UNIVERSITI PUTRA MALAYSIA

POLICY ANALYSIS OF BEEF PRODUCTION SYSTEM IN PENINSULAR MALAYSIA

FAUZIA YASMIN

FEP 2001 2

POLICY ANALYSIS OF BEEF PRODUCTION SYSTEM IN PENINSULAR MALAYSIA

By

FAUZIA YASMIN

Thesis Submitted in Fulfilment of the Requirement
for the Degree of Doctor of Philosophy
in the Faculty of Economics and Management
Universiti Putra Malaysia

October 2001

DEDICATED TO MY

PARENTS, LATE DR. MD. ASHRAF ALI AND LATE MRS. ASHRAF ALI

BROTHERS, AHSAN ALI AND ASAD ALI

DAUGHTER, FARZANA YASMIN

AND TO MY HUSBAND, DR. S. M. ZIQRUL HAQ CHOWDHURY

FOR THEIR PATIENCE, CONSTANT ENCOURAGEMENT AND SUPPORT

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

POLICY ANALYSIS OF BEEF PRODUCTION SYSTEM IN PENINSULAR MALAYSIA

By

FAUZIA YASMIN

October 2001

Chairman: Zainal Abidin Bin Mohamed, Ph.D.

Faculty: Economics and Management

In order not to be dependent on foreign countries for beef, Malaysia needs to increase her beef production to attain self-sufficiency level in the near future. In doing so, she needs to analyze the effect of different alternative production and decision-making policies in beef production and achievement of self-sufficiency level in beef. Thus, the objectives of the study were to develop a system modeling for beef production decision-making, to evaluate the impact of production and trade policies on beef production, to determine the cost and return to government investment for importation of breeding stock and to suggest policy measures for beef production in Peninsular Malaysia.

Simulation matrix (SIMM) model was developed based on system approach methodology to analyze the objectives of the study. The SIMM model was used to simulate the female breeding stock, male breeding stock, male calves and female calves and slaughter and production components of the beef production system. The ex-post SIMM model for beef production system from 1960-1996 was used as a base to simulate the ex-ante component by varying the rate of policy variables such as different

calving, slaughter, mortality rates and the level of importation of female breeding stock. Thus, five SCENARIOS of different rates in decision-making variables were developed to analyze the impact of such variables on beef production in Peninsular Malaysia. SCENARIO 3 was found to be the most promising decision making strategy to attain self-sufficiency level at reasonable time frame and cost of investment. Under SCENARIO 3, at 76-80% calving rate, 5-7% slaughter rate, 1-2% mortality rate with 10000 heads/year, 5000 heads/year, 500 heads/year importation of beef cattle, dairy cattle and buffalo female breeding stock respectively, the results of BCR (1.96) and positive NPW show that beef production can be increased economically and 100% self–sufficiency can be achieved in the period 2011/2012 at lower government investment cost for importation. Whereas SCENARIOS 1, 2, 4 and 5 show the negative NPW and less than 1 BCR and 14%, 24%, 13% and 11% self-sufficiency rate respectively due to lower calving rate and importation of female breeding stock, higher slaughter and mortality rate indicating that are not economically acceptable.

Simulated results indicate that in order to maintain the higher level of self-sufficiency in beef, mortality rate and slaughter rate will have to be reduced. On the other hand, the rates of calving and importation of female breeding stock will have to be increased. The management of breeding stock is an important component in beef production system in order to achieve the level of self-sufficiency in beef.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan ijazah Doktor Falsafah

ANALISA POLISI BAGI PENGELUARAN DAGING LEMBU DI SEMENANJUNG MALAYSIA

Oleh

FAUZIA YASMIN

Oktober 2001

Pengerusi: Zainal Abidin Bin Mohamed, Ph.D.

Fakulti: Ekonomi dan Pengurusan

Untuk tidak terlalu bergantung kepada negara-negara luar bagi keperluan daging lembu, Malaysia mestilah meningkatkan pengeluaran daging lembu untuk mencapai tahap sara diri dimasa akan datang. Oleh itu, Malaysia mestilah menganalisa kesan keatas pelbagai alternatif polisi dalam pengeluaran daging lembu dan pencapaian tahap sara diri. Maka objektif kajian ini adalah untuk membentuk satu model yang berteraskan sistem bagi membuat keputusan untuk pengeluaran daging, mengkaji kesan pengeluaran, dasar perdangan keatas pengeluaran daging, menentukan kos dan pulangan keuntungan kedapa pelaburan kerajaan bagi mengimpot stok pembiakan. Selain daripada itu kajian ini juga mencadangkan polisi yang bersesuaian untuk pengeluaran daging lembu di Semenanjung Malaysia.

