seasonal variations; they are higher during the Thanksgiving and Christmas seasons and lower at other times of the year.

The section of Table 3 entitled "Determining Market Value of Turkeys at the Farm Gate" shows how prices are determined by these contracts. The only assumptions necessary for price determination are those for Urner Barry price, processing charges and the yield factor. The processor has no obligatory knowledge of feed or other costs incurred in producing the turkeys. Thus, the other assumptions are inconsequential in determining the price received under formula pricing contracts.

Formula pricing contracts are usually written on a flock-to-flock basis; however, some are available for a three-year period. Any type of bird may be contracted with these instruments. The type of turkeys contracted will depend upon the anticipated needs of the processors. These contracts are generally not used to price off-season flocks, and therefore growers can use any type of growing system including ranging to produce birds.

Table 4 summarizes the contract terms available to turkey growers in Minnesota. The first four items are common to all contracts; the next eight items point out the differences between the contracts.

## IV. ADOPTION OF COORDINATING ARRANGEMENTS

The Western and South Atlantic regions of the U.S. were the first areas to make widespread use of contracts. Contracts were common in those areas by the late 1950s and early 1960s (USDA, 1985a; Gallimore). The use of contract arrangements in Minnesota has increased

Table 4. Summary of Terms for Minnesota Contracts

| | Resource providing | Cost-plus | Formula pricing |
|---|---|---|---|
| Common to all contracts | | | |
| Producer owns buildings, equipment and land | yes | yes | yes |
| Specifies minimum % and grade A's | yes | yes | yes |
| Condemns and DOA subtracted from liveweight delivered | yes | yes | yes |
| Processor provides loading machine and labor | yes | yes | yes |
| Distinguishing characteristics | | | |
| Processor provides feed and poults | in some contracts | no | no |
| Financial disclosure required | yes | no | no |
| Contract length | 5-10 yrs. | 3 yrs. | 3 yrs. |
| Type of bird contracted | heavy toms | all | all |
| Facility requirement | confinement | none | none |
| Price determination computed from Urner Barry | no | yes | yes |
| Considers production costs | yes | yes | no |
| Market participation | no | limited | full |

significantly since the late 1970s. Prior to that time most of the turkeys in Minnesota were produced by independent growers.

Many reasons are given for initiating contract agreements. Some of them are: procurement of inputs, bearing risk, assuring markets, increasing volume, gaining economies of size, increasing efficiency, scheduling production, financing and stabilizing volume (Gallimore; Oyloe; USDA, 1965; USDA, 1985a). It appears that processors have used contracts to obtain size economies are gain efficiency, while growers were primarily interested in shifting some of the price risk to contractors.

Processors have been the major coordinators in the turkey industry (USDA, 1973). In the South Atlantic region feed firms and hatcheries have also developed some contracting arrangements. This region also has "integrators." Integrators are usually retired growers who are familiar with the turkey industry. They may coordinate several activities with the grower including financing, veterinary services, procuring feed and obtaining contract agreements with processors.

There are six firms processing turkeys in Minnesota. They are Hubbard Foods, Swift-Eckrich, Jerome Foods, West Central Turkeys, Land O'Lakes and Jennie-O Foods. These firms do the majority of the contracting in Minnesota.

Gallimore estimated that the U.S. turkey industry was 50% integrated in 1957-58 (USDA, 1965). He estimated that only 13% of the production in the West North Central region in 1961 was under risk sharing contracts. Other regions and their percentages were: North Atlantic, 4%; East North Central, 16%; South Atlantic, 36%; South

Central, 34%; and West, 39%. A risk sharing contract was defined as one which "transferred some of the production risk and most of the major decisions from the producers to the contractors" (USDA, 1965, p. 2).

Resource providing and cost-plus contracts would fit the description of risk sharing contracts as used by Gallimore. According to a survey by the University of Minnesota in 1983, those two types of contracts account for 57.5% of all Minnesota turkeys sold for slaughter. Resource providing contracts accounted for 28.6% of turkeys sold for slaughter, cost-plus 28.9% and formula pricing 32.0%. Approximately 90% of Minnesota turkeys were marketed under contract in 1983 (Eidman).

In general, contracting has a much different connotation in Minnesota than other regions of the U.S. In Minnesota contracting involves primarily independent growers who have signed a marketing agreement with a processor. The grower makes most of the decisions regarding production of turkeys.

In the South Atlantic region contracts are mainly of the resource providing type where the contractor supplies poults, feed, and makes most of the management decisions. The grower is paid on a per bird basis for his labor and facilities; the rate of payment is influenced by the grower's ability to meet certain efficiency goals.

## V. EVALUATION OF SHARING RISK AND RETURNS

One goal of this analysis is to determine how the different types of contracts influence risk and returns in turkey production. Feed costs constitute 60-70% of the production costs for turkeys; thus

variability in feed costs is a major source of risk to the producer. Turkey prices are also highly variable.

Feed costs were estimated under six sets of ingredient price assumptions. These price assumptions yielded feed costs of $.0672, $.0681, $.0756, $.0840, $.0924 and $.1008 per pound. Examination of Urner Barry prices for the past 10 years indicated that nominal turkey prices had ranged between $.48/lb. and $.94/lb. Urner Barry prices of $.50, $.60, $.70, $.80, $.90 and $1.00 were used for this analysis.

Two additional Urner Barry prices were needed to accurately show the relationship of Urner Barry price to returns to labor and management (RLM) when limited and unlimited splitting cost-plus contracts were used to market turkeys. They are the Urner Barry prices at which the splitting mechanism begins to influence grower price received and where the limiting clause limits the amount of splits received by a grower.

Recall from Table 3 that with splitting contracts, a base price and a market value are calculated. If base price exceeded market value then the base price was received regardless of Urner Barry price. At some Urner Barry price the market value will just equal base price and from that price upward the grower would receive a share of the excess. Once the excess exceeded the limit, producers with limited splitting contracts would again have their price fixed.

To obtain the Urner Barry price where the splitting occurs, one needs to equate the market value with the base price and solve for the Urner Barry price. The Urner Barry price at which the limit on splitting occurs is obtained by adding the amount of the limit to the

base price and equating that value to the market value. Table 5 shows these calculations using the assumptions from Table 3.

Returns to labor and management (RLM) for cost-plus contracts with limited and unlimited splits and for a formula price contract were calculated. Resource providing contracts were not analyzed since the RLM is constant at the amount stipulated by the contract. Exceptions may exist when premiums are paid to growers who are able to do better than the contract standards for percent grade A's, death losses or some other measure of performance. However, these premiums are not affected by the factors being examined, Urner Barry prices and feed costs.

Budgets developed at the University of Minnesota were used to calculate returns for combinations of the aforementioned feed costs and Urner Barry prices. Initially, feed cost was set at $.0672 while the Urner Barry price was varied from $.50 to $1.00. The RLM was recorded for each level of Urner Barry price. Feed costs were increased to $.0681 and the process of varying the Urner Barry price and recording RLM was repeated. The entire process was repeated until all combinations of feed cost and Urner Barry price had been budgeted for each of the contracts.

The feed cost of $.0681 was obtained by assuming that the current price for corn ($1.92/bushel) and soybean meal ($.0681/lb.) were the weighted average costs for those inputs. An estimate of maximum and minimum prices for corn and soybean meal during the past 10 years was developed by examining data reported in Ag Prices -- Annual Summary, published by the USDA. Feed costs were calculated based on these estimates of minimum and maximum values and three intermediate values

Table 5. Calculating transition prices

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Splitting clause becomes effective

Base price = market value
$.3375 = (UB 2/ - $.21) x .82

($.3375 / .82) + $.21 = UB
$.6216 = UB

Excess exceeds the limit

Base price + limit = market value
$.3375 + $.10 = (UB - $.21) x .82
(($.3375 + $.10) / .82) + $.21 = UB
$.7435 = UB

---

2/UB is Urner Barry.

of ingredient prices.

The item labeled "other cost/turkey" in Table 3 was calculated by formulas within the enterprise budgets. Assumptions for calculating turkey price were as shown in Table 3. The enterprise budgets also assumed that 80% of the turkeys would meet grade A standards with the remaining 20% being grade B. The price of grade B birds was five cents per pound less than the price for grade A's (Ford).

The budgets were used to calculate net returns based on the placement of 10,000 tom poults raised to 23 pounds with a production system which included ranging (i.e., field raising versus total confinement). Flock mortality from placement to load out was assumed by the budgets to be 7.99%. Deaths were distributed across the entire production period with higher death rates initially followed by gradual declines in the death rate (Ford). The RLM is the residual after all other costs of production have been paid. It is a return to all labor, both operator and hired.

For the first few increments of 10,000 birds all labor could likely be supplied by the owner-operator. At some point, however, labor would have to be hired to meet the needs of the operation. The residual return to all labor was calculated so it would be valid for projecting returns for larger flock sizes and would not raise the issue of operator labor fixity.

Influence of Turkey Price on RLM

The impact of various turkey prices on RLM when feed cost is $.0681/lb will be presented first. Urner Barry price quotes are used as proxy for wholesale turkey prices since they are widely accepted by

the industry. Returns to labor and management for 10,000 turkeys marketed with a formula pricing contract is -$23,700 when the Urner Barry price is $.50/lb. A return of $61,300 is achieved when the Urner Barry price is $1.00/lb. Figure 2 shows that the relationship between RLM and Urner Barry price is linear with formula pricing contracts.

Returns to labor and management is truncated at -$3000 for producers marketing their turkeys with either limited or unlimited splitting cost-plus contracts. This occurs since they both use the same method for calculating base price, and since the base price exceeds the market value as determined by the contract.3/ Returns to labor and management eventually begin to increase (become less negative) linearly with splitting contracts as the Urner Barry price increases. In Figure 2 the lines for the splitting options lie to the left of the formula price line, indicating the Urner Barry price needed to obtain a given RLM is higher for the splitting contracts than for the formula pricing contract. This phenomena can be thought of as the "cost" of having losses limited at low Urner Barry prices with the splitting contracts. A maximum RLM of $29,100 is possible with the cost-plus unlimited splitting contract when the Urner Barry price is $1.00.

Returns to labor and management trace the same path for limited and unlimited splitting contracts until the limit on splits becomes effective. From that point forward RLM is constant at approximately

3/If this is not clear, the reader should review Table 3 inserting an Urner Barry price of $.50 in the section entitled "determining market value." The calculations will yield a market value of $.2378/lb. which is less than the base price per pound of live turkey. Producers with both limited and unlimited splitting will receive $.2378/lb.

$7300 for limited split contracts while it continues to increase for unlimited split contracts. The influence of Urner Barry price on RLM for limited and unlimited splitting cost-plus contracts is also shown in Figure 2.

Graphs depicting these same relationships between the various contracts for five levels of possible feed costs are shown in Figures 7 through 11 located in the Appendix. The graphs have the same general shape for all levels of feed cost; however, their relative positions shift.

