final report

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Development of a Crossbreeding System Evaluation Tool for Cattle Producers

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1. Executive Summary

A spreadsheet was developed with multiple sheets, that allow comparison of different crossbreeding systems from different combinations of Australian cattle breeds. The program allows comparison of pure breeding systems, 2-way crossing systems and 3-way crossing systems. The comparison is based on system efficiency, and considers input and output from production of steers, fattening heifers and culled cows. The program allows the user to vary the number of replacement heifers from their own herd. The input parameters (related to weights at fixed ages, fat scores, reproduction, mortality, and associated heterosis) are read from a table and a herd model is used to calculate the number of animals used for replacement and slaughter. Growth curves are derived from weights, and the feed input needed for growth and maintenance is derived and aggregated at a herd level on a monthly basis. A summary sheet allows selection of breeds, and calculation of key system parameters, such as feed needed, revenue from slaughter animals, days to slaughter, feed per kg of meat produced, and other derived parameters.

The current version of the tool should be seen as a demonstration version, and can be used as a basis for further development. Further development needs to involve 1) improved logistics in the 3 way crossing system, 2) the addition of a composite module, 3) road testing and fine tuning the technical and economic parameters 4) adding into the growth curve the different degrees of fatness of the breed combinations used, 5) an interface that allows consultants and breeders unassisted use of the tool. The fifth point needs to involve discussions with a consultative group comprising practically-oriented researchers and end users.

2. Description of the crossbreeding tool

A brief description is given here. Examples of the different sheets are in the Appendix.
The program uses mainly macros (Visual Basic code) for most calculations, but a number of tables are based on linked formulas on the sheets (i.e. 'Excel code')

The different SHEETS are

Input & results summary

- Sets the production system parameters and allows choosing breeds.
- It chooses base input parameters, such as target weight, mating date, feed price, etc.
- If a variable is changed, it show 'update all' and recalculates the Tables.
- Provides a summary of the system efficiency and other key parameters and it gives a comparison among different crossing types (1 pure, 1 2WC, one 3WC)

Details about each of the three mating types are in the separate sheets for each system:

- *Straightbred*
- *2breed cross*
- *3breed cross*

  These sheets give:
  - The numbers in each system, the weights and the prices
  - It shows income and cost per animal type (steer, females, cows), on a per animal basis, and also on a per breeding cow basis (more important)
  - A picture with animal number in each category (replacements, fattened, etc.)
  - A graph that gives the feed requirement pattern over the year (per month).
  - Detailed Tables with number of animals per age class, and feed requirement for each month of the year. There are Tables for cost per parity to determine culling and replacement rates. These can be used to check the system, but are not critical.

    Examples are given in the appendix.

Database

Contains the breed means for all traits as well as heterosis estimates (all were obtained from Wayne Upton, AGBU). For traits and breeds, see Appendix.

Growthcurve

This sheet is not actively used by the program, but it illustrates how growth curves are determined and from that feed costs.

The current version of the tool should be seen as a prototype and be used for demonstration of principles. It can be used as a basis for further development.
There is currently no detailed manual, other than this document.

3. Recommendations for further development

Further development is recommended to:

1) improve the logistics in the 3 way crossing system,
2) develop a composite module,
3) road test and fine tune the technical and economic parameters
4) add into the growth curve the different degrees of fatness of the breed combinations used,
5) discuss and develop an interface that allows consultants and breeders unassisted use of the tool.

Re 1) the numbers in the 3-breed cross.

- For a purebred I use a given number of breeding females e.g. N=1000
- For a 2-breed cross, I inseminate a fraction with terminal sires. Need a certain amount for replacement, although there is an option to purchase replacements
- For a 3 breed cross this all becomes more complicated. I have not yet finished the picture (in yellow), and thus the full sheet.

Re 3)

We need to have a look at the price premiums (at the end of database-sheet). There are now very high premiums for e.g. Charolais.

The data base also needs further scrutiny and discussion. Sometimes it seems a bit rough to have the same heterosis % for all traits. For some breeds (e.g. Jersey) the 600 day weight (A+M) can be higher than mature weight.

Re 4)

Currently, I am only looking at target weight. I have not yet implemented fat curves and target both weight and fat. This will often result in compromises or ‘unachievable’ so needs a bit of thinking.

