GETTING THE MOST OUT OF PIGBLUP AND $INDEX

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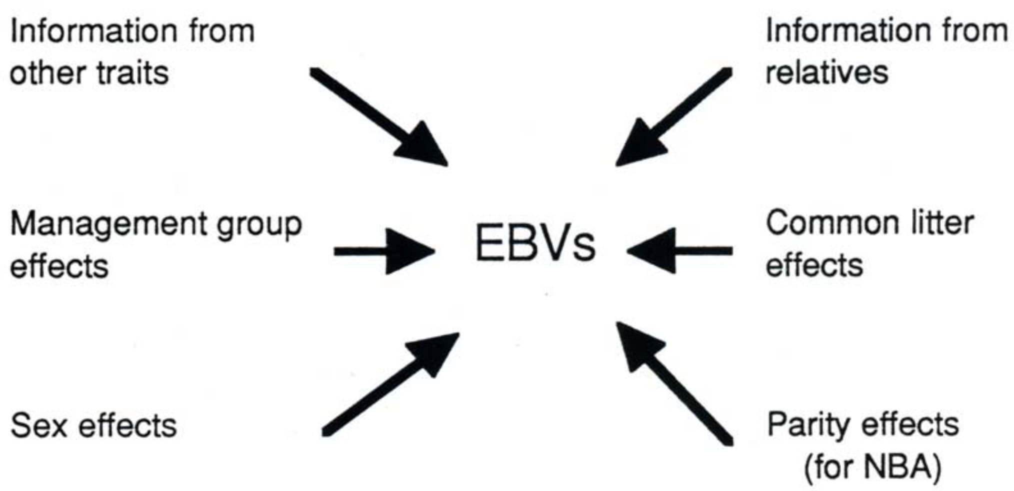
1. EBVs AND OBJECTIVES

PIGBLUP's Estimated Breeding Values (EBVs) are better than EBVs obtained by other less advanced methods because PIGBLUP makes better use of all the recorded information in assessing the genetic merit of all animals. In calculating a pig's EBV for a trait (ADG, for example) PIGBLUP takes into account not only the pig's phenotype (its own measured ADG) but also information from all its known relatives, past and present, measurements on related traits, such as backfat, and systematic non-genetic effects, such as litter or sex effects.



Given that you now have a more accurate assessment (for each trait in the PIGBLUP analysis) of the genetic merit of each animal, the question arises of how to use these EBVs. How do you combine these EBVs into a single value upon which to base selection/culling decisions? The answer to this dilemma rests with how you have defined the breeding objective for the breed/line being considered.

In general, one could say that all breeders have the same breeding objective, to maximise profit by satisfying the market. However, achieving this general breeding objective often differs between breeding operations. If a breeder decides that only one trait (e.g., growth rate) is important to their breeding objective the above dilemma doesn't exist. He or she can just rank animals on their EBVs for ADG to make selection/culling decisions and make faster genetic progress than if they had selected only on the animals measured ADG.

Maintaining profitability leads the majority of breeders to be interested in more than one trait, although many breeders are fairly vague in defining their objective. When asked, some will indicate that they are breeding for a line of pigs that is very lean, grows fast while eating a minimum of feed and the females have large litters. This is a commendable ideal, but very difficult to achieve in a single line of pigs. Many commercial producers are buying genetic programs rather than just pigs as it is easier to make use of breed/line complementarity and heterosis in putting together a genetic program than try to breed for the ultimate pig in a single line. Breeders, in defining their breeding objective, need to consider how the commercial producer is going to use their seedstock in a genetic program as this market will determine what to breed for.

The $INDEX module of the PIGBLUP system is a tool for breeders to use in helping them to firmly establish their breeding objective. It operates by considering two sub-objectives (the growing-finishing sub-objective and the sow sub-objective) of the pig's life cycle. The growing-finishing sub-objective uses economic and production inputs to define costs and returns in the growing-finishing department of the production unit so that the value of the trait EBVs for each pig can then be determined. Likewise, the sow sub-objective determines costs and returns for producing an additional pig so the EBV for NBA can be valued. These two sub-objectives are then combined into a single overall objective (the $EBV) upon which to base selection/culling decisions.

