Australian Government
Department of Agriculture

AUSTRALIAN Pork™

Using Specific Functional Dietary Fibre Sources to Increase the Number of Piglets Weaned per Sow per Litter

Final Report
APL Project 2012/1033.493

December 2013

The University of Adelaide
Dr William van Wettere
The University of Adelaide
Roseworthy Campus SA 5372

Table of Contents

List of Tables

1. Acknowledgements

This project is supported by funding from Australian Pork Limited and the Department of Agriculture.

The author would like to thank Dr's Cherie Collins, Rebecca Athorn, David Henman and David Cadogan as well as the Rivalea technical team for all their input, help, support and advice during the development and conduct of this project.

2. Executive Summary

The low number of piglets weaned per sow per year places a considerable constraint on the productivity of the Australian pig industry. There are three steps to alleviating this problem; one, maximise the number and viability of the piglets born; two, minimise the sow body tissue loss during lactation without compromising piglet growth and survival; three, ensure the optimal environment for the developing ovarian follicles and oocytes destined to ovulate at the first post-weaning oestrus.

The objectives of this study were to determine whether the inclusion of functional fibre sources in sow gestation and lactation diets would improve piglet growth and survival pre-weaning, increase sow lactation feed intake and improve subsequent sow reproductive performance. To this end, parity 1 – 3 sows were fed either a standard gestation or lactation diet (Control; n = 119 sows; mean parity 1.7 ± 0.07) or a functional fibre gestation and lactation diet (FunctF; n = 127 sows, mean parity 1.6 ± 0.06 were used in this experiment. Treatments commenced on day 90 of gestation and ended at the first post-weaning oestrus.

Overall, the functional fibre diets reduced sow weight loss during lactation ($P < 0.05$), appeared to increase sow lactation feed intake ($P = 0.134$), tended to increase the proportion of sows returning to oestrus within 14 days of weaning ($P < 0.1$) but also appeared to decrease subsequent litter size ($P = 0.165$). There was a numerical, but not significant, increase in the weight and growth of piglets sucking FunctF sows. Interestingly, when the analyses was conducted with piglet and not sow as the experimental unit, piglets born to and sucking FunctF sows were heavier than their control equivalents at birth (20 g; $P=0.095$), seven days of age (50g; $P = 0.06$), 21 days of age (120 g; $P < 0.05$) and weaning (130 g; $P < 0.05$). Importantly, suckled litter size (post-fostering) and the number of piglets weaned were the same for both treatment groups.

In conclusion, the current data indicate a positive effect of functional fibre sources in gestation and lactation diets on certain aspects of sow and piglet performance. However, further work is recommended to focus on the effects of the functional fibre sources on sow reproductive performance on a markedly larger scale (400 sows per treatment). Further, considering the subtle improvements in piglet weight and growth characteristics it is also worth investigating this on a larger scale.

3. Background to Research

Currently, the productivity and profitability of the Australian breeding herd is constrained by low numbers of pigs weaned per sow per year, which reflects low litter sizes and high incidences of pre-weaning mortality. The key to alleviating this problem is multifactorial, but can be achieved by addressing three key issues. First, the number and viability of the piglets born alive must be maximised. Second, mobilisation of the sow's body reserves during lactation must be minimised without compromising piglet growth and survival pre-weaning. Thirdly, optimal endocrine and metabolic support must be provided for the developing oocyte destined to ovulate at the first oestrus post-weaning. Modification of nutrient intake by the sow, during gestation and lactation, represents a relatively simple commercial strategy to achieve the aforementioned objectives.

Recent European data indicates that increasing the fibre content of the diets fed to sows during late gestation, immediately pre-farrowing and during lactation can positively affect sow and piglet performance (Guillemet et al., 2007, Oliviero et al., 2009; Peltoniemi et al., 2010)). However, the fibre sources used in these trials are not readily available, or cost-effective, in Australia. Recently, I have demonstrated that feeding diets rich in lupin hulls and lupin meal prior to mating can improve embryo survival in gilts during summer. Based on these data, this project determined whether feeding a diet rich in functional fibre from day 90 of gestation through to the next mating reduced incidences of pre-weaning mortality, increased piglet growth pre-weaning and increased subsequent litter size.

4. Objectives of the Research Project

- To determine whether including functional fibre sources in late gestation diets will reduce incidences of pre-weaning mortality and increase sow lactation intake
- To determine whether the inclusion of functional fibre sources in lactation diets will increase lactation intake and thus milk production and piglet growth pre-weaning
- To determine whether the inclusion of functional fibre sources in lactation diets will increase subsequent litter size

5. Introductory Technical Information

Low numbers of pigs weaned per sow per year currently constrains the productivity and profitability of the Australian breeding herd, and is due to low litter sizes and high incidences of pre-weaning mortality. Litter size is determined by the number of ova shed (ovulation rate), the number of embryo's surviving implantation (embryo survival) and the number of implanted foetuses surviving to term (foetal survival) (van Wettere and Hughes, 2007). In parity one sows, low feed intakes and large suckled litter sizes impair ovarian follicle growth and reduce the quality of the oocytes shed and thus the embryos created at the first post-weaning oestrus (Zak et al., 1997; Quesnel et al., 2007). In the first lactation, low feed intakes are common with demand for nutrients generally exceeding voluntary intake. Therefore, feeding diets which promote voluntary intake and/or improve growth and development of the follicle-oocyte complex appear to be the best option to improve metabolic status and embryo viability in early parity sows. We have recently demonstrated that feeding nulliparous sows (gilts) a lupin based diet prior to ovulation significantly increased both the developmental competence of pre-ovulatory oocytes (Weaver et al., 2011) and embryo survival rate at day 30 post-insemination (van Wettere et al., 2012). Specifically, treatment (Lupin versus Standard diet) increased ($P < 0.05$) the proportion of oocytes reaching metaphase II in vitro (89 versus 72%; Weaver et al. 2013), the number of embryos present on day 30 post-insemination (11.2 versus 13.8) the number of embryos expressed as a proportion of corpora lutea (embryo survival; 0.77 ± 0.04 versus 0.91 ± 0.04) van Wettere et al., (2012). Our data builds on previous studies demonstrating that feeding a sugar beet based diet prior to ovulation promoted luteinising hormone release, improved oocyte developmental competence and embryo survival, as well as decreasing the proportion of litters containing intra-uterine growth restricted foetuses (Ferguson et al. 2006; Ferguson et al., 2007).