Model Matrik Simulasi (SIMM) telah dibentuk berdasarkan kaedah pendekatan sistem untuk menganalisa objektif kajian ini. Model SIMM digunakan dimana komponen-komponen stok pembiakbakaan lembu jantan dan betina, anak lembu jantan dan betina,

penyembelihan dan pengeluaran disimulasikan dalam sistem pengeluaran daging. 'Ex-post' model SIMM digunakan sebagai simulasi asas bagi komponen 'ex-ante' dengan mempelbagaikan paras angkubah seperti kadar pembiakan, penyembelihan, kematian dan tahap impot untuk stok pembiakbakaan lembu betina. Untuk tujuan tersebut lima SENARIO telah dibentuk dengan mempelbagaikan paras angkubah pembuat keputusan bagi menganalisa kesan angkubah ini keatas pengeluaran daging lembu di Semenanjung Malaysia. Didapati, keputusan SENARIO 3 adalah yang terbaik sekali untuk mencapai objektif sara diri dalam jangkamasa dan kos pelaburan yang munasabah. Senario ini menjanakan 76-80% kadar pembiakan, 5-7% kadar penyembelihan dan 1-2% kadar kematian bagi 10000 ekor/tahun, 5000 ekor/tahun, 500 ekor/tahun untuk pengimpotan stok pembiakbakan lembu pedaging, lembu tenusu dan kerbau masing-masing. Keputusan 'BCR' (1.96), 'NPW' yang positif menunjukkan bahawa pengeluaran daging lembu boleh di lakukan secara ekonomik dan tahap sara diri yang sepenuhnya dicapai pada tahun 2011/2012 dan penurunan impot pelaburan bagi pihak kerajaan. Sebaliknya, SCENARIO 1, 2, 4 dan 5 menunjukkan 'NPW' yang negatif dan 'BCR' kurang dari 1 dan pencapaian tahap sara diri yang rendah pada paras 14%, 24%, 13% dan 11% masing-masing. Ini adalah hasil daripada kadar pembiakan dan impot pembiakbakaan lembu betina yang rendah dan dimana kadar penyembelihan dan kematian lembu terlalu berlebihan maka SENARIO-SENARIO tersebut tidaklah ekonomik.

Keputusan simulasi menunjukkan bahawa untuk mengekalkan kadar sara diri yang tinggi, kadar kematian dan penyembelihan mestilah dikurangkan dan kadar pembiakan

anak lembu dan impot stok pembiakbakaan lembu betina mestilah ditingkatkan. Oleh itu pengurusan stok pembiakbakaan adalah komponen yang sangat penting dalam sistem pengeluaran daging untuk mencapai tahap sara diri yang sepenuhnya.

ACKNOWLEDGEMENTS

First and foremost, my heartfelt thanks to Almighty Allah for giving me the strength and will-power to complete this challenging task.

It give me much pleasure to express my deep sense of gratitude to Associate Professor Dr. Zainal Abidin Bin Mohamed, Chairman of the Supervisory Committee, for his cooperation, advice and day to day supervision during the entire period of the research and guidance toward the completion of my thesis. Deep sense of gratitude is also to Professor Dr. Mad Nasir Bin Shamsudin, for his keen interest in the problem, affectionate encouragement and valuable suggestions in course of preparing the thesis. For beef production and modeling system analysis I would like to acknowledge the assistance of Dr. Md. Eusof Bin Jamak as member of the Supervisory Committee.

I am grateful to the Government of Bangladesh, for providing scholarship to my Ph.D. research work under ARMP-BLRI part (IDA credit 2815-BD).

Special thanks to my daughter, Farzana Yasmin, who sacrificed her times during the course of study particularly during the writing of this thesis. I am also thankful to my husband for his time to time inspiration and help during the study period. Lastly, my heartfelt appreciation to my brothers for their understanding and support during the period of my study.

