Networks, Power and Dependency in the Agrifood Industry

Harvey S. James, Jr.

Mary K. Hendrickson

Philip H. Howard

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The Department of Agricultural and Applied Economics is a part of the Division of Applied Social Sciences of the
College of Agriculture, Food and Natural Resources at the University of Missouri
200 Mumford Hall, Columbia, MO 65211 USA
Phone: 573-882-3545 • Fax: 573-882-3958 • http://dass.missouri.edu/agecon

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Abstract: We review research on power, dependency and the concentration of agrifood industries and report updated concentration figures for selected agrifood sectors. We then utilize network exchange theory to identify principles of dependency and network relations and describe network relationships within the broiler, beef and commodity crop sectors. We argue that this study demonstrates that network analysis can inform on the nature, source and extent of differential dependencies and asymmetric power relationships within the agrifood sector.

Introduction

The agrifood industry has experienced significant structural changes during the second half of the twentieth century. While much has been written about these changes from a variety of perspectives, what we are most interested in is whether these changes have negatively affected the competitive advantages of farmers vis-à-vis industry firms. As an illustration, consider the fact that in 1990 the top four firms in the pork packing industry controlled 40 percent of the market, whereas by 2010 the four firm concentration ratio had increased to 67 percent (GIPSA 2011; Wise and Trist 2010). If the number of pork packers buying hogs declines, then there will be fewer firms competing for hogs from hog producers. Basic economics suggests that this would result in an increase in the market power of pork packers collectively relative to hog producers. This is a concern because of a greater likelihood that pork packers will engage in competitive practices that are harmful to hog producers.

Legal, social and economic analyses have raised questions about power relationships within the agrifood industry by examining how the existence and exercise of market power actually works and to whose advantage (e.g., Carstensen 2008; Foer 2010; Zheng and Vulkina 2009), how power can structure global relations of production and consumption and political institutions (McMichael 2000, 2009; Friedmann and McMichael 1989; Heffernan 1984; Friedland1984, 1994) or discipline labor and other groups within the food system (UFCW 2010). In this chapter we address the question of how the structure of the agrifood industry relates to the relative power of agribusiness firms and farmers. In doing so we stress that while the question of relative power applies to all segments of the agrifood industry, our concern is primarily directed at the perspective and position of farmers and producers. Specifically, we focus on the extent to which structural characteristics of the agrifood industry affect power issues arising from a farmer's position in and connection to networks of exchange relationships that exist in different agricultural commodities. The reason for our focus on farmers is simple: the question of whether there is adequate competition in the agrifood industry is generally not raised by or on behalf of agribusiness firms. Rather, the question of adequate competition and its economic, social and political benefits is raised on behalf of farmers.[1]

Other than analyses of market power (e.g., monopoly, monopsony) and antitrust issues, and with perhaps a few other exceptions (e.g., Kuhn 1964), economists have offered relatively little commentary on the subject of "power" (Oleinik 2011). Moreover, legal interpretations in antitrust law have shifted primarily to a prioritization of consumer welfare – mostly defined in terms of price – which leaves little room for exploring questions of harm to producers and others within the supply chain (Carstensen 2008; Foer 2010). For instance, Shelanski (2010, pp. 184-185) of the Federal Trade Commission testified that

> Monopsony, the power of buyers, can become a concern when buying power becomes concentrated in too few hands, although reduced payments to upstream suppliers may not harm and instead can benefit final consumers when benefit is measured in terms of their food bills. So some of the buying power that agricultural providers make in front along the supply chain may be beyond the scope of traditional antitrust enforcement.

A study of power within the agrifood industry is complicated by the fact that there are many definitions and conceptualizations of power, some of which are contradictory, and there are competing perspectives of how and why power arises and is used. Weber (1978) defines power in terms of the ability to impose one's will on others, in spite of their resistance. Some scholars view power as a relational process (Foucault 1980; Lukes 1974) and as embedded in

[1] Five different workshops on competition within the agrifood system were held in 2010 in the US, in locations that allowed access and participation by farmers and producers. Transcripts of the hearings can be found at USDA-DOJ (2010).

social networks (Granovetter 1985). Political power theorists consider specific behavior and decision-making processes (Dahl 1961), arguing that while power may be manifested in the non-decision (i.e. structuring formal agendas) and through the structure of relationships, power is ultimately manifested in domination or control, where the basic maxim is '*Control the resource or control the people'* (see Lukes 1974; Gidden 1984). Critical theorists have long studied power and resistance, particularly in development theory through the lens of the intertwined power of capital (accumulation) and state (legitimation), with the latter also being a forum for resistance by those without access to capital (McMichael 2000; O'Connor 1973).

Because there are contradictory views of power, we approach the problem indirectly by drawing on Emerson (1962) and other sociologists who define power in terms of dependency. Dependency is the state of relying on the actions of others in order to achieve some objective. According to Emerson (1962, p. 32), "the dependence of one party provides the basis for the power of the other." Sociological and similar literatures on dependency are helpful because they link the structural relationships of actors, such as those defined by network relations, to relative dependency. Dependency is also more tractable as an analytical device than is power because dependency is "a less evasive concept than power, one more easily operationalized" (Marsden 1987, p. 147). Therefore, in this chapter we identify principles of dependency and network relations and describe network relationships within the broiler, beef and commodity crop sectors in order to identify and articulate the nature, source and extent of dependencies and power relationships of farmers vis-à-vis agribusiness firms.

Previous research on agrifood industry structure

Structural analysis of the food system has long been of interest to social scientists, particularly the social, economic and ecological impacts of power and agency in the global agrifood system. They have often placed farmers – or at least a focus on production – front and center in their analyses. In a series entitled "Who Will Control Agriculture?" published in 1973, agricultural economists influential in policy arenas warned that the changing organization of agriculture did not enhance the efficiency or productivity of the system, but could instead exact social and psychological costs on farmers and society, including limiting the economic freedom of individuals (Breimyer, Guither and Sundquist 1973). Using four case studies, one of which examined the broiler industry, Breimyer (1965) argued for agriculture policies that would keep a competitive system of agriculture in place.

Writing since the 1970s, rural sociologists and political scientists interested in agrifood developments analyzed how power was expressed through intertwined economic and political processes, generally viewing capital (or actors with more capital) as having the upper hand with distinct negative impacts on farmers, workers, consumers and the environment (e.g. Heffernan 1972; Friedland, Barton and Thomas 1981; Friedmann and McMichael 1989; Burch and Lawrence 2009; Bonanno and Constance 2008). In the 1990s, scholars critiquing what they considered a rigid structuralist view of power in the food system focused on how actors shaped the local manifestations of restructuring in agriculture and food (Goodman and DuPuis 2002; Miele and Murdock 2002). For these scholars, producers and consumers exerted agency by resisting changes in the food system and spearheading the development of alternative agrifood networks (for a discussion of these alternative networks, see Allen 2004). In the latter view, power circulated through nodes with no one actor dominating completely. Bridging these camps, Wilkinson (2006) built on the work of Granovetter (1985) to develop the notion of global production networks that exerted a certain amount of influence in shaping the global agrifood system but acknowledged that individual actors could change these networks through a variety of options.

Another important strand of work has focused on more narrowly defined competition issues that seek to explore structure and conduct from economic and legal perspectives. The interest is competitive markets *per se* because of the important benefits they are assumed to provide for society in terms of price, choice, or democratic action and other social goods (Lynn 2009). Because of these benefits, government has an interest in ensuring a competitive environment. To this end, economists and other social science scholars, including government regulators, have regularly examined and reported the state of agrifood industry concentration either through measures such as the concentration ratio of the top four firms in an industry (CR4) or the Herfandal-Hirschman Index (HHI) which estimates the amount of competition between firms based on the size of firms in an industry. Table 1 reports the CR4 for a dozen agricultural commodities and sectors.