Incidences of piglet mortality during the immediate post-partum period are determined largely by the viability of the piglets at birth, which in turn reflects conditions experienced in utero (Foxcroft et al., 2007), as well as duration of farrowing (Oliviero et al., 2010). Although piglet viability at birth is the primary determinant of the piglet's ability to survive to weaning, it is only logical that strategies which reduce the duration of farrowing, as well as increase sow milk production, and thus feed intake by less viable piglets, will improve survival rates and pre-weaning growth of less viable, smaller piglets. Increasing the fibre content of diets fed during late gestation, immediately pre-farrowing and during lactation can positively affect sow and piglet performance. Specifically, feeding higher fibre diets increased piglet growth rate prior to weaning (Guillemet et al., 2007; Quesnel et al., 2009), reduced constipation in sows and increased piglet weight gain to day 5 post-partum (Oliviero et al., 2008), and increased piglet liveweight at birth and day 22 post-partum (Che et al., 2011). A reduction in constipation reduces farrowing duration in sows (Oliviero et al., 2010). Further, high fibre gestation diets promote lactation intake, especially early in lactation (Guillemet et al., 2007; Guillemet et al., 2010). More recently, Langendijk (2011) observed an increased piglet birthweight when sows were fed 3.5 kg of a high fibre diet compared to a normal gestation diet during late gestation. Although, feeding the high fibre diet did not promote lactation intake in this trial, it is worth noting that 1) high feeding levels in late gestation appeared to have a negative effect on sow production in lactation, which contradicts the body of data present in the literature; 2) the lactation performance of the sows observed in the trial of Langendijk (2011) was worse than is normal for animals of that parity (Herde et al., 2011). Specifically, mean daily feed intake was on average 1.3 kg / day less for Langendijk (2011) compared to Herde et al., (2011), and sow weight loss for the 3.5C treatment in Langendijk (2011) approximately double the equivalent treatments in Herde et al., (2011). In both trials, feeding a high fibre diet during late gestation followed by an abrupt change to a standard (low fibre) lactation diet may have reduced feed intake early in lactation, justifying the need to determine the effects of continuing to feed high fibre diets into lactation and the post-weaning period.

In the majority of previous studies, the high fibre diets have been formulated according to crude fibre content, as this is the most common method of diet formulation used by commercial nutritionists. However, crude fibre only measures the certain fraction of fibre that is left after acid and basic digestion in the laboratory, or the supposed "undigested" fibre (proportion of insoluble fibre plus lignin) in the animal. Furthermore, the crude fibre procedure only measures 65% of total cellulose, around 50% of the lignin, 20% hemicellulose and very little to no pectin. It is, therefore, suggested that crude fibre is a very inaccurate method of measuring total dietary fibre content. The first step required to increase the accuracy of fibre measurement is to divide the fibre fraction into Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF). The NDF fraction encompasses most of the fibre (cellulose, hemicellulose, lignin), as well a minor amount of digestible protein, however it only measures around 10% of the pectin (highly digestible form of fibre). The ADF fraction includes only the cellulose, lignin and silica, however this group of fibre, polyphenols and sand is not desirable, and can be broadly classified as non-functional. In general terms, if ADF is subtracted from NDF, most of the remaining fibre is hemicellulose (arabinoxylan β glucan which are high in cereals; a proportion of pectins that represent the main non-starch polysaccharide (NSP) component of grain legumes and oil seeds, such as soybean, lupins and canola, plus mannans e.g., glucomannans and galactomannans).

Specific fibres such as pectin and insoluble arabinoxylan can significantly improve gut function and the reproductive performance of the sow. High pectin from sugar beet pulp and lupins has been shown to improve satiety in gestating sows (Peltoniemi et al., 2010), as well as significantly improve oocyte and embryo quality in gilts and sows (Ferguson et al., 2007; Weaver et al., 2013; van Wettere et al., 2012).

It is, therefore, evident that while increasing the fibre content of late gestation and lactation diets can improve sow and piglet performance, more sophisticated diet formulation is required to maximize the levels of beneficial fibre present in these diets. Furthermore, it is increasingly evident that the voluntary intake of modern genotypes, both in gestation and lactation, limits the capacity to improve nutritional status and performance by simply increasing intake. Consequently, modifications in dietary composition, rather than dietary intake, will provide the solution to improving dam and progeny performance. Using diets formulated to optimize fibre composition, the current proposal describes an experiment designed to determine whether increasing the quantity and type of fibre included in gestation and lactation diets affects sow and piglet performance. Specifically, whether these diets will reduce incidences of early post-partum mortality and increases pre-weaning piglet growth and survival, as well as improving the quality of the embryos produced at the first post-weaning oestrus, thus increasing second litter size.

6. Research Methodology

6.1 Experimental design

A total of 246 parity 1 – 3 sows were used in this experiment. On day 90 of gestation, sows were randomly allocated, within parity, to one of two treatments.

- Treatment One (Control; n = 119 sows; mean parity 1.7 ± 0.07 (mean ± SEM)): sows fed a standard gestation and lactation diet throughout the experimental period
- Treatment Two (FunctF; n = 127 sows, mean parity 1.6 ± 0.06): sows fed a 'functional fibre' diet from day 90 of gestation until first oestrus post-weaning.

Diet specifications for the Control gestation and lactation diets and FunctF gestation and lactation diets are presented in Appendix 1. Sows were housed in groups of 45 or 90 during gestation and fed from electronic sow feeders. Approximately 4 days prior to predicted farrowing date, sows were moved to traditional farrowing crates. Weaning took place 26.9 ± 0.03 days after farrowing (range; 23 – 31 days), with sows mated at their first post-weaning oestrus.

6.2 Experimental measure

Sows were weighed and P2 backfat measured on day 90 of gestation, at entry into the farrowing shed and weaning. Sow lactation feed intake was recorded, as was subsequent reproductive performance (weaning to oestrus interval, mating and pregnancy outcome, reasons for culling as well as subsequent total born, born alive, still born and mummified). Subsequent litter size data for sows returning to oestrus post-mating and re-mated were excluded from the analysis. Individual piglet liveweight (LW) was measured at birth, day 7 post-partum and at weaning. Timing and reasons for piglet mortality were recorded, as was the number of piglets removed or added to a litter.

6.3 Data analysis

Unless otherwise stated all data are presented as mean ± standard error of the mean (SEM). Using the individual piglet weights, the following calculations were made; the number of piglets with a birthweight less than 1 kg; the coefficient of variation in piglet birthweight, day 7 weight and weaning weight as well as piglet growth; and minimum piglet weight within the litter at birth, day 7 and weaning. Based on piglet growth rate between birth and weaning, an adjusted day 21 piglet weight was calculated.

Treatment effects on all variables, with the exception of the proportion of sows pregnant, culled or farrowing, were analysed using a general analysis of variance (unbalanced design) with parity included as a co-variate, and replicate built in. Sow weight and P2 change during lactation, as well as the number of piglets weaned were added as co-variates to the model when analysing treatment effects on subsequent reproductive performance. Sow was considered to be the experimental unit, except when the effects of treatment and piglet gender on piglet growth pre-weaning were investigated. Piglet birthweight was added to the model as a co-variate when the effect of parity, treatment and piglet gender on piglet performance were analysed. Treatment and parity effects on the proportion of sows with a weaning to oestrus interval of 7 or 14 days or less, the proportion of sows pregnant, farrowing and culled for non-reproductive reasons were analysed using a chi-square test performed using Excel. All other analysis was conducted using Genstat.