2. DETERMINING ECONOMIC AND PRODUCTION INPUTS

The $INDEX module uses economic and production inputs to determine the economic worth of each EBV for an animal (e.g., +38g/day for ADG), by assessing costs and returns. For example, a boar with a high positive EBV for ADG will be expected to produce progeny which reach market weight sooner, thereby saving daily costs of maintaining a pig in the grower. Therefore, progeny from this boar would be more profitable as production costs would be reduced. Likewise, a boar with a high, positive EBV for backfat (a fat boar) will be expected to produce progeny that are fatter than average and, if there are penalties at the abattoir for exceptionally fat pigs, these pigs would have carcases of reduced value. Therefore, progeny from this boar would be less profitable as returns would be reduced. For the sow sub-objective, a boar with a high EBV for NBA would be expected to have daughters with larger litters so would be more profitable than boars siring less productive sows. Using these costs and returns, the EBVs of each animal are combined into the respective sub-objective (growing-finishing or sow objective). The economic and production inputs required by the system are presented in Tables 1 and 2.

TABLE 1: Economic Inputs to $INDEX

Item	Unit	Default	Your Estimate
Average Carcase Market price	$/kg	2.15	-------
Premium for AUS-MEAT grid fat class cypher 0	$	0.00	-------
Premium for AUS-MEAT grid fat class cypher 1	$	0.00	-------
Premium for AUS-MEAT grid fat class cypher 2	$	0.00	-------
Premium for AUS-MEAT grid fat class cypher 3	$	0.00	-------
Premium for AUS-MEAT grid fat class cypher 4	$	0.00	-------
Premium for AUS-MEAT grid fat class cypher 5	$	0.00	-------
Cost of Feed in the feeder	$/kg	0.24	-------
Non-feed costs per day	$/pig/day	0.15	-------

TABLE 2: Production Inputs to $INDEX

Item	Unit	Default	Your Estimate
Number of pigs born alive	pigs	10.2	-------
Pre-weaning mortality	%	21	-------
Post-weaning mortality	%	1	-------
Average daily live weight gain	gm/day	517	-------
Average p2 fat depth	mm	13	-------
Live weight feed conversion	kg feed/kg pig	3.5	-------
Target carcase weight	kg	65	-------
Average dressing percentage	%	74	-------

What economic and production inputs should you use? The major goal of breeders is to increase the profitability of their herds, but this largely depends on how their breeding stock performs in their customers' herds. A breeder's success depends on the success which commercial piggeries have using their breeding stock. The breeder's goal is then to breed a pig which is profitable to that commercial environment. Therefore, when deciding on economic and production inputs for use in the $INDEX program you should use inputs that will reflect average values which will be valid for the breeders' customers over the next five to seven years. You should not be concerned with short-term fluctuations in feed, labour and market prices. The inputs should only be changed if there is a long-term shift in costs, returns or performance levels or changes in production technology which introduce permanent price changes.

If you don't have the economic and production information available that is required for inputs, default values based on national averages are provided. A possible source of help in deriving these inputs would be "The Australian Pig Industry Reference Manual" compiled by the Pig Research and Development Corporation. The default values for the AUS-MEAT grid fat class cyphers are zero. Since local markets are so variable it is preferable for you to assess your customers' pricing structure and input these values rather than for $INDEX to provide national default values. If the AUS-MEAT grid fat class cyphers are left at zero, PIGBLUP will ignore backfat EBVs when calculating the $EBV.

Once the EBVs of the animal have been combined into the respective growing-finishing and sow sub-objectives, these two sub-objectives are combined into a single total objective (the $EBV) for use in selection of replacements. The marketing inputs supplied by you (Table 3) are used in combining these two sub-objectives. The marketing inputs should reflect percentages that are relevant to your herd. This enables the module to place the appropriate emphasis on production versus reproductive traits depending on your major market for breeding stock (i.e., terminal sires, breeding gilts or dual-purpose sires).

TABLE 3: Marketing Inputs to $INDEX

Percentage of male pigs reared that are sold and/or used as:		
Terminal sires (used to produce market pigs)	-------	%
Maternal sires (used to produce replacement gilts)	-------	%
Slaughter pigs	-------	%
Total	100	%

Percentage of all gilts reared that are sold and/or used as:		
Replacement gilts	-------	%
Slaughter pigs	-------	%
Total	100	%

Table 4 presents an example of economic, production and marketing inputs for a terminal sire line of pigs. Relative to backfat classes, penalties are given for animals in the AUS-MEAT fat class cyphers 3-5 with no premiums for lean pigs. Note the percentages for boars sold (or used) as terminal sires. This breeder is keeping or marketing for breeding 40% of boars produced with the rest going to slaughter. As some replacement females are needed to maintain this line, 15% of females produced are kept as replacements.

