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Innovative Heifer Development Increases Lactation Potential

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The economic future of any livestock operation depends largely on a sound rearing program for replacement animals. The success of replacement heifers, in turn, is determined by efficiency of body growth and, more importantly, subsequent lactation potential. For nearly 20 years, NDSU has been studying nutritionally-directed compensatory feeding programs for developing dairy (Ford & Park, 2000; Park et al., 1987, 1989) and beef (Park et al., 1998) heifers, gilts (Crenshaw et al., 1989) and young female rats (Park et al., 1988, 1994; Kim et al., 1998). These programs improve animal growth, mammary gland development, and enhance lactation potential.

Stair-step nutrition regimen. The basic idea of our compensatory regimen (commonly called stair-step) is to exceed energy requirements at times when the heifer can make the best use of it, (during hormone-sensitive developmental stages, i.e., puberty/breeding, gestation) and reduce energy levels when the animal is not as likely to put it to good use. Most of Dr. Park's research with growing dairy heifers has centered on a three-step feeding schedule of restriction and high-energy diets that starts when the heifer is about six months of age.

1. In the first step, calves are fed for three months (age six to nine months) on an energy-restriction diet that contains 70 percent of the average energy consumption of the control animals. Protein nutrition is maintained at National Research Council (NRC) dairy levels by increasing the crude protein from 12 percent to 17 percent of the dietary dry matter. At nine months of age, heifers are switched over to a high energy diet containing 130 percent of the NRC energy requirements for two months.
2. During step two, puberty and breeding, heifers are about 11 months of age. They are placed on another energy restriction diet for a period of four months, followed by two months of a high energy ration. Heifers are usually bred during the high energy phase at approximately 16 months of age.
3. During step three, (gestation) 17 month old heifers are again fed an energy restriction ration for five months and then moved to high energy (130 percent) the last two months until prepartum for calving at 24 months of age.

Heifer growth and lactation potential. Heifers raised on a stair-step regimen consume less feed and have higher daily gains resulting in significantly improved growth efficiency. Overall, growth efficiency (weight gain divided by dry-matter intake) for the stair-step heifers is 13 percent (range of 8-16 percent), compared with just over 8 percent (range of 4 to 14 percent) for conventionally fed animals. Multiple lactation records show that stair-step heifers produce 10 percent more milk than traditionally-fed counterparts. This increase in milk yield from first-calf heifers amounts to approximately 1,984 pounds of milk per heifer over 250 days while achieving post-calving weights close to their control counterparts (Park et al, 1989).

More recently, heifers raised on the stair-step regimen have a significant increase in milk yield during the first (21 percent) and second (15 percent) lactation (Ford and Park, 2000). Others

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Data Flow: Will It Be There?

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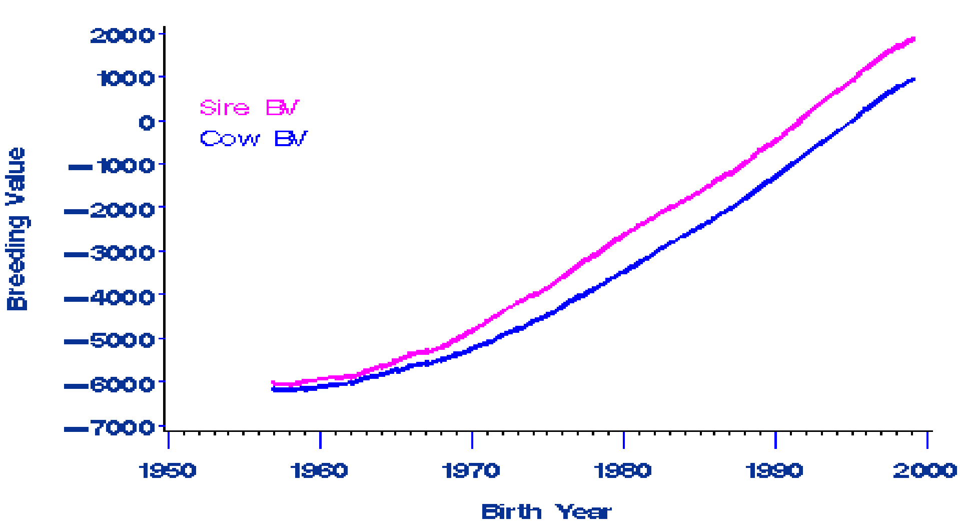
Proper genetic evaluation depends upon the flow of producer data to a central processing facility that ultimately forwards the data to the Animal Improvement Program Laboratory (AIPL). The United States Department of Agriculture (USDA) started collecting milk and fat production records of individual cows in 1895. An organized national milk-recording program was in place in 1908. Since then Dairy Herd Improvement (DHI) has been a keystone of the dairy industry. In 1935 only 2% of dairy cows were enrolled in a milk-recording program, but access to that data provided the first national sire evaluation, calculated from daughter-dam comparisons in 1936, that allowed producers to select potential herd sires on production merit.