[Table 1 about here]

We think it is valuable to give farmers, in addition to scholars, policymakers and other stakeholders in the food system, a snapshot picture of the marketplace as presented in table 1 for two different reasons. First, in most cases we report both market share data figured in the simple CR4, as well as the dominant firms in each sector. This picture allows farmers to understand the wide reach of corporate actors. Second, we believe it is important for farmers to have information on their position in the marketplace. Many already have this knowledge as lived experience but might not possess the information across a variety of sectors.

While it is true that competition has been traditionally measured and litigated through the analysis of structure (mostly using an HHI index) and conduct (i.e., specific acts of uncompetitive behavior), more recent analysis has critiqued market share as imperfect and an often misused analysis of structure (Domina and Taylor 2009). Instead, these scholars have focused on differences between buyer and seller power, particularly as it relates to farmers.[2] Wise and Trist (2010) conclude there is significant evidence of buyer power in the hog market and join with Domina and Taylor in calling for empirical analysis that is "farm-centered" and reliant upon "detailed economic data." As Domina and Taylor (2009, p. 14) assert

> "Governmental agencies charged with antitrust enforcement must recognize complex and unique characteristics of each individual market chain, or system. The ways in which market power is manifested in the poultry industry are considerably different than in the beef industry, for example. Therefore, a single metric or ―have model will travel approach to competition analysis is woefully inadequate."

These commentators distinguish between buyer power and seller power because they argue that power is exercised differently in each situation and both buyer and seller power can compromise the competitive nature of the market. Antitrust law has focused for the most part on seller power, in the sense that in a monopoly situation, sellers can command a price above the level considered competitive which harms consumer welfare in the form of higher prices. Buyer power has often been considered the mirror image of seller power which many scholars

[2] Domina and Taylor (2009) and Carstensen (2008) are concerned that buyer power and seller power have different measures and impacts. Analysis of market share is hard to calculate because of the difficulty in establishing the parameters of the market – in particular the geographical nature of markets; the inelasticity of particular market sectors like most in the agrifood industry, and the fact that competitive circumstances are very different in different sectors of the food system (e.g. the poultry industry has completely different parameters than the beef industry).

vehemently reject (Chen 2008; Gundlach and Foer 2008; Foer 2010; Carstensen 2008; Domina and Taylor 2009). Foer (2010) testified at a workshop on competition in agriculture organized by United States Departments of Agriculture and Justice that seller power takes effect in very highly concentrated markets (which he estimates at 60-70 percent market share) while buyer power can be exhibited in relatively unconcentrated markets (for example around 20 percent). Thus, the traditional focus on HHI is not an adequate metric in measuring buyer power. Chen (2008) dissects the definition of buyer power, relying on concepts of *monopsony* and *countervailing power (*bargaining power).[3] For Chen, monopsony power that is exercised in the presence of perfect competition among sellers is deadweight loss and bad for consumers.[4] When there is some sort of countervailing power present, then consumer welfare can sometimes be enhanced.

Carstensen (2008) argues that the source of buyer power, the capacity and incentive of the buyer to exploit their market power, and the incentives to discriminate among sellers all must be considered when examining buyer power. For instance, high switching costs on the part of a supplier (which reflect the time and effort necessary for a supplier to find another buyer) or the quantity and proportion that a buyer takes from a supplier (c.f. the notion of *captive draw* introduced when the Department of Justice filed to stop the merger of grain giants Cargill and Continental)[5] can enhance buyer power. Other examples of enhanced buyer power occur when the monopsonist operates in both monopsonistic and competitive markets, which affects the prices paid to suppliers in different areas. Buyer power can also occur in an all-or-nothing arrangement that exists when suppliers use economies of scale to supply that buyer at a particular price, but will experience significant diseconomies if the buyer abandons that supplier. Foer (2010) also cautions about the "waterbed" effect where one buyer forces a discriminatory low price on a supplier which gains that buyer a competitive advantage, while at the same time the supplier tries to recoup some profit in selling to other buyers, thereby putting them at a

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[3] Chen's (2008:247) definition: "*Buyer power* is the ability of a buyer to reduce price profitably below a supplier's normal selling price, or more generally the ability to obtain terms of supply more favorably than a suppliers' normal terms. The normal selling price, in turn, is defined as supplier's profit-maximizing price in the absence of buyer power. In the case where there is perfect competition among suppliers, the normal selling price of a supplier is the competitive price, and the buyer power is *monopsony power.* On the other hand, in a case where competition among suppliers is imperfect, the normal selling price is above the competitive price, and the buyer power is *countervailing power*."

[4] Lynn (2006; 2009) argues that Wal-Mart uses its monopsonistic power to force concessions from suppliers rather than collecting higher prices from consumers.

[5] US v. Cargill and Continental. United States District Court for the District of Columbia. Civil No. 1: 99CV01875. Section VI, Paragraphs 20-26.

disadvantage in the market place vis-à-vis buyer number one. Foer (2010, p. 223) calls this a "double whammy" that leads to the first buyer becoming an "ever-increasing behemoth."

This discussion shows that different forms of power can exist in agricultural networks, that these different forms of power have different impacts, and that legal and economic theories need to "catch up" to the realities of how agricultural and food markets are operating. What is missing is a better conceptual model that helps to explain the existence and exercise of power within the agrifood system. In what follows we use the concept of relative dependencies created through networks to identify principles that can help us understand what is going on in various networks of relationships in the agrifood system. Our exploration and explanation of farmer positions within the networks will help scholars recognize the complexity of dependencies among actors connected in agrifood networks, and even the possibility that dependencies may not change when industry concentration changes (or can change when industry concentration does not).

Networks, dependency and power

We draw on network exchange theory in order to understand better dependency and power within the agrifood arena. Network exchange theory is based on the work of Emerson (1962), Cook and Emerson (1978); Cook et al. (1983), Markovsky, Willer and Patton (1988) and others. Like economic models, in network exchange theory (NET) the focus of analysis is the exchange (e.g., transactions), and actors are assumed to be rational and to maximize benefits (see Cook et al. 1983, f.n. 12). Unlike economic models, however, behavior of actors is not assumed to be a function of incentives derived directly from profit (or utility) maximization calculations. Rather, the behavior of actors is assumed to be derived from power imbalances that arise from differences in the dependencies of potential exchange partners. Thus, the concept of dependency is central to the NET perspective on power.

An actor is dependent on another when he or she must rely on the actions of others. Dependency is affected positively by the value of the assistance or participation a person requires of another in order to achieve his or her objective and negatively by the number and quality of resources available because of that assistance.[6] Emerson (1962) equates power with dependency, so that the more dependent an actor is on a second actor, the more power the second actor has over the first. The power-dependence relation is expressed as follows:

$$P_{ab}=D_{ba},$$

which reads as "the power of A over B is equal to, and based upon, the dependence of B upon A" (Emerson 1962, p. 33). When parties within an exchange relation are equally dependent on each other, then power is balanced and neither party will possess a power advantage. However, if the dependencies are unequal so that one party is more dependent on the other, that is, if there are "differential dependencies" (Cook 1987, p. 216) so that $D_{ab}>D_{ba}$ (the dependency of A on B is greater than the dependency of B on A), then there will be a power imbalance in favor of the least dependent of the two parties (see also Molm 1987).

This perspective provides important insights about power, which will be discussed next, but it also embodies a significant weakness reflected in the difficulty of identifying imbalances in an exchange relationship or network. What would a perfectly balanced exchange relationship and network look like? Are there objective indicators showing that exchange partners are, or are not, equally dependent on each other? These are difficult questions to answer. However, we argue that NET can advance our understanding of power because it offers a way to establishing clear principles and objective, identifiable indicators. This chapter provides a step in this advancement.

