CROP YIELD UNCERTAINTY: ISSUES FOR NEW GENERATION COOPERATIVES

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ABSTRACT

This paper examines issues for cooperatives raised by the inherent variability in agricultural crop production. Volume-based contracts between growers and their cooperatives, and cooperatives' investment and operating decisions are discussed in the context of supply channel management systems emerging in food and fiber production systems.

INTRODUCTION

Food and fiber production and distribution systems are in the midst of dramatic changes. The opportunities and challenges will be available to both traditional and New Generation Cooperatives (NGCs). With their emphases on volume-based contracts, specialized processing capacity, and demand driven coordination (discussed below), NGCs can be seen as responses to changes taking place in food and fiber systems. Broadly, these systems are adjusting to: (1) new developments in production practices from biotechnology and precision farming technology; (2) increasing globalization of markets and production; and (3) consumer driven changes such as buying patterns, nutrition, and food safety issues. Vertical integration through ownership and contracts,[1] strategic alliances, and increasingly sophisticated information processing capability are facilitating implementation of industrial sup-

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[1] See Rachael E. Goodhue, *Input Control in Agricultural Production Contracts*, 81 AM. J. AGRIC. ECON. 616 (1999), for analysis of production contracts.

ply channel management concepts.[2] Overall, the changes imply increasing, customer-oriented coordination between stages in vertical production-marketing systems.[3] Agricultural producers and agribusinesses will face traditional risks such as yield variability due to inherent biological and physical characteristics of plant and animal production, market and price risks, and financial risks. Importantly, there will be new types of risks from relationships with partners and customers in supply channels.[4]

This paper focuses on how crop yield variability affects NGC grower-members and their cooperative businesses in the context of vertical supply systems. A number of NGCs have formed in recent years, but it is too soon to generalize from the limited experiences to date. Rather, this paper identifies issues relevant when yields are higher-than-normal versus lower-than-normal. After highlighting especially relevant features of NGCs in the next section, three case scenarios are developed to identify outcomes and issues likely to arise for NGCs in different market situations. The last section summarizes practical questions NGCs must address.

I. NEW GENERATION COOPERATIVES

In this paper, the term NGC typically is applied to member-owned firms operating specialized, value-added processing facilities and/or marketing differentiated products. Further, the firms are assumed to exhibit the four distinguishing characteristics summarized by Cook: (1) closed membership with delivery rights in volume terms tied to processing capacity; (2) members invest upfront equity in proportion to delivery rights; (3) the delivery rights are transferable; and (4) a marketing agreement (contract) between the member and cooperative specifies product characteristics such as quality and/or variety and timing of delivery in addition to quantity.[5] Equity capitalization[6] and valu-

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[2] *See* Victoria Salin, *Information Technology in Agri-Food Supply Chains*, 1(3) INT'L FOOD & AGRIBUS. MGMT. REV. 319, 319-34 (1998). Salin examines the role of information technology in supply chain alliances.

[3] See Jean Kinsey & Ben Senauer, *Food Marketing in an Electronic Age*, CHOICES, 2nd Quarter 1977, at 32-35 for an overview of changes in food retailing systems.

[4] Michael D. Boehlje & David A. Lins, *Risks and Risk Management in an Industrialized Agriculture*, 58 AGRIC. FIN. REV. 1, 1-16 (1998). Boehlje and Lins catalog various sources and types of risks, and discuss their implications.

[5] Michael L. Cook, *The Future of U.S. Agricultural Cooperatives: A Neo-Institutional Approach*, 77 AM. J. AGRIC. ECON. 1153, 1153-59 (1995).

[6] *See* Michael L. Cook, *Capital Formation in Cooperatives, in* FAMC-97-1 COOPERATIVES: THEIR IMPORTANCE IN THE FUTURE FOOD AND AGRIC. SYSTEM 1153, 1153-59

ation of delivery rights[7] are not directly affected by crop yield variations and are beyond the scope of this paper.

Crop yield variations raise particular issues for NGCs stemming from a market orientation, the use of volume-based contracts, closed memberships tied to processing capacity, and cost efficiencies from specialized facilities.