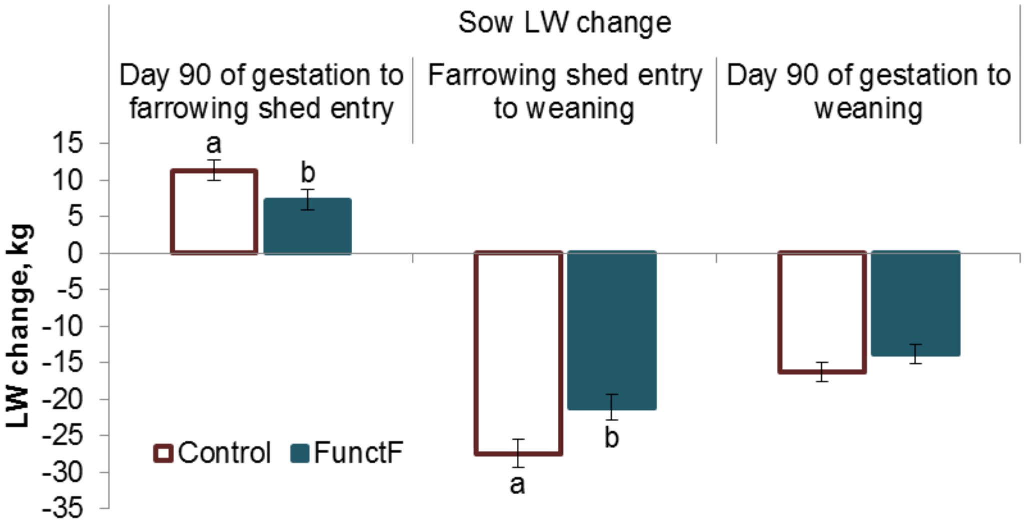
7. Discussion of Results

There was no effect of treatment on sow P2 or LW at any measurement point (Table 1). However, FunctF sows gained less weight between day 90 of gestation and entry into the farrowing shed, but lost less weight during lactation compared to Control sows ($P < 0.05$; Figure 1). Weight change between day 90 of gestation and weaning was -16.3 ± 1.32 and -13.8 ± 1.27 kg for Control and FunctF sows ($P = 0.185$).

Table 2: Liveweight (LW) and P2 backfat (P2) of Control and FunctF sows on day 90 of gestation, farrowing shed entry and weaning

	Treatment	
	Control	**FunctF**
Sow P2, mm		
Day 90 of gestation	24.6 ± 0.43	24.6 ± 0.42
Farrowing shed entry	23.5 ± 0.41	23.1 ± 0.40
Weaning	20.4 ± 0.38	20.2 ± 0.37
Sow LW, kg		
Day 90 of gestation	259.3 ± 1.65	259.4 ± 1.60
Farrowing shed entry	270.6 ± 2.16	266.7 ± 2.09
Weaning	243.0 ± 2.12	245.6 ± 2.05

Table 2: Liveweight (LW) change for Control and FunctF sows; [ab]within time period indicate significant difference; P < 0.01)



There was no effect of treatment on the number of piglets born alive, mummified or still born at the first farrowing (Table 2). Following fostering, the number of piglets was identical for both treatments, and sows from both treatments weaned the same number of piglets. Piglet pre-weaning mortality, pre and post-fostering was unaffected by sow treatment.

Table 3: Effect of Control and FunctF diets on sow litter size, litter size suckled, piglet fostering, mortalities and removals as well as daily sow feed intake during the first farrowing and lactation.

	Treatment		Significance
	Control	**FunctF**	**(P value)**
Litter size for farrowing one			
Total Born	12.5 ± 0.26	12.4 ± 0.25	0.891
Born Alive	11.7 ± 0.25	11.3 ± 0.24	0.240
Stillborn	0.70 ± 0.12	0.83 ± 0.12	0.456
Mummies	0.19 ± 0.06	0.29 ± 0.06	0.190
Fostering and litter size suckled			
Piglets fostered on	1.0 ± 0.15	1.1 ± 0.15	0.469
Piglets fostered off	1.1 ± 0.13	0.8 ± 0.13	0.039
Litter size post-fostering	11.3 ± 0.09	11.3 ± 0.09	0.803
Litter size on day 7	10.2 ± 0.14	10.20 ± 0.13	0.933
Litter size at weaning	9.5 ± 0.16	9.6 ± 0.16	0.642
Piglet mortalities and removals			
Pre-foster (%)	0.03 ± 0.01	0.04 ± 0.01	0.508
Post-foster (%)	0.16 ± 0.02	0.15 ± 0.01	0.747
Total (pre + post-foster deaths)	2.11 ± 0.19	2.18 ± 0.18	0.776
Average sow feed intake (kg / day)	6.81 ± 0.06	6.93 ± 0.06	0.134

There was a tendency ($P < 0.1$) for more sows in the FunctF group to return to oestrus within 14 days of weaning compared to control sows (91 versus 83%). There was no significant effect on the days to oestrus between treatments, with FunctF and Control sows having a WOI of 6.7 and 7.6 days, respectively. There was no effect of treatment on farrowing rate; however, the total number of piglets born at the subsequent litter was lower for FunctF compared to Control sows (0.5 piglets; $P = 0.165$).

Table 4: Subsequent reproductive performance of Control and FunctF sows

	Treatment		**Significance**
	Control	**FunctF**	**(P value)**
WOI, days	7.6 ± 0.64	6.7 ± 0.60	0.300
Proportion sows with a WOI			
≤ 7 days	0.79	0.86	P > 0.50
≤ 14 days	0.83	0.91	P < 0.10
≤ 21 days	0.91	0.95	P < 0.20
21 days plus	0.09	0.05	P < 0.20
Proportion sows removed between weaning and oestrus	0.08	0.04	P < 0.20
Farrowing rate	0.81	0.82	P > 0.50
Removed non-reproductive reasons	0.07	0.08	P > 0.50
Subsequent litter size			
Total born	13.1 ± 0.32	12.6 ± 0.28	0.165
Born alive	12.0 ± 0.28	11.5 ± 0.25	0.214
Stillborn	0.92 ± 0.13	0.73 ± 0.12	0.303
Mummies	0.23 ± 0.06	0.28 ± 0.06	0.500

When individual piglet liveweights and growth rates were analysed with sow used as the experimental unit, there were no treatment effects on piglet and litter birth characteristics (Table 4). Piglets suckling FunctF sows were heavier at all measurement points, and grew faster prior to weaning; however, these differences were not significant.

Table 5: Individual weight data for piglets born to, and suckling, Control and FunctF sows.

	Treatment		Significance
	Control	**FunctF**	**(P value)**
Piglet birthweight			
Mean (kg)	1.56 ± 0.02	1.58 ± 0.02	0.441
Minimum (kg)	1.04 ± 0.03	1.05 ± 0.03	0.841
CV, %	18.3 ± 0.58	19.12 ± 0.57	0.293
Day 7 LW (kg)			
Mean individual LW	2.86 ± 0.04	2.91 ± 0.04	0.184
Total litter weight	29.11 ± 0.54	30.11 ± 0.53	0.189
Adjusted day 21 LW (kg)			
Mean individual LW	6.26 ± 0.06	6.33 ± 0.06	0.374
Total litter weight	60.03 ± 1.17	61.80 ± 1.12	0.276
Weaning weight (kg)			
Mean individual LW	7.82 ± 0.09	7.89 ± 0.09	0.554
Total litter weight	75.14 ± 0.94	76.74 ± 0.89	0.218
Average piglet weight gain (kg)			
Birth to day 7	1.29 ± 0.04	1.35 ± 0.03	0.137
Birth to day 21	4.68 ± 0.06	4.77 ± 0.06	0.285
Birth to Wean	6.25 ± 0.09	6.34 ± 0.09	0.473

To investigate the effect of piglet gender on performance pre-weaning, piglets were considered as the experimental unit for one set of data analysis (Table 5). There was an effect of treatment (FunctF versus Control; Table 5) on mean individual piglet weight at birth (20 g; P=0.095), seven days of age (50g; P = 0.06), 21 days of age (120 g; P < 0.05) and weaning (130 g; P < 0.05). Male piglets were significantly heavier than female piglets at birth (50 g) and seven days of age (70g). There was also a numerical, but non-significant, effect of gender on piglet LW at 21 days of age and weaning, with male piglets weighing 60 and 100 g more, respectively.