3. USING THE $EBVS

Table 5 presents EBVs for individual traits and the $EBVs for boars using the economic, production and marketing inputs from Table 4. Boars F and H had the same EBV for ADG (+19), but, since this is a terminal sire index (where more emphasis is placed on production traits), boar F had a higher $EBV because of the better EBV for BF. Boar G had a fairly low EBV for ADG (+2) but because of the high EBV for BF had a fairly high $EBV. Since the $INDEX is defining the breeding objective, selections should be based on the $EBV value. As an example, suppose the boars in Table 5 are coming off test on a farm where 8 boars are kept at any one time to service sows in that breed/line. The older boars have the EBVs presented in Table 6.

TABLE 4: Example of Terminal Sire Inputs to $INDEX

Average Carcase Market price	$	/kg2.15
Premium for AUS-MEAT grid fat class cypher 0	$	0.00
Premium for AUS-MEAT grid fat class cypher 1	$	0.00
Premium for AUS-MEAT grid fat class cypher 2	$	0.00
Premium for AUS-MEAT grid fat class cypher 3	$	-0.15
Premium for AUS-MEAT grid fat class cypher 4	$	-0.25
Premium for AUS-MEAT grid fat class cypher 5	$	-0.50
Cost of Feed in the feeder	$	/kg0.24
Non-feed costs per day	$	/pig/day0.15
Number of pigs born alive	number	10.2
Pre-weaning mortality		%21.
Post-weaning mortality		%1.
Average daily live weight gain		gm/day517.
Average p2 fat depth		m ml3.
Live weight feed conversion		kg/kg3.5.
Target carcase weight		kg65.
Average dressing percentage		%74.

Percent of boars sold (or used) as terminal sires	40%
Percent of boars sold (or used) as maternal sires	0%
Percent of boars sold (or used) as slaughter boars	60%
Total	100%

Percent of gilts sold (or used) as replacement gilts	15%
Percent of gilts sold (or used) as slaughter gilts	85%
Total	100%

TABLE 5: Example Report - Terminal Sire Line Index - (Young Boars)

ID	ADG	BF	NBA	$EBV	ID	ADG	BF	NBA	$EBV
A	+27	-1.4	-.03	+48	S	+9	0.8	0.0	+1
B	+32	-0.2	-0.4	+46	T	-5	-0.9	0.2	0
C	+23	-0.6	0.0	+40	U	-3	-0.5	0.1	0
D	+16	-0.3	0.5	+35	V	-6	-0.2	0.5	0
E	+25	0.1	-0.5	+30	W	+9	0.7	-0.3	-1
F	+19	-0.2	-0.2	+29	X	-6	-1.2	-0.1	-2
G	+2	-1.5	0.4	+20	Y	-5	-0.3	-0.1	-6
H	+19	0.9	0.3	+19	Z	0	0.3	-0.2	-8
I	+12	0.3	0.2	+18	AA	-5	0.1	0.1	-9
J	+9	-0.4	-0.3	+14	BB	-5	0.1	-0.2	-11
K	+8	-0.5	-0.5	+10	CC	11	1.6	-0.4	-15
L	+7	-0.5	-0.4	+9	DD	-12	0.1	0.0	-22
M	+10	0.0	-0.5	+8	EE	-1	0.7	-0.9	-25
N	+11	0.9	0.3	+6	FF	-2	1.0	-0.9	-32
0	+11	0.8	0.0	+4	GG	-19	-0.1	-0.1	-33
P	+2	-0.3	-0.1	+4	HH	-15	-0.1	-0.9	-35
Q	+2	-1.1	-0.5	+3	II	-13	0.9	-0.3	-41
R	+4	0.3	0.1	+3	JJ	-14	1.0	-0.2	-42

TABLE 6: Example Report - Terminal Sire Line Index - (Old Boars)

ID	ADG	BF	NBA	$EBV
1	+24	-1.4	0.2	+53
2	+37	0.7	0.00	+48
3	+36	0.8	0.2	+46
4	+20	-0.7	0.2	+40
5	+27	-0.1	-0.3	+40
6	+17	-0.6	0.3	+37
7	+22	0.2	0.4	+36
8	+30	0.8	0.0	+34

Note that there are 3 young boars (A, B and C) that have $EBVs which are better than a number of the older boars standing to service sows (6, 7 and 8). One could say that the selection/culling decision should be to replace 6, 7 and 8 with A, B and C, but other practical considerations must also be accounted for prior to making the final decision. Suppose Boar 1 is a fairly old boar with a number of progeny in the herd. Even though he has the highest $EBV (+53) of all boars being considered, he should perhaps be replaced to avoid problems with accumulation of inbreeding. Perhaps Boars A, B and C are closely related, and the breeder would not want to keep all three as this could also cause inbreeding problems. Another consideration would be that three young boars would not be able to serve as many sows as the three older boars (with normal management practices), and the breeder could be put into the situation of having to overwork boars for a period. Finally, a visual appraisal would have to be made of the young boars to evaluate their breeding soundness. It would do the breeding program little good having a boar with a $EBV of +48 if he can't walk! It must be emphasised that PIGBLUP is a tool to augment the skills of the good breeder, not replace them. Having $EBVs on animals gives the breeder a much better picture of the genetic merit of those animals, but they must be used in light of the specific breeding operation (i.e., its size, animal flow, breeding soundness of the animals, etc.).