A. Market Orientation

By coordinating production to market requirements, NGCs can fill particular niches in evolving supply channel systems. However, this entails a fundamental shift in the traditional expectation that cooperatives will serve members by marketing all that is produced. In the case of NGCs, one of the potential advantages to a grower from investment in an NGC is to secure a "home" for production. Harris, Stefanson, and Fulton emphasize that the investment to secure delivery rights creates a defined claim on the surplus earnings (and responsibility for losses) of the cooperative.[8] Thus, in addition to assuring an outlet for production, growers have a vested interest in the success of the cooperative, which in turn requires an enhanced sensitivity to market forces.

B. Contracts

The relationship between an NGC and its members is defined in their marketing agreement.[9] Marketing agreements or contracts are not novel for processing-marketing cooperatives. An essential purpose of marketing contracts is to constrain opportunism[10] by members and

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(Michael L. Cook et al. eds., 1997). *See also* Claudia Parliament & Zvi Lerman, *Risk and Equity Capital in Agricultural Cooperatives,* 8 J. AGRIC. COOPERATION 1, 1-14 (1993).

[7] *See* Charles V. Moore & Jay E. Noel, *Valuation of Transferable Delivery Rights for Marketing Cooperatives,* 10 J. AGRIC. COOPERATION 1, 1-17 (1995). *See also* the case study entitled: *Tri-Valley Growers: A New Age Co-op,* HARVARD BUSINESS SCHOOL CASE N9-597-088 (July, 1997).

[8] Andrea Harris et al., *The New Generation Cooperatives and Cooperative Theory,* 11 J. AGRIC. COOPERATION 15, 21 (1996).

[9] For an overview of marketing contract considerations for cooperatives, see DAVID W. COBIA, *Special Topics for Marketing Cooperatives, in* COOPERATIVES IN AGRICULTURE 202-04 (David W. Cobia ed., 1989).

[10] From a transactions cost model perspective, two fundamental purposes of contracts are to minimize costs associated with adjustments to unforeseeable circumstances (bounded rationality), and to constrain opportunism. *See* OLIVER E. WILLIAMSON, THE ECONOMIC INSTITUTIONS OF CAPITALISM 43-84 (1985).

outside interference from other processors or growers.[11] Marketing agreements are common for cooperatives operating at all levels of California's diverse range of agricultural crop sectors.[12] Most contracts are acreage based, but important cases of volume-based contracts include wine grapes and processing tomatoes. Typical "exclusive" marketing contracts require the member to deliver all production from specified locations or under particular ownership-control to the cooperative. Such contracts have a rich history in the development of cooperatives in California and beyond, and are associated with Aaron Sapiro and the California School of Cooperative Thought.[13] In contrast to a supply based system, marketing contracts for NGCs define both membership and delivery responsibilities, and specific product characteristics. The latter convey market requirements and cooperative policies to growers to guide production decisions.

C. Memberships and Processing Capacity

NGCs typically build and operate specialized facilities designed to achieve minimum costs at particular utilization levels. Presumably, the expected market volume would be consistent with the plant's most efficient operating volume. In turn, delivery rights are nominally defined in volume terms, with membership limited to a desired aggregate of delivery rights. The finite size of the facilities implies an upper bound or closure of membership at the optimal volume.[14]

Each season, the NGC contracts with members for volumes based on their nominal delivery rights. With acreage based membership agreements, variations in crop yields are directly passed on to the cooperative's volume. With volume-based contracts, however, the cooperative may have more control over the amount of product handled and growers have responsibility for variations in yields.

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[11] See USDA FARMER COOPERATIVE SERVICE INFORMATION BULLETIN NO. 100, LEGAL PHASES OF AGRICULTURAL COOPERATIVES 158-265 (1976), for an introduction to the long and deep history of legal interpretations of cooperative marketing contracts.

[12] *See* DAVID K. SMITH & HENRY N. WALLACE, USDA AGRICULTURAL COOPERATIVES SERVICE RESEARCH REPORT NO. 87, COOPERATIVES IN CALIFORNIA AGRICULTURE (1990).

[13] *See* Henry N. Wallace, *Aaron Sapiro: The Man, His Philosophy, and the California School of Cooperative Thought,* AGRIC. COOPERATION 133-43 (1988). *See also* LEON GAROYAN, CALIFORNIA'S CONTRIBUTION TO COOPERATION (Center for Cooperatives, University of California, Davis Working Paper Series No. 1-A, 1989).