A key insight of network exchange theories is that the structural characteristics of the network affect the differential dependencies and hence relative power of actors within the network. This chapter focuses on two aspects: position within a network and type of network connection. First, position within the network is important because differential dependency is by definition defined relative to others. For example, other things being equal, the more central an actor is within the network, the more alternative opportunities that actor is expected to have relative to others within the network, such as actors located along the periphery (see Hanneman and Riddle 2005, chapter 10). While centrality within a network is an important indicator of network power, centrality and number of alternatives are not perfect indicators of differential

[6] Emerson (1962, p. 32) provides this specific definition: "The dependence of actor A upon actor B is (1) directly proportional to A's motivational investment in goals mediated by B, and (2) inversely proportional to the availability of those goals to A outside of the A-B relation."

dependencies, because there is no consensus as to its definition and measurement (Freeman 1979).

Second, the effect of relative network position is attenuated by the types of connections linking actors within the network and the overall configuration of the network (Cook et al. 1983). There are two general types of connections linking actors with the network that affect relative dependency: *negative* connections and *positive* connections. In negatively connected networks, a decision to exchange with one actor implies that exchanges with other actors do not occur. In positively connected networks, an exchange with one actor facilitates or requires a complementary exchange with other positively connected actors. Moreover, like electronic circuits that can be connected either in parallel or series, positive connections can exist in parallel or series. A positive connection is parallel when, for instance, the purchase of an input requires the purchase of a second input. A positive connection is in series along a value chain, where a purchase of an input by a processor results in a later sale of a product to another buyer (indeed, all connections along a value chain are by definition positive).

Positive and negative connections in networks have different implications. According to Yamagishi, Gillmore and Cook (1988, p. 849), in networks characterized by negative connections, “the availability of resources from alternative exchange relations determines the distribution of power.” Importantly, this is the basis for the standard economic perspective in which (market) power is determined largely by the number of competitors or alternatives a market participant faces. In positively connected networks, “the local scarcity of resources determine the distribution of power” (Yamagishi, Gillmore and Cook 1988, pp. 849-850), meaning that the agent possessing the (relatively) more scarce resource has more power than others within the network because scarcity affects the dependence of others. Importantly, positive connections both affect local scarcity and transmit the effects of local scarcity along the network. Positive connections create local scarcity when they act as barriers to resource transmission through the network. For instance, an intermediary or “middleman” can facilitate an exchange between two actors, but it also acts as a barrier if the only way for two actors to interact is through the intermediary. Moreover, while positive connections are not the only source of local scarcity – geography, contract, technology and other factors can influence local scarcity and thus create dependencies – these effects are transmitted along positively connected networks (in series) and are amplified by the effect of intermediary “barriers.”

Within a network it is the combination of positive and negative network connections that matters, not just the number of negative connections, in determining the relative dependency of actors. Thus, Cook et al (1983, pp. 288-289) state that "An important point to be made is that treating number of alternatives as a perfect indicator of resource availability can result in erroneous predictions when applied to connected sets of exchange relations and suffers from the same deficiency as a simple degree-based measure of centrality." As shown next, the presence, position, and number of positive connections can amplify or attenuate the effect of a change in the number of alternative (negative) exchange relations.

For example, suppose assemblers of a product purchase inputs from one of a dozen different input suppliers. Suppose further that these suppliers produce similar goods of comparable quality and that they are also similarly priced. In this situation, let's say that there is a relative balance of power within the network consisting of assemblers and suppliers. In other words, initially neither assemblers nor suppliers have a power advantage (or dependency disadvantage) over the other. Now, suppose there is a change in technology so that the purchase by the assemblers of the input from the suppliers requires a complementary or parallel purchase of a second input from a second group of sellers. It should be clear from this change that the relative dependency of the assemblers *cannot* remain static. Because of the addition of a parallel exchange within the network – characterized by the requirement that a purchase from one supplier requires the purchase of a second input from another supplier – assemblers are made relatively more dependent upon suppliers collectively. The reason is simple. When the assemblers purchase one input, the change in technology means that they cannot complete assembly of the product without the addition of the second input, making the assemblers dependent on that input's supplier. Whereas originally a dependency did not exist, the change in technology creates a dependency for the assemblers as depicted by the existence of an additional positive network condition.

Consider a further illustration of the effect of positive connections on networks, based on the simple network relations given in Figure 1. The networks depicted here contain agents, labeled A through D, and paths connecting them. The dashed lines representing connections between A_i and B are *negative*, meaning that if B exchanges with one relation it does not exchange with the others. In contrast, the solid lines representing B-C and C-D connections are *positive*, meaning that exchanges are not exclusive but are contingent upon each other. As shown in Figure 1a, B has three options for exchanges, while each A_i has only one exchange opportunity. Therefore, B's power exceeds that of A_i because B is less dependent on a particular A_i than A_i is on B. For example, if A_1 does not offer terms acceptable to B, B can seek exchange opportunities with either A_2 or A_3.

[Figure 1 about here]

In Figure 1b, the exchange network connecting A_i and B is expanded to include other agents within the network. Specifically, the addition of C and D in series with B means that B, C and D are positively connected. Like the addition of the parallel input requirement that changes the relative dependency of assemblers described above, the addition of C and D to the network *cannot* leave the relative dependency of A_i and B unchanged. In order to understand the change in dependency resulting from the addition of a series of positive connections, one must assess which agent possesses the (relatively) more scarce resource. In the case of Figure 1b, as explained by Yamagishi, Gillmore and Cook (1988), B has more power than A_i not only because the negative connection between A_i and B offers more opportunities for B to exchange with A_i than for A_i to exchange with B, but also because the introduction of the positive connections with C and D within the network places B between A_i and C. The result is that resources or advantages offered to the network by C and D are now relatively scarcer to A_i than to B because A_i has to go through B to obtain them, thus further increasing B's power over A_i. Similarly, because D has to go through C in order to obtain whatever advantage the participation of A_i and B provide to the network, C has more power than D; that is, resources or advantages offered by A_i and B are relatively scarcer to D than they are to C. In the B-C relation, note that because B has multiple alternatives for exchange opportunities with respect to A_i, B's ability to become locally satiated in the A_i-B relation – that is, to be able to obtain resources from A_i – is greater than the ability of C to become locally satiated in the C-D relation. Therefore, relative to B, C controls the more scarce resource or advantage, thus giving C more power than B. Accordingly, it is predicted that C's power over B will in turn affect A_i, thus diminishing B's power over A_i. These results have been supported in experimental studies (see Yamagishi, Gillmore and Cook, 1988, for a complete discussion).

