SELECTION FOR FEED EFFICIENCY

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The efficiency of feed utilization is traditionally defined as the quantity of feed consumed per lb of gain (or 100 lb of gain) or as the reciprocal, that is, the amount of gain to be obtained per lb (100 lb) of feed consumed.

Of the traits commonly considered in a selection program, reproduction is the most important and feed conversion or feed efficiency is second in importance. The reason for this is obvious in that approximately 70-75% of the costs of gestating and raising a pig to market weight are feed costs. So feed conversion (feed efficiency) is an important trait.

An item of concern about this trait is that it says nothing about the composition of the gain, only the amount of feed needed to produce a certain amount of gain. It may be a pound of fat, or a pound of muscle, probably a little of each.

The feed energy consumed each day is first used by the pig just to maintain its own body. The amount of feed (energy) required for this maintenance depends on the weight of the pig, that is, it requires more feed to keep the body of a 200 lb pig functioning than does a 50 lb pig. Therefore to compare feed efficiency or feed conversion values between animals, it is important that the animals be tested over a constant weight period. An animal that grows fast will have less days in which to maintain its 160 lb (70 lb-230 lb) compared to a pig that grows less fast.

An animal that consumes more feed per day than required for maintenance will then lay down tissue (muscle, necessary fat, and bone) and additional feed will enable the pig to lay down more tissue until that pigs growth potential per day is met. There are different genetic potentials for the growth of muscle, necessary fat and bone per day. Beyond that point fat deposits are laid down. Therefore pigs with a large appetite have a tendency to be less efficient because the extra energy consumed is being used for fat deposition which would require 7 or 8 times the energy compared to a similar amount of muscle deposition. Restriction of the quantity of feed consumed each day could make an animal more efficient if the restriction is not so severe as to restrict its daily tissue growth. This is the reason why some Europeans restrict daily feed consumption, that is to improve the feed efficiency (conversion) and to reduce the backfat. To summarize, the items that influence feed conversion are body maintenance, muscle growth potential and appetite.

Some data to substantiate the importance of appetite (daily feed consumption) and its influence on feed conversion is shown in figure 1. It shows that as average daily feed consumption increases the amount of feed per unit gain decreases, which is desirable, to a point where the daily consumption is average for the group. Beyond this point the feed conversion figure then increases. Because of this the pig with an extremely large appetite has a propensity to be less efficient. At the same time that the average daily consumption increases the probe backfat also increases.

Other work by Iowa State University to indicate the appetite has an effect on carcass composition and thus on feed conversion is shown in table 1. Using animals which have been previously classified as being stress susceptible or stress resistant on the basis of halothane testing shows that the daily gains are reduced slightly in the positive pigs compared to the negative pigs, the feed consumption of the stress positive pig is 1 lb per day less than the stress negative pig. This is reflected in the positive pig having less fat at the 10th rib, more loin eye area and a lower (more desirable) feed conversion than the stress negative animal. If these pigs are indexed using the NSIF index the stress positive pig would index more than 25 points higher than the stress resistant normal pig. The larger portion of this index superiority comes from the much better feed conversion figure. This needs to concern us in the genetic improvement of swine as it appears that selecting on NSIF index would increase the frequency of stress positive animals in the breeding herd. A possible solution could be to correct the various traits of economic importance to a constant daily feed consumption using appropriate adjustment factors.

How effective is selection for improved feed conversion? Recently completed research at Iowa State University indicates that a herd of swine can be improved by selection for lower feed conversion values in individually fed boars. But the amount of improvement is less than previously thought, having a realized heritability of less than 10% (figure 2). Associated with this improved feed conversion was the tendency to have less feed consumption per day (figure 3), slightly more daily gain (figure 4) and backfat that was not changed greatly (figure 5).

In addition to this, even though these animals were individually fed theroretical research indicates that testing in littermate groups is equally as accurate as testing individually (table 2). However if the penmates to be tested are from 2 different dams and one sire a loss of accuracy is noted depending on the number of animals tested per litter because of the decreased relationship among penmates. Therefore if the intensity at which selection takes place is equal for group testing as individual testing the response from selection should be approximately the same.

