

# WHAT DOES PIGBLUP DO FOR YOU?

Willi Fuchs

## 1. WHAT IS PIGBLUP?

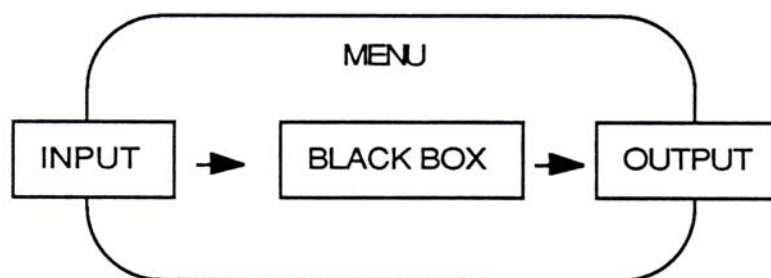
PIGBLUP is a **tool** (software package for IBM compatible micro-computers) to calculate **Estimated Breeding Values**.

It divides phenotypic performance into:

- Genetic effects
- Environmental effects
- Other effects (parity, permanent environment ...)

Currently PIGBLUP Versions VI.0 and VI.1 are available commercially. V2.0 is now in development and will hopefully be ready for release in early 1992.

## 2. WHAT IS THE PIGBLUP SOFTWARE?



### 2.1 Inputs

- (i) *Extract*: The piggery data including individual **performance** and pedigree information. It is an 'extract\*' of the data from the herd recording system.

PIGBLUP is set up for purebred animals (or stabilised synthetic lines) and handles only one breed at a time.

(ii) *Economic Inputs*: Information about the economic environment of the piggery to derive index weightings for calculating the \$INDEX.

- Economic inputs: Prices and costs.
- Production inputs: Average production level of the herd.
- Marketing inputs: Breed/line type specification.

These inputs can be different for the different breeds bred in a piggery. PIGBLUP provides a set of default values (see Fact Sheet Number 6).

(iii) *Limits*: Range checks on the data in the extract are examined to make sure that only valid information is used in the analysis. The system asks for minimum and maximum values for:

- Off-test weight
- Lifetime average daily gain - (ADG)
- Backfat (p2) - (BF)
- Number born alive - (NBA)
- Age at first farrowing
- Farrowing interval
- Gestation length
- Feed conversion ratio - (FCR), in V1. 1 only
- Test period daily gain - (TPG), in V1.1 only

(iv) *Variance components*: PIGBLUP supplies default values, which are the best estimates currently available for Australia, but, especially for overseas countries, these values might not be suitable.

(v) *Run parameters*: Inputs which control the PIGBLUP analysis. The menu asks the user for inputs or sets up defaults.

- Path name of the data extract.
- Breed which should be analysed.
- Boar code.
- User declared management group.
- Run type.

## 2.2 Black Box

The black box consists of four major parts with the following main functions:

(i) Data preparation:

- Read in the data extract
- Range checks (output in the exclusion report)
- Adjustment for backfat
- Defining the management groups
- Setting up genetic relationships between animals
- Preparation for the next programs

(ii) Production analysis:

- Calculation of the EBVs for ADG and BF (TPG, FCR)
- Calculation of the genetic trends
- Calculation of solutions for fixed effects

(iii) Reproduction analysis:

- Calculation of the EBV for NBA
- Calculation of the genetic trend
- Calculation of solutions for fixed effects

(iv) \$INDEX

- Deriving the economic values for the growth finishing and the sow herd sub-objectives
- Calculation of the \$INDEX for every animal
- Merging together the EBVs for production, reproduction and the \$INDEX
- Calculation of a \$INDEX trend

## 2.3 Output

(i) Run log:

- Contains details about the run
- Error messages (if errors occurred)
- The current and the previous run log is available.

(ii) Exclusions report:

- Contains the records which have been excluded with an error message explaining why the record was rejected.

(iii) EBVs: EBVs for ADG, BF (TPG, FCR), NBA and the \$INDEX for all animals which are either:

- Parents of other animals with records, or
- Younger than 200 days

(iv) Trends:

- Genetic trends
- Environmental trends
- Trend in the \$INDEX

## 2.4 Menu

The menu is your interface to the PIGBLUP analysis. If it is inconvenient for you to use it or if you prefer to work at the "DOS - prompt" level, PIGBLUP can be executed outside the menu. This could be the case if you work within your own "shell" like "Windows" or similar products.