Many advances have been incorporated into the program since those humble beginnings. The adoption of computer processing in 1951 by Bliss Crandall and Lyman Rich led to the development of state and regional processing centers. Eliminating hand calculation of records increased availability and decreased the cost of DHI to all dairy farmers. With the development of electronic procedures to analyze milk fat, laboratories were established to test for milk fat centrally, increasing reliability of the estimates and reducing the cost to analyze a sample. Additional instrumentation was developed to test for protein and somatic cells, then these components were added to the database. The AIPL incorporated these variables into the genetic evaluation programs, providing producers more tools with which to optimize their herd's genetic improvement.

Allowing a large number of producers access to the program has resulted in dramatic increases in the number of records that flowed to AIPL for genetic evaluation. In 1970, DHI had 839,343 cows enrolled. By 2001, enrollment increased to 4,226,692 cows. In recent years, much of this increase in participation was due to the development of alternative testing plans. These plans provided producers greater flexibility in choosing milk-recording plans that fit their needs. For example, not all milkings in a 24-hour period had to be sampled, nor samples taken at all or any of the milkings. With the evolvement of innovative testing programs and the removal of the "official" label on records, AIPL adopted a weighing factor for data that permitted the use of several new types of records in their system. Quality was measured as to number of times a cow's milk was weighed in a 24-hour period, sampled in a 24-hour period, and sampled in her lactation.

Figure One: Change in Milk Breeding Values for Holstein Cattle, Calculated February 2002.



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(Heifer Development, continued from page 1)

(Barash et al, 1994; Choi et al, 1997; Peri et al, 1993; Yambayamba and Price, 1997) have also reported an increase in milk yield in first lactation dairy heifers raised under a similar regimen.

Boosting mammary cells. During energy restriction, the animal does not get a full load of energy. Mammary development of the restricted heifers lags behind that of those that are conventionally raised. However, when energy suddenly becomes available during the high-energy feeding period, the animal does not waste the energy (e.g. for making fat cells). Instead, the energy is used for stimulation and fuller growth of milk-producing cells in the udder. Therefore, the increase in milk yield is attributable to permanently increasing both milk-producing cell number and cell size in udder tissues (Ford and Park, 2000; Moon and Park, 1999).

Working Model for Heifer Rearing. It has been repeatedly said that high feeding intensity (i.e., unregulated excessively high plane of nutrition) imposed during prepubertal phase, in particular, causes a severe reduction in milk yield potential (Little and Kay, 1979; Sejrsen et al., 1982). However, other studies have been shown a positive (Park et al., 1987, 1989, 1998; Choi et al., 1997; Ford and Park, 2001) or no (Gardner et al., 1988; Van Amburgh et al., 1998) relationship between prepubertal accelerated growth and lactation performance. These discrepancies may be due to differences in growth model (e.g. regulated vs uncontrolled growth rate) or type of nutrition regimen (e.g. energy intake vs total feed intake), as well as age and hormonal state (e.g. prepuberty, puberty, or gestation) during which the nutrition regimens were examined.