As was mentioned previously, the feed conversion (efficiency) value does not take into consideration the composition of the tissue being deposited. Because of this a new definition of efficiency has been developed at Auburn University that takes into account the daily muscle growth over a constant number of days per unit of feed consumed while on test. This new efficiency value is called

Daily Muscle Growth Efficiency

where

$$\text{DMGE} = \frac{\text{(lb muscle/day on test) X 70}}{\text{cwt. feed consumed on test (70-230 lb)}}$$

Pounds of muscle was adapted from the NPPC procedure to evaluate market hogs. From this

lb muscle = 2.0 + .33 (live weight) + 5 (loin eye area) - 11 (backfat)

Data from the 1977 fall season of the Iowa Swine Testing Station (96 pens - 288 pigs) were used to examine this new efficiency value with other performance traits and compared with the traditional value for feed conversion and the NSIF index.

Figure 6 shows the affect of daily feed consumption on DMGE, feed conversion and NSIF index. As daily feed consumption increases the feed conversion value also increases (becomes poorer). This is reflected to some extent in the NSIF index. The more a pig eats per day the lower is the NSIF index. With DMGE, daily feed consumption has a very small effect. In fact daily feed consumption is not related to DMGE which is a desirable characteristic of this measure of efficiency.

Figure 7 gives the relationship of average daily gain with DMGE, feed conversion and the NSIF index. DMGE increases quite sharply as average daily gain increases. The NSIF index also goes up as average daily gain goes up but not to the extent as DMGE. The feed conversion value is essentially unchanged as average daily gain increases. This indicates that feed conversion and average daily gain are not associated with each other and to know something about the feed conversion of an animal requires that the feed consumption be measured. It is not good enough to know only the average daily gain. If this relationship holds for pigs that are brought from many herds to a central testing station, it may indicate that a new selection index for central test stations may be needed.

Figure 8 gives the relationship of backfat thickness with DMGE, feed conversion and the NSIF index. Backfat has the largest effect with DMGE indicating that as backfat increases the daily muscle growth efficiency improves. Why this is true is not known.

Figure 9 shows the relationship of DMGE and the NSIF index with feed conversion. As the feed conversion figure increases (becomes less desirable) both DMGE and NSIF index become poorer with the NSIF index being affected slightly more than DMGE.

Conclusions

As feed conversion (efficiency) is one of the more important traits with regards to the costs affecting the swine industry, feed consumption should be measured from a constant weight to a constant weight (70 lb - 230 lb). As the feed conversion value does not take into consideration the composition of the gain some thought might be given to redefining efficiency as daily muscle growth efficiency. This would then give the quantity of daily muscle growth for a constant number of days per unit of feed consumed during the weight constant testing period. As this is the goal of the swine industry, this would be a more realistic measure of efficiency.

Table 1. PERFORMANCE OF STRESS SUSCEPTIBLE AND STRESS RESISTANT PIGS

Trait	Stress Classification +	-
Daily gain (lb)	1.79	1.85
Daily consumption (lb)	5.0	6.0
Fat 10th rib	1.10	1.22
Loin eye area	5.0	4.6
Feed conversion	2.94	3.24
NSIF index	113.7	86.4

Testing period 90 lb - 210 lb

TABLE 2. EFFECTIVENESS OF VARIOUS METHODS IN THE GENETIC IMPROVEMENT OF FEED EFFICIENCY

TRAIT	RELATIVE ACCURACY
F/G, INDIVIDUAL	100
F/G, 2 LITTERMATES/PEN	97
F/G, 5 LITTERMATES/PEN	100
F/G, 2 LITTERS OF 2 PIGS/PEN	85
F/G, 2 LITTERS 3 PIGS PEN	93
F/G, 2 LITTERS 1 PIG PEN	73

FIGURE 1. THE RELATIONSHIP OF AVERAGE DAILY GAIN, FEED PER UNIT GAIN AND PROBE BACKFAT TO AVERAGE DAILY CONSUMPTION.