The basic functions of the menu are:

- Checking inputs from the user
- Branching into the different parts of PIGBLUP
- File handling
- Steering and executing the "black box"
- Selecting/viewing/printing the output
- Graphing the trends

### 3. WHAT ARE EBVs?

#### 3.1 Definition:

- EBVs (Estimated Breeding Values) describe how much genetic superiority or inferiority is expected to be passed on to the progeny of an animal. It is the genetic value of an animal as a parent.
- EBVs are expressed as differences from standard or average animals. The average EBV of the base animals is zero.

#### 3.2 Important to Consider:

- Because EBVs are deviations, EBVs always have to be considered as differences from the mean used to obtain these deviations. The absolute value is not of interest, only the relative ranking of the animals is important.
- Because the base is set different for every herd, PIGBLUP EBVs cannot be compared between herds. But within a herd the EBVs can be compared over time and with all animals included in the analysis.
- EBVs from different runs should not be compared either because of possible changes in the data extracts (i.e., correcting errors in the data file), "fixing" of pedigrees, changing limits or the progress of time (520 weeks), whereby different animals could define the base.

#### 3.3 PIGBLUP calculates EBVs for:

V1.0	ADG	Average daily gain over the pig's lifetime
	BF	Backfat
	NBA	Number of piglets born alive
V1.1	As for V1.0, plus	
	TPG	Average daily gain over the test period
	FCR	Feed conversion ratio
V2.0	(not released yet) As for V1.1, plus	
	three different carcass measurements.	

## Example

Animal ID	ADG	BF	NBA
841103	28.0	-0.6	0.2

For this boar, the EBVs are:

- for ADG, 28 grams/day **above** the base of the herd,
- for BF, 0.6mm **below** the base, and
- for NBA, 0.2 pigs/litter **above** the base.

An EBV of 0 means that animal's breeding value is equal to the average breeding value of the animals in the genetic base.

If this same boar was mated to a group of sows with EBVs of 0 for the three traits, the expected average EBVs of their progeny would be:

- +14 grams/day for ADG,
- -0.3mm for BF,
- +0.1 pigs/litter for NBA

(the boar contributes only half of the progeny genetic makeup)

Likewise, if this boar was mated to a sow whose EBVs were:

- +10 grams / day for ADG,
- -0.1mm for BF, and
- +0.3 pigs/litter for NBA,

the average EBVs of their progeny would be expected to be:

- +19 for ADG,
- -0.35 for BF, and
- +0.25 for NBA (the average of two parents' EBVs).

#### 4. WHAT MAKES PIGBLUP THE MOST ADVANCED GENETIC EVALUATION SYSTEM FOR PIGS?

(i) BLUP

PIGBLUP uses the BLUP procedure to calculate EBVs. This is the most advanced analytical methodology and produces the most accurate estimates of breeding value currently available.

BLUP stands for:

<b>Best</b>	(minimum variance of the estimates)
<b>Linear</b>	(the estimation function is linear)
<b>Unbiased</b>	(the estimates are unbiased or "on target" if the model is correct)
<b>Prediction</b>	(we must predict each animal's genetic merit)

(ii) Animal Model

The first and most important step in designing BLUP procedures is to define the model. A model is the way we think a phenotypic measure (the trait we observe) is expressed by the animal, based on research results. This describes which factors contribute or take part in that expression and how they interact together (variances and co variances of traits and relatives, fixed or random effects).

PIGBLUP uses following animal models:

Production:

$$y_{ijkn} = mgr_{in} + a_{kn} + p_{jn} + e_{ijkn}$$

where  $y$  = observation of animal  $k$  born in litter  $j$  for the trait  $n$   
 $mgr$  = year-season-management sex group  $i$   
 $a$  = genetic effect of the animal  $k$  for trait  $n$ ; (var =  $A * G$ )  
 $p$  = effect of the common litter  $j$  for trait  $n$ ; (var =  $E$ )  
 $e$  = residual effect; (var =  $R$ )

Reproduction:

$$y_{ijkl} = mgr_i + f_j + mt_k + a_i + p_i + e_{ijkl}$$

where y	=	NBA or sow 1, parity j in the mgr i
f	=	effect of the j-th parity
mt	=	effect of the k-th mating type
a	=	genetic effect of the sow 1;(var = $As^2_A$ )
p	=	permanent environmental effect of the parities of sow1; (var = $Is^2_p$ )
e	=	residual effect; (var = $Is^2_R$ )

(iii) Multiple trait

The production traits are analysed in a multiple trait analysis. Multiple trait means that all traits are analysed simultaneously, using the information from all traits recorded to compute the EBVs for each trait. The covariances between traits give the appropriate emphasis to each piece of information. In PIGBLUP it is not necessary for all traits to be observed on all animals.