Re 5)

This needs to involve a consultative group with practically oriented researchers and end users (e.g. Bill Kiernan, Wayne Upton, Bill Hoffman, Don Nicol).
Suggestions about possible improvements that could be made;

- hardwire a few scenarios (target weights and muscle)
- show more genotypes (combinations) of one crossing type at the same time
- even show the best genotype or the top 5 for a given market.
- Profit per enterprise rather than per unit of input

Appendix 1 - Description and examples of different sheets

SHEET: Input & Results Summary

1. Gives a comparison among different crossing types (1 pure, 1 2WC, one 3WC)
2. (later we should here display also more of each type)
3. This sheet contains base input parameters, such as target weight, mating date, feed price, etc.
4. If a variable is changed, it show 'update all' and recalculates the Tables

Main System Variables			Other variables	
herd size	1000		Feed content MJME/ton	10000
target weight steers (kg)	450	! update all	Mating date	15-Nov
target P8fat steers (mm)	5	! update all		
price $/kg live steers	2.00			
feed cost $/MJME	0.01			

It also allows choosing a breed or combination of breeds (choose from a roll down list) and will ask to click on "update". There is also a choice to buy heifers rather than breeding them.

straight breeding		
breed	Shorthorn	
percent own heifers (%)	100%	
purchase price per heifer	900	
two way cross		
terminal sire breed	Angus	
maternal breed	Friesian	
percent own heifers (%)	100%	
purchase price per heifer	900	
three way cross		
terminal sire breed	Charolais	
maternal grandsire breed	Shorthorn	
maternal granddam breed	Jersey	! update

A summary of each system;

	profit per breeding cow	income $ per tonne feed	kg meat/ MJ feed	$$ efficiency	Feed requi (tonnes)
straight breeding	**85**	**113**	**58.87**	**112.6%**	**6,704**
two way cross	**96**	**113**	**53.66**	**113.2%**	**7,318**
three way cross	**381**	**155**	**57.56**	**155.0%**	**6,929**

inal sire breed

With a bit more detail per animal group;

		days to slaughter	steers		heifers		cows	
			nr sold	$/margin	nr sold	$/margin	nr sold	$/margin
straight breeding	**total**	**512**	**428**	**491**	**239**	**403**	**166**	**705**
two way cross	**total**	**395**	**403**	**632**	**157**	**528**	**206**	**1039**
	F1	375	171	620	157	528	0	0
	0	410	233	641	0	547	206	1039

Details about each of the three mating types are in the spreadsheets

Straightbred
2breed cross
3breed cross

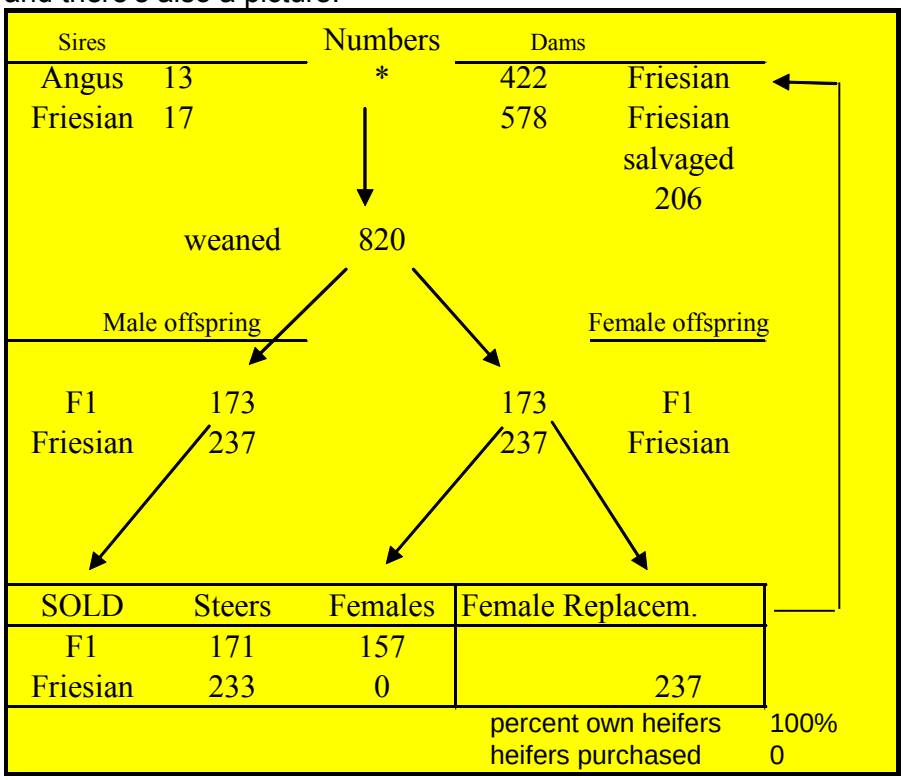
These sheets give the numbers in each system, the weights and the prices. It shows income and cost per animal type (steer, females, cows), on a per animal basis, and also on a per breeding cow basis (more important).