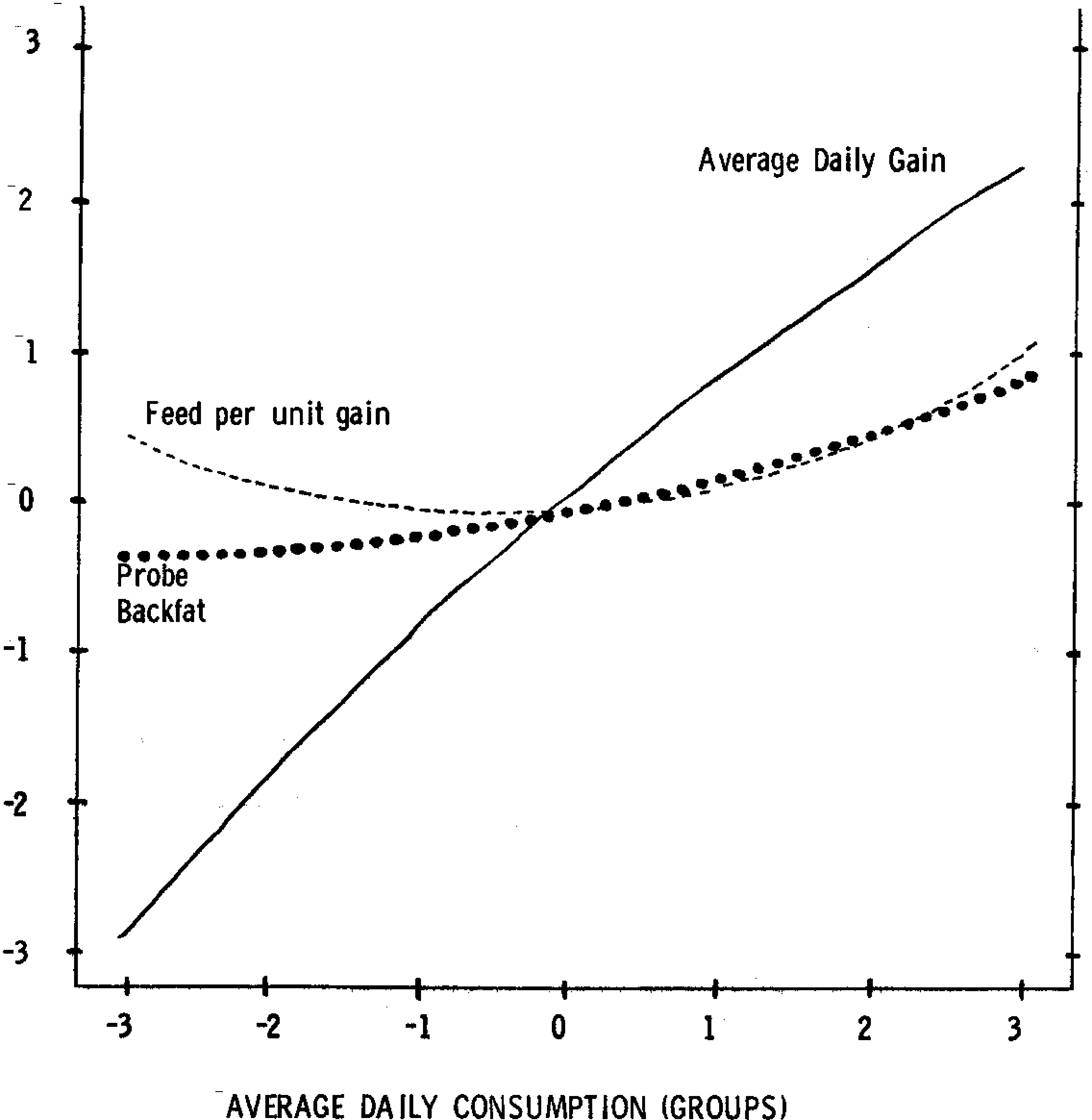


FIGURE 2. RESULTS OF SELECTION FOR IMPROVED FEED CONVERSION.

