Aligning Incentives for Accelerated Heifer Growth in Custom Heifer Growing Contracts

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Abstract: Dairy managers today are faced with the decision to either raise their own replacements on the dairy farm or send heifers to a custom heifer grower. The largest potential challenge of contracting out the heifer raising enterprise revolves around the potential for a moral hazard problem because of hidden action on the part of the custom heifer grower. A principal-agent framework was used to elicit contract terms which provide incentives for the custom heifer grower to perform accelerated growth without heifers becoming over-conditioned. In order to provide incentives to custom growers, heifers returned to the dairy farm should be compared in performance to other heifers of similar age. We solve for the price paid per pound of gain, price paid for inch of wither height above the average heifer on the operation, deduction per unit of body condition score over or under ideal body condition score, and percent of the value of milk production above the average milk production by herd peers. Such comparisons are similar to tournament contracts, such as those used in raising poultry or swine.

Keywords: contracts, heifer growth, moral hazard

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While dairy farms have been increasing in size and specialization for decades, recent years have witnessed an acceleration of these trends. As farms continue to become larger and more consolidated, they are also becoming increasingly specialized. As farms become specialized in milk production, farm managers are assessing their 'comparative advantages', leading to increased attention paid to opportunity costs on the farm operation. For example, enterprises not directly resulting in milk sales (e.g., crop production for feed, heifer rearing, raising beef steers, custom harvest operations) are assessed in terms of the opportunity cost of maintaining these enterprises versus expanding the number of milking cows (increasing milk production and sales). The opportunity costs on the farm can be assessed in terms of what else the management, labor, and capital used to maintain the heifer operation, for example, could generate if it were utilized in another productive process. Often, given management time, labor, and capital constraints farms are outsourcing activities that were once managed and performed on the dairy operation when it was likely smaller and more diversified (Wolf). A common choice for dairy farms specializing in milking cows is to outsource the heifer rearing to a custom heifer grower. A custom heifer grower generally takes heifer calves from the dairy farm within the first week of calf life and is responsible for raising that calf until she is bred and returned to the farm just prior to first calving.

The cost associated with raising replacements heifers is the second largest expenditure on the dairy farm next to the cost of feed for the milking cows (Heinrichs). Raising heifers involves an investment which will not yield a return until the heifer becomes part of the milking herd or is sold. Raising expenses include cash and non-cash costs. When hiring a custom heifer grower, it is expected that increased cash expenses may be incurred, whereas raising heifers on the dairy farm may include increased non-cash costs (e.g., homegrown feed).

Today, dairy managers recognize that the opportunity costs of the assets, time, and capital devoted to heifer rearing are often too great to continue to raise heifers, or simply recognize that heifer rearing is not a strength or comparative advantage of the farm and that such activities would be better performed by an outside agent. Many of these dairies find that outsourcing the heifer rearing to a custom heifer raiser frees up assets, management, labor, and capital for other activities which the farm may be better suited to capitalize on in other ways. The decision to move the heifers off the farm and to a heifer grower is often based on the dairy farm wanting to make more room available for milk cows, lessen nutrient management problems on the farm, or to free up management time that is currently devoted to calf and/or heifer management (Wolf).

Contracting heifers to an outside heifer grower is, however, not without challenges or disadvantages. The largest potential challenge revolves around the potential for a moral hazard problem because there is potential for hidden action on the part of the custom heifer grower. The dairy farm cannot be certain that the custom heifer grower is putting forth appropriate effort and management in raising his calves. Other potential disadvantages to the dairy producer include losing an outlet for lower quality feeds on the dairy (because often heifers are fed the lower quality feeds on the dairy that may not be fed to milking cows), the possibility of poorer quality replacement heifers, loss of management control, any fixed costs associated with facilities devoted to replacement rearing, and the potential for conflicts with the custom heifer raiser (Endsley, Atkeson and Nott). Further, Wolf and Harsh highlight similar concerns in the potential for increased cash outflows in order to pay a custom grower, loss of management control over heifers, biosecurity risks, and the introduction of the potential for conflict with the custom heifer raiser. Further, we hypothesize that underlying many managers' concerns about moving towards the use of a custom heifer raiser is the notion that the custom heifer grower does not have the same level of incentives as the owner to produce as high quality a heifer as biologically possible

in an efficient and timely fashion. Whether implicitly or explicitly the dairy farm recognizes the moral hazard problem inherent in the situation in which a farm is contracting with a custom heifer grower.