4. USING PIGBLUP TRENDS

PIGBLUP provides an excellent tool to allow seedstock producers to evaluate the success or failure of their breeding program on a regular basis. It achieves this be generating genetic and environmental trends for the herd. Genetic trends are reported by quarters within a year. These values represent the average EBV of all animals born within that quarter. Environmental trends are reported by quarters within a year for each user-recorded management group. These values represent the average environmental effect for that management group within the quarter. Genetic and environmental trends are produced for each of the traits in the PIGBLUP analysis (ADG, BF and NBA) so the breeder can assess how these are changing over time.

Figures 1 and 2 present the genetic and environmental trends for ADG in a herd of Large Whites. This herd has made fairly good genetic progress in growth rate over the past 7.5 years, improving the genetic merit of the herd by almost 50 grams/day. It must be emphasised that this is genetic improvement, which is what the commercial producer is interested in. The environmental trend in ADG for this herd is fairly constant with a decrease during the last quarter of '84 and first quarter of '85. This decrease in the trend could have been due to a severe heat spell, a feed source problem, a disease outbreak or something else environmental in nature that reduced the growth rate of animals over this period. This could also be a function of the data structure. If, for some reasons, there were only a few animals tested during this period, a poor estimate of the environment could have been obtained. PIGBLUP also outputs the number of animals represented in each quarter so this can be assessed. This herd also shows a slight positive environmental trend in the later years. This is expected, since over time there should be technological improvements in feed rations, equipment and husbandry practices, but this improvement in management practices must not be confused with improvements in the genetics of the herd when assessing the breeding program.