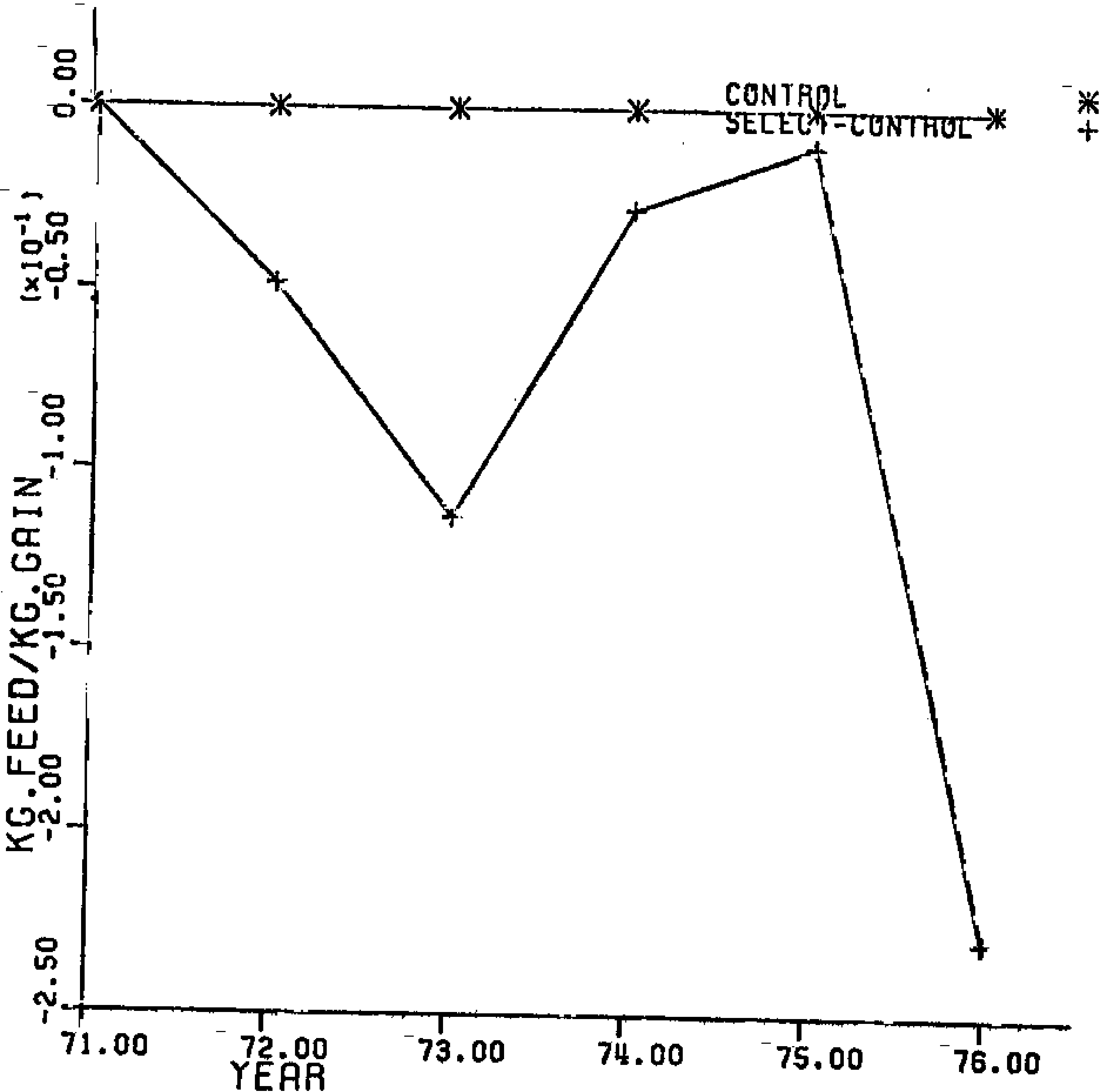


FIGURE 3. CHANGES IN DAILY FEED CONSUMPTION ASSOCIATED WITH FEED CONVERSION SELECTION.