Table 6: Effect of sow dietary treatment and piglet gender on piglet liveweight (LW) when piglet was used as the experimental unit

	Sow Treatment		**Piglet Gender**		**Significance#**	
	Control	**FunctF**	**F**	**M**	**ST**	**PG**
Piglet LW, kg						
Birth	1.53 ± 0.01	1.55 ± 0.01	1.51 ± 0.01	1.56 ± 0.01	<0.10	<0.01
Day 7	2.88 ± 0.02	2.93 ± 0.02	2.87 ± 0.02	2.95 ± 0.02	0.06	<0.01
Day 21	6.19 ± 0.04	6.31 ± 0.04	6.22 ± 0.04	6.28 ± 0.04	<0.05	0.309
Weaning	7.75 ± 0.05	7.88 ± 0.05	7.77 ± 0.05	7.86 ± 0.05	<0.05	0.160

ST – Sow treatment; PG – piglet gender

Overall, the current data demonstrate that feeding a functional fibre diet from day 90 of gestation and during lactation significantly affected sow body weight change. Feeding the functional fibre diet reduced sow weight gain during gestation; however, whether this was a reflection of dietary effects on sow metabolism or intake cannot be established. More importantly, sow weight loss during lactation was significantly lower for animals fed the functional fibre diet, and this was associated with a numerical, but not significant, increase in daily feed intake during lactation (120 g / day; P = 0.142).Even more importantly, this reduction in sow weight loss was not accompanied by any reduction in piglet weight or number at weaning.. Together, these data could indicate a positive effect of feeding functional fibre diets on sow milk composition rather than milk volume, and this should be examined in future studies.

Dietary effects on subsequent sow reproduction are slightly contradictory. The proportion of sows returning to oestrus within 14 days of weaning tended to be higher for sows fed the functional fibre diet; however, there was a reduction in subsequent litter size of 0.5 piglets / litter (P = 0.165). Considering the positive effects of feeding the functional fibre diet on sow weight loss during lactation, and the positive effect this is likely to have on incidences of premature culling and longevity, it is important that further work is conducted to confirm what influence this diet has on subsequent reproduction.

8. Implications & Recommendations

Based on the current data, the author suggests that formulating gestation and lactation diets based on their functional fibre composition can have beneficial effects on sow and piglet performance; however, there are a number of areas which require further investigation. Specifically it is suggested that the effect of feeding a functional fibre diet immediately pre-farrowing and during lactation on sow lactation and subsequent reproductive performance is investigated using a larger number of animals (approximately 400 per treatment, to allow for treatment effects on reproduction as well as piglet growth to be investigated with sufficient statistical power).

9. Intellectual Property

The author is unclear whether there is intellectual property associated with the diet formulation, this will need to be discussed with the nutritionists involved (Dr David Cadogan) prior to submission of the complete final report.

10. Technical Summary

There have been no technical developments per se; however, the current body of work does suggest that the functional fibre diet positively affected male piglet birth weights and pre-weaning performance, and significantly reduced lactation weight loss.

11. References

Che, L., Fend, D., Wu, D., Fang, Z., Lin, Y., Yan, T., (2011) Effect of dietary fibre on reproductive performance of sows during the first two parities. Reproduction Domestic Animals 46; 1061-1066

De Leeuw, JA., Bolhuis, JE., Bosch, G., Gerrits, W.J. (2009) Effects of dietary fibre on behaviour and satiety in pigs. Proceedings of the Nutrition Society 67; 334-342.

Ferguson, E., Slevin, J., Edwards, S., Hunter, M., and Ashworth, C. (2006) Effect of alterations in the quantity and composition of the pre-mating diet on embryo survival and foetal growth in the pig. Animal Reproduction Science 96(1), 89-103.

Ferguson, E., Slevin, J., Hunter, M., Edwards, S., and Ashworth, C. (2007) Beneficial effects of a high fibre diet on oocyte maturity and embryo survival in gilts. Reproduction 133(2), 433-439.

Foxcroft GR, Vinsky MD, Paradis F, Tse WY, Town SC, Putman CT, Dyck MK, Dixon WT. (2007). Macroenvironment effects on oocytes and embryos in swine. Theriogenology 68; S30-S39.

Guillemet R, Dourmad JY, Meunier-Salaün MC. (2006) Feeding behaviour in primiparous lactating sows: impact of a high fibre diet during pregnancy. Journal of Animal Science 84; 2474 – 2481.

Guillemet R, Hamard A, Quesnel H, Père MC, Etienne M, Dourmad JY, Meunier-Salaün MC., (2007) Dietary fibre for gestating sows: effects on parturition progress, behaviour, litter and sow performance. Animal; 872-880.

Guillemet R, Guérin C, Richard F, Dourmad JY, Meunier-Salaün MC. (2010). Feed transition between gestation and lactation is exhibited earlier in sows fed a high fibre diet during gestation. Journal of Animal Science 88; 2637-2647.

Herde, P. J., Kind, K. L., Gatford, K. L., Hughes, P. E., van Wettere, W. H. E. J. (2011) Effect of feeding frequency and dietary fibre content during late gestation on lactation performance of first parity sows. In. Manipulating Pig Science XV, p251. Edited by R. J. Van Barneveld. Australasian Pig Science Association, Werribee.

Langendijk., P. (2011). Lactogenesis: late gestation diets and hormonal intervention. Final report prepared for the Co-operative Research Centre for an internationally competitive pork industry.

Oliviero C, Kokkonen T, Heinonen M, Sankari S, Peltoniemi O. (2009) Feeding sows with high fibre diets around farrowing and early lactation: impact on intestinal activity, energy balance related parameters and litter performance. Research in Veterinary Medicine 86; 314 -319.

Oliviero C, Heinonen M, Valros A, Peltoniemi O. (2010) Environmental and sow-related factors affecting the duration of farrowing. Animal Reproduction Science 119; 85 – 91.

Peltoniemi OA, Tast A, Heinonen M, Oravainen J, Munsterhejm C, Halli O, Oliviero C, Hameenoja P, Virolainen JV (2010) Fertility of sows fed ad libitum with a high fibre diet during pregnancy. Reproduction Domestic Animals 45; 1008 1014.

Quesnel H, Etienne M, Pere C (2007). Influence of litter size on metabolic status and reproductive axis in primiparous sows. Journal of Animal Science 85; 118 – 128.

Quesnel H, Meunier-Salaün MC, Hamard A, Guillemet R, Etienne M, Farmer C, Dourmad JY, Père MC. (2009). Dietary Fibre for pregnant sows: influence on sow physiology and performance during lactation. Journal of Animal Science 87; 532-543.

Van Wettere WHEJ, Hughes PE (2007). Gilt management, oocyte quality and embryo survival. In: Paradigms in Pig Science, Nottingham University Press. Pp 329 – 358.