Accelerated Heifer Growth

Recently, accelerated heifer growth potential has been assessed by researchers and U.S. commercial dairymen. Definitions of optimal body size for replacement heifers are necessary among commercial dairy farms in order to effectively evaluate replacement heifer management programs (Hoffman). General agreement within the industry is that heifers should be bred when they achieve sufficient size (generally measured by the weight of the heifer) rather than an age of breeding benchmark (Wolf, Hadrich and Vandehaar).

Common industry benchmarks for Holstein heifer growth, regarding when heifers are expected to be bred and calve for the first time are indicated in Table 1 (Bailey and Murphy). The main driver behind accelerated heifer growth is that given the weight standard in place for breeding, a heifer which grows at a faster rate will achieve the size stipulated for breeding, and therefore for calving and the initiation of lactation, at a younger age (Wolf, Hadrich and Vandehaar). Basically, dairymen are seeking to convert heifers into milk producing cows at an earlier age, in an effort to reduce total heifer raising costs and increase the number of days of productive life for the heifer in the herd.

Recent advancements have indicated that calves and heifers can be managed for 'accelerated growth'. Van Amburgh and Tikofsky define the concept of accelerated growth as, " … a systematic approach to redefining nutrient requirements from birth and setting specific targets and goals from the day of birth that appear to more closely resemble 'normal growth'." Further, Van Amburgh and Tikofsky include that their definition of accelerated growth includes

evaluation of the farm, both in management and environment, to ensure proper management for all factors involved in the success of the rearing system. Clearly, several factors are involved in the management of a successful accelerated heifer growth program. Given the increased intensity of heifer management necessary for accelerated heifer growth, dairy farms must determine how to provide incentives for custom heifer growers to put forth maximum effort in raising calves.

Challenges associated with accelerated heifer growth revolve mainly around the desire to have heifers reach breeding size at a faster rate, but also for heifers to have the appropriate body conditioning and stature. Van Amburgh et al. observed that animals fed for accelerated weight gains had higher body condition scores and were shorter (when measured in height to the withers) than those not accelerated. If heifers are simply pushed to gain weight without careful balances of nutrients developed for optimal growth rates, they can become over-conditioned. Dairy science research suggests possible adverse affects of accelerated heifer growth include a decrease in subsequent milk production (see Mourits et al. and Van Amburgh et al.). Additionally, heifers that are over-conditioned have higher probabilities of dystocia (difficulty) during calving. Dystocia is linked as a contributing factor to reduced milk yield (Dematawewa and Berger), increased incidence of health concerns and metabolic disorders, and decreased fertility (Dematawewa and Berger). Detrimental effects on subsequent milk production, coupled with dystocia, which may lead to further depression of future milk production, are a major concern for dairymen considering accelerated heifer growth. Thus, accelerated heifer growth requires careful management of the feed program.

Dairy producers interested in accelerated heifer growth must pay special attention to the nutrient balance in feed for calves and heifers and closely manage the environment in which heifers are raised. Given the increased management time and expense associated with accelerated heifer growth, it is hypothesized that since aligning incentives for raising heifers is difficult,

creating incentives for additional effort, expense, and care with accelerated growth will require a complete rethinking of the contract design. Moral hazard is a concern in custom heifer rearing. This paper seeks to prescribe a contract which aligns incentives for custom heifer raisers to perform accelerated heifer growth, and monitor heifers adequately as far as structure and body condition score[1] in order to minimize any potential for decreased milk production in the future.