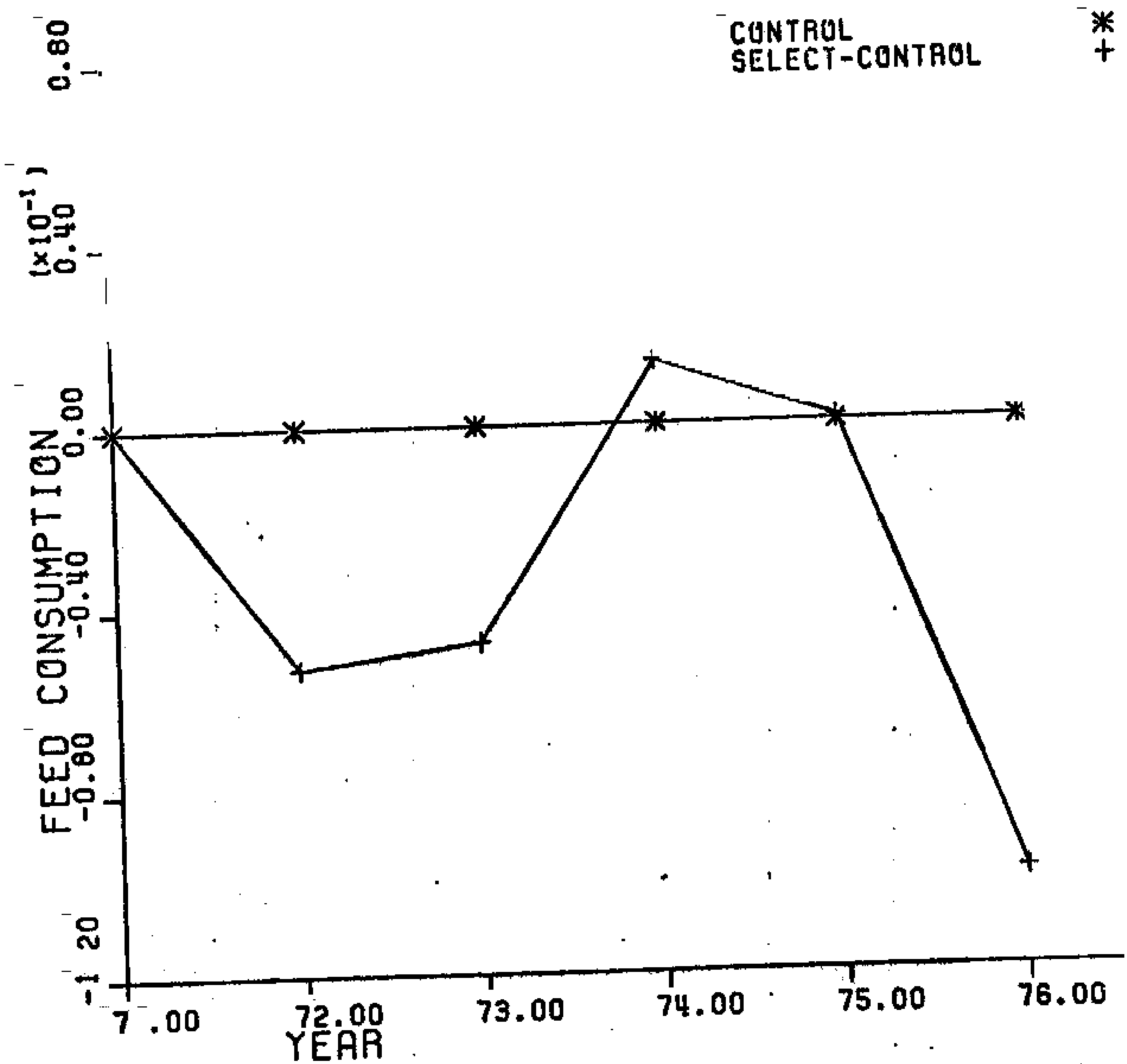
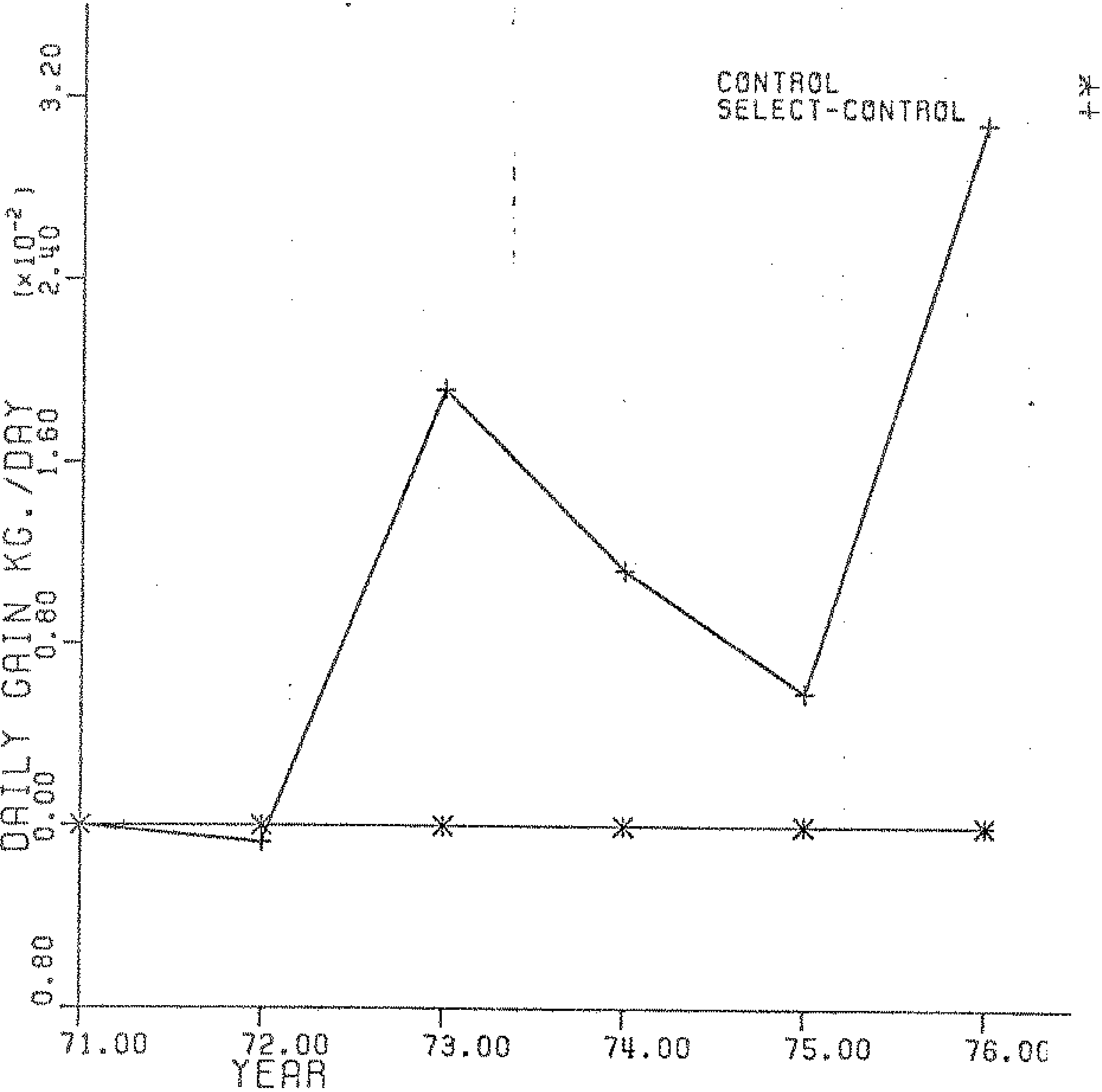