Van Wettere WHEJ., Terry R., Weaver A., Herde P., Hughes, PEH. (2012) Adding lupin fibre to pre-mating diets improved potential litter size of gilts mated during the seasonal infertility period. International conference on Animal Reproduction 2012 (Accepted abstract)

Weaver AC, Kelly JM. Kind KL, Gatford, KL, Kennaway, PJ, Herde PH, , van Wettere WHEJ (2011). Oocyte maturation and embryo survival in nulliparous female pigs (gilts) is improved by feeding a lupin-based high-fibre diet. Reproduction, Fertility, Development 25; 1216 – 1223.

12. Publications Arising

As yet there have been no publications arising from this research. However, it is the authors' intent to publish this data in the form of a paper for an international peer-reviewed journal, as well as any other format requested by APL.

Appendix One

```
17
=================================================      Rivalea       (6198)
=================================================
:
:
:    Single-Mix        (FM)       * Corowa *       {15} FEBRUARY 2013           ALL DATA           12:26 07/02/13
0001 :
: 1048.4/1.21                    (    1)  Plant=1        henmadav
:
=============================================================================================================================
====

                                                  Formula basic data
                    --------------------------------------------------------------------------------
                    Code      :       9970         Name      : 12R087 A GESTATION CONTROL

                    Sell price:         0.0        Batch [Kg]:      3000.0      Group code:        120
                    Cost      :       282.099      Created   : 06/02/13         Version   :
                    Margin    :      -282.099      Updated   : 07/02/13         FM origin :       2090
                    Tonnes    :         0.0        User name : henmadav         VM key    :       2090

                    External reference: 6,P,B,GE
                    Script file name  :

                                                          Analysis
   --------------------------------------   --------------------------------------   -------------------------------------
-
   [VOLUME]   %         :       100.0       #ISO/LYS   G/G       :         0.64367   VIT:D3     IU/KG      :
3094.059406
   [DRYMAT]   %         :        89.062673  #TRY/LYS   G/G       :         0.246462  VIT:E      IU/KG      :
74.257426
   DE_PIG     MJ/KG     :        12.795808  #VAL/LYS   G/G       :         0.88455   #AME/ALY   G/G        :        0.26799
   NE4G       MJ/KG     :         9.461994  AMETH      %         :         0.129996  #ACY/ALY   G/G        :
0.426477
   #ALY/NE4G  GM/MJ     :         0.051266  AM+C       %         :         0.286217  #AM+/ALY   G/G        :
0.590042
   DEENZYME   MJ/KG     :        13.03996   ATHREO     %         :         0.265387  #ATH/ALY   G/G        :
0.547101
   PROTEIN    %         :        11.199347  AISOLEUC   %         :         0.303079  #AIS/ALY   G/G        :
0.624803
   FAT        %         :         1.651314  ATRYPTO    %         :         0.090565  #ATR/ALY   G/G        :
0.186701
   STARCH     %         :        49.30429   AVALINE    %         :         0.335152  #AVA/ALY   G/G        :
0.690923
   FIBRE      %         :         4.289109  ACYSTINE   %         :         0.206875  #ATH/DE_   GM/MJ      :        0.02074
   ASH        %         :         4.881188  AP+T       %         :         0.794193  ATYROSIN   %          :
0.312158
   CALCIUM    %         :         0.858706  APHENYL    %         :         0.213423  LNAA       GM         :
76.540044
   T:PHOS     %         :         0.496594  ALEUCINE   %         :         0.582726  #TRY/LNA   G/G        :
0.004623
   AV:PHOS    %         :         0.358584  AHISTID    %         :         0.226408  BULKDENS   KG/HL      :
58.373333
   ENZAVPHOS  %         :         0.375907  AARGININ   %         :         0.497132  IONOPHORE  PPM        :        0.0
   CAL:PHOS   G/G       :         1.729192  SALT       %         :         0.390845  W6 FA      %          :        0.0
   CAL:AVPHOS G/G       :         2.394713  %LEGUMES   %         :         0.990099  W3 FA      %          :        0.0
   P:PHOS     %         :         0.306301  ABC        MEQ/KG    :       630.537294  W6:W3      G/G        :        0.0
   CAL:ENZAVP G/G       :         2.284359  SODIUM     %         :         0.13551   SAT FA     %          :        0.0
   LYSINE     %         :         0.572638  POTASS     %         :         0.490512  MONO FA    %          :        0.0
   ALYSINE    %         :         0.485079  CHLORIDE   %         :         0.326458  POLY FA    %          :        0.0
   METHION    %         :         0.174616  MAGNES     %         :         0.140103  ENDF       %          :
2.528475
   M+C        %         :         0.40767   NA+K_CL    MEQ/KG    :        90.474007  GE         MJ/KG      :
9.866543
   THREO      %         :         0.353811  CHOLINE    MG/KG     :       988.470957  RACTOP     PPM        :        0.0
   ISOLEUC    %         :         0.368589  LACTOSE    %         :         0.0       VIT:K      MG/KG      :
0.990099
   TRYPTO     %         :         0.141133  N:D:F:     %         :        17.772673  VIT:B1     MG/KG      :
1.485149
   CYSTINE    %         :         0.245856  LINOLEIC   %         :         1.03666   VIT:B2     MG/KG      :
4.950495
   VALINE     %         :         0.506527  A:D:F:     %         :         6.470112  VIT:B6     MG/KG      :
2.970297
   HISTIDIN   %         :         0.257251  RUMIN:ME   MJ/KG     :        11.539947  VIT:B12    MG/KG      :
69.306931
   LEUCINE    %         :         0.730684  LAYER:ME   KCALS/KG  :      2676.010711  NIACIN     MG/KG      :       19.80198
   PHENYLAL   %         :         0.490349  SULPHUR    %         :         0.173114  PANTOTH:   MG/KG      :
14.851485
   P+T        %         :         0.662222  COPPER     PPM       :         5.940594  BIOTIN     MG/KG      :
99.009901
   ARGININE   %         :         0.61006   COBALT     PPM       :         0.0       FOLIC      MG/KG      :        9.90099
   TYROSINE   %         :         0.357835  MANGANES   PPM       :        22.277228  VIT:C      MG/KG      :       49.50495
   T:EAA      %         :         4.71503   ZINC       PPM       :        44.554455  SELPLEX    PPM        :
0.222772
   #LYS/DE_   GM/MJ     :         0.044752  IRON       PPM       :        59.405941  ORG IRON   PPM        :
59.405941
   #ALY/DE_   GM/MJ     :         0.037909  IODINE     PPM       :         1.485149  ORG ZINC   PPM        :
44.554455
   #MET/LYS   G/G       :         0.304933  SELENIUM   PPM       :         0.222772  ORG MANG   PPM        :
22.277228
   #M+C/LYS   G/G       :         0.711916  CHROMIUM   PPB       :       297.029703  ORG COPPER PPM        :
5.940594
   #THR/LYS   G/G       :         0.617861  VIT:A      IU/KG     :     14851.485149

                              Raw material                        Available       %            [Kg]          Tonnes
           ------------------------------------------------- --------- ------------- ------------- ---------------
                    1 WHEAT                                      [X]       44.986667      1349.6            0.0
                   12 BARLEY                                     [X]       36.666667      1100.0            0.0
```