FIGURE 1

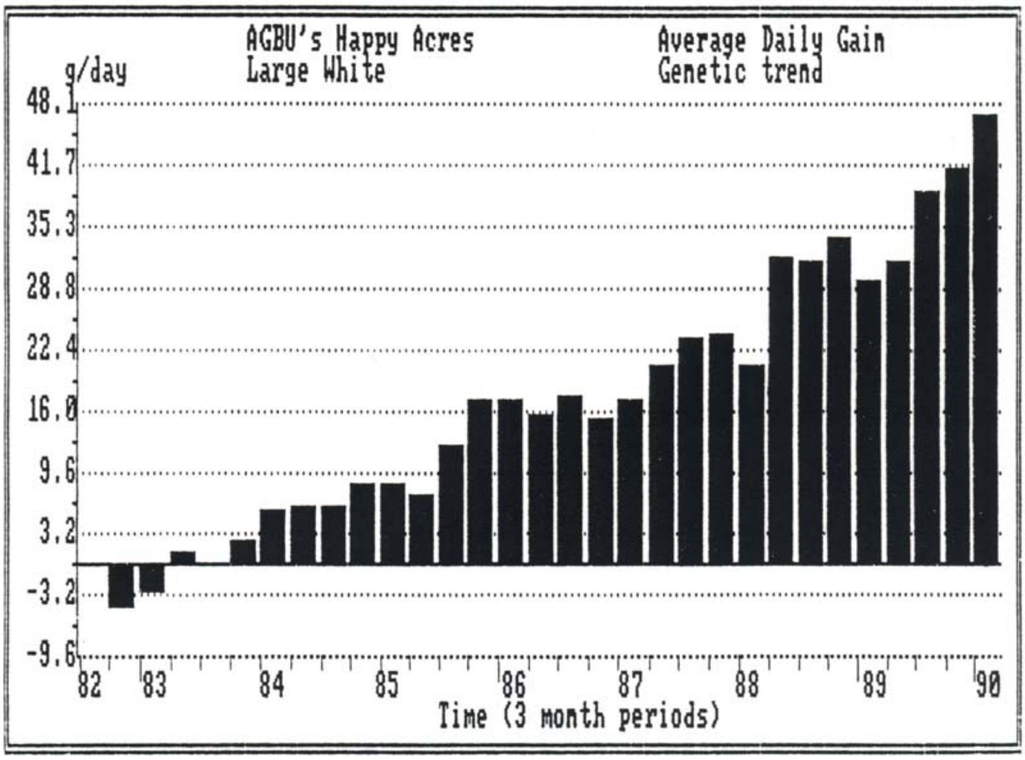
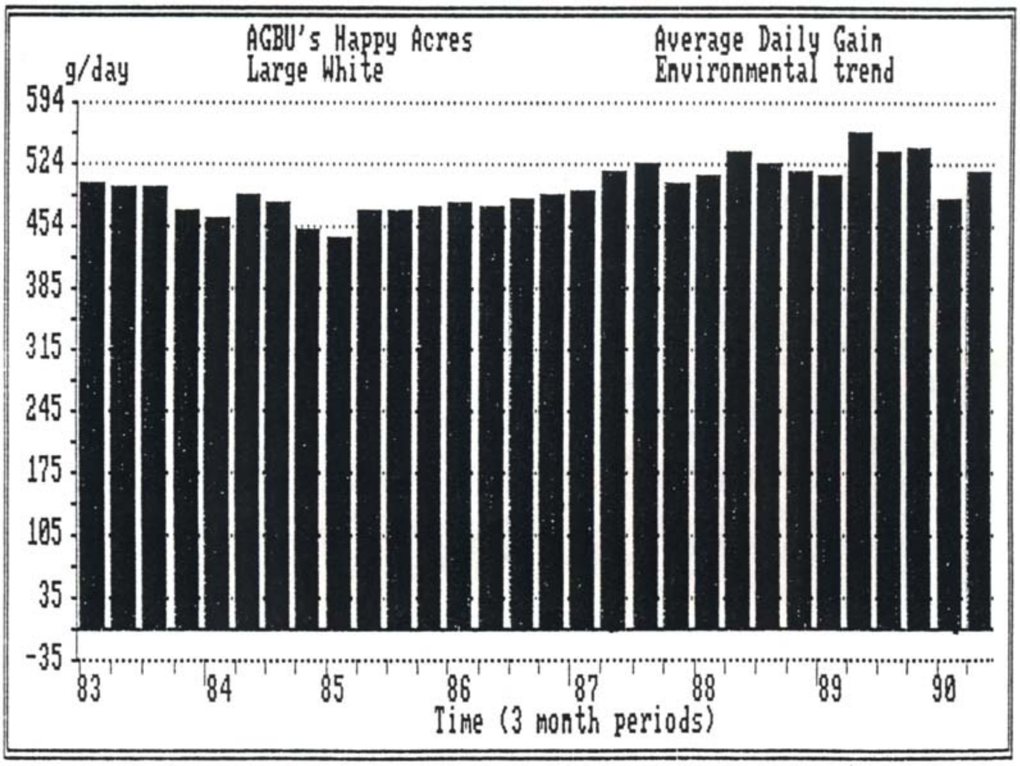


FIGURE 2



This point is well demonstrated by examining the genetic and environmental trends of a different Large White herd (Figures 3 and 4). In the 3+ years, this herd has made very little genetic progress with regard to growth rate. However, the environmental trend shows an increase of more than 70 grams/day. This could have been due to changes in the feeding program, the rectification of a previous disease problem or some other environmental change that improved the growth rate of these pigs. This breeder could tell prospective customers that the growth rate in the herd had been improved by more than 70 grams/day (and wouldn't be presenting a false testimonial), but the improvement was not genetic. Buyers of breeding stock are interested in the genetic merit of the seedstock as they may not have the same production system on their farm.

Figures 5 and 6 present the genetic and environmental trends for a third herd of Large Whites. For this herd there has been no genetic improvement in growth rate over time and there is also a negative environmental trend. Possible reasons for the lack of genetic trend could be that growth rate was not in the breeding objective for this herd (e.g., this breeder was concentrating solely on selecting for litter size).

Possible reasons for the negative environmental trend could be a gradual decline in the growing environment (equipment not being repaired and maintained) or a build-up, over time, of sub-clinical pathogens (e.g., a health problem) that depressed growth rate. Alternatively, in trying to get back data into the PIGBLUP system, all animals with records were included, but, in the early years there were very few animals with records. Perhaps only animals that had been selected were recorded. This would give poor estimates of environmental effects in the early years and hence affect the trends. EBVs would also be affected, and this would be an example of how selection bias can affect the analysis. As stated earlier, PIGBLUP also outputs the number of animals represented in each quarter so this can be assessed. It is recommended that if data from early years is to be included, there should be sufficient to provide reliable estimates of trends and EBVs.