TABLE OF CONTENTS

		Page
DEDICATION		ii
ABSTRACT		iii
ABSTRAK		v
ACKNOWLEDGEMENTS		viii
APPROVAL		ix
DECLARATION		xi
LIST OF TABLES		xv
LIST OF FIGURES		xxv
LIST OF ABBREVIATIONS		xxxi
CHAPTER		
1	**INTRODUCTION**	1
	1.1 Problem Statement	5
	1.2 Objectives of the Study	9
	1.3 Significant of the Study	9
2	**MALAYSIAN LIVESTOCK INDUSTRY**	11
	2.1 Population	12
	2.2 Slaughter	17
	2.3 Production	19
	2.4 Consumption	21
	2.5 Import	24
	2.6 Self-sufficiency	33
	2.7 Price	36
	2.8 Government Policies and Development	36
3	**LITERATURE REVIEW**	45
	3.1 Econometric Models	45
	3.2 System Simulation Models	52
4	**METHODOLOGY**	61
	4.1 System Modeling Specification: Theoretical Framework	61
	4.2 The Formulation of a Mathematical Model: Beef Population Distribution Component	73
	4.2.1 Female Breeding Stock (FBS)	77
	4.2.2 Male Breeding Stock (MBS)	78
	4.2.3 Female Calves (FC)	80
	4.2.4 Male Calves (MC)	81
	4.3 The Formulation of a Mathematical Model:	

Slaughter and Production Component 83
4.3.1 Slaughter 83
4.3.2 Fresh Beef Production 86
4.4 The Formulation of Mathematical Model: Production and Consumption Component 87
4.4.1 Beef Production 87
4.4.2 Consumption for Beef 90
4.5 Management Decision Making Component 91
4.6 Cost and Benefit Analysis 93
4.6.1 Net Present Worth (NPW) 95
4.6.2 Benefit-Cost Ratio (BCR) 95
4.6.3 Partial Budgeting 96
4.7 Data Collection 97
4.8 Estimation Procedures 97
4.9 Ex-post Validation Procedure 99
4.9.1 Ex-post Simulation (Statistical Test) 99
4.9.2 Ex-post Validation (Subjective Assessment) 101
4.10 Stochastic in Modeling 103

5 RESULTS AND DISCUSSION 104
5.1 Ex-post Simulation for Beef, Dairy, Buffalo 104
5.1.1 Population Distribution Component for Beef Cattle 104
5.1.2 Population Distribution Component for Dairy Cattle 117
5.1.3 Population Distribution Component for Buffalo 129
5.1.4 Slaughter and Production Component 141
5.2 Ex-post Validation for Beef, Dairy, Buffalo 147
5.2.1 Population Distribution Component for Beef Cattle 147
5.2.2 Population Distribution Component for Dairy Cattle 159
5.2.3 Population Distribution Component for Buffalo 171
5.3 Ex-ante Simulation Analysis from 1997 to 2015 Under Different SCENARIOS 183
5.3.1 Different Components, SCENARIO 1 185
5.3.2 Different Components, SCENARIO 2 202
5.3.3 Different Components, SCENARIO 3 219
5.3.4 Different Components, SCENARIO 4 236
5.3.5 Different Components, SCENARIO 5 254
5.4 The Summary of Ex-ante SIMM model for All SCENARIOS 271
5.4.1 Total Beef Animal Population 271
5.4.2 Total Slaughter 276
5.4.3 Beef Production 281
5.4.4 Beef Import 286

5.4.5 Beef Self-sufficiency 290
5.4.6 Beef Import Cost 294
5.4.7 Total Benefit 298
5.4.8 Total Cost 302

6 SUMMARY AND CONCLUSION 306

REFERENCE 318

APPENDICES
A Ex-post Simulation Analysis 322
B Ex-post Validation Analysis 340
C Ex-ante Simulation Analysis 352
D Estimated Coefficients 382
E Investment Cost 383