Impact of Feed Costs on RLM

Producers with formula pricing contracts are very vulnerable to yearly variations in feed costs. As feed costs increase, RLM for each level of Urner Barry price shifts to the left. The minimum RLM decreases from -$23,000 at a feed cost of $.0672/lb. to -$43,200 at a feed cost of $.1008/lb. The maximum RLM decreases from $61,900 to $41,731 for the respective feed costs.

Cost-plus unlimited splitting contracts fix the lower limit of RLM to approximately -$3,100 for all levels of feed cost. As feed costs increase, higher Urner Barry prices are needed to move RLM above this minimum and trigger the splitting clause. The higher feed costs also cause RLM to decrease for each level of Urner Barry price once the minimum return is exceeded. This is shown graphically by a leftward shift of the line depicting RLM for unlimited splitting contracts. Maximum RLM is $29,500 at low feed costs and $19,400 at high feed costs.

As was noted earlier, the limited and unlimited split contracts

trace out the same relationship between RLM and Urner Barry at low Urner Barry prices. However, once the limit on splitting is exceeded their paths diverge. As feed costs increase, the Urner Barry price at which they diverge also increases. Equivalent RLM is obtained under both cost-plus contracts for a wide range of Urner Barry prices when feed cost is $.1008. Maximum RLM is approximately $7300 for all ranges of feed costs when limited splitting contracts are used.

In general these results indicate that:

- Formula pricing risks a large potential negative return and allows the greatest potential positive RLM.
- Cost-plus contracts with unlimited splitting also allow a significant positive RLM.
- Cost-plus contracts limit potential negative RLM.
- Cost-plus contracts with limited splitting limit the potential positive returns when the split limit is reached.
- As feed costs increase, the potential maximum RLM decreases with formula pricing and cost-plus unlimited splitting contracts.
- As feed costs increase, the potential for loss with formula price contracts increases.
- As feed costs increase, the difference in potential profits between unlimited and limited split cost-plus contracts decreases.

## Urner Barry Price Probabilities

Thus far the discussion has concerned how RLM is influenced by Urner Barry prices and type of contract when feed costs are known. It has been shown that the cost-plus contracts significantly reduce the risk of negative returns, particularly at the upper ranges of feed costs. What is unknown is the probability associated with low Urner Barry prices and negative RLM.

The Index of Prices Paid by Farmers, Items Used for Production was

used to deflate the nominal Urner Barry prices to 1986 levels (USDA, 1987). The 10-year history of Urner Barry prices was felt to be too short to use standard statistical techniques for forming a price distribution so a triangular distribution is used instead. A triangular distribution is a method for estimating subjective probabilities when the absence of distributional information or the cost of obtaining such information relative to the potential benefits limits the amount of data available. It involves specifying three events: the lowest, most likely, and highest prices that may occur (Olson).

The average annual deflated Urner Barry price for the 10 years was $.7017 with a maximum of $.8786 occurring in 1978 and a minimum of $.5838 occurring in 1983. These values were used as estimates of the most likely price, the lowest price, and the highest price, respectively. A histogram of the distribution, estimated by the triangular distribution method, is shown in Figure 3.

This histogram of Urner Barry prices allows more complete analysis of the risk characteristics associated with various contract arrangements. This price distribution was combined with cost and other data and used as input into the Agricultural Risk Management Simulator (ARMS).

The Agricultural Risk Management Simulator (ARMS) is a microcomputer program that evaluates strategies for managing the risks associated with uncertainty about enterprise yields and output prices. ARMS evaluates management strategies by budgeting their annual net cash flows under a specified number of possible yield and price

combinations; and summarizes the results of this analysis in a way that helps in the comparison of strategies (King).

Since ARMS was designed for crop farming, some adjustment of the data was needed. For this analysis three strategies were designated: production of turkeys under a formula pricing contract, production under a cost-plus contract with unlimited splitting, and production under cost-plus contracts with limited splitting. Interest charges (as determined by the University of Minnesota enterprise budget) were entered as the variable cost of growing turkeys under each contract. The remaining expenses from the enterprise budget discussed earlier, with the exception of labor, were designated as an overhead expense of the farm. Labor costs were excluded so that this analysis would show how Urner Barry price probability would influence the distribution of RLM.

Prices and output were stated in terms of hundredweights of live turkey. Output reflected the death losses stated earlier and was designated as a constant amount known with certainty. The Urner Barry price distribution data was used to formulate and structure price probabilities. Each Urner Barry price was transformed by the formulas of Table 3 into a corresponding effective price received by growers. These effective prices for each contract strategy were assigned their corresponding Urner Barry probability from Figure 3 and entered into ARMS. ARMS then randomly drew 250 price-output combinations from the price and output distributions (output was constant).

Given enterprise and overhead cost data and a set of management choices, net cash return to labor and management can be calculated for

each of a large combination of output and price combinations. The resulting net cash return levels can then be used to construct a sample distribution of the RLM (King). The RLM cumulative distribution function obtained using this procedure when feed cost is $.0681 is shown in Figure 4. Figure 4 contains all the information of Figure 2, but shows how the probability associated with Urner Barry prices influences RLM.

This distributional information makes possible the estimation of the probability that RLM will fall below a given level for the various contracts. The procedure to estimate the probability that RLM will fall below a given level has three steps:

1. Determine which contract and which level of RLM is to be examined.
2. For that contract, find the point on the RLM line which equals the value under consideration.
3. Read the value on the vertical axis corresponding to the point on the RLM line. This is the probability, expressed as a decimal, that RLM for this contract will fall below the specified level of RLM.

Since one is the maximum value attainable, then it follows that one minus this value (1-x) is the probability that RLM will exceed the stated level.

As an example, suppose we are interested in the probability that RLM will fall below zero for each of the contracts. Reading the value on the vertical scale at which the RLM for formula pricing contracts is zero yields a value of approximately .19. 4/ Thus there is a 19% chance that RLM will fall below zero for the formula pricing contracts.

4/The dashed lines of Figure 4 indicate where each of the probability estimates were measured.

The two cost-plus contracts have a .25 probability of negative returns. Conversely, the probability of positive RLMs is .81 (1-.19) and .75, respectively.

There is approximately an 8% chance that RLM for formula pricing contracts will be lower than the minimum RLM provided by either of the cost-plus contracts. This probability is observed at the point where the RLM line for cost-plus contracts crosses the RLM line for formula pricing contracts.

Approximately 68% of the time both cost-plus contracts will provide the same RLM. Therefore, there is a probability of .32 that cost-plus contracts with unlimited splitting will have a RLM exceeding the maximum obtainable with limited splitting contracts. Formula pricing contracts have .55 probability of exceeding the maximum RLM obtained with limited splitting contracts. Formula pricing contracts will exceed the maximum RLM of unlimited splitting contracts 30% of the time. Figures 12 through 16 show RLM cumulative distributions for the other feed costs analyzed and can be found in the Appendix.

Table 6 shows how these probabilities change as feed costs increase. The probability of formula price contracts providing a return smaller than the minimum level provided by the cost-plus contracts increases from .08 with a feed cost of $.0672/lb. to .66 as feed costs increase to $.1008/lb. Formula pricing and cost-plus contracts have much higher probability of providing a return less than zero when feed costs increase. The probability that unlimited splitting cost-plus contracts will have an RLM greater than the limited split contracts diminishes to almost zero at feed costs of $.1008/lb.

Table 6. Percent probability that specified RLM relationships will occur as feed costs increase

| | Formula price < minimum cost-plus | Formula price < 0 | Cost-plus < 0 | Unlimited split > maximum limited split | Formula price > maximum limited split | Formula price > maximum Unlimited split |
|---|---|---|---|---|---|---|
| Feed cost/lb. | | | | | | |
| $.0672 | 8 | 19 | 24 | 32 | 57 | 30 |
| $.0681 | 8 | 19 | 25 | 32 | 55 | 30 |
| $.0756 | 27 | 42 | 51 | 25 | 40 | 27 |
| $.0840 | 40 | 48 | 54 | 13 | 36 | 24 |
| $.0924 | 55 | 62 | 69 | 5 | 23 | 15 |
| $.1008 | 66 | 71 | 78 | 1 | 15 | 11 |

A significant decrease also occurs in the probability that RLM from a formula price contract will exceed either of the cost-plus contracts.

Evaluation Using Stochastic Dominance

The RLM cumulative distribution functions allow one to use stochastic dominance criteria to determine which type of contracts certain producers will prefer. First degree stochastic dominance rests on the very reasonable assumption that decision makers prefer more to less. For two choices F and G, F dominates G by first degree stochastic dominance if the cumulative probability (on the vertical axis) of F at all outcomes (on the horizontal axis) is less than or equal to the cumulative probability of G, with the inequality holding for at least one outcome level (Boehlje and Eidman).

Consider unlimited splitting contracts in Figure 4 to be choice F and limited splitting contracts to be choice G. The cumulative probabilities for both contracts are equal for all outcomes less than approximately $7300. Above that level, the cumulative probability for unlimited splitting contracts is less than the cumulative probability for limited splitting contracts. Unlimited splitting contracts dominate limited splitting contracts by first degree stochastic dominance; thus, based on the assumptions used, cost-plus contracts with unlimited splitting are preferred to those with limited splits.

When formula price and unlimited splitting contracts are compared we find that the cumulative distribution functions cross. Unlimited split contracts have less probability of RLM falling below -$3000; however, the cumulative probability of formula price is less than that of unlimited splitting for all levels of RLM greater than -$3000. In

this case neither choice dominates by first degree stochastic dominance. When cumulative distribution functions cross, second degree stochastic dominance may be useful in making decisions.

Second degree stochastic dominance also assumes decision makers prefer more to less, but it also assumes they are risk averse. Given two actions F and G, F is preferred to G by all decision makers who are risk averse if the area under the cumulative distribution function of F never exceeds and somewhere is less than the area under the cumulative distribution function of G (Boehlje and Eidman).

Figure 5 is a replica of Figure 4 and will be used to evaluate the application of second degree stochastic dominance to the formula price and cost plus unlimited splitting contracts. This figure shows the areas under the formula price and cost-plus unlimited splitting cumulative distribution functions. The area which is double hatched is common to both cumulative distribution functions and therefore does not influence the grower's contracting decision.

Let's assume choosing cost-plus unlimited splitting contracts is action F and choosing formula pricing contracts is action G. The difference in area under the cumulative distribution functions can be seen by considering areas 1 and 2 in Figure 5. Since area 2 clearly exceeds area 1, then the area under F (cost-plus unlimited splitting) is larger than that of G (formula pricing). However, for reasons explained in the next paragraph, neither contract is dominant by second degree stochastic dominance when feed costs are $.0681. 5/

5/See Michael D. Boehlje and Vernon R. Eidman, Farm Management (New York: John Wiley and Sons, 1984), pp. 460-71, for a full discussion of second degree stochastic dominance. Also contained in this reference is the formula used to calculate the area under a cumulative distribution function and an example of its use.