FIGURE 3

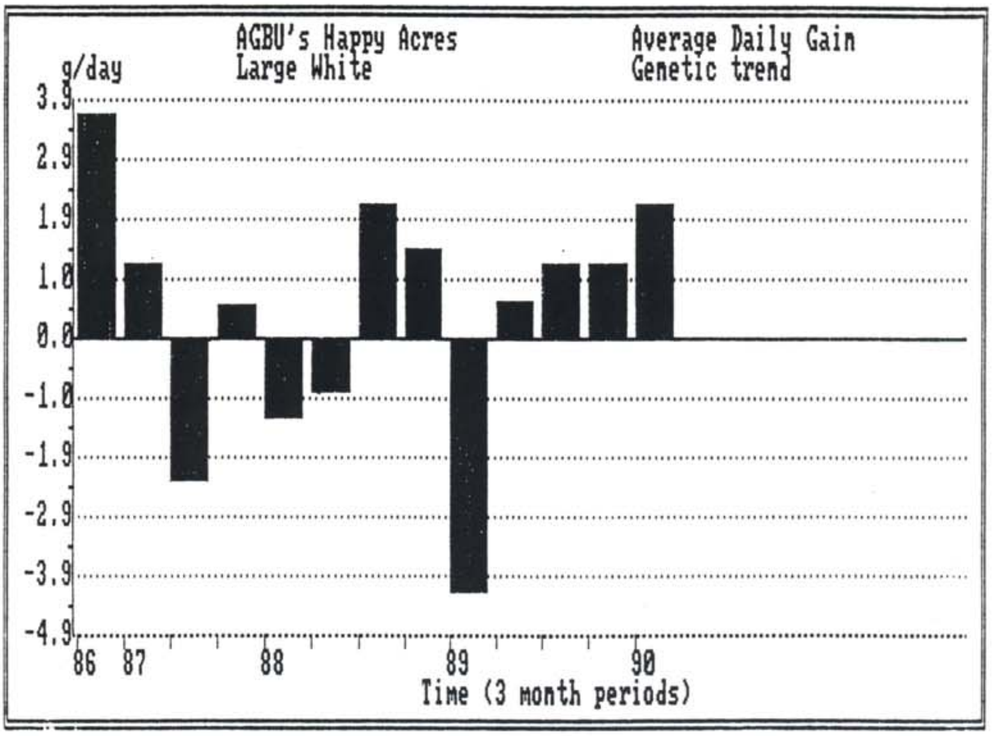


FIGURE 4

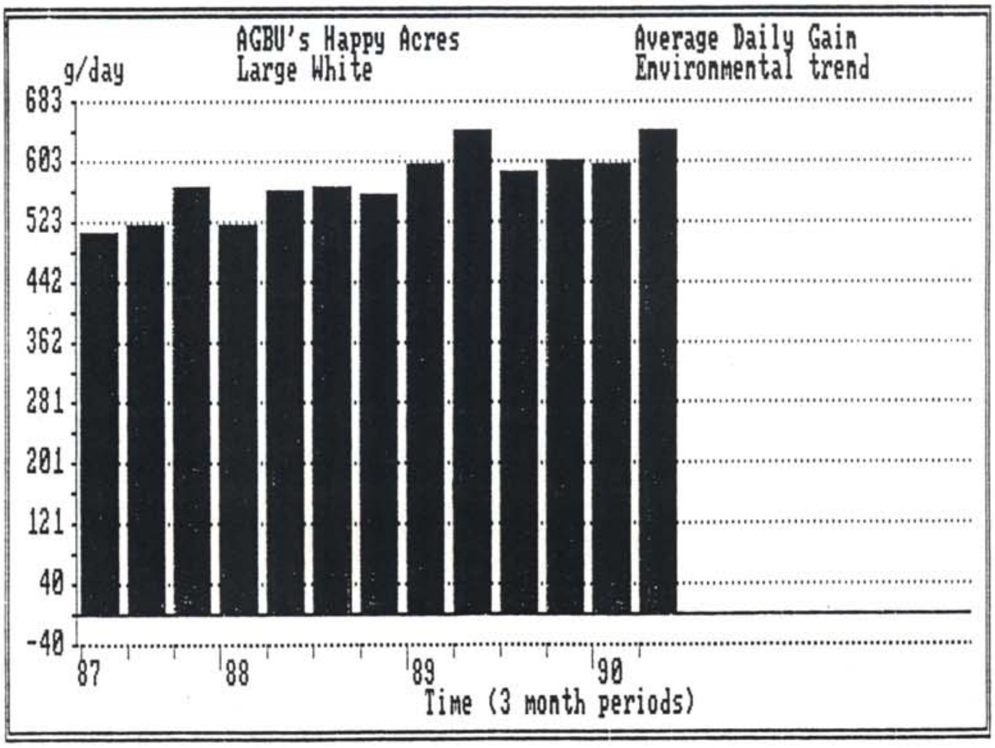