We, as well as others (Barash et al., 1994; Choi et al., 1997; Mantysaari et al., 1999; Peri et al., 1993; Yambayamba and Price, 1997), have shown that heifers raised on a well-controlled nutrition regimen (i.e., energy realimentation following a period of energy restriction) during certain hormone-sensitive growth stage(s) can significantly affect mammary development and lactation potential.

While this multi-step nutrition regimen is effective for heifer development and life-long performance, dairy and beef producers and animal scientists are demanding a simplified compensatory growth nutrition program. We are investigating one-step models focusing on the last two trimesters of gestation. We believe that gestation is the most critical stage of mammary development because the majority of mammary growth occurs during this time. Also, compensatory growth established during the last trimester of gestation may improve overall metabolic status of prepartum heifers (i.e., health during transition period).

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(Data Flow, continued from page 3)

In 1997, AIPL used just 2.5 million cows of the 4.5 million cows submitted for their genetic evaluation. With more records and more variables, AIPL has continued the development of genetic evaluation. The adoption and use of this technology by dairy farmers has resulted in a continual increase in the breeding values of the dairy population (Figure 1). In 1999, the National Dairy Shrine survey ranked genetic evaluation as the second most positive and significant change in the last 50 years behind artificial insemination.

Advances in microcomputers and larger size production units have jeopardized data flow. With the introduction of microcomputers into dairy management in the early 1980's, software development followed two paths. One route used a program that was intended for on-farm use only. Data did not flow to any other database. The alternative path allowed for on-farm use as well as submitting data to a central location for database maintenance. This insured that both databases were in agreement as of the last processed date or the last time the producer had sent data to the mainframe. In recent years, this distinction has become less defined since methods evolved for farm-only programs to forward their data to a central location. When the on-farm database remained "master", corrections made on the mainframe needed to be conveyed and made on the on-farm systems. If this is not done, the two databases differ.

Although the flow of records to AIPL has been maintained so far, the elimination of state borders for DHIA's and the ability of a producer to elect where his records are processed, has impacted state/regional databases. Now if a state wishes to maintain a database, data has to be collected from each center servicing that state. In the case of Texas, data flows from four different processing centers. The records are in different formats and different procedures are used to calculate certain management variables. This has resulted in some herds not being in the centralized database for all months. In addition, herds with independent programs are not in the database. In Texas, stand-alone programs currently account for 15% of the herds. Databases at one time included all herds enrolled in DHI, now they are missing key segments of the total dairy population. At some point the loss of information will jeopardize the accuracy of these databases for evaluating industry trends and in sire evaluation.

Different uses of records are emerging. As producers start to think of their operation as a production process, the need to have data to detect a change becomes a critical management need. As herds continue to increase in size, management strategies become more dairy specific. Microcomputer capability negates the need for central processing.

(Data Flow, continued from previous column)

As similarly managed herds seek to make comparisons, databases maintained by third parties that contain only those herds are becoming a more common occurrence. Some processing centers have established benchmarking programs for a herd to be compared against their cohorts, however if the records are not in the database, comparisons become a mute point. Additionally, the question of data access continues to increase. Once records leave a dairy, they are maintained in a central database and those records are accessible by outsiders. No standard exists for how long a record is maintained in a central database. For example, some processing centers do not keep records after a cow is culled, while others keep her in the active herd for a specific number of months and then archive her to the dead file. If data is maintained, that data is accessible by both producers and industry professionals.

The processing center is becoming less of a focus as a data gatherer in the dairy industry. With alternative databases being developed, shifting some data away from a central database, the controversy rests with whether producers receive benefits from allowing their records to flow for general use. As more producers think of their operation as a process, the need to have baseline data from which to determine if a change is taking place becomes a critical and sensitive part of process control. The success of the genetic evaluation program has shown that having access to records for educational programs and research is beneficial to the whole dairy industry. Technology is allowing us to collect more data and calculate and maintain that data where it was collected. We have already started down the road and no one has installed the road signs. Is the industry willing to continue sharing its data for genetic evaluation, research and other industry wide use?

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