BIODATA OF AUTHOR 388

LIST OF TABLES

Table		Page
1.1	The Malaysian economy from the year 1995 to the year 2000.....	2
1.2	Sector's contribution to GDP, Malaysia, RM million, 1995-2015.....	3
1.3	Agricultural value added in Malaysia, 1995-2015 (RM million in 1987 prices).....	4
1.4	The contribution of livestock and beef to GDP in Malaysia, RM million 1970-2000.....	6
2.1	Livestock production in Peninsular Malaysia, thousand metric tonnes, 1995-2005.....	12
2.2	Livestock population by types in Peninsular Malaysia, heads and percentage (%), 1960-2000.....	14
2.3	The population of buffalo, beef cattle, dairy cattle in Peninsular Malaysia heads and percentage (%),1960-2000.....	16
2.4	The recorded slaughter of livestock in Peninsular Malaysia, heads, 1987-2000.....	17
2.5	The slaughter performance of cattle (beef and dairy) and buffalo in Peninsular Malaysia, heads and percentage (%), 1960-2000.....	20
2.6	The production of beef, mutton, pork and poultry in Peninsular Malaysia, metric tonnes, 1960-2000.....	22
2.7	The consumption of beef, mutton, pork and poultry Peninsular Malaysia, metric tonnes, 1960-2000.....	25
2.8	The per capita consumption of livestock products in Peninsular Malaysia, Kg, 1990-2000.....	27
2.9	The imported population of cattle, goat, sheep, buffalo, poultry and swine in Peninsular Malaysia, heads, 1961-2000.....	29
2.10	Beef, mutton and pork importation in Peninsular Malaysia, metric tonnes and percentage (%),1960-2000.....	30

2.11 Beef importation in Peninsular Malaysia, metric tonnes and percentage (%), 1988-1996..... 32

2.12 Self-sufficiency in beef, mutton, pork and poultry in Peninsular Malaysia, percentage (%), 1960-2000..... 34

2.13 The average retail price of beef, mutton, poultry and pork in Peninsular Malaysia, RM/kg, 1960-2000..... 37

5.1 Ex-post simulation analysis for beef cattle female breeding stock in Peninsular Malaysia, thousand heads, 1970-1996..... 106

5.2 Ex-post simulation analysis for beef cattle male breeding stock in Peninsular Malaysia, thousand heads, 1970-1996..... 109

5.3 Ex-post simulation analysis for beef cattle female calves in Peninsular Malaysia, thousand heads, 1970-1996..... 112

5.4 Ex-post simulation analysis for beef cattle male calves in Peninsular Malaysia, thousand heads, 1970-1996..... 115

5.5 Ex-post simulation analysis for dairy cattle female breeding stock in Peninsular Malaysia, thousand heads, 1970-1996..... 118

5.6 Ex-post simulation analysis for dairy cattle male breeding stock in Peninsular Malaysia, thousand heads, 1970-1996..... 121

5.7 Ex-post simulation analysis for dairy cattle female calves in Peninsular Malaysia, thousand heads, 1970-1996..... 124

5.8 Ex-post simulation analysis for dairy cattle male calves in Peninsular Malaysia, thousand heads, 1970-1996..... 127

5.9 Ex-post simulation analysis for buffalo female breeding stock in Peninsular Malaysia, thousand heads, 1970-1996..... 130

5.10 Ex-post simulation analysis for buffalo male breeding stock in Peninsular Malaysia, thousand heads, 1970-1996..... 133

5.11 Ex-post simulation analysis for buffalo female calves in Peninsular Malaysia, thousand heads, 1970-1996..... 136

5.12 Ex-post simulation analysis for buffalo male calves in Peninsular Malaysia, thousand heads, 1970-1996..... 139

5.13 Ex-post simulation analysis for total slaughter in

Peninsular Malaysia, thousand heads, 1970-1996..... 142

5.14 Ex-post simulation analysis for total beef production in Peninsular Malaysia, thousand metric tonnes, 1970-1996..... 145

5.15 Ex-post validation analysis for beef cattle female breeding stock in Peninsular Malaysia, thousand heads, 1970-1996..... 148

5.16 Ex-post validation analysis for beef cattle male breeding stock in Peninsular Malaysia, thousand heads, 1970-1996..... 151

5.17 Ex-post validation analysis for beef cattle female calves in Peninsular Malaysia, thousand heads, 1970-1996..... 154

5.18 Ex-post validation analysis for beef cattle male calves in Peninsular Malaysia, thousand heads, 1970-1996..... 157

5.19 Ex-post validation analysis for dairy cattle female breeding stock in Peninsular Malaysia, thousand heads, 1970-1996..... 160

5.20 Ex-post validation analysis for dairy cattle male breeding stock in Peninsular Malaysia, thousand heads, 1970-1996..... 163

5.21 Ex-post validation analysis for dairy cattle female calves in Peninsular Malaysia, thousand heads, 1970-1996..... 166

5.22 Ex-post simulation analysis for dairy cattle male calves in Peninsular Malaysia, thousand heads, 1970-1996..... 169

5.23 Ex-post validation analysis for buffalo female breeding stock in Peninsular Malaysia, thousand heads, 1970-1996..... 172