FIGURE 5

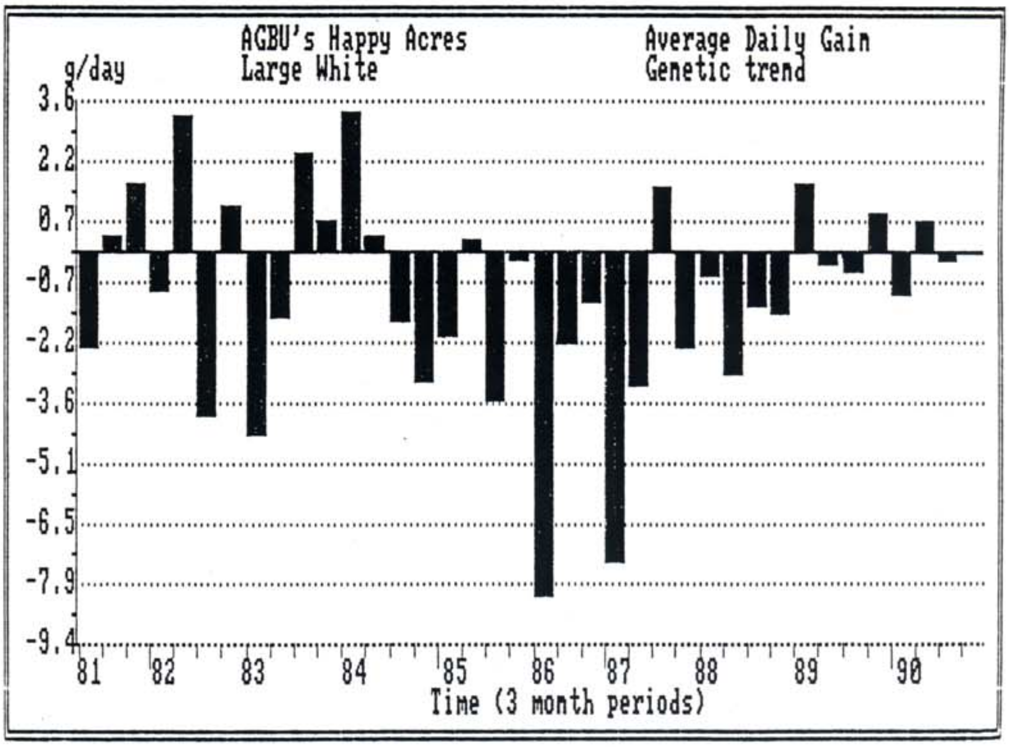
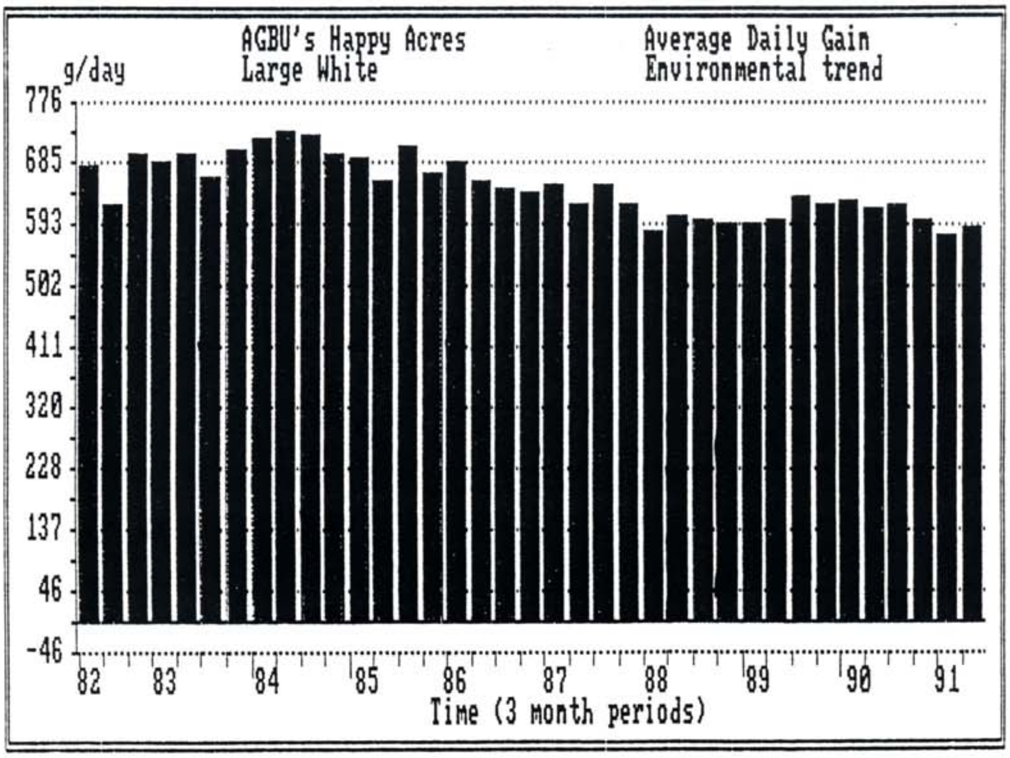