Adequate frame growth, rather than more inexpensively achieved weight gain (i.e., bodyfat), is what the dairy farmer desires. The concern, however, is that it is less costly to achieve weight gain in which heifers become over-conditioned but do not have adequate frame-size. Therefore, the dairy farmer seeks to create a contract which provides the incentives for the custom heifer grower to perform accelerated heifer growth – which will require more effort and higher costs than simply having heifers gain weight quickly and become over-conditioned.

Contracts are important in order to formalize agreements between the dairy farm and the heifer grower (Wolf). Endsley, Atkeson and Nott recommend that a written contract should be used to establish the management and economic conditions regarding the heifer growing agreement. Furthermore, formal contracting with custom heifer raisers makes logical sense because of the sizeable investments in relatively specific assets that are needed in order to raise heifers. The degree of asset specificity for heifer rearing is not nearly as great as in poultry, or even pork, production however barns of adequate size, feed storage, and machinery are necessary in order to continue raising heifers. These assets could be reallocated to dairying or to use with another species of livestock, although some renovation would be necessary.[2]

[1] Body condition scoring is a scoring system from 1 to 5, used for dairy cattle to assess the conditioning of the animal. A body condition score of 1 indicates a very thin animal and a body condition score of 5 indicates an extremely fat animal. Scoring standards exist within the industry and many industry professionals provide body condition scoring assistance.

[2] The degree to which buildings would need to be renovated will vary greatly across operations. Overall, asset specificity in heifer rearing is generally less than in other livestock production, although some degree of specificity is

A recent survey by Wolf (2003) indicated that of 61 custom heifer growers responding to his survey, sixty-nine percent used some form of a written contract. Further, several payment schemes were utilized in these contracts. Example payment schemes and the percentage of the sample reporting the use of each scheme are displayed in Table 2.

Many of the contracts currently used in the industry are fixed-payment contracts, meaning that the custom grower receives a fixed payment (either daily or per-heifer raised) for their services, irregardless of performance.[3] Such fixed-payment contracts are similar to fixed-wage contracts, in which there exist incentives for shirking, unless effort or performance is being closely monitored. Given the nature of heifer rearing, close monitoring by the dairy farm will almost surely be prohibitively expensive, as often a raiser is used to free management and labor time on the dairy farm, and thus additional labor required for monitoring would be counterproductive.

Prescriptive Analysis and Optimal Heifer Growing Contracts

Contracts which prescribe payment per pound of weight gain most closely approximate the type of contract proposed for aligning incentives for accelerated growth. Challenges remain, however, in making sure that growth achieved is growth in stature, depth, and frame size rather than fat which will be detrimental to the future heifer performance.

In order to provide incentives to heifer growers, heifers should be compared to their peers for evaluation, meaning heifers, once returned to the dairy farm, should be compared in

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present. Certainly, knowledge associated with raising and breeding heifers is specific to dairying, if not heifer rearing specifically.

[3] It is acknowledged that even within fixed-payment contracts there is often a clause for death loss of calves. Generally, a set mortality rate of calves at the heifer grower is considered "acceptable" to the dairy farm. If this level of mortality is exceeded, there is generally some provision for shared liability for the loss of additional calves between the dairy farm and the grower. Such agreements regarding calf mortality are acknowledged, although they are not the focus of this analysis.

performance to other heifers of similar age. By comparing the performance across heifers in the herd, performance across multiple heifer growers can be assessed. Such comparisons are similar to tournament contracts, such as those used in raising poultry or swine.

Knoeber assessed the use of tournament contracts in broiler production, and determined that tournaments used in growing broilers are not intended to identify a winner or the most capable grower, but to provide incentives to growers. Knoeber went on to identify difficulties in broiler tournament contracts, including that if the relationship between effort of the grower and the output is too deterministic, that an equilibrium may not be identified. Additionally, if those involved in the tournament are aware of ability differences amongst themselves, the lowest ability person may not see incentive for effort – and may just concede to accepting the lowest position within the tournament. Either of these challenges can result in decreased incentive for the participants of the tournament. Knoeber highlights advantages to tournament contracts used in broiler production that are applicable to dairy heifer rearing, including that tournaments save monitoring and measuring costs because comparison to relative performance is allowed.[4] Further highlighted by Knoeber is that tournaments are easily adjusted and flexible arrangements which eliminate the incentive for the principal (dairy farmer here) to conceal information from the growers.