(Alternative is to do this on a per DSE or tonne of feed basis)

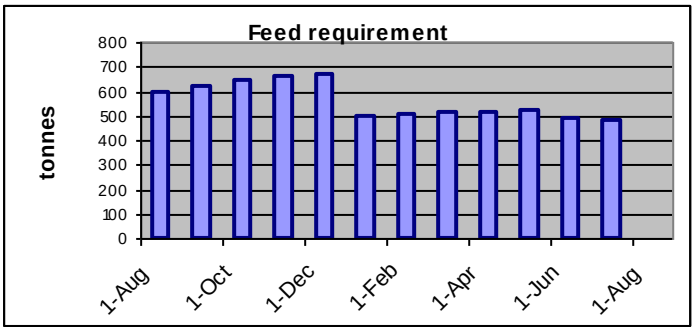
2 WAY CROSS BREEDING SYSTEM

Angus	**X**	**Friesian**	dam breed	F1 offspring		total cows	1000	
			Friesian	**Angus**			per individual	
Output				X **Friesian**			income	cost
Steers	Nr sold per year		233	171		per steer	1006	374
	Weight		451	449		per fat heifer	895	367
	Price/kg		2.26	2.20		per cow	1369	2096
Heifers	Nr sold/yr		0	157		per replacem heifer	-	764
	Weight		429	426				
	Price/kg		2.16	2.10				
Cows	Nr sold/year		206	0			on a herd basis, incl. culled	
	Weight		700	0			p e r a n n u m	
	Price/kg		1.96	0.00			per breeding cow	
Input						steers	406	157
% heifers			23.7			heifers	140	63
steers days to slaughter			410	375		cows	282	316
$$ feed young stock till 1st calv			764			own young stock		195
$$ feed to fatten a steer			379	367		purchased heifers		0
$$ feed / mature cows per year			330			total	828	732
total feed input MJME			73,184,154	Profit per breeding cow			**96**	
total feed input tonnes			7,318	$$ efficiency			**113.2%**	
				cost per tonne feed			100	
				$income/tonne feed			**113**	
update				total tonnes meat sold		392.7		
				kg meat sold/ 10GJ feed			**53.66**	
				kg meat sold per tonne feed			53.7	

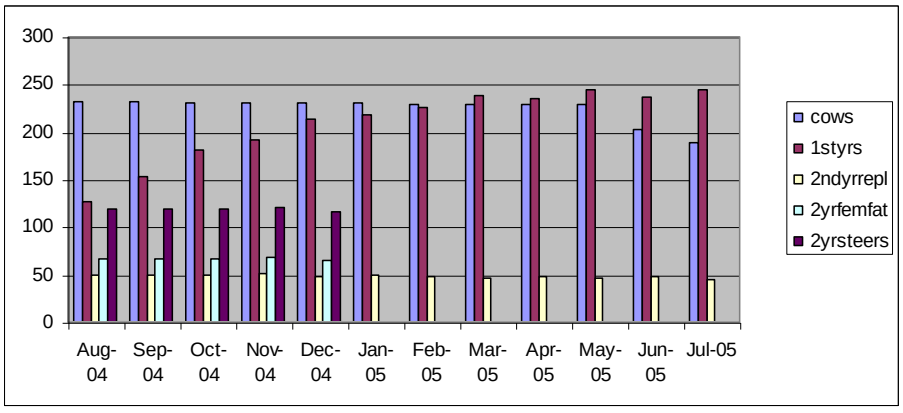
and there's also a picture:



It gives also a feed requirement pattern over the year, i.e. per month.



but maybe the next is more informative (next is per animal type, number x requirement



There are detailed tables with number of animals and feed requirement for each month of the year. There are also tables for cost per parity to determine culling and replacement rates. These can be used to check the system, but are not critical.