FIGURE 4. CHANGES IN DAILY GAIN ASSOCIATED WITH FEED CONVERSION SELECTION.



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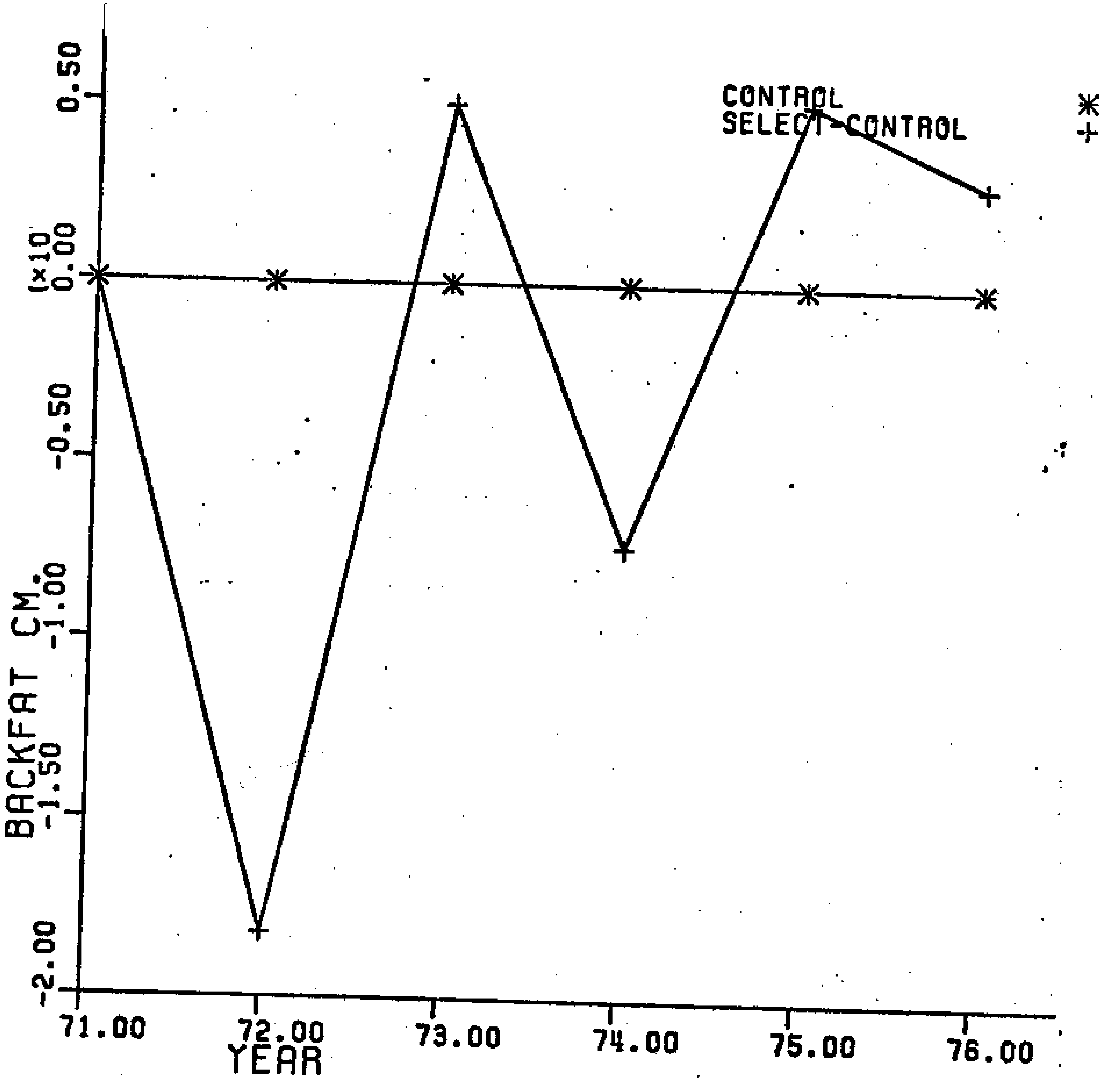