Heifer rearing offers some challenges aside from those observed in the broiler industry, when considering tournament contracts. Custom heifer grower facilities vary by individual operation, and many are refurbished dairy operations that previously housed milking cows. Custom grower facilities are generally more diverse than poultry or swine custom growers, making comparison across growers more difficult than with swine or poultry, where facilities and

[4] By allowing comparison to relative performance rather than the necessity to measure absolute performance, monitoring and measuring costs can be saved. These savings are possible because tournaments difference out the effects of common shocks which would be experienced by all raisers.

feed are more standardized. Further, there are fewer boundaries to entry to begin custom growing heifers than would be seen in poultry or swine production because there are more individual dairy farms with which to contract than there are poultry or swine integrators.

Several factors also make heifer rearing well-suited to aspects of tournament style contracts. Since heifers are coming from a single dairy farm, genetics of heifers sent to multiple growers should be comparable, assuming that heifers are not selected for quality by the farm when determining heifers to be sent to various growers. Further, heifers return to a single milking operation from the heifer raiser, so comparisons of performance once returning to the dairy farm are possible.

Principal Agent Model

With the above analysis in mind, a principal-agent framework was used to elicit contract terms which would provide incentives for accelerated heifer growth to the custom heifer raiser. A key assumption underlying the development of the following model is that a written contract exists between the dairy farm and the custom heifer raiser. A formal written contract is needed in this analysis due to the increased complexity in contracting for accelerated heifer growth versus previously used custom heifer raising contracts.

Underlying assumptions in the development of the model include that the principal (the dairy farm) is risk neutral and that the agent (the custom heifer grower) is risk averse. Further, the dairy farm is assumed to be using more than one custom heifer grower at any given time.[5] The principal is seeking to maximize the total expected profit of the farm. Given the heifer rearing enterprise is only a small portion of the total farm business, within the heifer enterprise

[5] The potential for the use of more than one heifer grower by a single dairy farm is increasing as farms become more specialized and larger in scale. Large-scale dairy farms are likely to employ more than a single raiser given calves will be born throughout the year and 'overflow' is likely if only a single raiser is employed.

the dairy farm is seeking to minimize total costs subject to heifers being returned from the grower at a certain weight (which is determined by the preferences of the dairy farm). Thus the principal wishes to have the custom heifer growth accelerated, and is seeking to provide contract terms that provide the correct incentives. Given these constraints, the principal's problem can be expressed as minimizing heifer rearing costs as follows, subject to individual rationality and incentive compatibility constraints:

$$\underset{P_{lb},STATB_B BCS_D,MP_B}{Minimize}\ C_H = \left(LB_{Gain} * P_{lb}\right) + \left(Max\left(HGT_{Shoulder} - HGT_{Avg},0\right) * STAT_B\right) - \left(\left|BCS - BCS_{Ideal}\right| * BCS_D\right) + \left[MP_B * P_{Milk/lb} * 305days * Max\left(LACT - LACT_{Avg},0\right)\right]$$

$$s.t.\ \text{FINAL}_{\text{Weight}} = f\left(LB_{Gain}; BTH_{Weight}, HEALTH, BREED, GENETICS, OTHER\right) \geq X = g\left(PREF_{Owner}; BREED, GENETICS, OTHER\right)$$

$$IR = EU = \left[\lambda * U\left[\begin{array}{l}(LB_{Gain} * P_{lb}) + MP_B * P_{Milk/lb} * 305days * \\ Max(LACT - LACT_{Avg},0) + \\ (Max(HGT_{Shoulder} - HGT_{Avg},0) * STAT_B) - \\ (\left|BCS - BCS_{Ideal}\right| * BCS_D) - ACCEL_{Costs}\end{array}\right] + (1-\lambda) * U\left[\begin{array}{l}(LB_{Gain} * P_{lb}) - \\ \left(\left|BCS - BCS_{Ideal}\right| * BCS_D\right) \\ - ACCEL_{Costs}\end{array}\right]\right] \geq EU(RESERVATION)$$