The lesson here is that relative dependency, and hence relative power, within a network can be determined through a careful and comprehensive examination of not only the number of exchange options that a particular actor has within a network but also the nature of that exchange relation relative to other connections the actor has within the network and the relative scarcity of resources exchanged within the network. That is, specific dependencies can only be determined through analyses of specific network structures and actors. That said, the NET framework does provide general principles and implications for understanding the dependency and power in the agrifood industry. From the perspective of an agent within the network, we offer the following principles:

> Principle 1: *A reduction in the number of negative exchange connections in a network increases the relative dependency of the agent, other things being equal.*

> Principle 2: *The addition of a positive exchange connection in parallel with other connections in a network will generally increase the relative dependency of the agent, other things being equal.*

> Principle 3: *The addition of a positive exchange connection in series with other connections in a network may increase or decrease the relative dependency of the agent, other things being equal, depending on whether the agent is locally more or less satiated from exchanges with others in the network.*

> Principle 4: *A combination of changes in negative and positive exchange connections within a network can either compound the relative dependency of the agent or have countervailing effects, depending on how the connections affect the relative scarcity of resources.*

As an illustration, compare the *relative* dependency of farmers engaged in three types of crop farming: genetically-modified (GM), conventional, and organic. For GM farming, producers purchase seeds that contain a gene that makes the plant tolerant to herbicides like glyphosate. For conventional farming, producers purchase non-GM seeds and control weeds and pests with a number of different chemical inputs. For organic farming, producers use conventional seeds but do not use chemical inputs to control for weeds and pests. If the GM farmer and conventional farmer purchase the same types of inputs (e.g., seeds, chemical herbicides, labor and machinery), then the relative dependency of the conventional farmer is less than it is for the GM farmer, other things being equal. Even though both conventional and GM farmers have the same number of parallel positive connection (four in this example: seeds, chemicals, labor and machinery), the fact that the herbicide tolerant seed requires a specific type of chemical herbicide means that the number of negative exchange connections between GM farmer and seed company and between GM farmer and farm chemical companies is smaller than the number for the conventional farmer. In contrast, because the organic producer does not rely on any farm chemical input (e.g., he or she has positive connections with only seeds, labor and machinery), the organic producer is relatively less dependent than the conventional and GM farmers, other things being equal.

Of course, the *absolute* level of dependency of the GM farmer, conventional farmer and organic farmer will depend on substantially more considerations than just seeds and chemical inputs. Dependency can arise at any point of exchange. All exchange points need to be considered before a final assessment of dependency can be made for a particular agent. For example, the dependency advantage that an organic farmer has over conventional crop producers because he does not face a positive exchange connection with chemical herbicide producers may be eroded if there is scarcity in the farm labor market and the organic farmer has a greater reliance on farm labor for weed control than the conventional farmer. Similarly, if the number of outlets to which an organic producer can sell his output is smaller than the number of places a GM producer can sell his output, then one must balance the dependency advantage the organic farmer has upstream relative to the GM farmer with the dependency disadvantage the organic farmer has downstream.

In summary, NET can provide an important perspective on dependency and power in the agrifood industry, particularly from the perspective of farmers. Specifically, NET analysis suggests the following insights. First, the differences between buyer and seller power explained above become very important to the farmer and impact whether relationships between farmers and other actors are characterized by positive or negative connections. Second, by looking at simple measures of concentration, like CR4 or HHI, one emphasizes the disappearance of negative connections available for farmers, but overlooks the implications of positive connections in the network. Third, it is important to explore the implications of positive and negative connections collectively between farmers and other actors in the agrifood system in order to understand how dependencies are created and how they impact power relationships in the network. For instance, changes in agricultural technologies might result not only in the disappearance of a negative connection, but also force farmers into a positive connection that then defines other relationships that are available to or required by them. Finally, the study of relative dependency is best made by examining changes in the network structure over time, for instance, by noting not only the change in the number of negative exchange connections but also the existence and nature of positive exchange connections within the network.

Differential dependencies in stylized agrifood networks

Farmers are in a unique position within the network connecting all players in the agrifood system. At the center of the network, farmers take agricultural inputs, such as seeds and genetics, labor, machinery, fertilizer and weed control products, and convert these inputs into agricultural commodities. As actors along the periphery of the agrifood network, agricultural input suppliers are dependent upon farmers collectively as buyers of their products and as gatekeepers to exchange connections further along the agrifood value chain. Similarly, food processors and retailers are dependent upon farmers for their primary product inputs, namely agricultural commodities. The positional advantage of farmers within the agrifood system, however, is attenuated by the nature of the negative and positive connections that bind them within the network of all actors and participants in the agrifood system. Although scholars have documented extensively the changes in the number of participants resulting from consolidation and other structural changes that have been occurring in the agrifood system over the previous decades, we draw on insights from network exchange theory to highlight how these changes have affected the relative dependency of farmers and producers in the specific cases of broilers, beef and corn and soybean growers. Admittedly our characterization of these networks is somewhat stylized. The relative dependencies of farmers and actors in specific agrifood networks will depend on their unique circumstances. However, these analyses illustrate the insights an NET perspective provides on power and dependency in the agrifood industry.

Broilers

The relationships that exist in the broiler industry are well-documented. In this volume Constance et al. summarize the evolution of the contract broiler system. A classic study comes from Heffernan (1972, 1984), who examined how farmers and communities benefitted from investment in poultry production in Union Parish, Louisiana. Over the course of 30 years – field research was conducted in 1969, 1982 and 1999 – the structural position of the producer changed greatly. In the early days, when four locally-owned integrators competed for growers, farmers and the community enjoyed economic and social benefits. These benefits declined as competition for growers decreased (two integrators operating in the county in the late 1970s dwindled to one by 1982). By 1999, poultry growers felt they had few options, that they would continue in debt, and that they would not recommend poultry production to their children (Hendrickson, et al. 2008). As options decreased, farmers felt less powerful and more dependent on the integrators.

[Figure 2 about here]

Today a typical arrangement for broiler production looks like Figure 2. In this particular instance, a grower (farmer) enters into a contract relationship with an integrator (poultry firm) to provide chicks, reasonable veterinary care, feed, scheduling of flocks, chicken catching, transportation and processing. In exchange, the grower contracts to provide labor and growout houses for the chicks. Growers typically obtain financing from banks or other lending institutions in order to construct, maintain, and upgrade growout houses.

Within this network, the connections between the grower and poultry firm and bank are positive. The contract with the integrator requires a growout house, which in turn requires financing from a lender. Importantly, a number of factors significantly enhance the dependency of growers on the integrator and lender. For instance, no other integrator will enter the geographic area (represented in Figure 2 by the dashed circle encompassing the farmer and grower) of their competitors.[7] According to Taylor and Domina (2010), most broiler processors locate processing plants so that they have growers within 50-60 miles of the plant, suggesting

[7] McDonald and Korb (2006) showed that 30 percent of broiler growers reported no other operation near them.

that geographically a single integrator may have 100 percent of the local market. This assertion is supported by poultry growers who testified at the USDA-DOJ workshop on antitrust in the poultry industry (USDA-DOJ 2010) that once they entered a contract with a company, that was their only option, even if other integrators operated within their county.[8] Virtually all inputs used by growers in raising chicks come from the single integrator, thus compounding the dependency of the grower on the poultry firm because these multiple inputs are positive connections; farmers cannot grow chicks unless all inputs are provided. Moreover, because of the perishability of the product – the flock needs to move out as soon as possible after it reaches market weight or the grower begins losing money – and because the grower must rely on the poultry firm to catch and transport the chicks, the grower's dependency on the poultry firm is magnified. As is widely documented, the grower cannot select different genetics, feed, vet care, or when chicks arrive or depart from his/her facility (Taylor and Domina 2010; Constance et al. this volume), yet the grower's profitability is dependent upon these factors. The grower needs a cash-flow contract to arrange financing from a bank, but typically these contracts do not cover the entire investment period of the facility. Contracts can be 12 months or less in length (see MacDonald and Korb 2006) in contrast to 10 years or longer for terms of bank lending. In addition, the integrator can require upgrades and facility changes when negotiating a new contract, thus perpetuating the dependency between the grower and the lending institution. All of these factors suggest that there is a significant dependency disadvantage of growers relative to integrators.