200	MILLMIX	[X]	13.6	408.0	0.0
300	CANOLA MEAL 35%	[X]	1.0	30.0	0.0
400	MEATMEAL 66%	[X]	1.0	30.0	0.0
500	WATER	[X]	1.0	30.0	0.0
502	NATUPHOS 5000	[X]	0.01	0.3	0.0
503	PORZYME 9310	[X]	0.026667	0.8	0.0
560	LIMESTONE	[X]	1.533333	46.0	0.0
576	DICALPHOS BIN ADD	[X]	0.35	10.5	0.0
990	BETAINE	[X]	0.02	0.6	0.0
1551	LYSINE MICRO	[X]	0.206667	6.2	0.0
1560	SOW REPLACE PAK MICRO	[X]	0.15	4.5	0.0
1566	REPRODUCTION BLEND MICRO	[X]	0.025	0.75	0.0
1585	SALT BIN MICRO	[X]	0.3	9.0	0.0
1592	VITAMIN BLEND A MICRO large	[X]	0.075	2.25	0.0
1598	VITAMIN BLEND B MICRO (above 1.5kg)	[X]	0.05	1.5	0.0
			101.0	3030.0	0.0

== Rivalea (6198)
==
:
:
: Single-Mix (FM) * Corowa * {15} FEBRUARY 2013 ALL DATA 12:26 07/02/13
0003 :
: 1048.4/1.21 (1) Plant=1 henmadav
:
==
====

Formula basic data

Code :	9971	Name :	12R087 B HIGH FIBRE GESTATION		
Sell price:	0.0	Batch [Kg]:	3000.0	Group code:	120
Cost :	267.213	Created :	15/01/13	Version :	
Margin :	-267.213	Updated :	07/02/13	FM origin :	2090
Tonnes :	0.0	User name :	henmadav	VM key :	2090

External reference: 6,P,B,GE
Script file name :

Analysis

[VOLUME]	%	100.0	#ISO/LYS	G/G	0.775777	VIT:D3	IU/KG	3094.059406
[DRYMAT]	%	88.981584	#TRY/LYS	G/G	0.334754	VIT:E	IU/KG	75.445545
DE_PIG	MJ/KG	12.597115	#VAL/LYS	G/G	0.902376	#AME/ALY	G/G	0.29595
NE4G	MJ/KG	8.797527	AMETH	%	0.123104	#ACY/ALY	G/G	0.451278
#ALY/NE4G	GM/MJ	0.047282	AM+C	%	0.268407	#AM+/ALY	G/G	0.645267
DEENZYME	MJ/KG	12.310581	ATHREO	%	0.278973	#ATH/ALY	G/G	0.670669
PROTEIN	%	12.556993	AISOLEUC	%	0.289973	#AIS/ALY	G/G	0.697114
FAT	%	1.830119	ATRYPTO	%	0.086422	#ATR/ALY	G/G	0.207764
STARCH	%	41.09703	AVALINE	%	0.321981	#AVA/ALY	G/G	0.774063
FIBRE	%	9.224092	ACYSTINE	%	0.187715	#ATH/DE_	GM/MJ	0.022146
ASH	%	4.862449	AP+T	%	0.734138	ATYROSIN	%	0.284267
CALCIUM	%	0.85903	APHENYL	%	0.213738	LNAA	GM	82.778378
T:PHOS	%	0.509195	ALEUCINE	%	0.550305	#TRY/LNA	G/G	0.004924
AV:PHOS	%	0.357746	AHISTID	%	0.212011	BULKDENS	KG/HL	56.430264
ENZAVPHOS	%	0.388287	AARGININ	%	0.500711	IONOPHORE	PPM	0.0
CAL:PHOS	G/G	1.687036	SALT	%	0.39103	W6 FA	%	0.0
CAL:AVPHOS	G/G	2.401229	%LEGUMES	%	13.729373	W3 FA	%	0.0
P:PHOS	%	0.331285	ABC	MEQ/KG	693.945875	W6:W3	G/G	0.0
CAL:ENZAVP	G/G	2.212355	SODIUM	%	0.13909	SAT FA	%	0.0
LYSINE	%	0.521982	POTASS	%	0.508523	MONO FA	%	0.0
ALYSINE	%	0.415962	CHLORIDE	%	0.28782	POLY FA	%	0.0
METHION	%	0.16909	MAGNES	%	0.155199	ENDF	%	2.148832
M+C	%	0.400611	NA+K_CL	MEQ/KG	107.18996	GE	MJ/KG	11.408977
THREO	%	0.407611	CHOLINE	MG/KG	866.888119	RACTOP	PPM	0.0
ISOLEUC	%	0.404941	LACTOSE	%	0.0	VIT:K	MG/KG	0.990099
TRYPTO	%	0.174735	N:D:F:	%	23.229835	VIT:B1	MG/KG	1.485149
CYSTINE	%	0.226742	LINOLEIC	%	1.012644	VIT:B2	MG/KG	4.950495
VALINE	%	0.471024	A:D:F:	%	11.848937	VIT:B6	MG/KG	2.970297
HISTIDIN	%	0.245317	RUMIN:ME	MJ/KG	11.505769	VIT:B12	MG/KG	69.306931
LEUCINE	%	0.680298	LAYER:ME	KCALS/KG	2470.343654	NIACIN	MG/KG	19.80198
PHENYLAL	%	0.454632	SULPHUR	%	0.151166	PANTOTH:	MG/KG	14.851485
P+T	%	0.655975	COPPER	PPM	5.940594	BIOTIN	MG/KG	99.009901
ARGININE	%	0.619975	COBALT	PPM	0.0	FOLIC	MG/KG	9.90099
TYROSINE	%	0.340234	MANGANES	PPM	22.277228	VIT:C	MG/KG	49.50495
T:EAA	%	4.132393	ZINC	PPM	44.554455	SELPLEX	PPM	0.222772
#LYS/DE_	GM/MJ	0.041437	IRON	PPM	59.405941	ORG IRON	PPM	59.405941
#ALY/DE_	GM/MJ	0.03302	IODINE	PPM	1.485149	ORG ZINC	PPM	44.554455
#MET/LYS	G/G	0.323938	SELENIUM	PPM	0.222772	ORG MANG	PPM	22.277228
#M+C/LYS	G/G	0.76748	CHROMIUM	PPB	297.029703	ORG COPPER	PPM	5.940594
#THR/LYS	G/G	0.780892	VIT:A	IU/KG	14851.485149			

Raw material	Available	%	[Kg]	Tonnes
1 WHEAT	[X]	38.173333	1145.2	0.0
12 BARLEY	[X]	27.5	825.0	0.0
110 LUPIN KERNELS 33%	[X]	1.866667	56.0	0.0
200 MILLMIX	[X]	16.9	507.0	0.0
285 LUPIN HULLS	[ ]	12.0	360.0	0.0