(iv) PIGBLUP is ready to go

The main feature of PIGBLUP is that you don't have to understand items (i), (ii) and (iii). Everything is set up professionally and you can use it on your microcomputer.

The main features of the PIGBLUP analyses are:

- PIGBLUP uses the animal's own performance plus information from all its known relatives.
- PIGBLUP uses the information on correlated traits.
- PIGBLUP removes effects like:
  - Genetic differences between age groups resulting from your previous selection decisions
  - Litter effects (parity)
  - Common litter environment effects
  - Preferential (or corrective) mating



- Unequal genetic competition among the comparisons of animals
  - Changes in environmental conditions (e.g. changes in feeding, climate, etc.)
  - Permanent environmental effects on an animals repeat records
  - Mating type == AI vs natural service (on request)
- PIGBLUP calculates trends
  - PIGBLUP combines the EBVs into a single \$INDEX
  - The \$INDEX can be customised for different breeds/lines and markets (buyers)

Some more advantages of PIGBLUP

- You can run PIGBLUP on your microcomputer on farm and as often as you like.
- It is easy to use.
- ABRI gives service and support.
- There is ongoing further development and research.
- Upgrades are continuously released.
- The international co-operation within the PIGBLUP technical team gives access to the latest technical developments world-wide.

## 5. TRENDS

The PIGBLUP software calculates genetic and environmental trends.

**Genetic trends** indicate changes of the genetic merit (EBVs) of the animals of the particular breed/line over time relative to the base animals (average 0 = starting point). They also indicate the relative genetic mean of the herd for the different time periods. (For example: The boar listed in Section 2 above with an EBV for ADG of +28 is below average, if the genetic trend in this herd is +30 or more).

**Environmental trends** reflect the changes (or lack of change = constant environment) of the conditions in which the animals had to perform. They also give an indication of the average production level. (For NBA, parity number 1 is set to zero, therefore the environmental trend for NBA gives the average production level of gilts over the years).

## **5.1 Definition**

Trends are calculated as averages of the effects (EBVs or management group effects) within specific time periods (three months) over years.

## **5.2 Usage**

Trends indicate the effectiveness of a breeding program and therefore give the user some feedback on which way the breeding program is headed.

## **5.3 Display**

PIGBLUP displays the trends:

- (i) As graphs (vertical bars)
- (ii) As tables with the number of effects averaged (i.e. number of animals) and the means for each sex.

The trends can be down loaded onto other systems for individual use, if the standard display of PIGBLUP is not adequate for the breeder's use, (i.e., development of brochures for marketing purposes).

## **5.4 Example**

The phenotypic trend for ADG of a herd has remained constant, over time, at 700 grams/day. Reasons for this could be:

- (i) The environment and the genetic merit of the breed/line didn't change at all.
- (ii) The genetic merit of animals has improved but the environment has deteriorated (by similar amounts).
- (iii) The environment has improved but the genetic merit of the animals has decreased.

## 6. MANAGEMENT GROUP DEFINITION

### 6.1 The Rules

Probably the first and most important step in deriving EBVs is to compare the performance of animals with those who performed under the same (or similar) conditions. This environment is called a management group. Every evaluation system divides the animals into such groups to find differences (contrasts) which should reflect genetic differences.

Three fundamental rules need to be considered when defining management groups:

- (i) *Equal conditions*: Only the records of animals which have performed under the same conditions should be included in the same management group.
- (ii) *Group size*: The groups should be big enough to permit reasonable comparisons.
- (iii) *Connectedness*: The animals in a group should be descended from at least two different dams and sires and they should have some other relatives in other groups.

### 6.2 PIGBLUP Defines the Management Groups as Follows

- (i) Sex: Only animals with the same sex are compared with each other.
- (ii) User recorded management groups: The user can record different environments, (feed, treatments or other factors which can influence the performance of an animal) and include these non-genetic effects in the analysis:
  - Production traits: record type 2, position 23
  - Reproduction: record type 4, position 45.

Any ASCII character is allowed when coding for a user-recorded management group.

A maximum of 9 different codes are allowed. (9 for production can be different to the 9 for reproduction).

(iii) *User declared management groups*: At the start of a analysis the user can define:

- Maximum number of weeks for boars (production)
- Maximum number of weeks for sows (production)
- Maximum number of weeks for reproduction

These numbers define the maximum length of time animals coming off test or farrowing will be allocated to the same management group. If the time exceeds the number of weeks, a new management group is created.