An important question is why the grower wants to enter into this dependent relationship? Two possible answers to this question illustrate the extent of the differential dependencies growers face relative to poultry firms. First, the grower is most likely socially integrated into the community with family life and social ties embedding him/her into the community. We cannot account for these kind of relationships and the network connections they engender in the simple schema presented here. However, the concept of embeddedness, which is a common concern of network theorists, might be very important in this case. For example, Heffernan (1984) showed that the rural lifestyle – hunting, fishing, social activities, etc. – could be an important part of

[8] The Department of Justice has argued that such a "captive draw" area in grain should trigger antitrust concerns. In their suit opposing the acquisition of Continental Grain by Cargill, the Department of Justice argued that there were significant geographic areas where the two firms competed for grain products that would be reduced to a *captive draw* area if the acquisition was approved. See US v Cargill and Continental. US District Court for District of Columbia. Civil No. 1: 99CV01875.

embedding the grower into the community and subjecting him or her to the limited economic activities available. Second, Taylor and Domina (2010) argue that the terms of the contract often change over time; the integrator offers better contracts at the beginning of contract poultry production, which enticed many growers into borrowing money to construct facilities, thus creating positive connections with integrators, who then change contracts mid-stream with the effect of increasing grower dependencies.

What is perhaps most interesting about the broiler case is that relative dependencies we document in these networks were apparent by the late 1950s, with the network structure changing relatively little since (see Constance et al. this volume; Breimyer 1965). However, between the 1960s and the early 1980s broiler contracts actually helped farmers in low-income farming areas improve the quality of their life as documented in North Georgia by Weinberg (2003) and in Union Parish, Louisiana, by Heffernan (1984).[9] Growers were able to get out of debt and build nice homes. Even though Breimyer (1965) reported limited dissatisfaction from growers in the early 1960s, there is now almost universal concern about broiler contracts, even from successful poultry growers (e.g. testimony at the May 2010 USDA-DOJ antitrust hearing in Alabama). Even though we agree with critiques of CR4 and HHI measures of concentration, it is important to note that the CR4 ratio stayed constant at 18 percent from 1964 to 1976 (Rogers 2002) and then started to increase to today's 53 percent. This may indicate that emerging grower dissatisfaction could result from the elimination of choice of integrators (e.g. the four integrators present in Union Parish, Louisiana in 1969 versus one today) even though the overall structure of the each network has stayed the same.

Beef

While the relative dependency of poultry growers is well-known and well-documented (Becker 2007; USDA-DOJ 2010), the networks in which beef producers operate show a different and more complicated mix of negative and positive network connections (see Figure 3). In beef

[9] Weinberg (2003, p 7) gives the example of a North Georgia family who were able to upgrade from a four room house with no indoor toilet to a seven room house with two baths after 20 years in the poultry business (1961-1982). "We all owe that to Gold Kist," [the farmer] said. "Chickens have been mighty good to this family." However, Heffernan (2012) says that farmers in Louisiana in his 1982 restudy were starting to show signs of distress but almost every survey participant would say 'go talk to so and so, you'll see what's happening' rather than openly reporting issues. Thus, he was unable to document this discontent for his study.

production, there are a large number of cow-calf operations in the US (758,000 farms had beef cows in 2007 according to the Census of Agriculture), which are dispersed across large geographical areas (MacDonald and McBride 2009; McBride 1997). Thus, a typical beef producer faces less consolidated markets for inputs than either the poultry growers of Figure 2 or the grain operators discussed below, because the producer can choose how to maintain the health of his animals as well as what genetics to use and what to feed. In other words, even though beef producers require a number of positively connected inputs like chicken growers, there are multiple options along each network path, thus attenuating the potential for adverse differential dependency. Ownership of beef genetics, for instance, is much less concentrated than dairy, pigs or poultry genetics (Gura, 2007). A cow-calf operator can choose to sell his calves as weanlings to a backgrounder operation or feed them longer before sending them on to a feedlot, which may or may not be located within the same geographic confine as the producer or backgrounder.

[Figure 3 about here]

However, some feedlots are in a positively connected relationship with a specific beef processor either through outright ownership or a contracting supply relationship, while the independent feedlots negatively connected to processors face a significant amount of buyer power at the processing level where the CR4 is equal to 81 percent. While processors like Tyson, JBS and Cargill possess relatively significant buying power from the beef producer or independent feedlot's perspective, their selling power is perhaps less significant as one of their buyers, Wal-Mart, is America's largest grocer with an estimated quarter or possibly a third of the grocery market.[10] This disadvantage for them is increased by the fact that because there are a large number of cow-calf and feedlot operations from which they can source beef cattle, they can become quickly satiated with product – that is, it is relatively easy for them to obtain production inputs – and as noted in the discussion of Figure 1, network actors locally satiated are at a dependency disadvantage relative to their trading partners.

[10] Today, the top 20 grocery stores have a combined 65 percent of the grocery market (Shelansky 2010), with estimates for Wal-Mart's share running from 23 percent (UFCW 2010) to 33 percent (Clifford 2011). Regardless, Mitchell (2011) and UFCW (2010, p. 5) note that Wal-Mart grew from 6 percent of grocery sales in 1998 to having larger grocery sales today than the "combined sales of its three closest competitors…."

The integrator relationship that exists in poultry and is expressed through production contracts is different, and to some extent less pronounced in the beef sector. For instance, in 2006/2007, roughly one-third of the production value in cattle was under contract versus nearly 90 percent for poultry and eggs (O'Donoghue et al. 2011), although this is changing. There is a great deal of concern in the beef industry about the use of "committed procurement methods" on the part of processing plants or packers, generally expressed through marketing agreements. These methods bypass openly negotiated markets, which tend to have negative connections and thus options for alternative trading alternatives. The use of these methods rose in the latter half of the last decade, and in at least one area, the Texas-Oklahoma regional market, "the proportion of the trade accounted for by the negotiated market … declined 13 percentage points from mid-2008 to mid-2009" (GIPSA 2011, p. iv). That said, producer dependencies could increase if the use production contracts in beef increases and if such packers begin specifying specific genetics, veterinary care and feed formulas, as is the case in broiler production.

Other changes also occurred in the structure of the beef industry between the late 1960s and today. The number of farms feeding out cattle declined by 40 percent between 1978 and 1992 (McBride 1997), with feeder cattle becoming concentrated in the Central and Southern Plains States by the early 1990s. According to McDonald and McBride (2009), today 262 feedlots could feed out 16,000 or more head at any one time, and such feedlots account for 60 percent of the fed-cattle marketings. Moreover, the beef industry essentially functions as a North American industry with Canadian producers involved in similar networks as US farmers (Adcock et al. 2006).[11]

Corn and soybeans

The last situation we will discuss is based on a typical corn or soybean row-crop producer network from the Midwest or South of the US. As depicted in Figure 4, the network relationships of corn and soybean growers are relatively less complex when compared with broiler and beef

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[11] It is also important to note that beef processing plants largely left unionized areas of the Midwest in the 1980s and 1990s after the introduction of boxed beef production created the opportunity for beef packers to build larger plants with faster processing speeds (and deskilled, less costly labor) in the Great Plains (Gouveia 1994; Stull, Broadway and Griffith 1995). Thus, a system of relatively dispersed slaughter plants and farmer feeders changed to a more geographically concentrated industry accompanied by changes in the CR4 where 36 percent of steers and heifers were slaughtered by the top firms in 1980 compared to 81 percent in 2009 (GIPSA 2011).

producers. Positionally, corn and soybean growers are more central within the network than broiler and beef producers, thus giving them the power advantage of centrality. However, like broiler and beef producers, the number of corn and soybean farmers relative to the number of input suppliers and buyer is large, thus increasing their degree of relative dependency.