[14] See Thomas L. Sporleder, *Membership Policy Alternatives for Marketing* Cooperatives, 3 J. AGRIC. COOPERATION 1, 1-11 (1988), for a discussion of alternative membership policies especially with respect to open versus closed membership.

Although in planning stages market target volume coincides with volume required for the plant's lowest cost, more often once the plant has been built, the target market volume and low cost operating volume will not be the same. If nominal delivery rights are determined relative to optimal processing capacity, and the target volume is different, the NGC will find itself unable to honor the nominal delivery rights. Consequently, grower-members' contracts are likely to be for volumes in proportion to their nominal delivery rights.

D. Cost Efficiencies

In practice, investments and operating costs must be determined for each particular situation. In general, however, intuition suggests cost efficiencies can be realized from the design and construction of modern facilities incorporating state-of-the-art technology, specialization in one or a few related products, and then matching volumes handled to the optimal design levels of the facility. The conventional wisdom is based on the idea (to be verified in each case) that there is a fundamental tradeoff in plant design. Relatively lower costs may be possible from a plant designed for utilization within a narrow volume range.[15] With plants designed for flexibility and efficiency over a wider range of utilization, minimum costs will be higher than possible from specialized systems.[16] The critical issues are the range of optimal processing volume and how much costs increase when the plant is operated below or above the optimal range.

Investment in specialized facilities raises two additional points. First, such facilities would have limited residual value for other purposes. Lenders may require relatively higher equity participation in such plants when the assets cannot be redeployed.[17] Second, given that NGCs typically are involved in contracting and negotiations with buyers in the supply channel, it is important to note that special purpose facilities can have significant impacts on relative contracting and negotiating positions.[18]

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[15] See George Stigler *Production and Distribution in the Short Run,* 47 J. POL. ECON. 305, 305-27 (1939), for the original exposition of this tradeoff. Also, LINDON J. ROBISON & PETER J. BARRY, THE COMPETITIVE FIRM'S RESPONSE TO RISK 247, 247-70 (1987), provides an investment model in a risk framework incorporating the flexibility-minimum cost tradeoff.

[16] *See* COBIA, *supra* note 9, at 205-06.

[17] *See* WILLIAMSON, *supra* note 10, at 306.

[18] *Id.* at 15-42. Asset specificity is the third dimension, along with bounded rationality and opportunism, in transaction cost analysis of contracting processes.

II. SCENARIOS

In this section of the paper, three successively more complex cases are developed. Once characteristics of the system are described, likely impacts of high and low yields are discussed. The purpose is to identify effects of crop yield variation at three levels of the supply chain: raw product growers, processors, and output buyers. In each scenario, the focus is on a single product processor (NGC), who deals with a key-buyer, and contracts with its member growers. Growers decide how many acres to plant, but the eventual yield is uncertain. Production is determined by acres planted times yield per acre. Throughout, the terms "high" and "low" are used to refer to higher than normal, and lower than normal crop yields. Growing conditions after the crop acreage is planted will determine final yields per acre. Within a group of growers, some may have high yields while others are low, and some trading can be arranged. It may be that the average turns out close to target volumes. But typically, it can be expected that growing conditions will affect all members similarly and trading will not avoid an aggregate shortfall or excess.

A. Scenario One: Single Buyer, One Processor, and Grower Volume Contracts

This basic model consists of one buyer of the processed product, a single purpose processor (NGC), and a restricted group of member growers who have designated delivery rights and contract each season with the processor for specified volumes of a raw product. The model would be applicable for NGCs involved in single source supply ventures, development of value-added, differentiated products, or production and processing of proprietary crops.

In this case, the buyer would estimate the volume of processed product required, perhaps sharing information with the NGC via efficient consumer response (ECR) systems. From the established target, the processor would work back to the volume of raw product required. The NGC then would determine raw product volumes expected from each of its members and execute contracts in proportion to nominal delivery rights. Finally, to determine the acreage to plant, growers would divide the volume contracted by their expected yield per acre.