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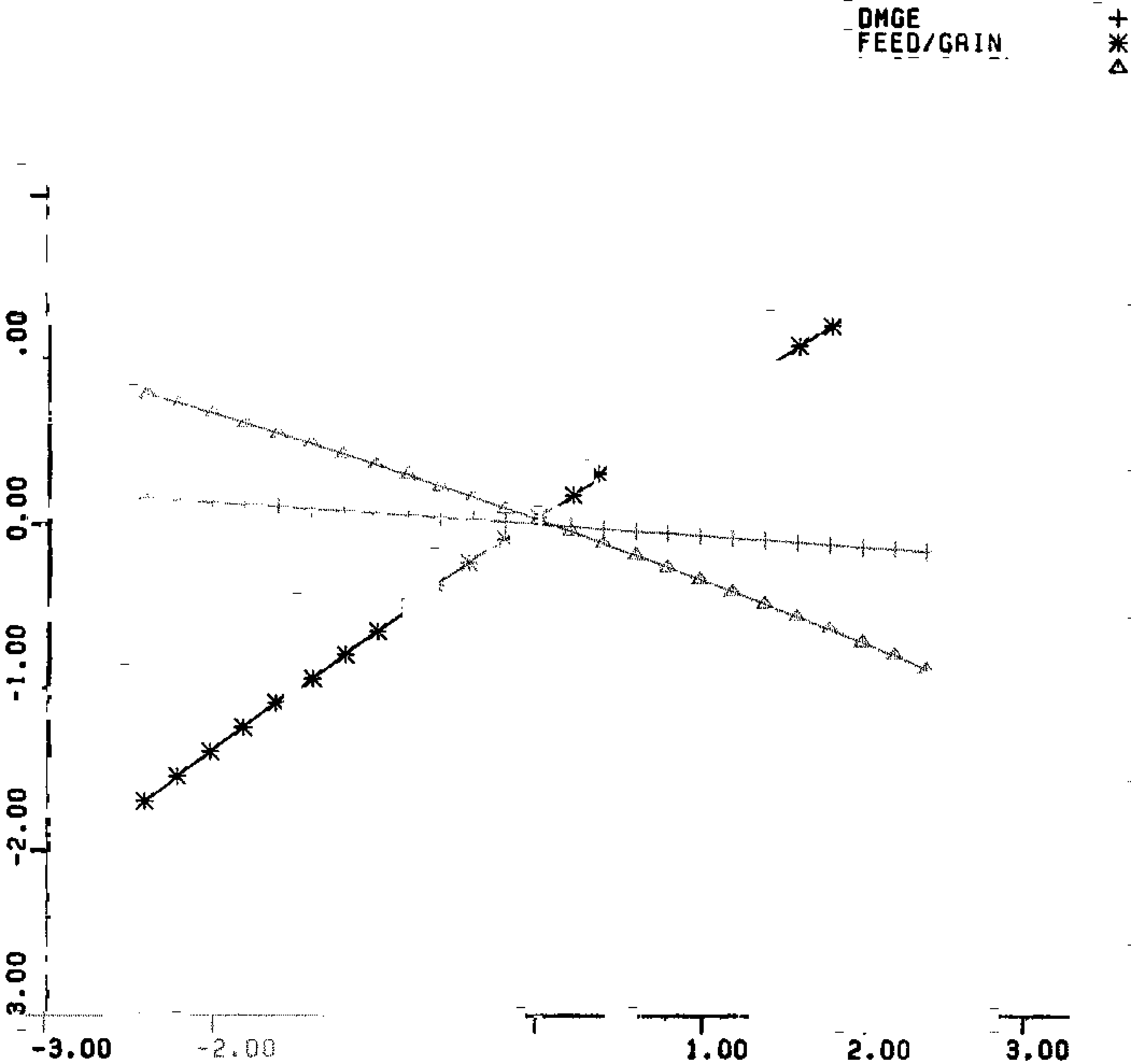

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FIGURE 7. RELATIONSHIP OF DMGE, FEED CONVERSION AND THE NSIF INDEX TO AVERAGE DAILY GAIN.