5.24 Ex-post validation analysis for buffalo male breeding stock in Peninsular Malaysia, thousand heads, 1970-1996..... 175

5.25 Ex-post validation analysis for buffalo female calves in Peninsular Malaysia, thousand heads, 1970-1996..... 178

5.26 Ex-post validation analysis for buffalo male calves in Peninsular Malaysia, thousand heads, 1970-1996..... 181

5.27 Ex-ante simulation analysis for beef cattle population in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 1..... 186

5.28 Ex-ante simulation analysis for dairy cattle population in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 1..... 189

5.29 Ex-ante simulation analysis for buffalo population in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 1..... 192

5.30 Ex-ante simulation analysis for total slaughter (thousand heads) and beef production (thousand metric tonnes) in Peninsular Malaysia, 1997-2015, SCENARIO 1..... 195

5.31 Ex-ante simulation analysis for beef importation, beef demand (thousand metric tonnes) and self-sufficiency level (%) in Peninsular Malaysia, 1997-2015, SCENARIO 1..... 197

5.32 Ex-ante simulation analysis for beef importation cost in Peninsular Malaysia, RM million, 1997-2015, SCENARIO 1... 200

5.33 Discounted benefit and cost of beef production in Peninsular Malaysia, RM million, 1997-2015, SCENARIO 1..... 201

5.34 Ex-ante simulation analysis for beef cattle population in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 2..... 203

5.35 Ex-ante simulation analysis for dairy cattle population in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 2..... 206

5.36 Ex-ante simulation analysis for buffalo population in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 2..... 209

5.37 Ex-ante simulation analysis for total slaughter (thousand heads) and beef production (thousand metric tonnes) in Peninsular Malaysia, 1997-2015, SCENARIO 2..... 212

5.38 Ex-ante simulation analysis for beef importation, beef demand (thousand metric tonnes) and self-sufficiency level (%) in Peninsular Malaysia, 1997-2015, SCENARIO 2..... 214

5.39 Ex-ante simulation analysis for investment cost of importation in Peninsular Malaysia, RM million, 1997-2015, SCENARIO 2..... 217

5.40 Discounted benefit and cost of beef production in Peninsular Malaysia, RM million, 1997-2015, SCENARIO 2..... 218

5.41 Ex-ante simulation analysis for beef cattle population in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 3..... 220

5.42 Ex-ante simulation analysis for dairy cattle population in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 3..... 223

5.43 Ex-ante simulation analysis for buffalo population in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 3..... 226

5.44 Ex-ante simulation analysis for total slaughter (thousand heads) and beef production (thousand metric tonnes) in Peninsular Malaysia, 1997-2015, SCENARIO 3..... 229

5.45 Ex-ante simulation analysis for beef importation, beef demand (thousand metric tonnes) and self-sufficiency level (%) in Peninsular Malaysia, 1997-2015, SCENARIO 3..... 231

5.46 Ex-ante simulation analysis for investment cost of importation in Peninsular Malaysia, RM million, 1997-2015, SCENARIO 3..... 234

5.47 Discounted benefit and cost of beef production in Peninsular Malaysia, RM million, 1997-2015, SCENARIO 3..... 235

5.48 Profitability by applying partial budgeting for SCENARIO 3 substituting SCENARIO 1 in Peninsular Malaysia..... 236

5.49 Ex-ante simulation analysis for beef cattle population in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 4..... 238

5.50 Ex-ante simulation analysis for dairy cattle population in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 4..... 241

5.51 Ex-ante simulation analysis for buffalo population in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 4..... 244

5.52 Ex-ante simulation analysis for total slaughter (thousand heads) and beef production (thousand metric tonnes) in Peninsular Malaysia, 1997-2015, SCENARIO 4..... 247

5.53 Ex-ante simulation analysis for beef importation, beef demand (thousand metric tonnes) and self-sufficiency level (%) in Peninsular Malaysia, 1997-2015, SCENARIO 4..... 249

5.54 Ex-ante simulation analysis for investment cost of importation in Peninsular Malaysia, RM million, 1997-2015, SCENARIO 4..... 252

5.55 Discounted benefit and cost of beef production in Peninsular Malaysia, RM million, 1997-2015, SCENARIO 4..... 253

5.56 Ex-ante simulation analysis for beef cattle population in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 5..... 255

5.57 Ex-ante simulation analysis for dairy cattle population in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 5..... 258

5.58 Ex-ante simulation analysis for buffalo population in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 5..... 261