The corn and soybean farmer requires a number of inputs, such as seeds, fertilizer, and other inputs, representing positive connections. In the case of seeds, for instance, the farmer has a number of options. The farmer can often source these among locally based seed dealers who are often neighbors or buy directly from seed companies. However, the dependency of positively connected relationships at this level is affected by the nature of the farm production methods chosen, as argued above in the previous section. It is most significant, other things being equal, when the decision to buy an herbicide-tolerant seed necessitates the accompanying purchase of herbicides owned by the same owner of the seed genetics (e.g. Round-up Ready soybeans or corn requires use of Round-up herbicide in order for farmers to benefit from the purchase of the GM seed). Moreover, there is great substantial seller power at the seed genetics level, with estimates that two firms, DuPont and Monsanto, controlled 58 percent of the US corn seed market in 2007 (Etter, 2007), and that the top four firms account for 53 percent of proprietary seed sales at the global level (ETC Group 2008).[12]

[Figure 4 about here]

In addition, soybean and corn production is heavily reliant on fertilizer, especially in the form of nitrogen, phosphorus and potassium (for a discussion, see Taylor 2010). Potash and phosphorous production has long been organized in cartels (Blas 2010; Etter 2008), where three cartels are thought to account for 70 percent of the global trade in these two fertilizers (Blas 2010).

When farmers wants to sell their corn or soybeans, they face concentrated buying power, although they have options, such as selling to local grain elevators or ethanol plants (although in the latter case farmers are often required to be members of cooperatives). Moreover, most grain elevators are dependent on moving grain to terminal elevators located on major waterways or

[12] For further discussion of the competitive nature of these markets see Moss (2010, 2011); Shi, Chavas and Stiegert (2008) and Hubbard (2009). For an animated representation of changes in the seed industry from the mid-1990s to present see Howard (2009).

ports that are often controlled by large grain traders like ADM, Bunge or Cargill. Buyer power is also represented by the fact that the top four soybeans processors control 85 percent of the market, while the top four wet corn millers account for 87 percent of the market. Ethanol, which in 2011 outpaced feed in terms of corn utilization, is also a consolidating market (Glenna and Cahoy 2009).

Ethics of Dependency

Ethical issues involve questions about what is right or wrong, good or bad, or acceptable and unacceptable, particularly with regard to how humans ought to act (see, for instance, Singer 1994). Ethical issues always arise when there is a conflict of interests and/or values. As differential dependencies emerge between network actors, their respective interests will increasingly conflict, thus creating ethical tensions. These tensions in turn raise a number of important ethical questions, including: Do differential dependencies create unfair advantages and disadvantages to actors in a network? Do the duties and obligations of actors in a network change when conditions create differential dependencies in their favor? Should network actors in these circumstances take into consideration how their use of the power differential dependencies give them affects other actors in the network? What is the nature of the harm that actors experience when others in the network take advantage of differential dependencies in their favor? What does it mean to "take advantage of differential dependencies"?

A comprehensive discussion of these and other questions is beyond the scope of this chapter. Scholars have commented extensively on many of these themes, such as power, dependency, harm and fairness.[13] However, unlike parent-child, teacher-student, employer-employee, king-subject and similar relationships in which differential dependency is inherent to and thus expected in the relationship, and in which norms have developed governing these relationships, differential dependencies are not, or ought not to be, automatically expected or presumed in agrifood networks. When they arise they deserve a careful ethical consideration of their nature and implications, particularly with respect to the norms that govern and ought to govern interactions between actors within the networks. Our assessment of the broiler, beef and corn and soybean production networks presented above is that ethical concerns arising from

[13] It is not possible to provide a comprehensive list of contributors. However, we are reminded of Davis and Blomstrom's (1971, p. 95) Iron Law of Responsibility, which states that "in the long run, those who do not use power in a manner which society considers responsible will tend to lose it."

differential dependency are strongest in the case of broiler production but guarded in beef and commodity crop production. Nonetheless, more work is needed to address ethical issues arising from network relationships in the specific case of the agrifood system, especially from the perspective of farmers and producers.

One potential direction is a consideration of how differential dependencies affect the ethical behavior of actors within the network. Ethical behavior, like economic behavior, is affected by the constraints that people face. Dependencies impose constraints on behavior. Hendrickson and James (2005) argue that constraints can increase the likelihood that agents will engage, or at least be tempted to engage, in behavior they consider unethical. When differential dependencies arise because of the characteristics of network relationships, there might be an increase in incentives for adversely affected actors to engage in or rationalize unethical conduct. For example, if farmers increasingly believe that they are at a disadvantage because of the dependencies they face in agrifood networks, then we might observe an upward trend in unethical behavior of farmers, which has support in research presented by James and Hendrickson (2008).

Conclusions

Our analysis demonstrates that farmers involved in different commodity networks face different issues – and thus different relative dependencies created by the distribution of positive and negative connections in the network. Within agrifood networks, buyer and seller dependencies are different, as argued forcefully by Carstensen (2008), Grundlach and Foer (2008) and Domina and Taylor (2009), especially because the entities who rank near the top in CR4 can experience significant dependency advantages on the buying end (e.g. beef packers with a CR4 of 82 percent) but when selling, the power resulting from differential dependencies is dissipated by the fact that other entities may possess significant buying power relative to them (e.g. Wal-Mart with somewhere between a quarter and one-third of the grocery market). More importantly, farmers experience buyer power and seller power differently in the three networks we examined, depending on how they are connected and the nature of the connections. For instance, row-crop producers tend to face seller power on the input side, and buyer power on the grain markets side, while for cow-calf producers the issue tends to be the buying power exerted on the feedlots with which they must deal.

We have also shown that dependencies can be created differently in the networks that we have examined. For instance, in the broiler arena the dependency disadvantage of parallel positive connections representing grower inputs are compounded by the fact that they usually are linked to a single input supplier that is also the only output buyer. This differential dependency is in turn compounded by the confines of geography and social embeddedness. Most likely, it is because poultry integrators do not operate in the same geography, and that farmers are searching for options that allow them to stay in place for family and lifestyle reasons, that they accept contractual obligations that create and expand relative dependency. Thus, we believe it is important to identify principles such as geographic constraints, embeddedness and the nature of contractual relations in particular commodities to understand more fully the farmers' relative position of dependency and power within an extended network structure.

What does this analysis mean for furthering our understanding of the competitive nature of the marketplace, the distribution of power within networks, and the relative power of the farmer in these networks? First, network exchange theories (NETs) can help bridge the gap between the focus on the structure of the marketplace (i.e. number of firms) and the conduct within that marketplace (i.e. exercise of market power, or the exertion of agency in the face of power) by highlighting the linkages that exist and what the impacts of those linkages are. By looking simply at the concentration ratio (whether CR4 or HHI) one emphasizes the disappearance of negative connections within the networks in specific commodities, but such an emphasis overlooks the effects of other connections within the network.

Second, NET can make a significant contribution to studies of agrifood concentration and the distribution of power within the agrifood system because it brings us straight back to a basic social reality – humans are social creatures who are dependent upon one another because we exist in networks of relationships. This reality is neither good nor bad, but NET theory and its focus on relative dependencies help us to explicate these basic relationships in new ways.

Third, if farmers are at a dependency disadvantage because of the structure of the negative and positive connections linking them to other parts of the agrifood network, is there anything that they can do to improve their situation? One of the reasons farmers and producers are at a dependency disadvantage is because there are so many of them, at least relative to other actors in the network. Both sellers to them, and buyers of their products, often face a significant number of negative network connections, thus providing substitutes if one farmer, for instance, chooses not to accept the terms offered by either seller or buyer. Could farmer organizations collectively bargain successfully on behalf of farmers (i.e. past efforts like those of the National Farmers Organization have had mixed success)? Academics like Levins (2002) have argued for the need to create countervailing power in certain networks that could ameliorate dependencies created through positive connections in the network.

While we do not have answers for these questions, we believe that exploring network exchange theory can help social scientists, legal experts and policymakers better understand the nature of the relationships that exist within the agrifood industry. Such an understanding can help society in fashioning remedies that improve the position of the farmer in these networks, if that is indeed a societal goal.