A necessary condition for one distribution to dominate another by first or second degree stochastic dominance is that its mean not be less. A second necessary condition is that the smallest value of a dominated distribution (Anderson). The calculated means of the RLM distributions are shown in the legend of each figure. Formula pricing has a higher mean than unlimited splitting for feed costs less than $.0924/lb., thus satisfying the first necessary condition. An inspection of the RLM distributions for the two contracts reveals that for each of these feed costs below $.0924/lb. formula pricing has some values which are smaller than unlimited splitting. The second necessary condition is not fulfilled and therefore no ranking of these contracts can be made by stochastic dominance. However, when feed costs exceed $.0924/lb. area 1 will exceed area 2 and unlimited splitting contracts will be preferred to formula pricing contracts.

Impact on Technological Adoption

Thus far our attention has focused on examining the role of contracting in sharing risk and returns. Another area of interest is the potential effect of the various contract types on technology adoption.

With formula price contracts the producer bears all of the production and price risk; he also makes all the management decisions. The market price provides the incentive to producers to adopt new technology and improve efficiency. It also guides his planning decisions with regard to when changes should be made in the method used to produce turkeys.

Cost-plus contracts with unlimited splitting transfer some of the

risk of low prices to the processor-contractor. In return the processor receives some of the upside potential. The producer still bears the production risk and makes management decisions. As was noted previously, cost-plus contracts with limited splitting are generally effective for a longer time period than those with unlimited splits. They again limit the downside price risk to producers. Some potential for profits is forfeited to the processor in return for the long-term promise to reduce losses.

It is possible that technological adoption would be delayed with a cost-plus contract. The grower would bear all the cost associated with the new technology yet would only receive a portion (50% in the example) of the marginal revenues generated by the technology. Thus the payoff of adopting a new technology would have to be higher with a cost-plus contract than with formula pricing or other full market participation arrangements. However, processors could encourage the use of a particular technology in the contract. If a new technology reduced production costs, processors could "force" the adoption of technology by a downward adjustment of the allowance for expenses used to calculate the guaranteed base price. For example, suppose a more energy efficient method of heating turkey barns was developed. When contracts are renewed, the processor could decrease the portion of "other cost/turkey" in Table 3 which is attributable to heating expenses. Producers who signed these contracts would face an increased risk of negative RLM at low Urner Barry prices unless they adopted the technology.

Resource providing contracts transfer many of the production

decisions to the processor. These contracts give the processor the leverage needed to stimulate technological adoption by the growers. The producer's returns are derived from the profit margin stipulated in the contract and are not influenced by the market price. This is why they are called "no market participation" contracts. The market price does not influence the grower's decision to adopt technology since it is essentially insulated from market price movements.

## VI. CONSIDERATIONS FOR INITIATING CONTRACTS IN OTHER INDUSTRIES

Industry volatility and the risk attitudes of the agents involved may be important factors when evaluating adoption of contracting to other areas of agriculture. Figure 6 shows nominal and deflated Urner Barry prices from 1977 to 1986. The trend is indicative of a boom-bust industry. During the lean years of the early 1980s many producers first made use of contracting arrangements to market their turkeys. Figure 6 shows that over the past 10 years inflation adjusted Urner Barry prices were at their lowest point during that time period. Furthermore, the stochastic dominance discussion in the previous section indicates that risk averse decision makers would choose to market their birds with a cost-plus type contract, especially if feed costs were greater than $.0924/lb.

In the past, turkey prices and production had a distinct seasonal price and production pattern. What role does the seasonality of production and prices play in contracting decisions? Useful insights in this area could possibly be gained by examining the fruit and vegetable markets.

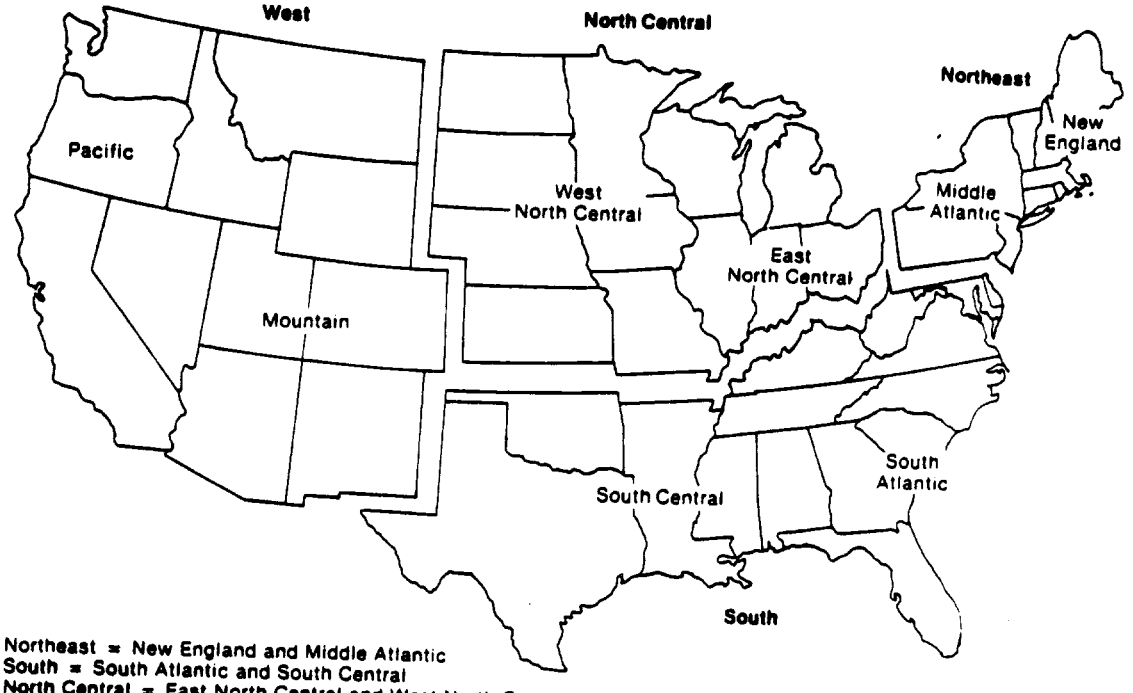
Size economies and improved efficiency were listed as reasons

processors entered contractual agreements in the turkey industry. Would contracts benefit processors in other segments of agriculture in a similar manner, or would contracts offer some other benefit?

Roy discusses contract farming in two of his books (Roy, 1963; Roy, 1972). He cites work which proposes several characteristics that favor integration and examines seven enterprises for the presence of those factors. It is interesting to note that three of the enterprises (broilers, turkeys, and eggs) which have several characteristics favoring integration have been substantially integrated since 1957 when the characteristics were originally proposed.

# APPENDIX

Figure 1. Poultry Production-Marketing Regions




Northeast = New England and Middle Atlantic
South = South Atlantic and South Central
North Central = East North Central and West North Central
West = Mountain and Pacific (excluding Hawaii and Alaska)

(Source USDA 1985A)

Figure 2. Returns to Labor and Management per 10,000 Turkeys Sold Under Contract When Feed Cost is $.0681/lb.