400	MEATMEAL 66%	[X]	1.0	30.0	0.0
500	WATER	[X]	1.0	30.0	0.0
502	NATUPHOS 5000	[X]	0.01	0.3	0.0
503	PORZYME 9310	[X]	0.026667	0.8	0.0
560	LIMESTONE	[X]	1.483333	44.5	0.0
576	DICALPHOS BIN ADD	[X]	0.333333	10.0	0.0
605	DL-METHIONINE	[X]	0.006667	0.2	0.0
1551	LYSINE MICRO	[X]	0.07	2.1	0.0
1553	THREONINE MICRO	[X]	0.03	0.9	0.0
1560	SOW REPLACE PAK MICRO	[X]	0.15	4.5	0.0
1566	REPRODUCTION BLEND MICRO	[X]	0.025	0.75	0.0
1585	SALT BIN MICRO	[X]	0.3	9.0	0.0
1592	VITAMIN BLEND A MICRO large	[X]	0.075	2.25	0.0
1598	VITAMIN BLEND B MICRO (above 1.5kg)	[X]	0.05	1.5	0.0
			101.0	3030.0	0.0

```
================================================       Rivalea        (6198)
================================================
:
:
:    Single-Mix         (FM)       * Corowa *        {15} FEBRUARY 2013             ALL DATA            12:26 07/02/13
0005 :
: 1048.4/1.21                      (    1)  Plant=1        henmadav
:
========================================================================================================================
====
```

Formula basic data

Code :	9972	Name	: 12R087 C LACTATION CONTROL		
Sell price:	0.0	Batch [Kg]:	3000.0	Group code:	120
Cost :	357.028	Created	: 20/02/03	Version :	
Margin :	-357.028	Updated	: 07/02/13	FM origin :	2080
Tonnes :	0.0	User name	: henmadav	VM key :	2080

External reference: 6,P,B,LA
Script file name :

Analysis

[VOLUME]	%	100.0	#ISO/LYS	G/G	0.44236	VIT:D3	IU/KG	3217.821782
[DRYMAT]	%	89.633927	#TRY/LYS	G/G	0.164376	VIT:E	IU/KG	128.712871
DE_PIG	MJ/KG	13.8523	#VAL/LYS	G/G	0.669439	#AME/ALY	G/G	0.185991
NE4G	MJ/KG	10.241422	AMETH	%	0.164414	#ACY/ALY	G/G	0.266395
#ALY/NE4G	GM/MJ	0.086315	AM+C	%	0.345022	#AM+/ALY	G/G	0.390303
DEENZYME	MJ/KG	13.904925	ATHREO	%	0.367452	#ATH/ALY	G/G	0.415676
PROTEIN	%	14.352175	AISOLEUC	%	0.351348	#AIS/ALY	G/G	0.397459
FAT	%	4.482333	ATRYPTO	%	0.105696	#ATR/ALY	G/G	0.119568
STARCH	%	47.666708	AVALINE	%	0.461734	#AVA/ALY	G/G	0.522331
FIBRE	%	3.774365	ACYSTINE	%	0.23549	#ATH/DE_	GM/MJ	0.026526
ASH	%	4.587622	AP+T	%	0.952826	ATYROSIN	%	0.394276
CALCIUM	%	0.94691	APHENYL	%	0.293038	LNAA	GM	69.831056
T:PHOS	%	0.50694	ALEUCINE	%	0.790757	#TRY/LNA	G/G	0.006743
AV:PHOS	%	0.53543	AHISTID	%	0.301201	BULKDENS	KG/HL	61.577046
ENZAVPHOS	%	0.402782	AARGININ	%	0.647851	IONOPHORE	PPM	0.0
CAL:PHOS	G/G	1.867892	SALT	%	0.44309	W6 FA	%	0.0
CAL:AVPHOS	G/G	1.768503	%LEGUMES	%	3.960396	W3 FA	%	0.0
P:PHOS	%	0.250389	ABC	MEQ/KG	592.353762	W6:W3	G/G	0.0
CAL:ENZAVP	G/G	2.350926	SODIUM	%	0.161459	SAT FA	%	0.0
LYSINE	%	0.998589	POTASS	%	0.446758	MONO FA	%	0.0
ALYSINE	%	0.883987	CHLORIDE	%	0.390716	POLY FA	%	0.0
METHION	%	0.254713	MAGNES	%	0.137768	ENDF	%	3.079942
M+C	%	0.486356	NA+K_CL	MEQ/KG	73.296578	GE	MJ/KG	12.120756
THREO	%	0.470882	CHOLINE	MG/KG	1142.311089	RACTOP	PPM	0.0
ISOLEUC	%	0.441736	LACTOSE	%	0.0	VIT:K	MG/KG	0.990099
TRYPTO	%	0.164144	N:D:F:	%	14.452	VIT:B1	MG/KG	1.485149
CYSTINE	%	0.272792	LINOLEIC	%	1.020088	VIT:B2	MG/KG	4.950495
VALINE	%	0.668494	A:D:F:	%	5.730662	VIT:B6	MG/KG	2.970297
HISTIDIN	%	0.35036	RUMIN:ME	MJ/KG	12.074492	VIT:B12	MG/KG	133.663366
LEUCINE	%	0.974222	LAYER:ME	KCALS/KG	2902.914302	NIACIN	MG/KG	19.80198
PHENYLAL	%	0.61108	SULPHUR	%	0.209664	PANTOTH:	MG/KG	14.851485
P+T	%	0.916736	COPPER	PPM	7.920792	BIOTIN	MG/KG	198.019802
ARGININE	%	0.766487	COBALT	PPM	0.0	FOLIC	MG/KG	19.80198
TYROSINE	%	0.418813	MANGANES	PPM	29.70297	VIT:C	MG/KG	99.009901
T:EAA	%	5.916326	ZINC	PPM	59.405941	SELPLEX	PPM	0.29703
#LYS/DE_	GM/MJ	0.072088	IRON	PPM	79.207921	ORG IRON	PPM	79.207921
#ALY/DE_	GM/MJ	0.063815	IODINE	PPM	1.980198	ORG ZINC	PPM	59.405941
#MET/LYS	G/G	0.255073	SELENIUM	PPM	0.29703	ORG MANG	PPM	29.70297
#M+C/LYS	G/G	0.487044	CHROMIUM	PPB	396.039604	ORG COPPER	PPM	7.920792
#THR/LYS	G/G	0.471547	VIT:A	IU/KG	14851.485149			

Raw material	Available	%	[Kg]	Tonnes
1 WHEAT	[X]	52.204333	1566.13	0.0
12 BARLEY	[X]	27.5	825.0	0.0
200 MILLMIX	[X]	5.766667	173.0	0.0
300 CANOLA MEAL 35%	[X]	4.0	120.0	0.0
400 MEATMEAL 66%	[X]	4.3	129.0	0.0

420	BLOODMEAL	[X]	1.0	30.0	0.0
500	WATER	[X]	1.0	30.0	0.0
502	NATUPHOS 5000	[X]	0.02	0.6	0.0
503	PORZYME 9310	[X]	0.02	0.6	0.0
514	SEMI REFINED FISH OIL	[X]	0.4	12.0	0.0
520	TALLOW-MIXER	[X]	2.433333	73.0	0.0
560	LIMESTONE	[X]	0.966667	29.0	0.0
990	BETAINE	[X]	0.2	6.0	0.0
1551	LYSINE MICRO	[X]	0.5	15.0	0.0
1560	SOW REPLACE PAK MICRO	[X]	0.2	6.0	0.0
1564	VITAMIN BLEND B MICRO	[X]	0.05	1.5	0.0
1565	VITAMIN BLEND E MICRO	[X]	0.014	0.42	0.0
1566	REPRODUCTION BLEND MICRO	[X]	0.05	1.5	0.0
1585	SALT BIN MICRO	[X]	0.3	9.0	0.0
1592	VITAMIN BLEND A MICRO large	[X]	0.075	2.25	0.0
			101.0	3030.0	0.0