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Table 1. Concentration ratios and dominant firms for selected agrifood sectors.

Industry Sector and Representative Firms	**CR 4**	**Date and Source Notes**
Beef Slaughter (Steer & Heifer) • Cargill • Tyson • JBS • National Beef	82 percent	2009 figures quoted in GIPSA (2011). Firm names taken from *2011 Feedstuffs Reference Issue*, September 15, 2010. Note that rankings are based on capacity while CR4 is based on actual slaughter.
Beef Production (Feedlots) • JBS Fiver Rivers Cattle Feeding (838,000) • Cactus Feeders (relationship with Tyson) 520,000 • Cargill Cattle Feeders LLC (350,000) • Friona Industries (275,000)	Top 4 Have one-time capacity for 1,983,000 head	Head numbers cited as one-time capacity from *Feedstuffs* (2010).
Pork Slaughter: • Smithfield Foods • Tyson Foods • Swift (JBS) • Excel Corp. (Cargill)	63 percent	2009 figures with 2008 at 65 percent, quoted in GIPSA (2011). Firm names listed based on capacity reported in *Feedstuffs* (2010).
Pork Production: • Smithfield Foods (876,804) • Triumph Foods (371,000) • Seaboard (213,600) • Iowa Select Farms (157,500)	Top Four Have 1,618,904 sows in production	*Successful Farming* (2010). *Feedstuffs (*2010) includes higher sow numbers for Smithfield at 922,251, Triumph at 371,500, and lower ones for Iowa Select at 152,500.
Broiler Slaughter: • Tyson • Pilgrim's Pride (owned by JBS) • Perdue • Sanderson	53 percent	2009 figures, with 2008 at 57 percent are quoted in GIPSA (2011). Firm names reported in Thornton (2010).
Turkey Slaughter • Butterball (Smithfield/Goldsboro) • Jennie-O (Hormel) • Cargill • Farbest Foods	58 percent	2009 figures with 2008 at 51 percent, quoted in GIPSA (2011). Firm names reported in Thornton 2010, p. 18). Note that Butterball is a joint venture of Goldsboro Milling and Smithfield Foods.
Animal Feed • Land O'Lakes Purina LLC • Cargill Animal Nutrition • ADM Alliance Nutrition • J.D. Heiskell & Co.	44 percent	CR 4 from 2007 Economic Census, US Census Bureau (2011), percent of value added. Firm names are rankings from Feedstuffs (2010) based on annual manufacturing capacity.
Flour Milling • Horizon Milling (Cargill/CHS) • ADM • ConAgra	52 percent	2007 Economic Census, US Census Bureau (2011), percent of value added. Firm names are based on author calculations.
Wet Corn Milling • ADM • Corn Products International • Cargill	87 percent	2007 Economic Census, US Census Bureau (2011), percent of value added. Firm names are based on author calculations.
Soybean Processing • ADM • Bunge • Cargill • Ag Processing	85 percent	2007 Economic Census, US Census Bureau (2011), percent of value added. Firm names are based on author calculations.

Rice Milling • ADM • Riceland Foods • Farmers Rice Milling • Producers Rice Mill	55 percent	2007 Economic Census, US Census Bureau (2011), percent of value added. Firm names are based on author calculations; among the largest rice processors, not necessarily listed in order of size.
Grocery • Walmart • Kroger • Safeway • Supervalu	42-51 percent	*NY Times*, January 2011, reported Wal-Mart at 33%, and Kroger, Safeway and Supervalu at 4-9% each (see Clifford, 2011). *Grist*, December 2011, reported Wal-Mart at 25% (see Mitchell, 2011). The top 20 grocery stores today account for roughly 65 percent of US grocery store sales, an increase from 39% in 1992 (Shelansky, 2010). Rankings from Moran and Chanil (2010).

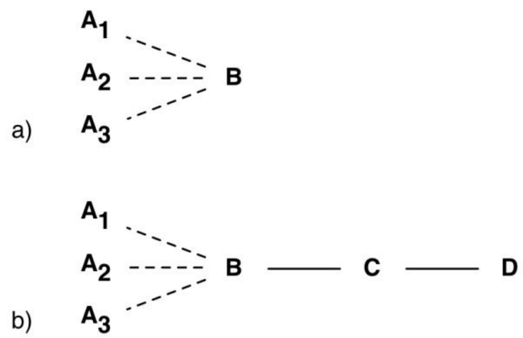

Figure 1. Simple network structures

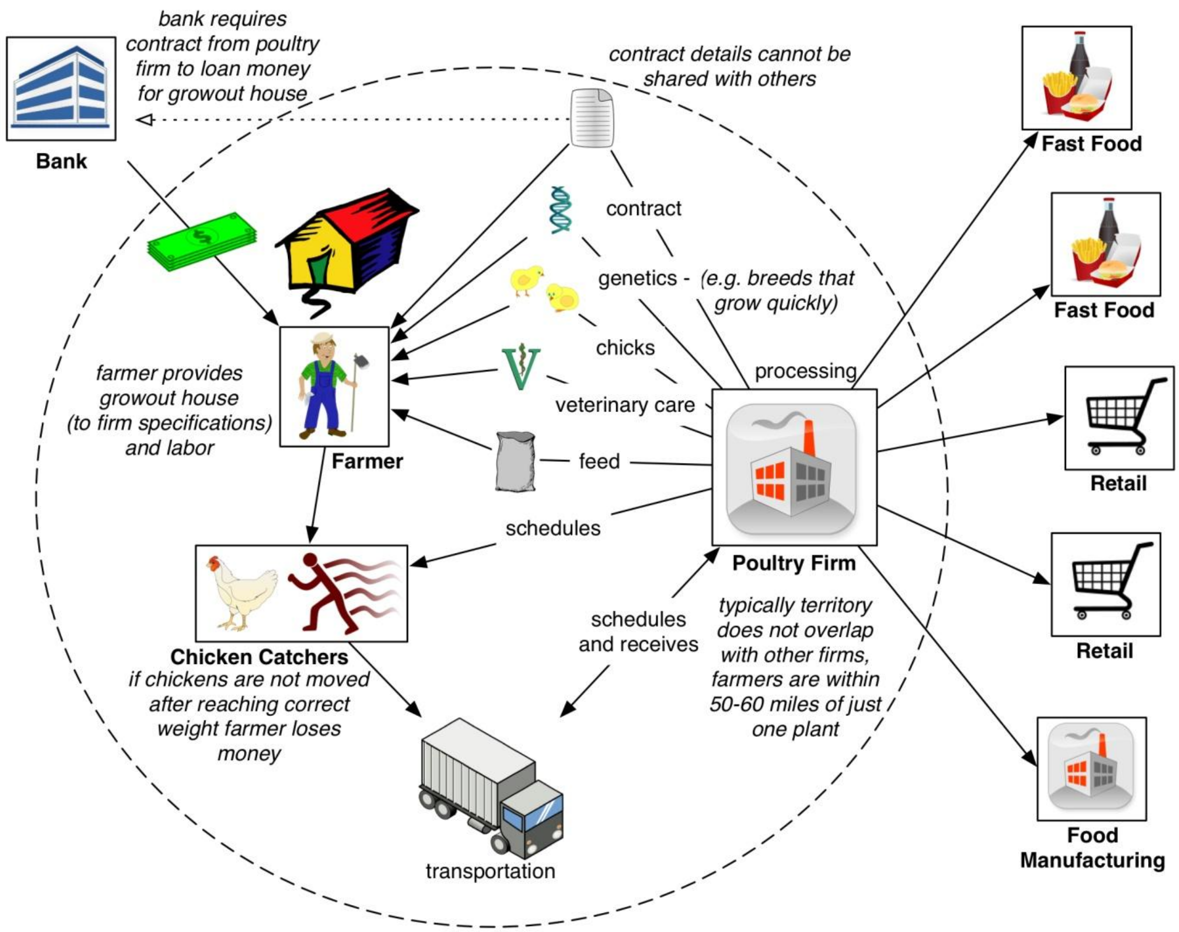

Figure 2. Typical relations among broiler growers, integrators and other agents in broiler growing networks.

