

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

**DEVELOPMENT OF A BREEDING OBJECTIVE FOR BEEF CATTLE
IN GHANA**

**A thesis presented in partial fulfilment
of the requirements for the degree of
Master of Agricultural Science in
Animal Science at**

Massey University

SEREKYE YAW ANNOR

1996

This thesis is dedicated to my late elder Sister,

Margaret Akua Addae Nsiah

who died on 21st. May, 1995, in the early stages of the thesis preparation

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my supervisors, Professors H.T. Blair and D.J. Garrick for the guidance and assistance they provided during the selection, planning, organisation and preparation of this work. The high quality of supervision demonstrated by my supervisors is greatly appreciated.

I would also like to thank Dr. C.K. Dake of the Agricultural and Horticultural Systems Management, Massey University for his enormous contribution to the development of the computer simulation models. The cordial environment provided by both staff and fellow postgraduate students within and outside the Department of Animal Science, Massey University has contributed to my enjoying the study. Special thanks are due for Misters, Samuel Opong, Joseph Ntim, Richard Spelman, Nicholas Lopez-Villalobos and Paul Charteris for their necessary support during my studies.

The assistance provided by The Government of Ghana, The New Zealand Vice-Chancellor's Committee and The Government of New Zealand in the form of financial support is gratefully acknowledged. I would also express my sincere gratitude to The Director of Animal Production Department, Ghana, Dr. A.K. Mosi for granting me study leave to undertake this course. I thank Dr. A.K. Mosi again for the data provided on the marketing, husbandry and pasture establishment costs, and prices of beef in Ghana. Thanks are also due to Mr. S.A. Adongo, The Northern Regional Animal Production Officer, Ghana, for the photographs on the breeds of cattle shown in chapter 3.

Finally, I would express special thanks to my wife Victoria, whose moral support buoyed me through this course.

ABSTRACT

Beef contributes slightly more than 30 % to Ghana's meat requirements. About 57 % of beef consumed annually is imported, with only 43 % being produced locally. Although Ghana has the potential for increased beef production, it has not achieved self-sufficiency in production. Constraints in animal production indicate that this impasse has resulted from lack of simple livestock production policy in the past. A policy on livestock production and development was passed recently, and the livestock industries in Ghana are undergoing major restructuring. The first requirement of such a programme which requires much research effort and planning is to identify the planned production, processing and marketing system(s). Using this information, the economic merit for various traits can be defined and subsequently the breeding objective for the individual livestock species.

The objectives of this work were to study the marketing and production systems of the beef cattle industry in Ghana and to calculate the economic values of traits of economic importance in N'dama and Zebu cattle. The results were used to draw guidelines needed for the genetic improvement of beef cattle in Ghana.

The marketing and production systems were studied using information in the literature. A computer model simulating life cycle production of breeding cow and growth performance of her offspring was developed to estimate economic values of survival, reproduction and growth performance traits, and food intake. Economic values were calculated based on difference between income and expense (profit) and with discount rates of 0, 10 and 20 %. They were defined as the marginal profit per cow per year resulting from 1 % change in the average level of each trait, whilst holding the level of all other traits constant. Income was partitioned between 3 year old bullocks and surplus heifers, and cull cow. Expenses included food, husbandry and marketing costs; these were calculated for all ages and class of stock.

The study of the production systems revealed that local cattle breeds are late maturing, with relatively small body size, poor reproductive and milk production capacities, but

are well adapted to their environment. On the other hand, Zebu have poor reproductive performance with large body size, medium milk yield and a relatively low adaptation. Trypanosomiasis was identified to be the most important environmental factor affecting the survival of cattle. Profit per cow per year of N'dama was on average 17 % more than that of the Zebu. Profit per cow per year almost doubled in both breeds, when food intake was removed from the objective, but the difference between the two reduced to only 7 % in favour of N'dama. Economic efficiency for N'dama and Zebu production systems were 31 and 24 % respectively. In general, survival traits had the highest economic value, followed by reproduction, growth rate and food intake, respectively. Predicted economic values for individual traits decreased with increasing discount rates. This was much more pronounced in reproductive traits than in all other traits. Removal of food intake from the objective tended to slightly increase the relative economic importance of reproductive traits and survival from birth to weaning, but trends in economic values almost remained the same.