$$IC = EU = \left[\lambda * U\left[\begin{array}{l}(LB_{Gain} * P_{lb}) + MP_B * P_{Milk/lb} * 305days * \\ Max(LACT - LACT_{Avg},0) + \\ (Max(HGT_{Shoulder} - HGT_{Avg},0) * STAT_B) - \\ (\left|BCS - BCS_{Ideal}\right| * BCS_D) - ACCEL_{Costs}\end{array}\right] + (1-\lambda) * U\left[(LB_{Gain} * P_{lb}) - \left(\left|BCS - BCS_{Ideal}\right| * BCS_D\right) - ACCEL_{Costs}\right]\right]$$

$$\geq EU = \left[\lambda * U\left[(LB_{Gain} * P_{lb}) - \left(\left|BCS - BCS_{Ideal}\right| * BCS_D\right) - NONACCEL_{Costs}\right] + (1-\lambda) * U\left[\begin{array}{l}(LB_{Gain} * P_{lb}) + MP_B * P_{Milk/lb} * 305days * \\ Max(LACT - LACT_{Avg},0) + \\ \left(Max\left(HGT_{Shoulder} - HGT_{Avg},0\right) * STAT_B\right) \\ - \left(\left|BCS - BCS_{Ideal}\right| * BCS_D\right) - NONACCEL_{Costs}\end{array}\right]\right]$$

where :

LB_{Gain} = pounds of gain while under the care of the heifer grower,

P_{lb} = the price paid to the heifer grower per pound of weight gain while under the care of the heifer grower,

$HGT_{Shoulder}$ = the height, in inches, to the shoulder of the heifer upon returning to the home farm,

HGT_{Avg} = the average height, in inches, to the shoulder of heifers in the herd upon returning to the home farm,

$STAT_{B}$ = the price paid per inch of height for the specific heifer over the average height of heifers of her age to the custom grower,

BCS = the body condition score of the heifer upon returning to the home farm,

BCS_{D} = the deduction per unit of body condition score difference from the ideal body condition score for a springing heifer that will be taken from what the heaifer grower is paid,

BCS_{Ideal} = the body condition score which the home farm has established as the ideal body condition score at which springing heifers should return to the farm,

MP_{B} = the percent of the value of the milk production of this heifer over and above the average milk production for first lactation heifers in the herd which will be paid to the heifer grower at the end of the 305 day lactation of the heifer,

LACT = average daily milk production of heifer,

$LACT_{Avg}$ = average daily milk production of first lacataion heifers in the herd,

$P_{Milk/lb}$ = the average price received for milk (per pound) over the 305 day lactation,

$FINAL_{Weight}$ = the weight at which the heifer is returned to the home farm from the heifer grower's,

BTH_{Weight} = the birthweight of the calf (proxy for the weight at which the heifer arrives at the heifer grower)

$PREF_{Owner}$ = the preferences of the owner of the heifer,

X = some predetermined weight at which the heifer will return to the home farm (deteremined by the owner of the heifer),

RESERVATION = another option which the heifer grower could pursue rather than growing heifers for this farmer.

$NONACCEL_{Costs}$ = costs incurred by the heifer grower if accelerated heifer growth is not done,

$ACCEL_{Costs}$ = costs incurred by the heifer grower if accelerated heifer growth is done,

$HQFEED_{Costs}$ = feed costs incurred by the heifer grower if accelerated heifer growth is done (assumes the use of high quality feeds),

$NONACCEL_{Costs}$ = costs incurred by the heifer grower if accelerated heifer growth is not done

$LQFEED_{Costs}$ = feed costs incurred by the heifer grower if accelerated heifer growth is not done (assumes the use of low quality feeds),

Underlying the above relationships are the following definitions:

$$LB_{Gain} = FINAL_{Weight} - BTH_{Weight},$$
$$ACCEL_{Costs} = h(HQFEED_{Costs}, EFFORT, ENVIRONMENT, OTHER), and$$
$$NONACCEL_{Costs} = j(LQFEED_{Costs}, EFFORT, ENVIRONMENT, OTHER).$$