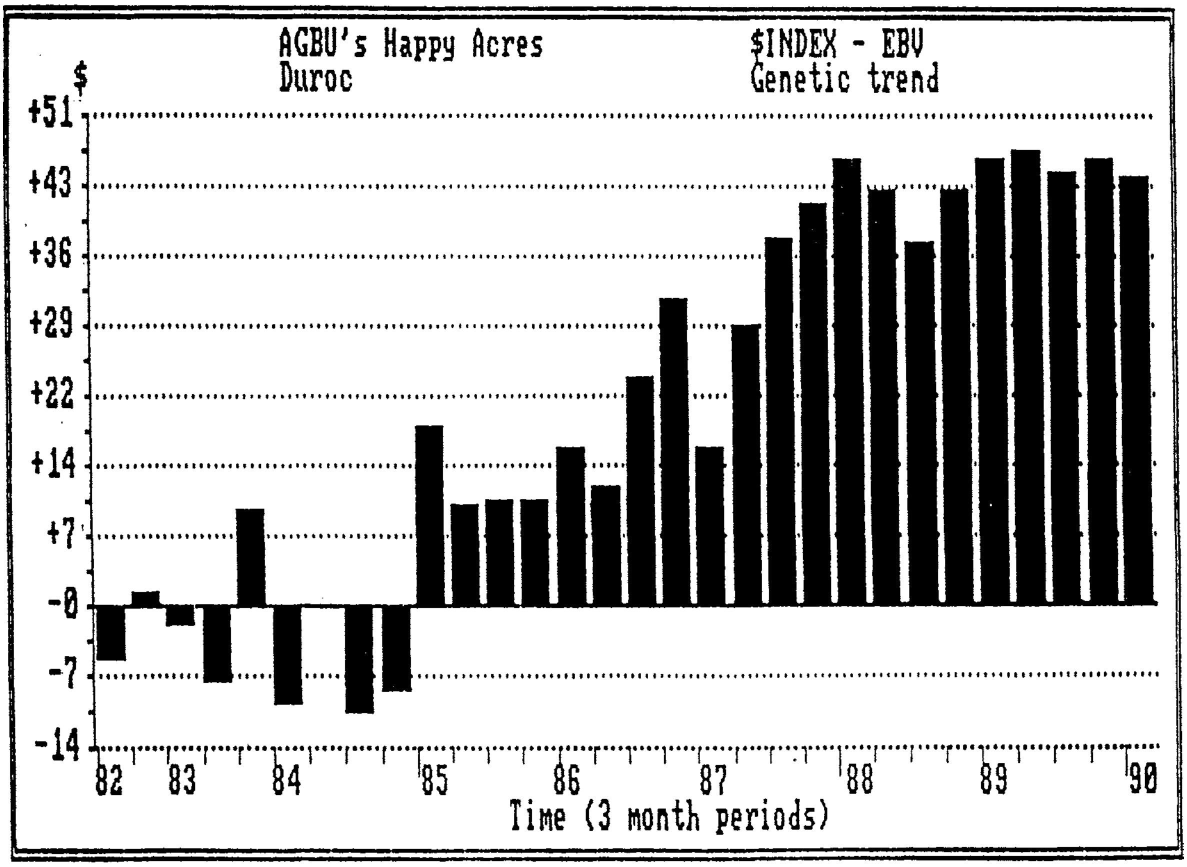
FIGURE 6



In addition to genetic and environmental trends for each of the traits in the PIGBLUP analysis, a trend of $EBVs is also produced by the system. Figure 7 presents an example. This trend reports the average $EBV for animals born within a quarter. It is **a measure of how the breeder is moving toward his defined breeding objective**. In this herd the average $EBV has increased by $40 over the time considered.

The trends produced by PIGBLUP give the breeder a useful tool in assessing the breeding program so that fine tuning can be done to move the breeder more effectively toward the desired breeding goal.

FIGURE 7



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