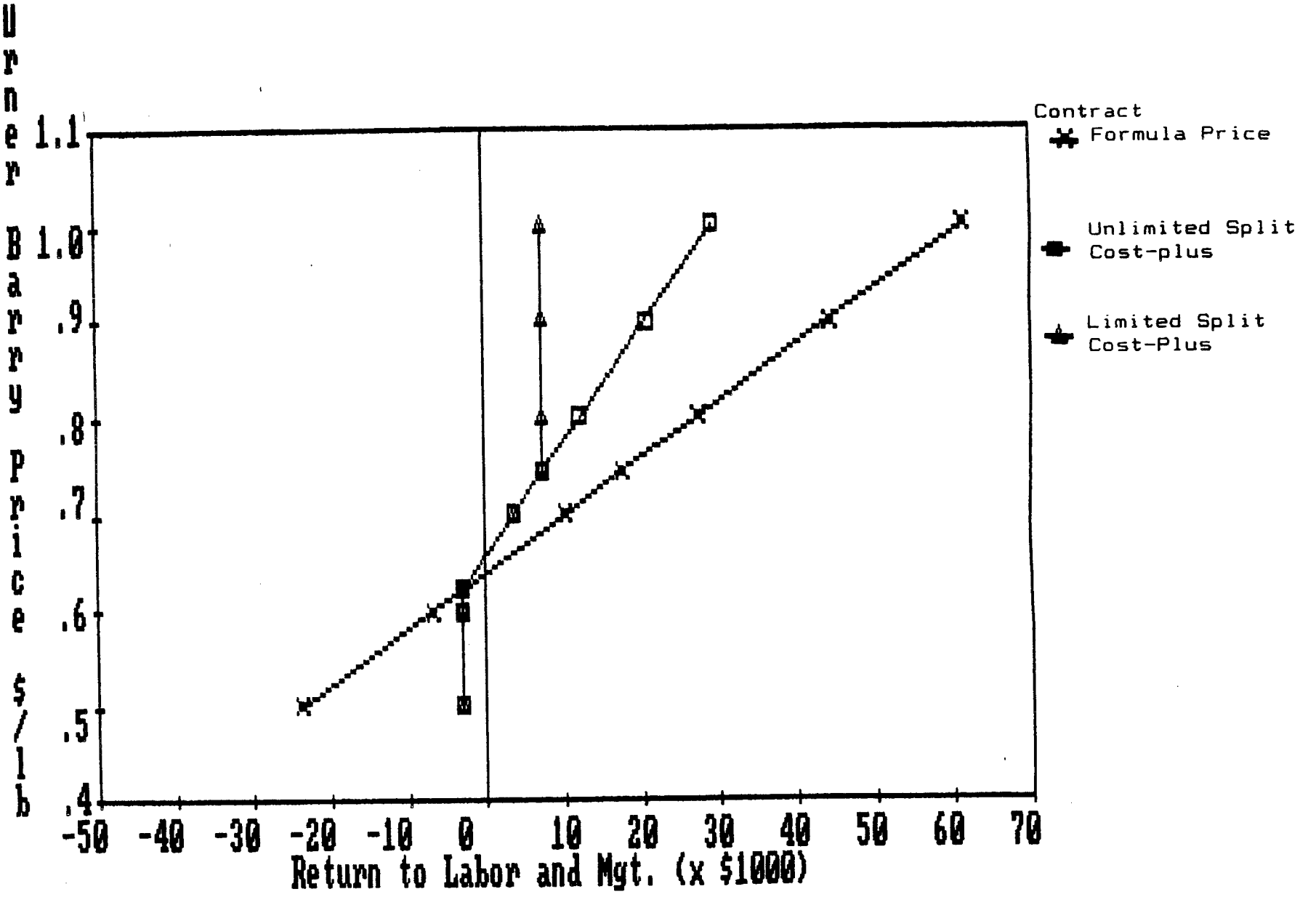


**Figure 3.** Histogram of Urner Barry Prices.

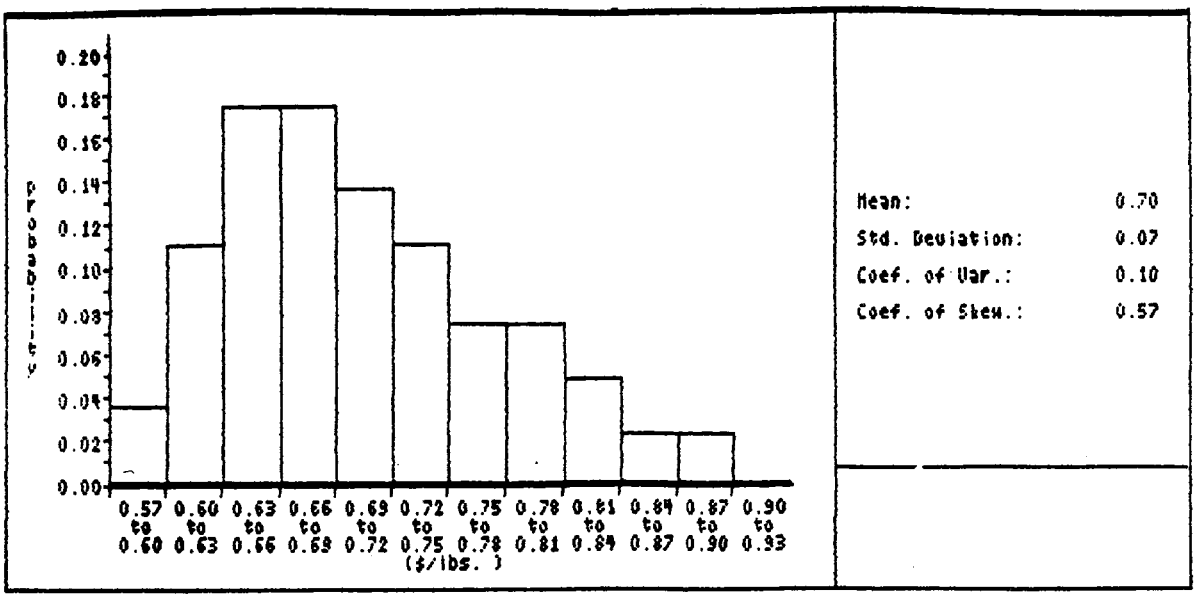


Figure 4. RLM Cumulative Distribution Function
When Feed Cost is $.0681/lb.

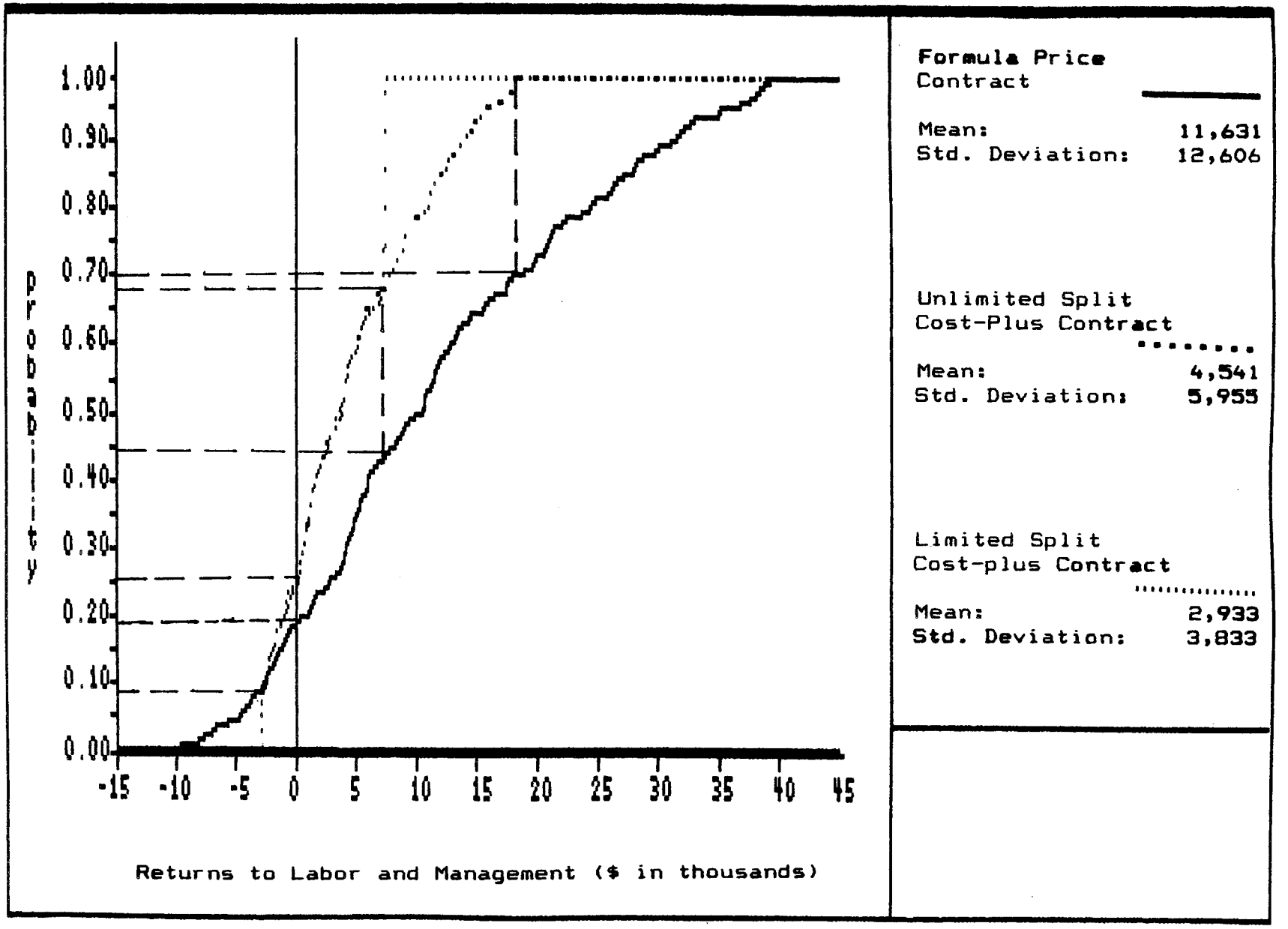


Figure 5. RLM Cumulative Distribution Function When Feed Cost is $.0681/lb.