== Rivalea (6198)
==
:
:
: Single-Mix (FM) * Corowa * {15} FEBRUARY 2013 ALL DATA 12:26 07/02/13
0007 :
: 1048.4/1.21 (1) Plant=1 henmadav
:
====

Formula basic data

Code :	9973	Name	: 12R087 D HIGH FIBRE LACTATION		
Sell price:	0.0	Batch [Kg]:	3000.0	Group code:	120
Cost :	328.504	Created	: 15/01/13	Version :	
Margin :	-328.504	Updated	: 07/02/13	FM origin :	2080
Tonnes :	0.0	User name	: henmadav	VM key :	2080

External reference: 6,P,B,LA
Script file name :

Analysis

[VOLUME]	%	100.0	#ISO/LYS	G/G	0.454907	VIT:D3	IU/KG	3217.821782
[DRYMAT]	%	89.190429	#TRY/LYS	G/G	0.181128	VIT:E	IU/KG	129.306931
DE_PIG	MJ/KG	13.291211	#VAL/LYS	G/G	0.623801	#AME/ALY	G/G	0.155806
NE4G	MJ/KG	9.515715	AMETH	%	0.130569	#ACY/ALY	G/G	0.25313
#ALY/NE4G	GM/MJ	0.088067	AM+C	%	0.300162	#AM+/ALY	G/G	0.358179
DEENZYME	MJ/KG	13.096972	ATHREO	%	0.32082	#ATH/ALY	G/G	0.382829
PROTEIN	%	13.923611	AISOLEUC	%	0.348753	#AIS/ALY	G/G	0.416162
FAT	%	3.573274	ATRYPTO	%	0.107722	#ATR/ALY	G/G	0.128543
STARCH	%	40.657219	AVALINE	%	0.43999	#AVA/ALY	G/G	0.525033
FIBRE	%	6.585833	ACYSTINE	%	0.212128	#ATH/DE_	GM/MJ	0.024138
ASH	%	4.704517	AP+T	%	0.913104	ATYROSIN	%	0.351025
CALCIUM	%	0.843279	APHENYL	%	0.311665	LNAA	GM	83.763406
T:PHOS	%	0.489595	ALEUCINE	%	0.723125	#TRY/LNA	G/G	0.005258
AV:PHOS	%	0.4732	AHISTID	%	0.281763	BULKDENS	KG/HL	57.765165
ENZAVPHOS	%	0.370116	AARGININ	%	0.645707	IONOPHORE	PPM	0.0
CAL:PHOS	G/G	1.722402	SALT	%	0.400384	W6 FA	%	0.0
CAL:AVPHOS	G/G	1.782077	%LEGUMES	%	12.244224	W3 FA	%	0.0
P:PHOS	%	0.311349	ABC	MEQ/KG	613.840561	W6:W3	G/G	0.0
CAL:ENZAVP	G/G	2.278418	SODIUM	%	0.140405	SAT FA	%	0.0
LYSINE	%	0.951655	POTASS	%	0.521318	MONO FA	%	0.0
ALYSINE	%	0.838023	CHLORIDE	%	0.371508	POLY FA	%	0.0
METHION	%	0.213318	MAGNES	%	0.144297	ENDF	%	2.110305
M+C	%	0.431141	NA+K_CL	MEQ/KG	87.606677	GE	MJ/KG	11.844373
THREO	%	0.44044	CHOLINE	MG/KG	1013.990231	RACTOP	PPM	0.0
ISOLEUC	%	0.432914	LACTOSE	%	0.0	VIT:K	MG/KG	0.990099
TRYPTO	%	0.172371	N:D:F:	%	20.020152	VIT:B1	MG/KG	1.485149
CYSTINE	%	0.254597	LINOLEIC	%	1.121073	VIT:B2	MG/KG	4.950495
VALINE	%	0.593643	A:D:F:	%	8.986817	VIT:B6	MG/KG	2.970297
HISTIDIN	%	0.334249	RUMIN:ME	MJ/KG	11.785961	VIT:B12	MG/KG	133.663366
LEUCINE	%	0.871517	LAYER:ME	KCALS/KG	2625.267036	NIACIN	MG/KG	19.80198
PHENYLAL	%	0.55981	SULPHUR	%	0.154551	PANTOTH:	MG/KG	14.851485
P+T	%	0.841082	COPPER	PPM	7.920792	BIOTIN	MG/KG	198.019802
ARGININE	%	0.808698	COBALT	PPM	0.0	FOLIC	MG/KG	19.80198
TYROSINE	%	0.419705	MANGANES	PPM	29.70297	VIT:C	MG/KG	99.009901
T:EAA	%	4.524064	ZINC	PPM	59.405941	SELPLEX	PPM	0.29703
#LYS/DE_	GM/MJ	0.0716	IRON	PPM	79.207921	ORG IRON	PPM	79.207921
#ALY/DE_	GM/MJ	0.063051	IODINE	PPM	1.980198	ORG ZINC	PPM	59.405941
#MET/LYS	G/G	0.224155	SELENIUM	PPM	0.29703	ORG MANG	PPM	29.70297
#M+C/LYS	G/G	0.453043	CHROMIUM	PPB	396.039604	ORG COPPER	PPM	7.920792
#THR/LYS	G/G	0.462815	VIT:A	IU/KG	14851.485149			

Raw material	Available	%	[Kg]	Tonnes
1 WHEAT	[X]	37.821	1134.63	0.0
12 BARLEY	[X]	27.5	825.0	0.0
110 LUPIN KERNELS 33%	[X]	6.366667	191.0	0.0
200 MILLMIX	[X]	15.8	474.0	0.0
285 LUPIN HULLS	[ ]	6.0	180.0	0.0
400 MEATMEAL 66%	[X]	0.9	27.0	0.0

420 BLOODMEAL	[X]	0.916667	27.5	0.0
500 WATER	[X]	1.0	30.0	0.0
502 NATUPHOS 5000	[X]	0.02	0.6	0.0
503 PORZYME 9310	[X]	0.02	0.6	0.0
514 SEMI REFINED FISH OIL	[X]	0.4	12.0	0.0
520 TALLOW-MIXER	[X]	1.333333	40.0	0.0
560 LIMESTONE	[X]	1.2	36.0	0.0
576 DICALPHOS BIN ADD	[X]	0.333333	10.0	0.0
990 BETAINE	[X]	0.2	6.0	0.0
1551 LYSINE MICRO	[X]	0.5	15.0	0.0
1560 SOW REPLACE PAK MICRO	[X]	0.2	6.0	0.0
1564 VITAMIN BLEND B MICRO	[X]	0.05	1.5	0.0
1565 VITAMIN BLEND E MICRO	[X]	0.014	0.42	0.0
1566 REPRODUCTION BLEND MICRO	[X]	0.05	1.5	0.0
1585 SALT BIN MICRO	[X]	0.3	9.0	0.0
1592 VITAMIN BLEND A MICRO large	[X]	0.075	2.25	0.0
		101.0	3030.0	0.0