(iv) *Maximum number of animals in one group*: This parameter determines how many animals can be in one management group. If this number exceeds the limit a new management group is created.

V1.0: 50 pigs for the production traits  
20 sows for the reproduction traits

V1. 1: User defined.

Each time the limit of either (iii) or (iv) is exceeded a new management group is initiated by the PIGBLUP system.

## 7. DATA EXTRACT

PIGBLUP expects the data extract in a fixed format. This extract includes three different types of records (animal, production and reproduction records).

The records have to be sorted on date of birth of the animals and within animal, on record type and parity number. This makes sure that the older animals come first (parents before their progeny) and all information of an animal appears sequentially.

### **Type 1: Animal Record**

- A type 1 record **must** exist for every animal with observations (production or reproduction) and may exist for animals without observations if they are parents.
- PIGBLUP uses only data within 10 years from today ( = system date for the current run on the microcomputer). If older data is in the extract PIGBLUP writes a error message into the run log and stops.
- The animal identifications (animal, sire and dam) must be unique within the breed.
- All records not matching the breed code are ignored (no error message).
- All dates have to be in the standard form day - month - year as DDMMYY. All dates must be older than the system date and within 520 weeks.
- The sex code can be any character. The user has to define in the run parameters which code is used for boars. Animal with other codes are assumed to be female.
- If the flag in position 46 is "\*" the system identifies this animal as an animal of interest. Animals of interest are by default only parents and animals younger than 200 days. Only animals of interest are included in the output. This flag is optional.
- Although sire and dam identification are marked as being mandatory, an unknown parent can be indicated with 10 spaces.

### **Type 2: Production Record**

- This record type is (unfortunately) slightly different between VI.0 and VI.1.
- All animals coming off test should be included in the extract and not only the data of the selected animals. Otherwise PIGBLUP can't account properly for this selection and this may cause some bias.
- If ADG, calculated from the weight and the date at the end of test and the date of birth, are out of the ranges set in limits then the whole record is rejected. If backfat or feed conversion ratio is missing or outside the set ranges the correct observation for ADG is still used in the analysis.

- The user recorded management group can contain any character (V1.1 two characters). Up to 9 different codes are allowed. The management group codes are not mandatory.
- In V1.1 backfat is formatted as an integer (without decimals) and therefore the on-farm backfat recording needs to be multiplied by 10.
- FCR is also formatted as an integer and needs to be multiplied by 100. (A FCR of 2.85 is stored as 285).
- Weight and date at start of test are optional.

**Type 3:   Reproduction Record**

- For every litter of a sow a separate record is expected. These records have to be sorted on parity number within sow.
- If a parity is missing or some data in a record are identified as being wrong all subsequent litter records are rejected.

The format for Record Types 1, 2 and 3 is given in Figure 1.

FIGURE 1: Format for Record Types 1, 2 and 3 for V1.0

Animal Record

Record Type	I1	*	(always = 1)
Animal Identification	A10	*	
Animal Breed	A2	*	
Dam Identification	A10	*	
Sire Identification	A10	*	
Date of Birth	3I2	*	(DDMMYY)
Sex	A1	*	
Litter Size the animal was born in	I2		
Number of Production Record	I1	*	(max = 1)
Number of Litter Records	I2	*	
Flag	A1		(* = flag on)

Production Record

Record Type	I1	*	(always = 2)
Animal Identification	A10	*	
Animal Breed	A2		
Weight at End of Test	I3		
Date of End of Test	3I2	*	(DDMMYY)
User Rec. Management Group	A1		(max 9 codes V1.1 A2)
Backfat	I2		(V1.1.I3 BF *10)
Weight at Start of Test	I2		
Date of Start of Test	3I2		(DDMMYY)
Feed Conversion Ratio	I3		(V1.1 only FCR * 100)

Litter Record

Record Type	I2	*	(always = 4)
Animal Identification	A10	*	
Animal Breed	A2	*	
Parity Number	I2	*	
Mating Date	3I2		(DDMMYY)
Service Sire Identification	A10		
Service Sire Breed	A2		
Mating Type	A1		(max 3 codes)
Date of Farrowing	3I2	*	(DDMMYY)
Piglets Born Alive	I2	*	
Piglets Born Dead	I2		
User Rec. Management Group	A1		(max 9 codes V1.1 A2)

All fields marked with "\*" are compulsory.

I = integer = numeric

A = character = alphanumeric

1-10 indicates the length of the field