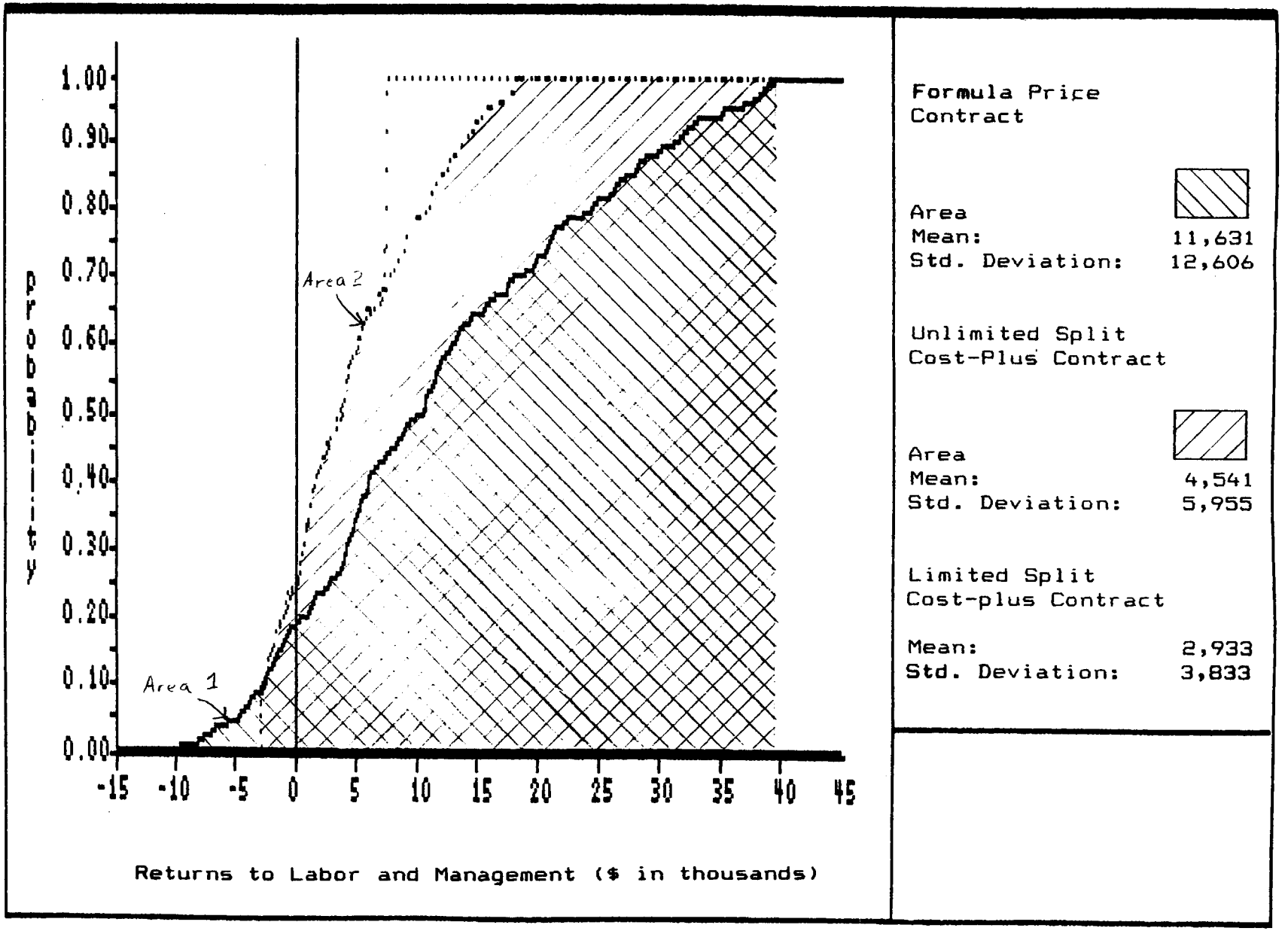


**Figure 6. Nominal and Deflated Yearly Average Urner Barry Prices for 1977 to 1986 (1986=100)**

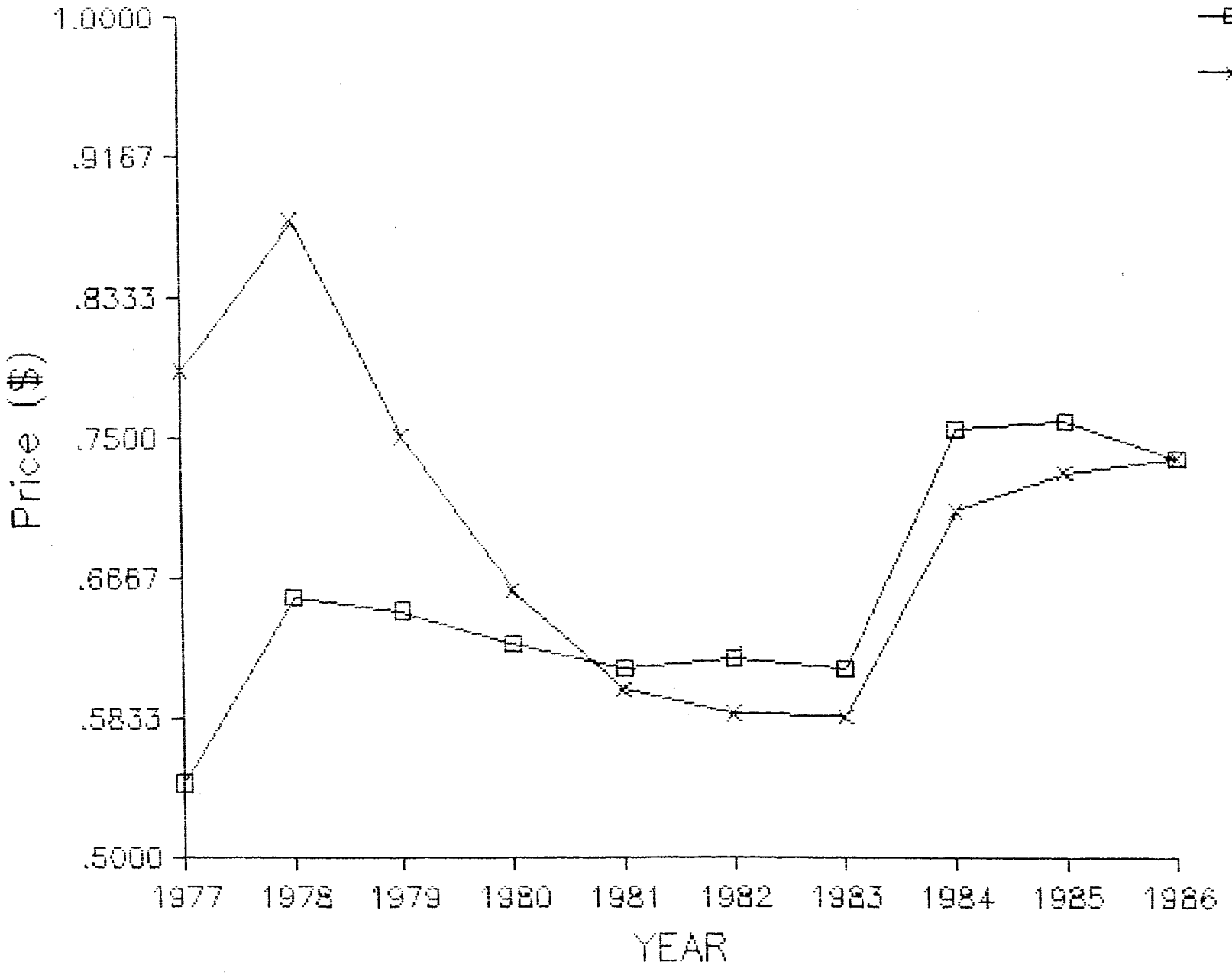


Figure 7. Returns to Labor and Management per 10,000 Turkeys Sold Under Contract When Feed Cost is $.0672/lb.

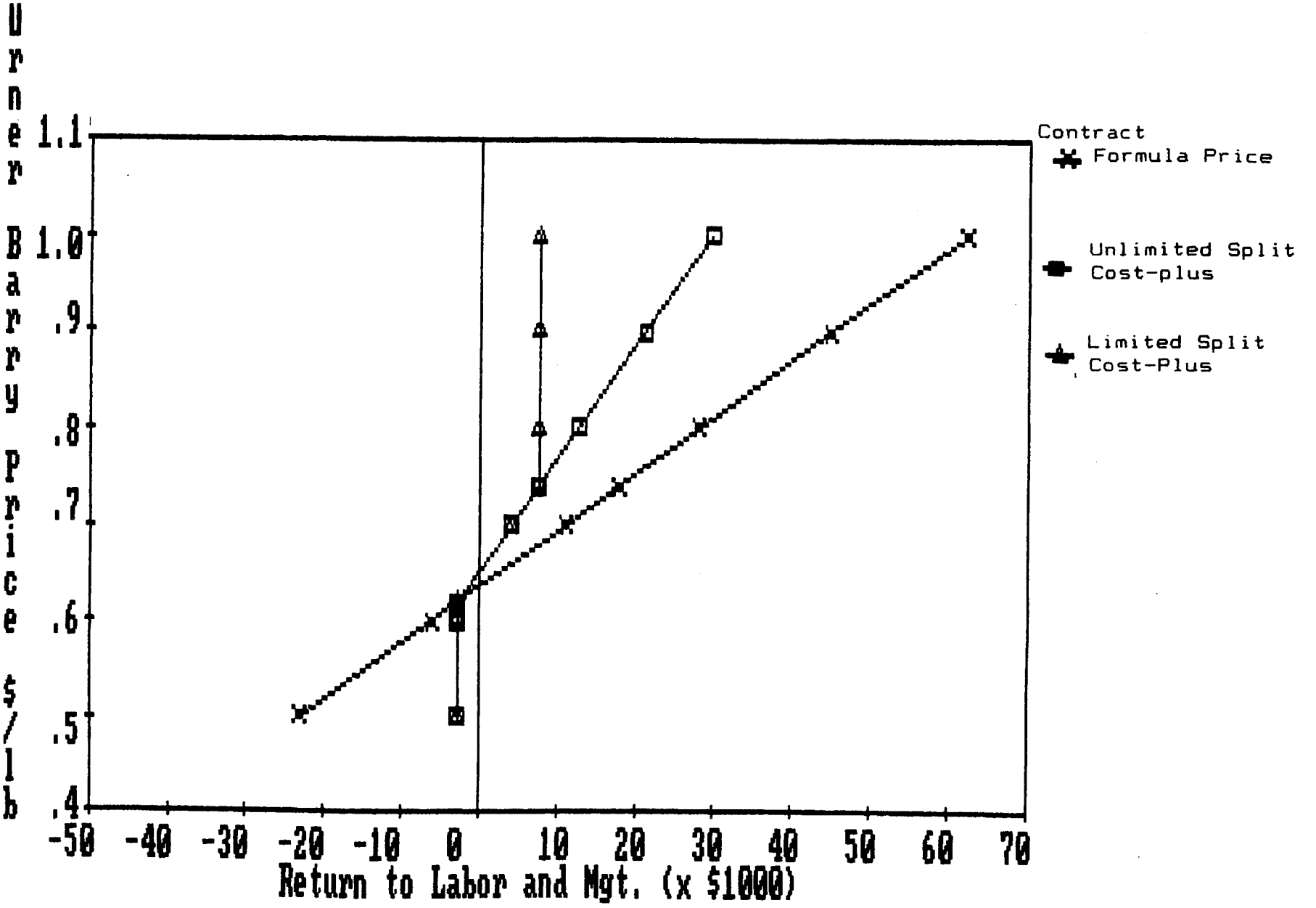


Figure 8. Returns to Labor and Management per 10,000 Turkeys Sold Under Contract When Feed Cost is $.0756/lb.

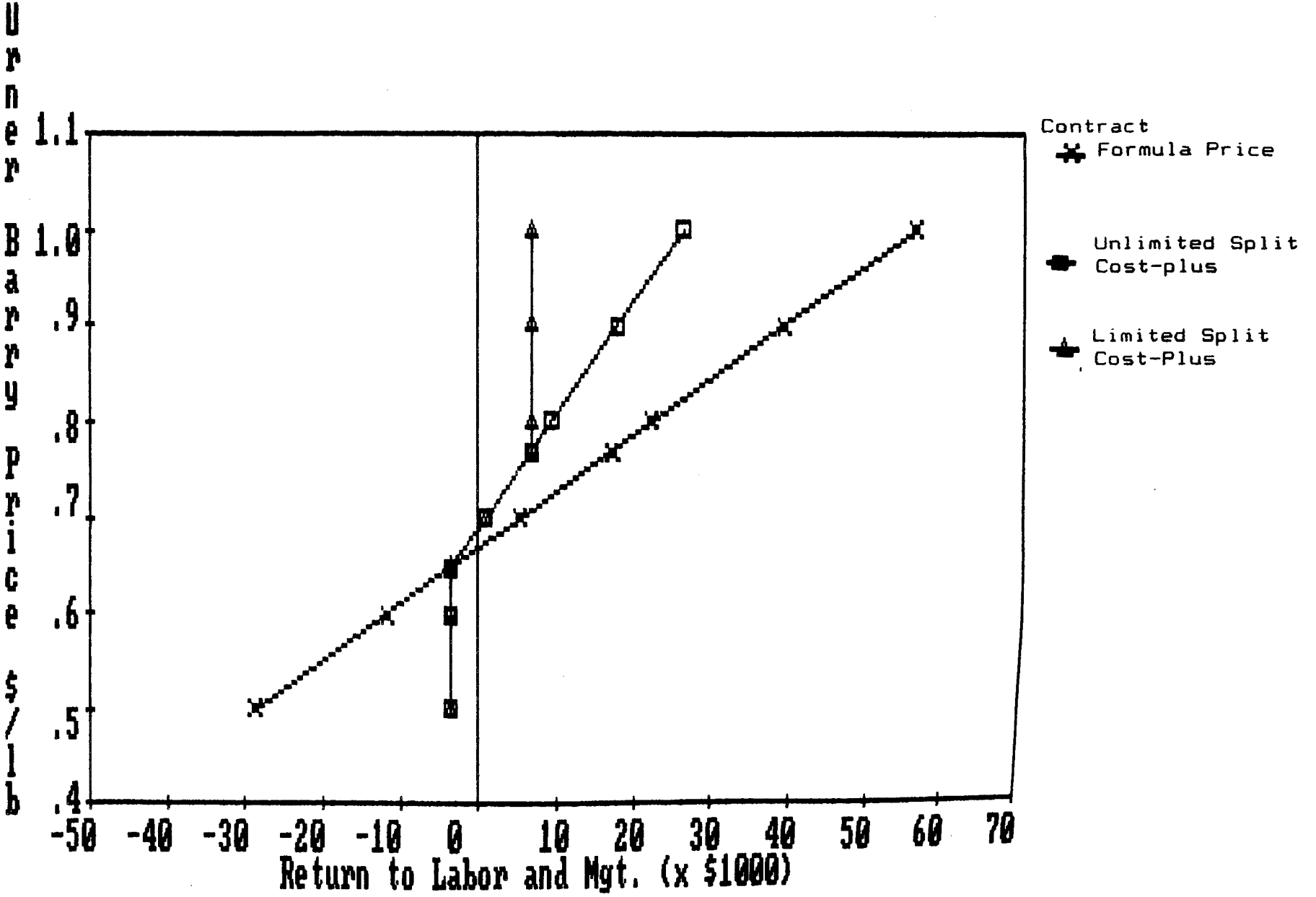


Figure 9. Returns to Labor and Management per 10,000 Turkeys Sold Under Contract When Feed Cost is $.0840/lb.