In essence, the pounds of gain are calculated simply by subtracting birth weight from the final weight at which the heifer is returned to the dairy farm. Additionally, the costs associated with accelerated and non-accelerated growth are defined as functions of the quality of feed used, level of effort put forth by the agent, and other farm management and environmental factors. The exact functional form determining the costs associated with accelerated or non-accelerated heifer rearing programs will differ across regions, custom heifer grower operation sizes, and levels of efficiency. The development of such functional forms are beyond the scope of this paper, although it is important to note that the costs associated with accelerated heifer growth will exceed those associated with non-accelerated heifer growth. Therefore, given the lower costs associated with non-accelerated heifer growth, in the absence of proper incentives, custom heifer growers will shirk by not shouldering the costs (or providing the effort) necessary for accelerated growth.

It is important to note throughout this analysis that the outcomes associated with accelerated heifer growth are not certain. It is entirely possible, and expected some proportion of the time, that even if all necessary efforts, feeds, and environmental qualities are provided by the custom heifer raiser, some heifers will not perform to the level necessary to achieve bonuses. Reasons which may affect whether a heifer performs well enough to received bonuses, and which

are at least partially outside the control of the grower are disease, initial calf health, infertility (which would delay the timing until the heifer was pregnant and returned to the farm), and heifer genetic potential. These issues are attempted to be captured by comparing the performance of the heifer to the average in the herd.

The probabilities of achieving and not achieving bonuses given the costs associated with accelerated heifer growth are incurred are assumed as follows:

$$\text{Probability (Any Bonuses or Premiums} \mid \text{Accelerated Growth Costs Incurred)} = \lambda,$$
$$\text{Probability (No Bonuses or Premiums} \mid \text{Accelerated Growth Costs Incurred)} = (1-\lambda),$$
$$\text{Probability (Any Bonuses or Premiums} \mid \text{Accelerated Growth Costs Not Incurred)} = \Omega, \textit{and}$$
$$\text{Probability (No Bonuses or Premiums} \mid \text{Accelerated Growth Costs Not Incurred)} = (1-\Omega)$$

Further, and perhaps most importantly for the incentives within the model, the probability of achieving bonuses given costs associated with accelerated heifer growth are incurred is greater than the probability of achieving bonuses given such costs are not incurred, $\lambda \geq \Omega$.

Overall, the principal seeks to select the price paid per pound of gain, the price paid for inch of height over and above the average heifer in the operation, the deduction per unit of body condition score over or under the ideal body condition score (as determined by the dairy farm management), and the percent of the value of milk production over and above the average milk production by the heifer's peers in the herd. As stated prior, body weight is not the best predictor of future heifer performance. Markusfeld and Ezra reported that the height of Holstein heifers at the time of first calving was a better determinant than bodyweight of peak and 305 day first lactation milk. Seiber et al. concur observing a positive relationship between the height at withers, chest depth, paunch girth, or pelvic width, and the milk yield of the first lactation, as compared to simply heifer body weight.

The height of the heifer and body condition score of the heifer are included in order to assess the size and structure of the heifer upon her return to the dairy farm. Body condition scoring, as it is somewhat subjective, should be performed by an outside party which is approved by both the dairy farm and the custom grower. To further strengthen the incentives within the contract, a third party would ideally be utilized for not only body condition scoring, but also for assessing the height of the heifer and verifying the milk production records. The same third party certifier of heifer body condition score, height, and milk production should assess all heifers for a given dairy farm – allowing the comparison among heifers from various growers to be as fair as possible and eliminating concern on the part of the grower that a dairy farm may seek to misrepresent the performance of the heifer once she arrives back at the farm to avoid paying performance premiums. On many commercial dairy farms, milk production records are already verified by an outside agency, such as the Dairy Herd Improvement Association (DHIA), so milk production levels can be easily verified. Additionally, a third party for body condition scoring and heifer weighing should be easily found by most dairy operations, as often veterinarians or other industry professionals are able to offer such services (particularly if there is an existing relationship with the farm).[6]