1. High Yields

When yields turn out higher than expected, the growers will have more raw product available than their contracts specified. Since there

are no alternative outlets in this case, the excess crop will be abandoned unless the ultimate buyer will handle the extra product and the plant has sufficient capacity. In order to move more volume through the system, any previously contracted prices may need to be renegotiated.

2. Low Yields

Because the contract growers are the only source, when yields are lower than expected, there simply will not be sufficient raw product to meet the target for processed product. Supply would be reduced throughout the channel. It is not clear how prices paid to growers would be affected, or whether or not there are penalties for failure to meet contract volumes. It is likely the NGC could not achieve volume related efficiencies. The costs of processing would be higher and growers' returns for their investments would be lower.

B. Scenario Two: Processed Product Inventories and Speculative Acreage

In this case, the basic model above is broadened by assuming the processed product is storable, and by allowing growers to speculate with the acreage planted. It is also assumed that in some cases, the NGC may accept more than contract volumes because inventories are possible, and there may be some flexibility in the quantity the key-buyer will take. The model applies to situations as above but adds inventories of the storable product.

The core system consists of a key-buyer of the processed product, an NGC, and members who contract with the NGC for specified volumes of a raw product. Planting more or less acres than indicated by the average yield is a realistic representation of how growers with volume contracts likely make decisions. For reference, define "normal-acres" to be the acres required to meet contract volume when yield is average or normal, and let "speculative-acres" denote the acres above (or below) normal-acres which are actually planted.

The key-buyer and processor would establish a processed product target, with allowances for inventories. The targets could be higher than planned use if inventories are low, and vice-versa. When the target volume is less than required to achieve efficiencies, the processor could consider adding to inventory. Again, once the target is established, the NGC would work back to the volume of raw product required, and determine raw product volumes expected from its members

in proportion to their nominal delivery rights. At this point, growers would decide how many acres to plant.

In making the planting decision, growers would consider the range of possible yields, the costs of growing the crop, penalties for failing to meet the contract volume, and the likelihood that the processor will be taking more than the contract volume. The circumstances will be different in each case, but basically the tradeoffs are between the marginal costs of production per acre, the potential for abandoning part of the crop, the penalties for underproduction, and potential returns if the processor accepts over-contract volumes.

1. High Yields

When yields turn out higher than expected, the growers will have sufficient raw product to meet contracts and there will be a surplus. The size of the un-contracted volume will reflect the high yields on the normal-acres, plus all the production from speculative-acres. Members will pressure the NGC to accept the excess crop, which otherwise will be abandoned. The NGC may be inclined to do so if the key-buyer will handle extra product or if inventories are judged a good investment and the plant has sufficient capacity. Prices for the processed product and returns for growers could be depressed in both the current and subsequent periods by inventories.

2. Low Yields

When yields are lower than expected, inventories will be drawn down and additions curtailed. Without sources beyond the contract growers and available inventories, supply would be reduced throughout the channel. Due to inventories and the question of who holds them, it is not certain how prices paid to growers will be affected. As in the previous case, if the NGC does not achieve volume related efficiencies, costs of processing would be relatively higher and growers' net returns per unit of volume would be lower, while at the same time, there are fewer units.

C. Scenario Three: Multiple Buyers, Several Processors, Growers and Non-Members

This case combines and extends the previous two models. The core key-buyer, NGC processor, and restricted grower-member set remain the focus. However, considering several buyers and processors expands the context. Further, it is assumed the raw product can be pro-

duced by growers who are not members of the NGC, which opens the possibility of obtaining supplies from non-members.[19] The processed product is storable, the NGC and key-buyer have some flexibility around a target volume, and both contract and non-member growers can plant speculative-acres. This model would be representative of the situation for firms operating in broad commodity sectors such as value-added niche processors, and marketing-processing cooperatives with established branded products.

In addition to the targets established with the key-buyer, the NGC also establishes targets with/for other buyers and goals for inventories. Other buyers and processors in the sector would be establishing targets at the same time. Each processor would determine raw product volumes, contracts would be negotiated,[20] and growers would determine the acreages to be planted. While the decision sequence is essentially the same as the previous two cases, here the situation is much more complex. In particular, the correspondence between the target sales to the key-buyer, the core processor's decisions, and member-growers decisions is much less direct.