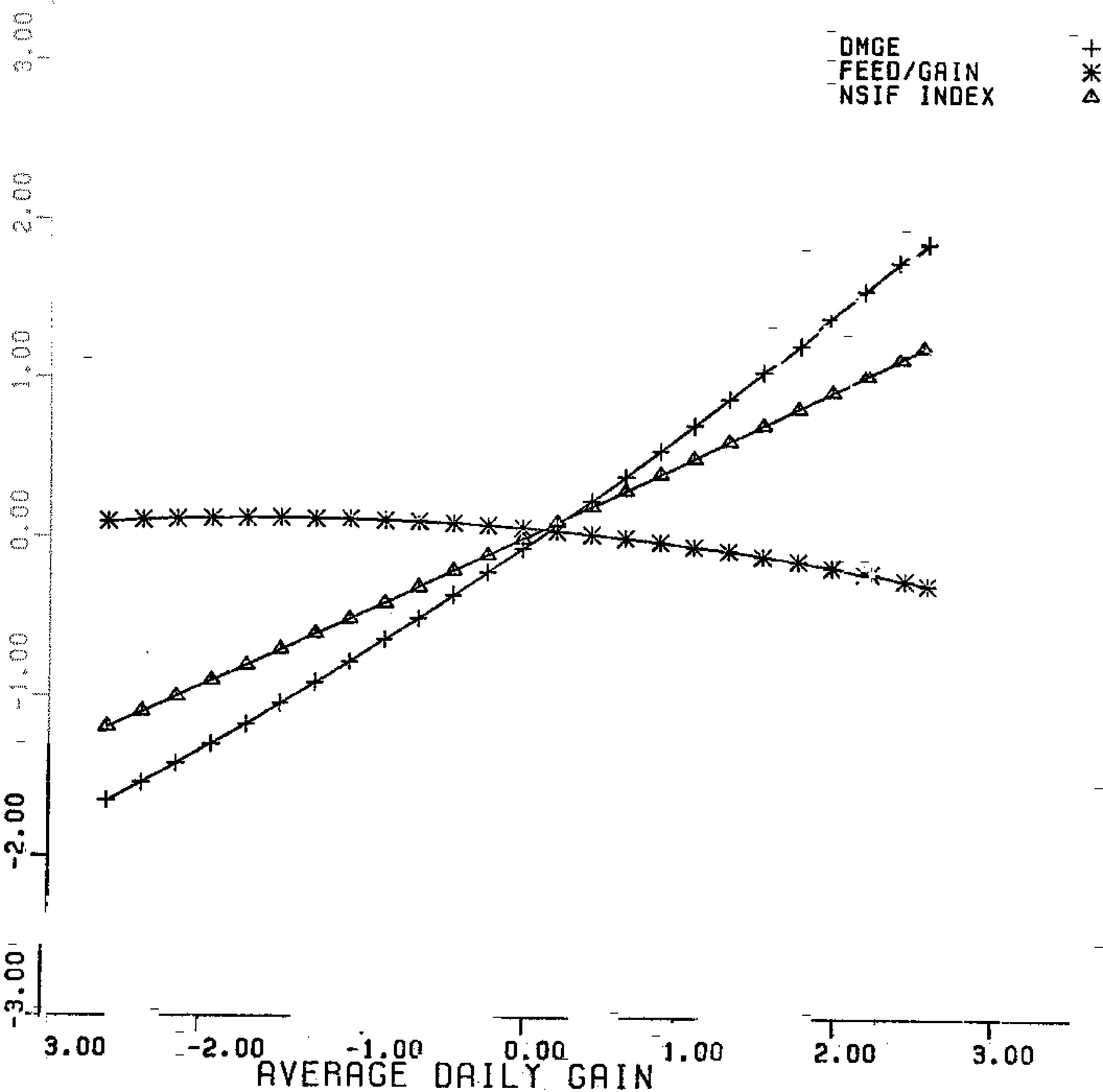

FIGURE 9. RELATIONSHIP OF DMGE AND THE NSIF INDEX WITH FEED CONVERSION.