The individual rationality constraint is necessary to ensure the participation of the agent in the contractual agreement. In this case, in order for the agent (heifer grower) to participate in the contractual agreement, the expected utility that is obtained from participation must be greater than the reservation utility. In other words, the expected utility from accepting these contract terms and expending the costs necessary for accelerated heifer growth must be greater than the reservation utility. The reservation utility of the agent is the utility that is expected from the

[6] Given the ease with which third party verification should be accomplished on most dairy farms, the added costs of third party verification are ignored for this analysis.

agent's next best option (which may be raising heifers for another farm which does not desire accelerated heifer growth, for example).

The incentive compatibility constraint is necessary in order to assure that the custom heifer raiser has the incentive to perform accelerated heifer growth. In other words, the contract must be constructed in such a way that the custom heifer grower has a higher expected utility from performing accelerated heifer growth than from shirking and not attempting accelerated heifer growth.

Underlying the above analysis, although not explicitly contained within the contract are the issues of reputation, repeated interaction between the two contracting parties, and the amount of trust between the two parties. For starters, the reputation of the dairy farm and the heifer grower in the industry are integrally important to establishing the above contract. Since heifers will be transported between the dairy farm and the custom heifer grower, the location of the farm with respect to the heifer grower is important. Farms will not wish to move animals great distances, and therefore, the reputation of the farms or custom growers within a certain geographical area will be an important factor. Additionally, there would ideally be some trust that given good performance with previous heifers that additional calves would be contracted to the same grower. Assuring growers that good performance will be rewarded with repeat business will strengthen incentives for high effort. Given the amount of natural variation in heifer performance and the positive probability that although maximum effort is expended by the grower that the heifer may not perform well enough to achieve bonuses, it would be ideal if a grower had multiple calves from a given dairy farm. If a grower were to raise only a single calf from a given dairy farm, there would likely be decreased perceived incentives by the grower because there is a chance that the calf could perform poorly irrespective of the amount of effort put forth. Having multiple calves could lessen the possibility that a genetically inferior or poor

quality calf was received, because there would exist multiple calves with the potential to achieve bonuses. In these ways, having a long-term relationship, trust between the contracting parties, and having multiple calves at a single grower will strengthen the incentives underlying the contractual agreement.

Conclusion

The topic of contracting between dairy farms and custom heifer growers for accelerated heifer growth is of increasing importance and increasing numbers of farms are engaging in such arrangements. A principal-agent framework was used to elicit contract terms which provide incentives for the custom heifer grower to perform accelerated growth without heifers becoming over-conditioned. The largest potential challenge of contracting out the heifer raising enterprise of a dairy farm revolves around the potential for a moral hazard problem because of hidden action on the part of the custom heifer grower. We seek to solve for the price paid per pound of gain, price paid for inch of wither height above the average heifer on the operation, deduction per unit of body condition score over or under ideal body condition score, and percent of the value of milk production above the average milk production by herd peers. Comparing heifers from custom growers to other similar heifers from the herd is an approach similar to tournament contracts, such as those used in raising poultry or swine.

As individual agricultural producers become more specialized there will be increased need for contract development to align incentives due to more farm inputs being purchased from outside providers. The increased use of such contracts can be expected in all production agriculture sectors and is not limited to dairy cattle, or even livestock, production. Therefore, eliciting contract terms which align incentives for accelerated heifer growth will generate discussion for analogous issues in various agricultural sectors.

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Table 1. Heifer Raising Benchmarks

Benchmark Event	Criteria
First breeding	785 pounds
	14-15 months of age
First calving	1350 pounds
	24 months of age

Source: Bailey, T. and J. M. Murphy, 1999

Table 2. Pay Schemes for Custom Heifer Growing

Contract type	Percent of Survey Respondents
Daily charge	51.6%
Sell-buy back	12.9%
Gain based (lbs of weight gain)	12.9%
Feed cost plus yardage	1.6%
Set payment per heifer	4.8%
Combination of methods	16.1%

Source: Wolf, 2003.