Development of a deterministic dairy herd model

Jouni Nousiainen, Lauri Jauhiainen, Minna Toivakka, Pekka Huhtanen

Agrifood Research Finland

FIN-31600 Jokioinen

Jouni.Nousiainen@mtt.fi

www.mtt.fi

Aim

- To create a dairy herd that consists of cows with different parities, heifers and calves.

- Herd composition should be as realistic as possible.

- Growth rate, body size and milk production capacity are dependent on age or parity.

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Deterministic model

- Historical milk recording data, called source data was utilised.

- A deterministic dairy herd model based on the information of culled cows is demonstrated.

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Source database

- Birth, calving and culling records of 48673 culled cows in 1786 herds.

- Three new databases:
  - culling rates of 25%, 5410 cows, 303 herds
  - 35%, 10442 cows, 369 herds
  - 45%, 14652 cows, 436 herds

Individual cow information

COW	1235	1236
BIRTH DATE	4.8.1993	19.12.1994
DATE OF CULLING	11.8.1998	2.12.1997
MAXIMUM PARITY	3	1
DATE OF FIRST CALVING	19.8.1995	15.12.1996
CALVING INTERVAL 1	422	.
CALVING INTERVAL 2	353	.
AGE AT 1ST CALVING	745	727
HERDLIFE	1088	352
AGE	1833	1079

Initial herd example

COW	1	2
MAXIMUM PARITY	4	3
DATE OF FIRST CALVING	4.9.1971	19.11.1971
DATE OF CULLING	21.3.1976	28.3.1975
BIRTH DATE	30.8.1969	8.9.1969

Data processing 1.

- A macro working in the SAS system was developed.

- The macro sorts the <u>initial herd</u> data by date of culling, and takes the cow with lowest value for further processing.

- Additionally, a cow from the <u>source database</u> is picked randomly, following "random sampling with replacement"- principle, i.e. same cow can be utilised several times.

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Data processing 2.

- The new cow:
  - information of the cullable and the database cow.
  - 1. calving date: culling date of the old cow + 1.
  - other values are calculated according to the database cow age, calving and culling variables.
- The macro processes until the predetermined date is reached.

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Example of data processing

COW	INITIAL HERD COW	DATABASE COW	NEW COW
BIRTH DATE	30.8.1969	.	18.3.1974
DATE OF CULLING	21.3.1976	.	21.6.1978
MAXIMUM PARITY	4	3	3
DATE OF FIRST CALVING	4.9.1971	.	22.3.1976
CALVING INTERVAL 1	.	362	362
CALVING INTERVAL 2	.	411	411
AGE AT 1ST CALVING	.	735	735
HERDLIFE	.	821	821
AGE	.	1556	1556

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Further processing of the final herd

- Those animals that are outside the desired time scale are deleted.

- Information for the all days of the life cycle is calculated according to the birth, calving and culling dates.

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Daily data in the herd model

ANIMAL	2447	2228	2154	1709
PARITY	0	0	1	3
AGE	187	636	789	1715
DAY	8.6.2005	8.6.2005	8.6.2005	8.6.2005
COW DAY	0	0	1	1
HEIFER DAY	0	1	0	0
CALF DAY	1	0	0	0
PRE PARTUM	652	289	0	107
DAYS IN MILK	0	0	0	304
DRY	1	1	1	0
CALVING	0	0	1	0

Examples of the use

- 10 year simulation, 10 herds and 50 cows/herd.

- The 25, 35 and 45% culling rates

- The annual average parity of culled and living cows, average numbers of cows, heifers and heifer calves, feeding days and calvings by parity were calculated.

Annual average simulation results

CULLING RATE	25 %	35 %	45 %
PARITY OF CULLED COWS	4.14	3.17	2.59
PARITY OF LIVING COWS	3.05	2.48	2.16
COWS/YEAR	50.0	50.0	50.0
1ST PARITY COWS	12.9	17.0	20.3
2ND PARITY COWS	11.0	13.1	13.9
3RD+ PARITY COWS	26.0	20.0	15.7
HEIFERS/YEAR	14.5	20.1	25.7
CALVES/YEAR	12.4	17.4	22.5
CALVES BORN	51.6	55.1	58.7
1ST PARITY CALVINGS	12.5	17.4	22.6

Conditions

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- The variation in the simulated herd is restricted to the one present in the original milk recording data.

- The data contains only the young stock that is needed for replacement purposes.

Cautions

- Subdata (25, 35 and 45 % culling rates):
  - may differ in the calving intervals
  - in the lengths of lactations without subsequent parity
  - confounding differences between them may exist.

- Source data:
  - How to manage exceptional and missing information ?

Conclusions

- Added production and feed consumption variables make this **dairy herd model a suitable tool** for management, environmental, nutritional, economic and breeding simulations.