1. High Yields

When yields turn out higher than expected, the contract growers will be able to meet their contract obligations. Some over-contract volume would be accepted and go into the intended channel, inventory, or perhaps other markets developed by the core processor. The latter may be an important outlet, but may entail prices and returns lower than those offered by the key-buyer. This would be the case, for example, if a specially handled product is diverted to a generic-commodity oriented market without premiums. Because the entire industry would be dealing with surpluses, prices would be depressed and processors would no doubt attempt to poach customers. Certainly the core-buyer would be in a strong position relative to the NGC and opportunism could flourish. On the grower level, to the extent the raw product is interchangeable among processors, there will be an active, but limited

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[19] *See* Rigoberto A. Lopez & Thomas H. Spreen, *Coordination Strategies and Non-members' Trade in Processing Cooperatives,* 36 J. AGRIC. ECON. 385, 385-96 (1985). The model developed by Lopez and Spreen provides a useful introduction to the issues.

[20] *See* Charles R. Knoeber & David L. Baumer, *Guaranteeing a Market and the Contracts of Bargaining Cooperatives,* 1 J. AGRIC. COOPERATION 1, 1-10 (1986), for their analysis of cooperative bargaining contracts.

and low return market for un-contracted production. Members will attempt to deliver as much as possible to the NGC.

2. Low Yields

When low yields prevail in this type of market system, prices will strengthen as expected, but other issues will also be important. In particular, supply chain relationships will be tested. The challenge for marketing will be placating customers who cannot get the supplies demanded. For the NGC, it would be more difficult to explain shortages when the core-buyer can see product going to other buyers. At the grower level, the NGC core processor may experience opportunistic behavior by its members who divert some contracted production to other processors who offer high incentives. The NGC will also be actively seeking supplies from non-members. As in previous cases, if the processor does not achieve volume related efficiencies, costs of processing would be relatively higher and growers' net returns per unit of volume would be lower. The strength of the contracts and commitment of members could be tested.

SUMMARY

The effects of crop yield variations on specialized agricultural processors such as NGCs should be studied in the context of the relevant commodity sector and organization of the market structures. The overall industry situation, channel relationships, efficient utilization of processing facilities, and member-growers' production decisions are all important dimensions that combine to determine how an NGC fares. Importantly, the outcomes will be different from year to year, and overall assessment should be over a period sufficiently long enough to observe performance over several low-yield, high-price, and high-yield low-price seasons.

Examination of scenarios highlighting different aspects of the operating environments for NGCs gives perspective to the potential and pitfalls for NGCs. Advantages from processing efficiencies may be illusory as crop yields vary from season to season and facilities cannot operate at optimal volumes. This is critical for dedicated facilities that handle a single product grown to specifications, or grown from a proprietary seed-stock only by a selected group of growers. If the raw product is undifferentiated, the NGC can have more control via volume contracts and supplies obtained from non-members. However, members will typically have alternative outlets and the NGC will have to be competitive to maintain member commitment, and/or will need

to develop (often contentious) policies for purchasing non-member raw product. The ultimate challenge is that when member production is low, other growers will be affected similarly.

Growers who seek an assured outlet for all or part of their production may be attracted to the delivery rights offered by NGCs. However, a conflict may arise over time between delivery rights and an NGC's market orientation. The crucial variable is the volume that can be marketed. In the planning stages, this may be consistent with the efficient plant volume, and the volume-based delivery rights can represent a share of the optimal plant capacity, as well as a share of the expected market. In practical situations after a plant is built, changes in the volume marketed will require that the volumes the NGC can contract for will be proportional, and not likely equal to the nominal delivery rights. When growers produce more than the contract volumes, for example, due to high yields or speculative-acreage, there will be pressure for the cooperative to accept the surplus.

Overall, the inherent variability in crop production creates special challenges for NGCs. Commitment over several high and low production years will be required to benefit from the strong supply channel relationships that are emerging in food and fiber production and distributions systems. Investment in new information technologies and dedicated application will be required to sustain relationships as variable supplies make it difficult to meet commitments. Returns will be dependent upon both successful marketing and processing cost efficiencies. The latter will be necessary but not sufficient to sustain members' commitment while benefits of enhanced market orientation accrue over several years.