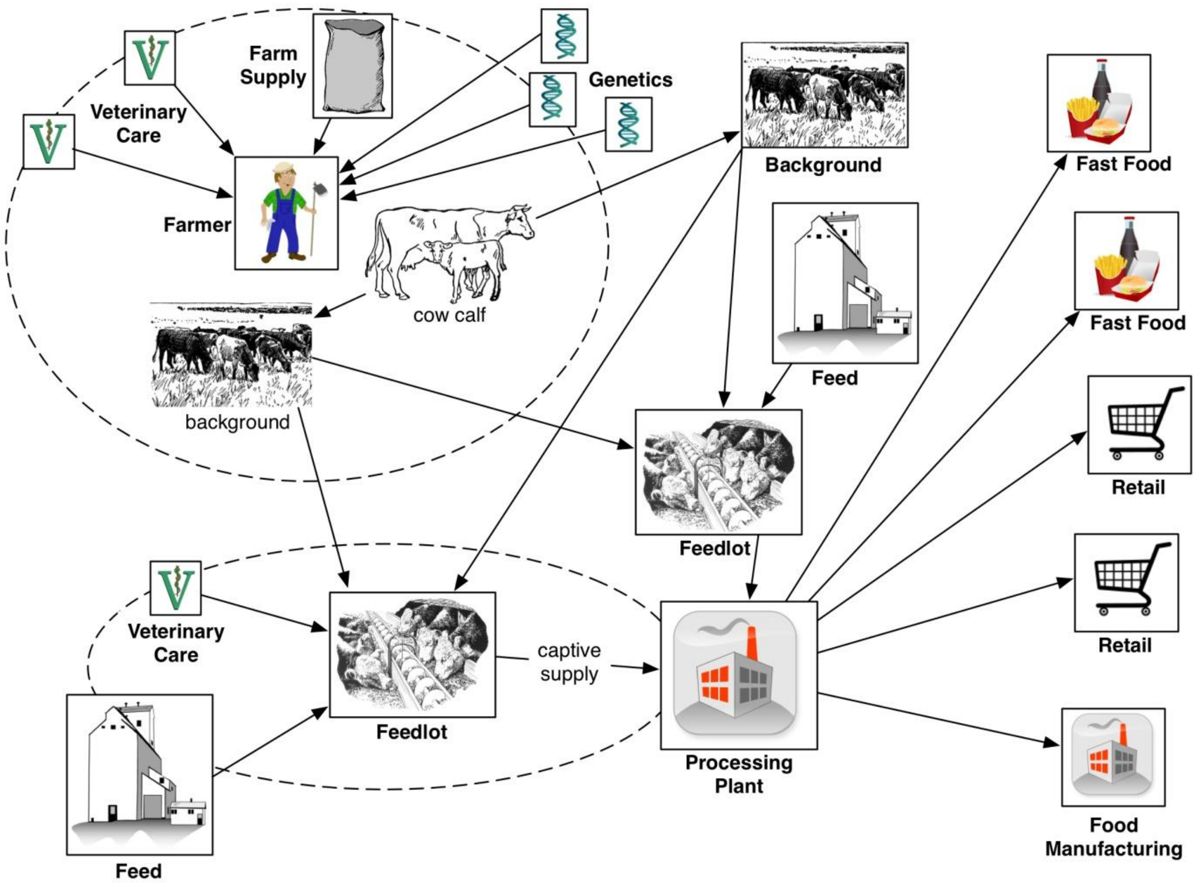

Figure 3. Typical relations among cattle growers, feedlots and other agents in beef cattle networks.

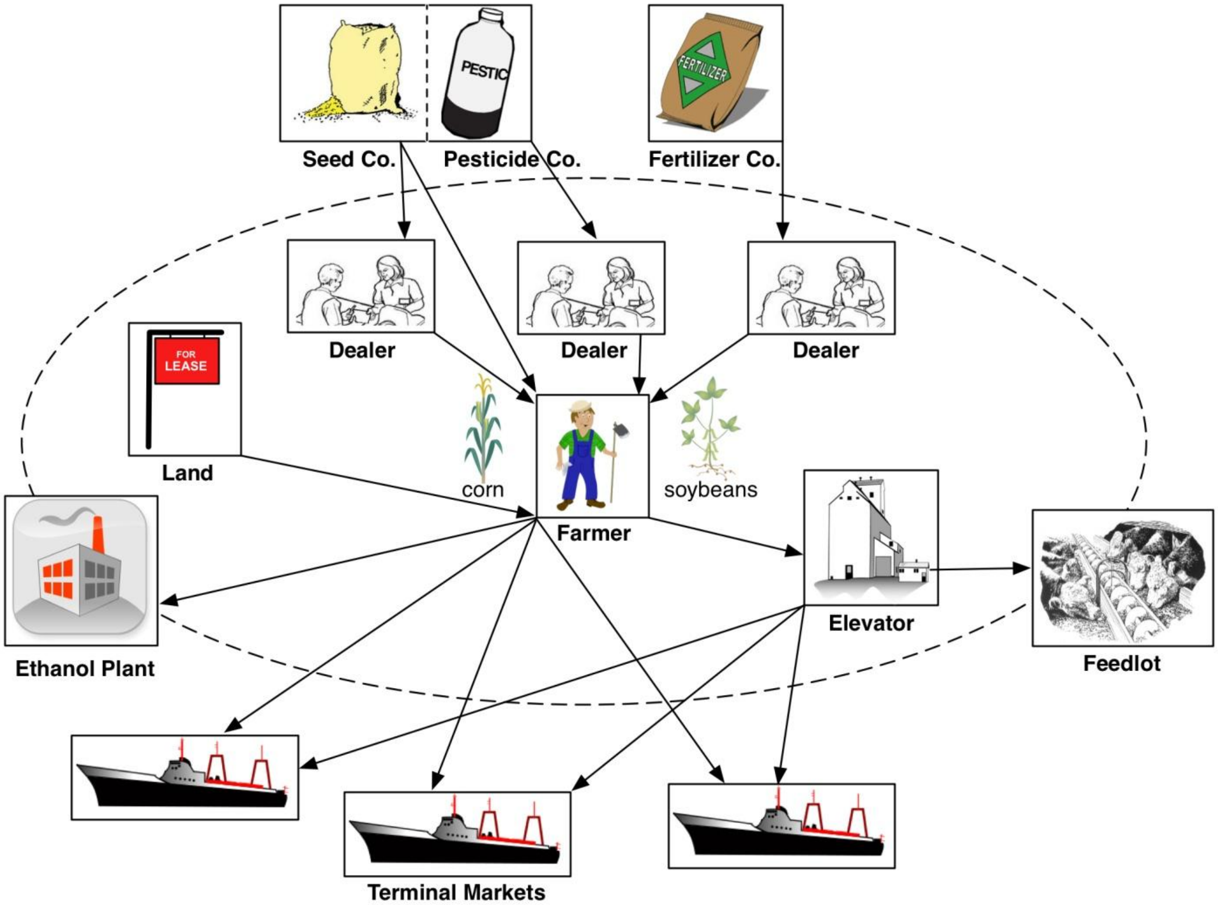

Figure 4. Typical relations among farmers and other agents in corn and soybean commodity crop growing networks.