It was concluded that smallholder cattle owners should be encouraged to use local breeds of cattle, whilst efforts are made to breed trypanotolerant larger cattle breeds.

Keywords: Beef cattle, Ghana, marketing and production systems, breeding objective, economic values, survival, reproduction, growth, food intake

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	iii
ABSTRACT	iv
TABLE OF CONTENTS	vi
LIST OF TABLES	ix
LIST OF FIGURES	xi
LIST OF EQUATIONS	xii
1. INTRODUCTION	1
2. PRINCIPLES OF BREED IMPROVEMENT	5
2.1 Beef cattle breeding programmes	5
2.2 The industry structure	6
2.2.1 Definition of industry structure	6
2.2.2 Unstructured breeding industries	7
2.2.3 Closed nucleus structures	9
2.2.4 Open nucleus breeding scheme	11
2.2.5 Sire reference scheme	13
2.3 Development of breeding objective	16
2.3.1 Introduction to breeding objectives	16
2.3.2 Specification of breeding, production and marketing system	19
2.3.3 Identification of sources of income and expense	21
2.3.4 Determination of biological traits influencing income and expense	25
2.3.5 Derivation of economic value of each trait	35
2.3.6 Crossbreeding	41
2.4 Selection criteria	44
2.5 Phenotypic and genetic parameters	46
2.6 Selection index	48

3.	CURRENT STATUS OF BREED IMPROVEMENT IN GHANA	55
3.1	Ghana: Location, climate and vegetation, and population statistics	55
3.1.1	Location of the country	55
3.1.2	Climate and vegetation	56
3.1.3	Human population statistics	58
3.2	Meat production and consumption in Ghana	61
3.3	Breeds of cattle in Ghana	63
3.3.1	Origin and distribution of cattle in Ghana	64
3.3.2	Livestock population statistics	66
3.4	Characteristics of cattle in Ghana	68
3.4.1	Physical characteristics	68
3.4.2	Adaptive (survival) characteristics	73
3.4.3	Growth and live weights	81
3.4.4	Reproductive characteristics	86
3.4.5	Milk production characteristics	90
3.4.6	Carcass characteristics	94
3.5	Livestock development policy in Ghana	95
3.6	The objective and structure of the cattle industry in Ghana	96
3.7	Management and production systems of the cattle industry in Ghana	100
3.8	Marketing of cattle and cattle products in Ghana	104
4.	DEVELOPING THE BREEDING OBJECTIVE	109
4.1	Introduction	109
4.2	Defining a typical Ghanaian beef cattle breeding, production and marketing system	109
4.3	Identification of sources of income and expense in production system	115
4.4	Determination of biological traits influencing income and expense	117

4.5	Derivation of economic value of each trait	119
5.	RESULTS AND DISCUSSIONS	122
5.1	The main elements of returns and costs	122
5.2	Economic values of traits in the breeding objective	128
5.3	The effect of removal of food intake from objective on the economic values of traits	134
5.4	Implications of the results in the tropics	136
5.5	Implications of the results to genetic improvement of cattle in Ghana	139
5.6	Guidelines for improvement of the beef cattle industry in Ghana	141
5.6.1	Improving the local breeds	141
5.6.2	Improving the Zebu or other exotic cattle	143
5.6.3	Genetic improvement using crossbreeding	144
5.7	Conclusions	145
5.8	Suggestions for further work	146
	REFERENCES	147
	APPENDIX I	183
	APPENDIX II	185
	APPENDIX III	187

