DETERMINING PREMIUM PAYMENTS FOR CONCENTRATION OF UNSATURATED FATTY ACIDS IN MILKFAT IN NEW ZEALAND BASED ON CHANGES IN FARM AND PROCESSOR PROFIT

A thesis presented in partial fulfilment
of the requirements for the degree of

Doctor of Philosophy

in

Animal Science

at Massey University, Palmerston North,
New Zealand

David Silva Villacorta

2014

Supervisors:

Prof Nicolas Lopez-Villalobos

Prof Hugh Blair

Dr Rebecca Hickson

Dr Alastair MacGibbon

Dedicate to my wife and daughters, who supported me each step of the way

ABSTRACT

Niche markets have emerged for dairy products with a high concentration of unsaturated fatty acids (UFA) in milkfat. Several studies have indicated that although milkfat UFA concentration could be increased on-farm by manipulation of the diet and genetic selection, farm profit could be negatively affected in the absence of a premium for milkfat UFA concentration. The objective of this study was to estimate, via simulation, a premium for milkfat UFA concentration, for dairy farmers in New Zealand that segregate cows, or feed oilseed supplements to dairy cows, to produce milk high in UFA. Data from New Zealand Holstein-Friesian cows were used to develop a stochastic farm model that simulated the physical and financial performance of dairy farms under New Zealand conditions. The farm model was then used to simulate a population of 1,820,000 cows and 5,600 dairy farms. From the population simulated, the top 17,150 cows for milkfat UFA concentration were segregated and randomly distributed onto 50 farms (UFA farms). The farm model was also used to simulate a group of 50 farms on which an oilseed supplement was fed to dairy cows during lactation (OILSEED farms). The characteristics of UFA farms and OILSEED farms were compared with those of 50 average farms (AVE farms). A deterministic milk processing model was used to simulate a dairy processor that processed and marketed the milk produced by AVE farms, UFA farms and OILSEED farms. A milk payment system which paid dairy farmers for milkfat ($/kg), protein ($/kg) and milkfat UFA concentration ($/kg milkfat), but penalised milk volume ($/L), was developed using data corresponding to the physical and financial performance of the dairy processor and the three groups of dairy farms simulated. In the absence of a premium for milkfat UFA concentration, the operating profit ($/ha) of UFA farms and OILSEED farms was significantly lower than that of AVE farms. For UFA farms, a premium of $0.47 to $0.51 /kg milkfat for each 0.1 g UFA/100 g milkfat increase (above 34.50 g UFA/100 g milkfat) equalled their operating profit ($/ha) to that of AVE farms. For OILSEED farms, a premium of $0.10 to $0.14 /kg milkfat for each 0.1 g UFA/100 g milkfat increase (above 37.50 g UFA/100 g milkfat) equalled their operating profit ($/ha)

to that of AVE farms. These premiums for milfat UFA concentration could help New Zealand dairy companies to further evaluate whether it is economically viable producing and processing milk high in UFA.

Keywords: unsaturated fatty acids, stochastic farm model, milk processing, premium, milk payment.

ACKNOWLEDGEMENTS

It would not have been possible to complete this PhD thesis without the help and support of those around me. First, I would like to express my special thanks to God, for having accompanied me during my years of study and for allowing me to complete this PhD thesis. A special thanks to my extended family, especially to my wife Sarah and my daughters Natalie and Olivia, whose constant support and great patience have enabled me to finish this race.

I am extremely grateful to my main supervisor Prof. Nicolas Lopez-Villalobos, who constantly challenged me and encouraged my research. Your teachings on simulation and genetics have contributed to my growth as a scientist. Thank you, Nicolas for your help, support and patience; I am glad to have work under your supervision. I am also very grateful to my co-supervisors, Prof. Hugh Blair, Dr. Rebecca Hickson and Dr. Alastair MacGibbon, for their good advice and support. Thank you, Prof. Blair for your advice and for challenging me with new ideas. Thank you, Rebecca for your corrections, comments and time you spent reading the different versions of my chapters. Thank you, Alastair for encouraging me to think beyond my limits and giving me a wider view of what implies altering the milkfat composition.

I am also thankful to Kevin Stafford, Debbie Hill and Wendy Graham, for their immediate attention to my academic needs during my years of study. I am grateful for the financial support given by the Institute of Veterinary Animal and Biomedical Sciences of Massey University, the Westpac Taranaki Agricultural Research Station (WTARS), Fonterra Co-operative Group, F W Dry Memorial Award and Helen E Akers PhD Scholarship. I hope the results from my PhD thesis contributes to further understand the opportunities, challenges and economic impact of altering milk composition at the farm level, specifically milkfat composition.

Although I cannot mentioned all of my friends and people I interacted with closely while studying at Massey University, my gratitude goes to all of them for their support, encouragement and for making my time at Massey more enjoyable. I specially thank my office mates (Nick, Alfredo, Jose, Ali, Javier, Gustavo) who share with me their joys, difficulties, frustrations and hopes.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 2

CHAPTER 3

CHAPTER 4

CHAPTER 5

CHAPTER 6

CHAPTER 7

LIST OF FIGURES

CHAPTER 3

CHAPTER 4

CHAPTER 5

CHAPTER 6

CHAPTER 7

LIST OF ABBREVIATIONS

ALA	α-Linolenic acid
BMP	Butter milk powder
c9 t11 CLA	cis 9 trans 11 conjugated linoleic acid
CCC	Concordance correlation coefficient
CHD	Coronary heart disease
CLA	Conjugated linoleic acids
DGAT1	Diacylglycerol O-acyltransferase 1
DHA	Docosahexaenoic acid
DIM	Days in milk
DM	Dry matter
EPA	Eicosapentaenoic acid
F%	Milkfat percentage
FTIR	Fourier transform infrared spectroscopy
HDL	High-density lipoprotein
LDL	Low-density lipoprotein
LW	Live weight
ME	Metabolisable energy
ME_l	Metabolisable energy for lactation
ME_{lwc}	Metabolisable energy for live weight change
ME_m	Metabolisable energy for maintenance
ME_p	Metabolisable energy for pregancy
MIRS	Mid-infrared spectroscopy
MJ	Mega joules
MS	Milksolids (milkfat + protein)
MUFA	Monounsaturated fatty acids
MY	Milk yield
n-3 *and* **n-6**	Omega 3 (ω-3) and omega 6 (ω-6) polyunsaturated fatty acids, respectively
NIRS	Near-infrared spectroscopy
P%	Protein percentage
PUFA	Polyunsaturated fatty acids
RPE	Relative prediction error

SCD	Stearoyl-CoA esaturase
SFA	Saturated fatty acids
SMP	Skim milk powder
TFA	Trans fatty acids
UFA	Unsaturated fatty acids
WP	Whey powder