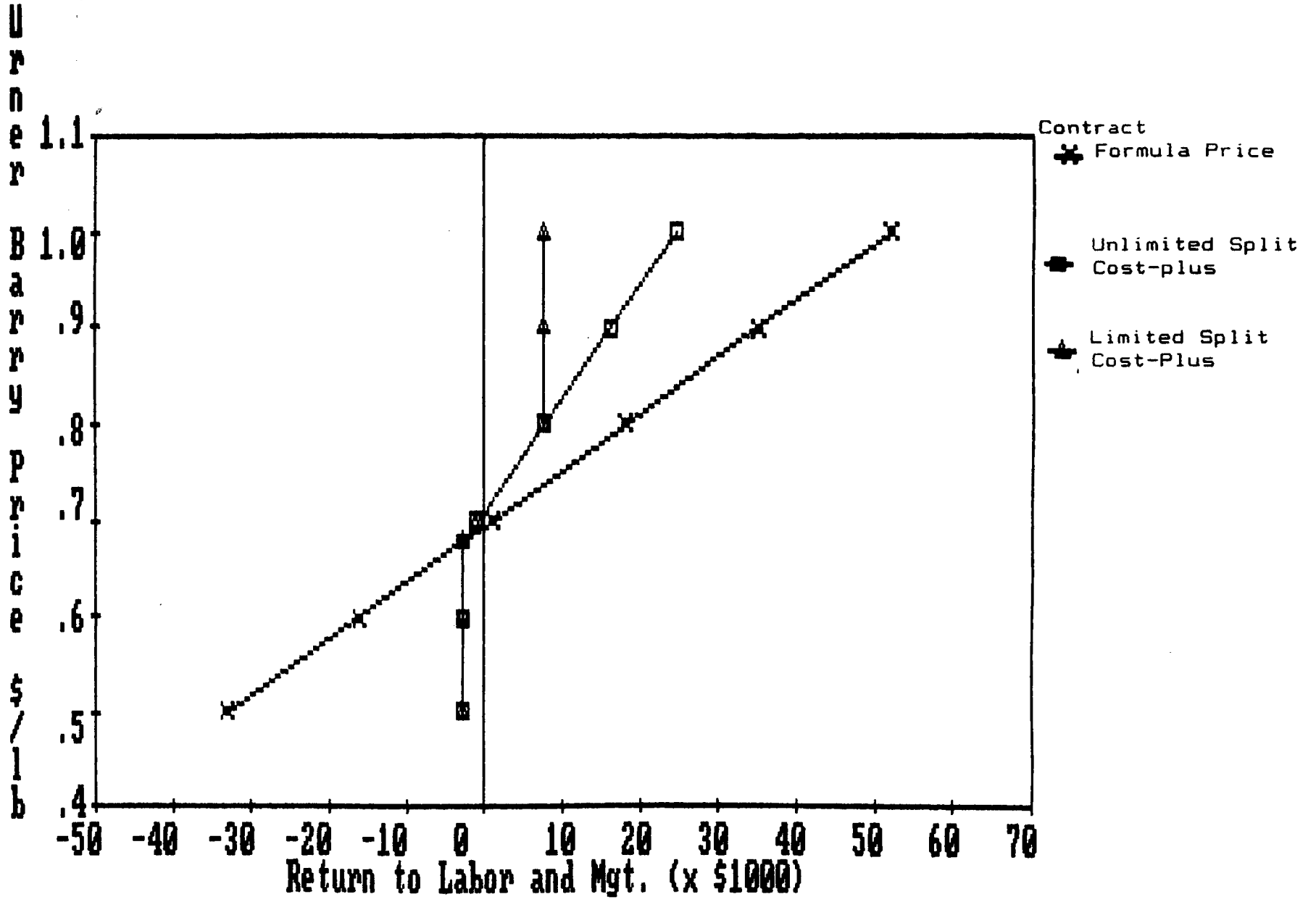


Figure 10. Returns to Labor and Management per 10,000 Turkeys Sold Under Contract When Feed Cost is $.0924/lb.

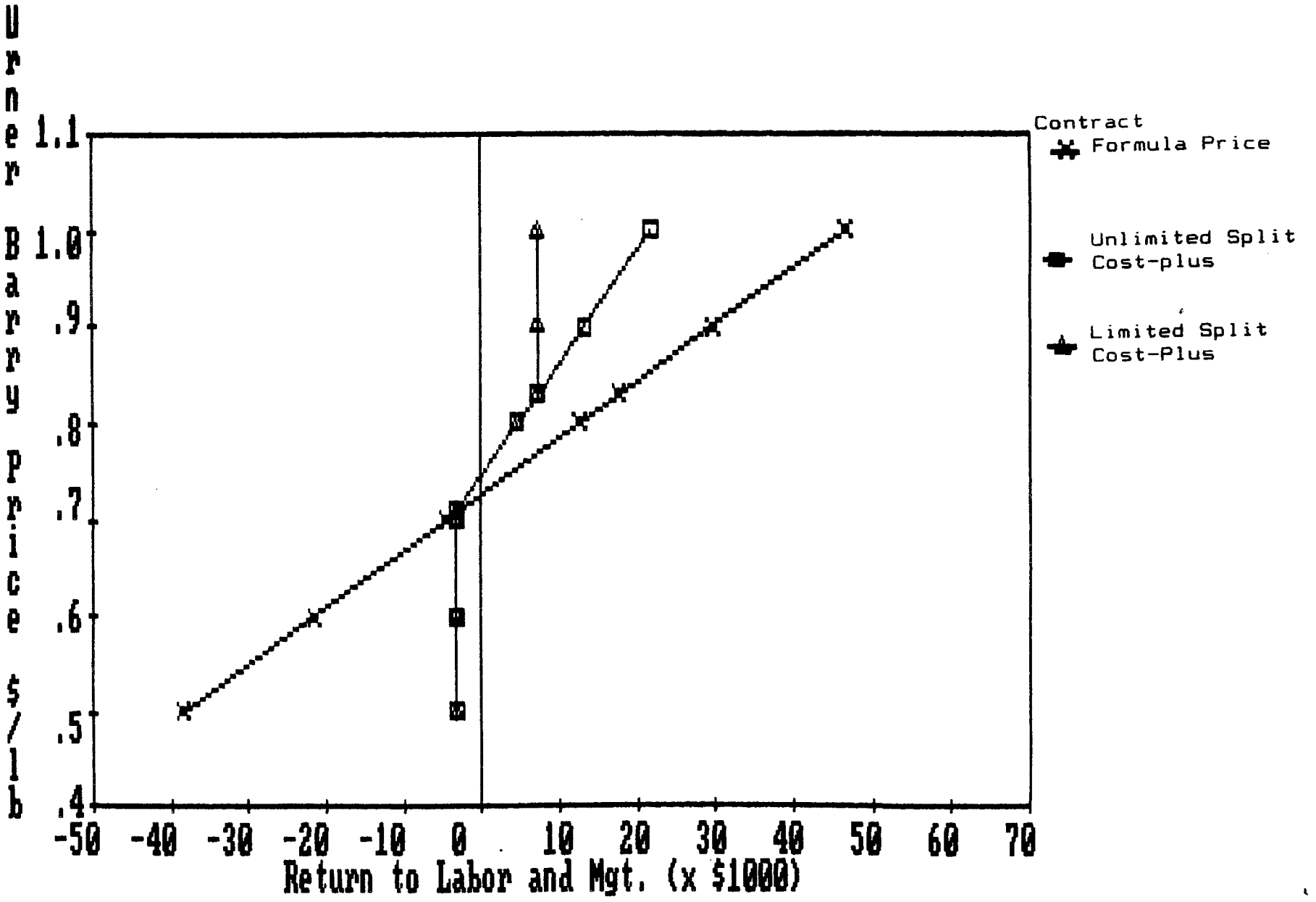


Figure 11. Returns to Labor and Management per 10,000 Turkeys Sold Under Contract When Feed Cost is $.1008/lb.