LIST OF TABLES

Table	Page
2.1 Heritability of quantitative traits of possible economic importance in beef cattle	27
2.2 Classification of traits based on response to selection and amount of hybrid vigour	42
3.1 World cattle densities	68
3.2 Electrophoretically determined haemoglobin components in N'dama, Zebu and West African Shorthorn cattle	76
3.3 Calf mortality rates in Ghana	81
3.4 Live weights and growth rates of WASH, N'dama, Zebu and Friesian cattle in Ghana	82
3.5 Live weights and growth performance of straightbreds and their crosses	84
3.6 The effect of supplementary feeding on live weight gains of WASH, N'dama and Santa Gertrudis x WASH cross	85
3.7 Reproductive performance of different breeds of cattle in Ghana	86
3.8 Reproductive performance of local breeds and their crosses	89
3.9 Milk production characteristics of WASH, N'dama, Zebu and Friesian cattle in Ghana	91
3.10 Milk yield of cattle fed either on natural pastures or natural pasture plus supplementary feed	92
3.11 Lactation performance of local and crossbred cattle	93
3.12 Carcass characteristics of WASH, N'dama and Zebu cattle	94
3.13 Establishment of livestock nucleus herds in different ecological zones in Ghana	98
3.14 Chemical composition of natural grassland in Accra plains	103

3.15	Classification of traits based on performance of different breeds of cattle in Ghana	107
4.1	Distribution of weights by age for male and female N'dama cattle	111
4.2	Value of expense for production systems	116
4.3	Biological traits influencing income and expense	118
5.1	Marginal cost associated with defining growth rate as a function of food intake	124
5.2	Cow's food cost as a percentage of total enterprise food cost at different levels of traits	125
5.3	Profit per cow per year for N'dama and Zebu cattle production systems	127
5.4	Economic values of traits in the breeding objective at different discount rates for N'dama production system	129
5.5	Economic values of traits in the breeding objective at different discount rates for Zebu production system	130
5.6	Economic values of growth rate assuming increase in growth rate leads to increase in food intake	132
5.7	Effect of removal of food intake from the objective on the economic values of traits in N'dama cattle production system	134
5.8	Effect of removal of food intake from the objective on the economic values of traits in Zebu cattle production system	135

LIST OF FIGURES

Figure	Page
2.1 A pyramid livestock industry structure in which genetic improvements should flow from top to the base	7
2.2 Relationships between genetic gain in the nucleus and commercial tiers	11
3.1 Ghana in its West African Setting	55
3.2 Vegetation map of Ghana	57
3.3 Population growth and percentage of people involved in Agriculture	58
3.4 Population distribution in Ghana	59
3.5 Importation of protein sources into Ghana	63
3.6 Livestock numbers in Ghana	67
3.7 West African Shorthorn cattle from Pong-Tamale Livestock Breeding Station, Ghana	70
3.8 A polled N'dama cow from Pong-Tamale Livestock Breeding Station, Ghana	71
3.9 A Zebu heifer from Pong-Tamale Livestock Breeding Station, Ghana	72
4.1 Generalized flow diagram for N'dama cow and her offspring derived from the average values of all traits	111
4.2 Generalized flow diagram for Zebu cow and her offspring derived from average values of all traits	112
5.1 Combined characters for individual animals	133

LIST OF EQUATIONS

Equation	Page
2.1 Genetic gain	8
2.2 Genetic gain in a two-tiered structure	10
2.3 Genetic gain in a three-tiered structure	10
2.4 Breeding objective	16
2.5 Profit	21
2.6 Efficiency	22
2.7 Reciprocal of efficiency	22
2.8 Aggregate breeding objective	35
2.9 Selection index	45
2.10 Aggregate selection index	50
2.11 Simultaneous equations to solve for weights of the selection index	52
2.12 Matrix representation of simultaneous equations	52
2.13 Index weightings in matrix form	52
4.1 Profit in the smallholder herd	115
4.2 Profit as a function of traits, cost and returns	120
4.3 Profit from different classes of stock	120