Flow and build up of sheets is through macros

For a given genotype (either pure, cross or 3-way cross)

1. Read in from database and display trait means, heterosis is accounted for, price premiums are derived from a table in the database.

   more columns if there are F1 and 3WC

	dam	F1 offspring
	Friesian	Angus X Friesian
Cow attributes		
Cow Mortality Rate %	3	
Cow Cull Rate non-repro %	15	
Max parities	7	
Bull Percentage	3	
Weaning Rate/calving (%)	82	
Age at first calf	850	
Intercalving Interval	380	
Birth Weight	42	42.64
Mature Weight	700	663
Steer Attributes		
Weaning Wt 200d	270	297
Yearling Wt 400d	415	435
Final weight 600d	583	593
P8Fat (mm)(steer @ 300kg)	10	11.5
P8Fat (mm) (at bull @500 days)	2.5	3.5
IMF% (steer @ 300kg)	4.50%	5.00%
Marbling Score (1-5 - steer @ 300kg)*	1.3	1.5
Muscle score A-E		
Muscle Score (A-E+ = 15 pnt scale)#	6	7
MQ4 Score	52	56
price premium muscle	-0.2	-0.1
price premium marbling	0.46	0.3

2. Fit growth curve through weights (see appendix)

   - More curves are fitted if there are F1 and 3WC
   - From each curve determine days to reach final weight (for steers) determine feed requirements for each month for each type of animals.
   - Those are averaged over genotypes if there are more.
   - This feed requirements are summarized in a working table, and brought to the summarizing tables described before.

cows	1yrs	2ndyrrepl	2yrfemfat	2yrsteers	Total	
3162	2744	1115	98	200	7318	total tonnes required
3.162	2.744	1.115	0.098	0.200	7.318	tonnes required per breeding cow
9.17	9.28	12.73	10.44	10.45		kg/animal/day
27511	27850	38190	31323	31349		$/animal/mo
cows	steers	fat hfrs	youngstock			
3.162	1.572	0.632	1.953		7.318	tonnes per breeding cow/year
316.16	157.16	63.20	195.32		731.8	$$ per breeding cow/year
3.301	3.390	3.402	3.790			per animal/year tonnes
9.04	9.29	9.32	10.38			per animal per day kg
0.90	0.93	0.93	1.04			per animal per day $$
330	339	340	379			per animal $$/year
27.13	27.86	27.96	31.15			per animal $$/mo

Database

Breeds used:

Angus
Shorthorn
Hereford
Brahman
Charolais
Limousin
Jersey
Friesian

Traits considered;
.

Reproductive Traits
Cow Mortality Rate %
Cow Cull Rate repro failure %
Max parities
Bull Percentage
Weaning Rate/calving (%)
Age at first calf - days
Intercalving Interval days
Weight Traits
Birth Weight Kg
200 day Weaning Wt Kg
400 day Yearling Wt
600 day Final Wt
Mature Weight Kg
Meat Quality Traits
P8Fat (mm)(steer @ 300kg)
P8Fat (mm) (at bull @500 days)
IMF% (steer @ 300kg)
Marbling Score (1-5 - steer @ 300kg)*
Muscle score A-E
Muscle Score (A-E+ = 15 pnt scale)#
MQ4 Score

Breed effects as well as maternal breed effects are provided.
Heterosis effects are considered the same for the three trait groups as well as for all breed combinations**.**

Appendix 2 - Growth curves and feed requirements

Given weights at days 0, 200, 400, 600 and mature weight, we fit a best curve, using a genetic algorithm to find the optimal parameters.

The equation is

Weight at time t (t in days) $W(t) = MW.[1-(1- (BW / MW)^{(1/\alpha)}) e^{\beta.t})^{\alpha}$

Where BW is birth weight and MW = mature weight. Hence, the best fit is solved for only 2 parameters.
From the growth curve, the feed requirement is determined as energy (E)

$E_{growth} + E_{maintenance}$

Where
E_{growth} on day t = .14 * [W(t) – W(t-1)] . (6.7 + 20.3 / (1 + Exp(-6 * W(t) / MW - 0.4)))

$E_{maintenance}$ on day t = 10.38 + 0.1138 .W(t) in MJ of ME.

There is a distinction between a growth for fattening animals and growth for replacements. I have assumed that MW of replacements is 95% of fattening animals. Maybe there should be an additional distinction between fattening males and females.