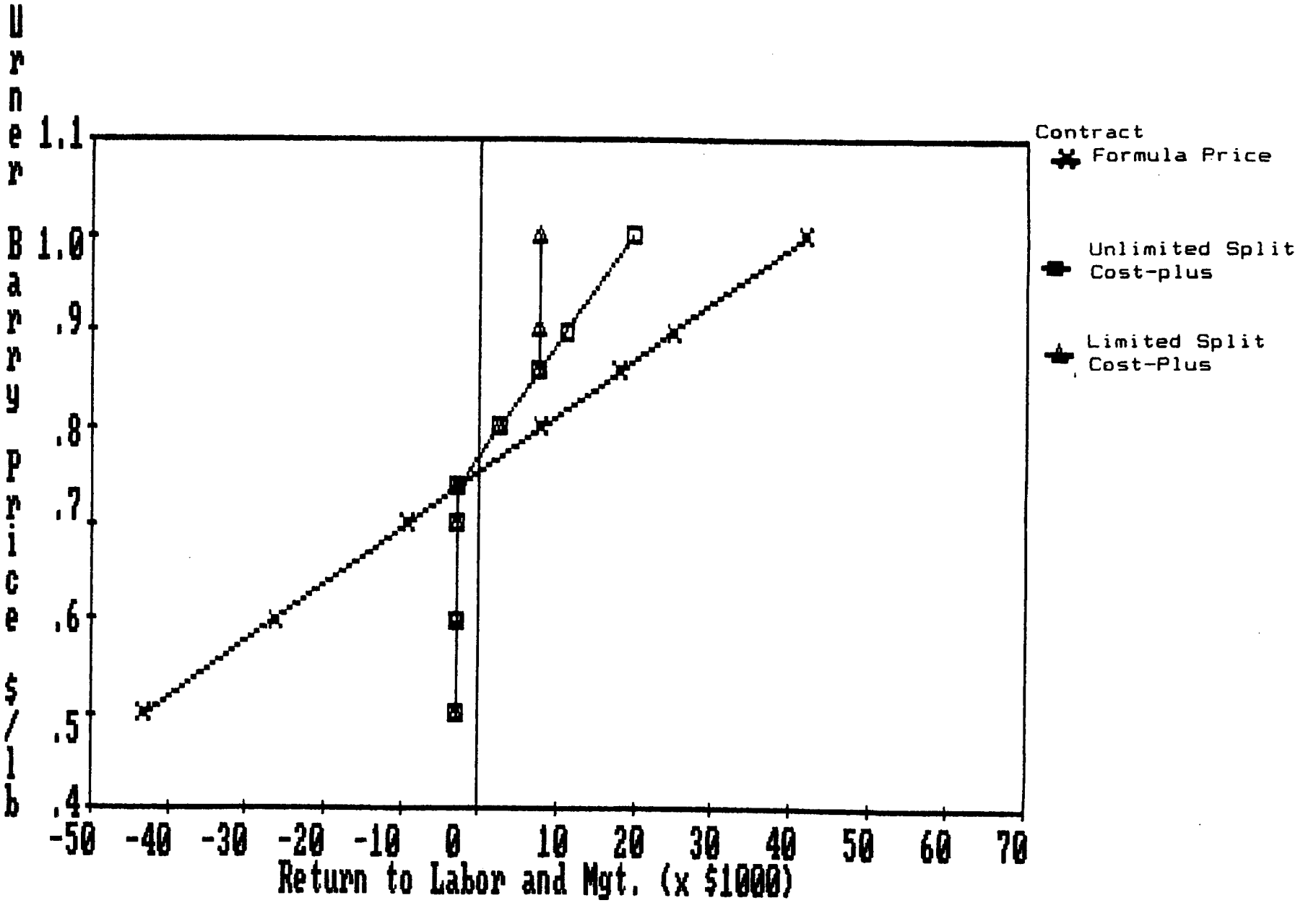


Figure 12. RLM Cumulative Distribution Function When Feed Cost is $.0672/lb.

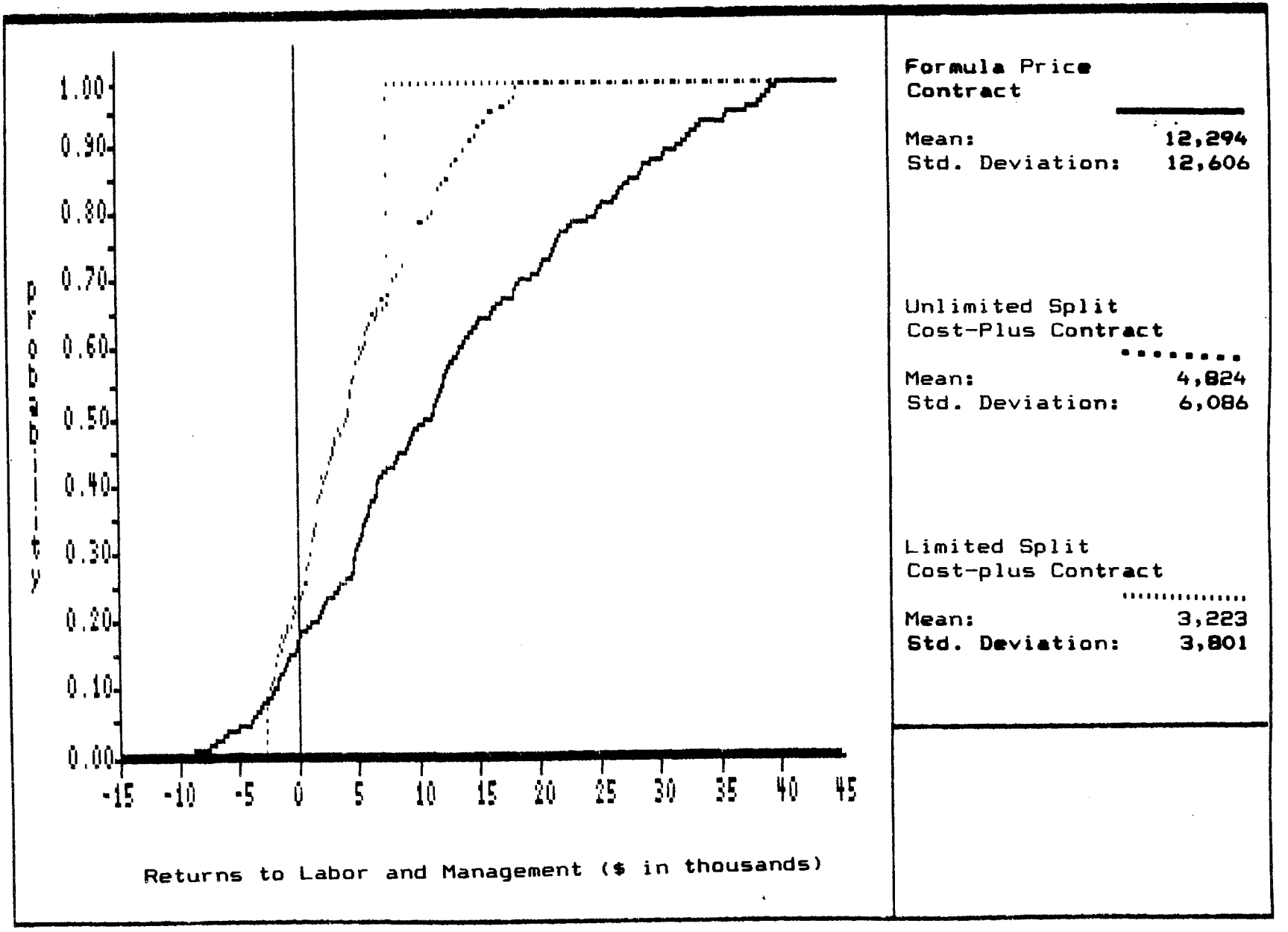


Figure 13. RLM Cumulative Distribution Function
When Feed Cost is $.00756/lb.

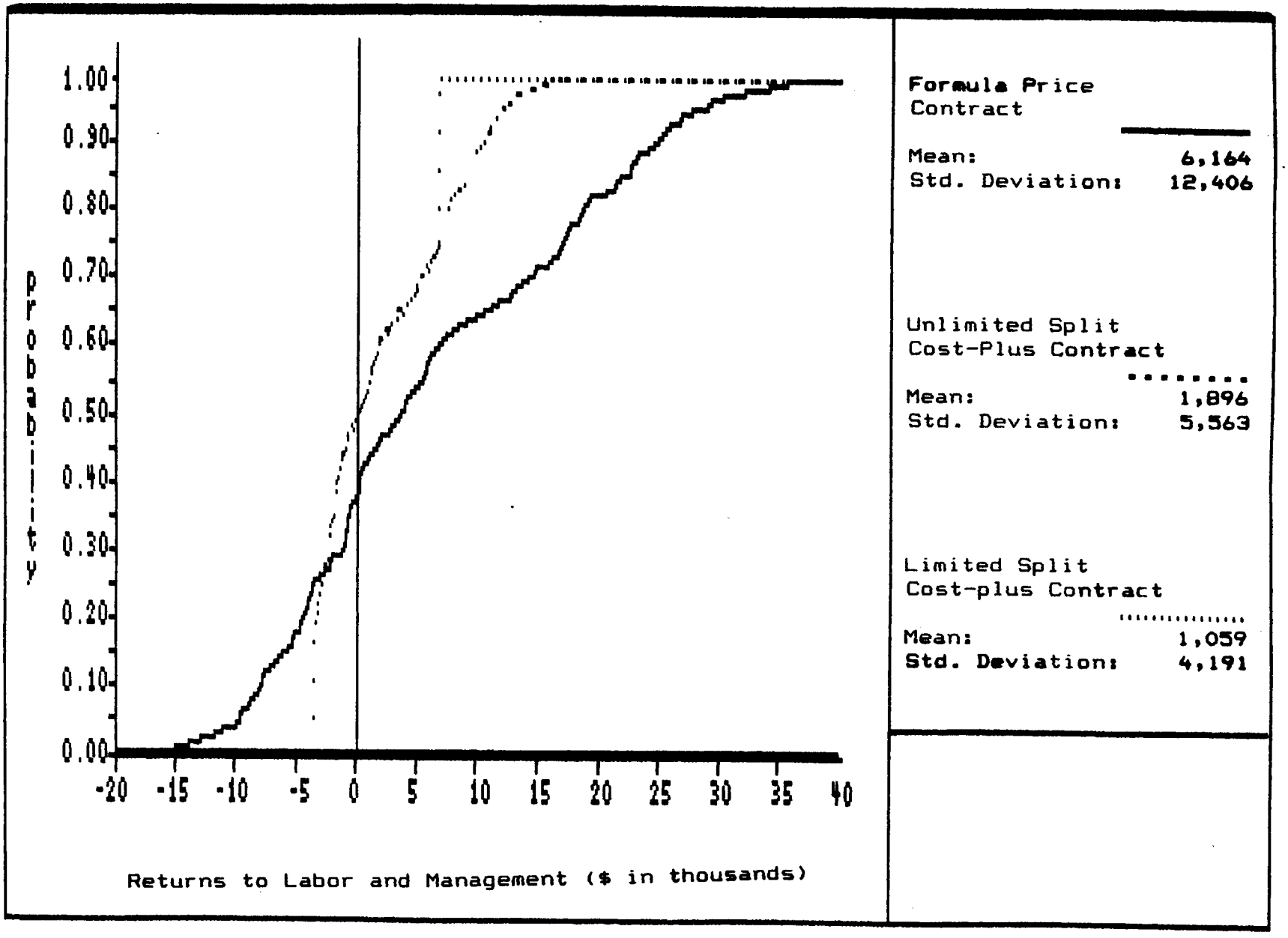


Figure 14. RLM Cumulative Distribution Function
When Feed Cost is $.0840/lb.

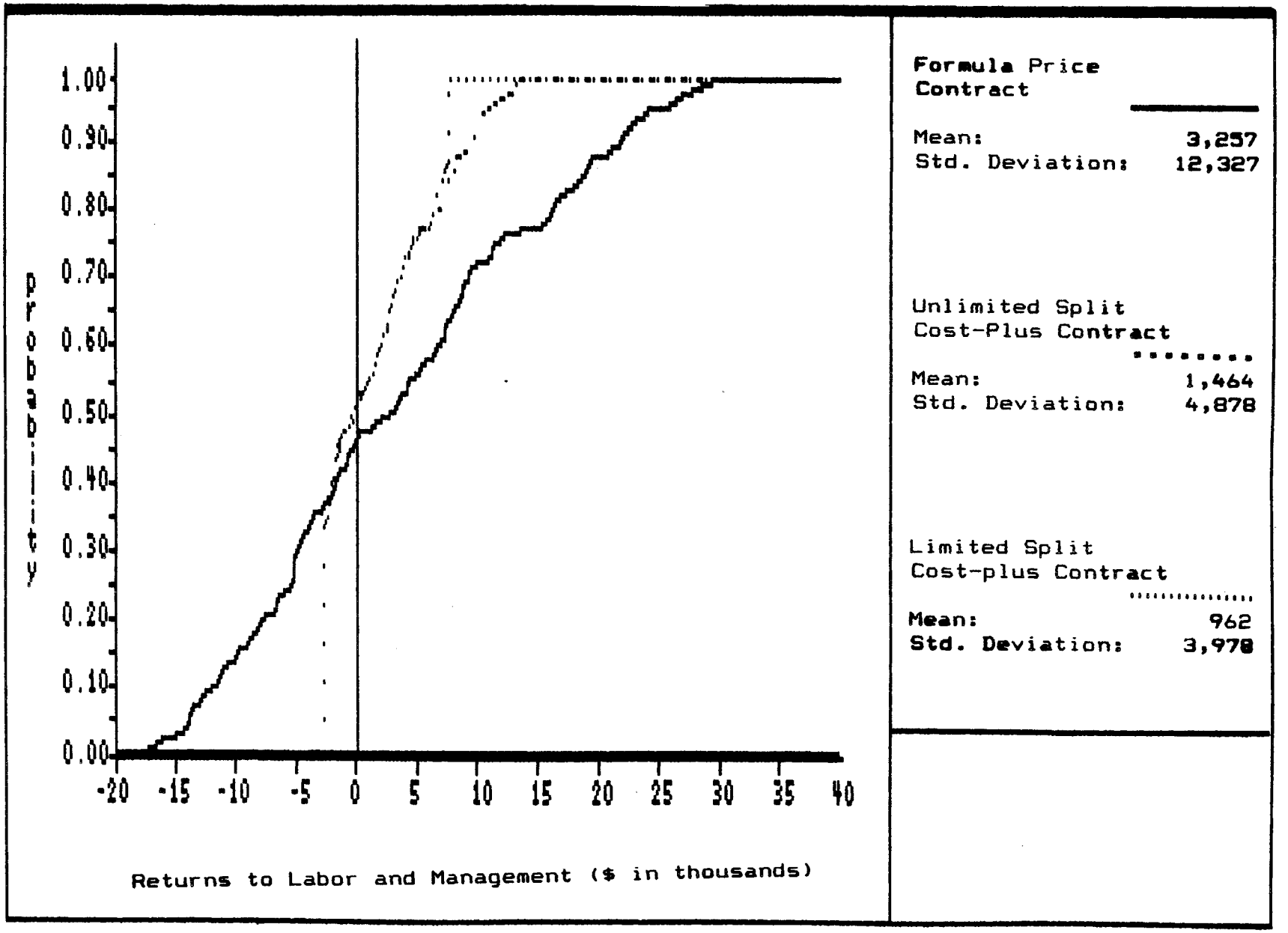


Figure 15. RLM Cumulative Distribution Function
When Feed Cost is $.0924/lb.

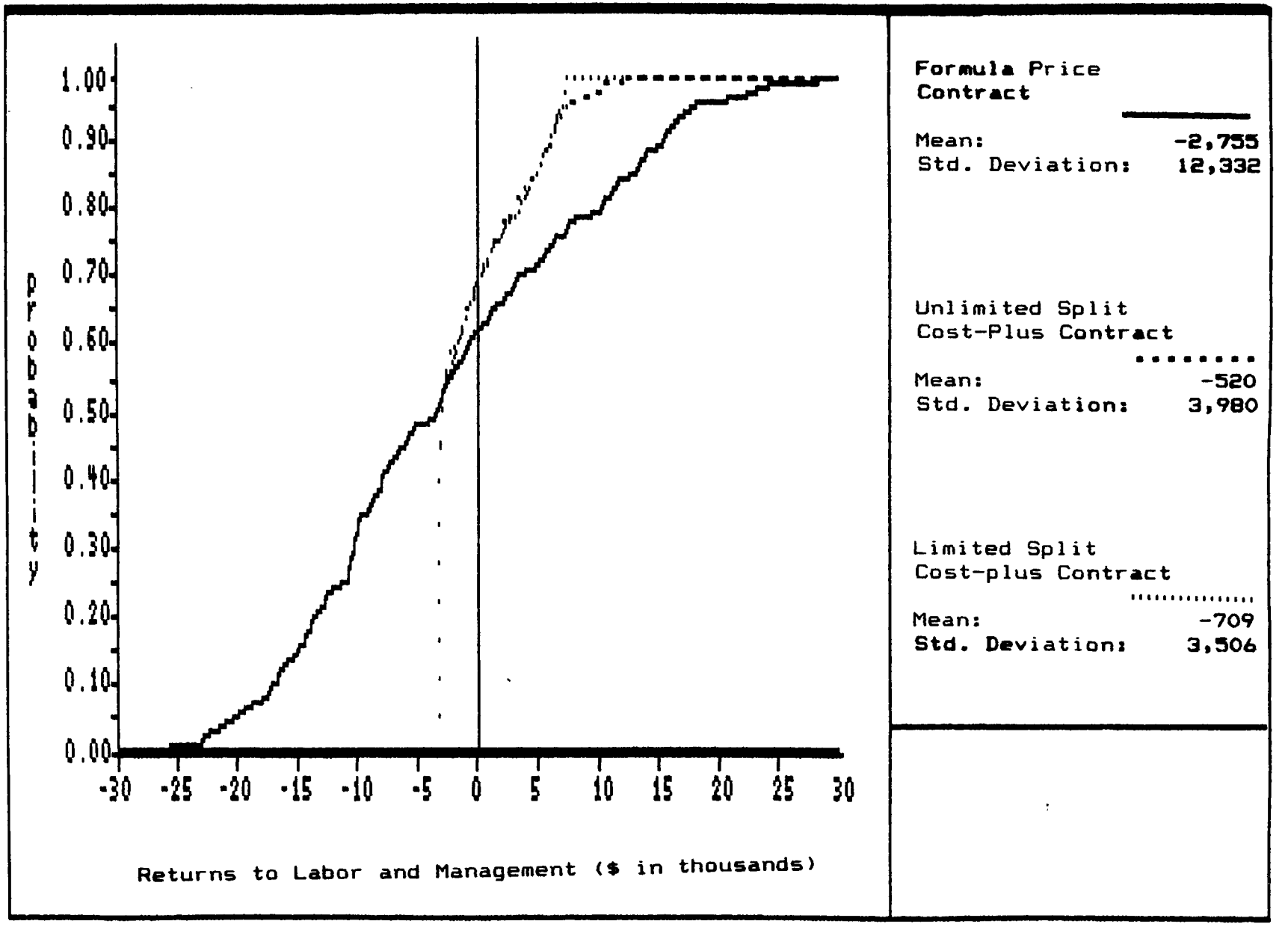
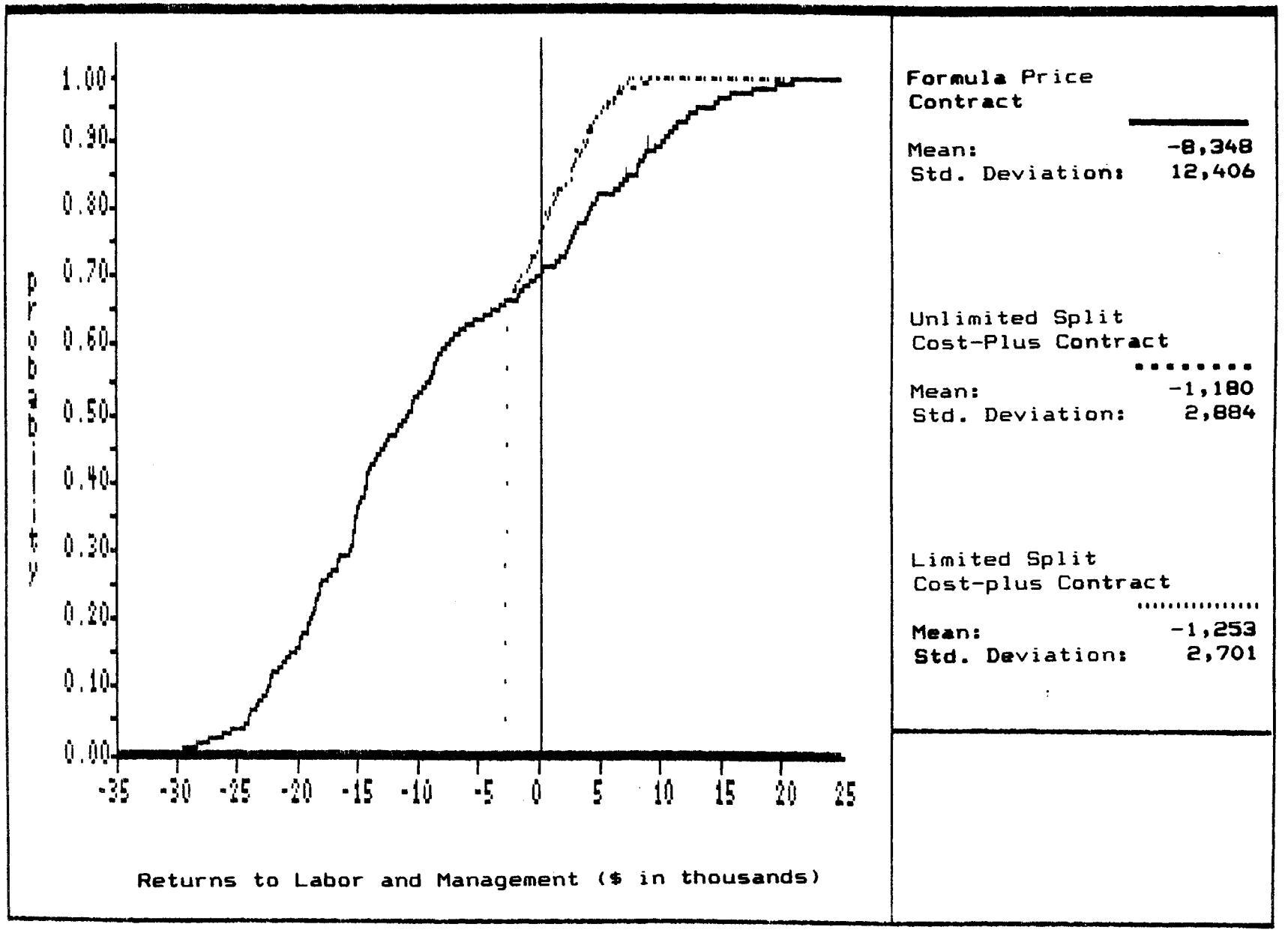


Figure 16. RLM Cumulative Distribution Function
When Feed Cost is $.1008/lb.



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