5.59 Ex-ante simulation analysis for total slaughter (thousand heads) and beef production (thousand metric tonnes) in Peninsular Malaysia, 1997-2015, SCENARIO 5..... 264

5.60 Ex-ante simulation analysis for beef importation, beef demand (thousand metric tonnes) and self-sufficiency level (%) in Peninsular Malaysia, 1997-2015, SCENARIO 5..... 266

5.61 Ex-ante simulation analysis for investment cost of importation in Peninsular Malaysia, RM million, 1997-2015, SCENARIO 5..... 269

5.62 Discounted benefit and cost of beef production in Peninsular Malaysia, 1997-2015, SCENARIO 5..... 270

5.63 Ex-ante simulation analysis for total beef animal population in Peninsular Malaysia, thousand heads, 1997-2015, all SCENARIOS..... 273

5.64 Ex-ante simulation analysis for total slaughter in Peninsular Malaysia, thousand heads, 1997-2015, all SCENARIOS 278

5.65 Ex-ante simulation analysis for total beef production in Peninsular Malaysia, thousand metric tonnes, 1997-2015, all SCENARIOS 283

5.66 Ex-ante simulation analysis for beef import in Peninsular Malaysia, thousand metric tonnes, 1997-2015, all SCENARIOS 287

5.67 Ex-ante simulation analysis for beef self-sufficiency in Peninsular Malaysia, percentage (%), 1997-2015, all SCENARIOS 291

5.68 Ex-ante simulation analysis for beef import cost in Peninsular Malaysia, RM million, 1997-2015, all SCENARIOS 295

5.69 Ex-ante simulation analysis for total benefit in Peninsular Malaysia, RM million, 1997-2015, all SCENARIOS 299

5.70 Ex-ante simulation analysis for total cost in Peninsular Malaysia, RM million, 1997-2015, all SCENARIOS 303

6.1 Ex-ante simulation analysis for all SCENARIOS in Peninsular Malaysia, 1997-2015 315

A.1 Ex-post simulation analysis for female beef cattle in Peninsular Malaysia, thousand heads, 1961-1996 322

A.2 Ex-post simulation analysis for male beef cattle in Peninsular Malaysia, thousand heads, 1961-1996 325

A.3 Ex-post simulation analysis for female dairy cattle in Peninsular Malaysia, thousand heads, 1961-1996 328

A.4 Ex-post simulation analysis for male dairy cattle in Peninsular Malaysia, thousand heads, 1961-1996 331

A.5 Ex-post simulation analysis for female buffalo in Peninsular Malaysia, thousand heads, 1961-1996 334

A.6 Ex-post simulation analysis for male buffalo in Peninsular Malaysia, thousand heads, 1961-1996 337

B.1 Ex-post validation analysis for female beef cattle in Peninsular Malaysia, thousand heads, 1975-1996 340

B.2 Ex-post validation analysis for male beef cattle in Peninsular Malaysia, thousand heads, 1975-1996 342

B.3 Ex-post validation analysis for female dairy cattle in Peninsular Malaysia, thousand heads, 1975-1996 344

B.4 Ex-post validation analysis for male dairy cattle in Peninsular Malaysia, thousand heads, 1975-1996 346

B.5 Ex-post validation analysis for female buffalo in Peninsular Malaysia, thousand heads, 1975-1996 348

B.6 Ex-post validation analysis for male buffalo in Peninsular Malaysia, thousand heads, 1975-1996 350

C.1 Ex-ante simulation analysis for female beef cattle in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 1..... 352

C.2 Ex-ante simulation analysis for male beef cattle in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 1..... 353

C.3 Ex-ante simulation analysis for female beef cattle in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 2..... 354

C.4 Ex-ante simulation analysis for male beef cattle in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 2..... 355

C.5 Ex-ante simulation analysis for female beef cattle in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 3..... 356

C.6 Ex-ante simulation analysis for male beef cattle in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 3..... 357

C.7 Ex-ante simulation analysis for female beef cattle in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 4..... 358

C.8 Ex-ante simulation analysis for male beef cattle in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 4..... 359

C.9 Ex-ante simulation analysis for female beef cattle in Peninsular Malaysia thousand heads, 1997-2015, SCENARIO 5..... 360

C.10 Ex-ante simulation analysis for male beef cattle in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 5..... 361

C.11 Ex-ante simulation analysis for female dairy cattle in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 1..... 362

C.12 Ex-ante simulation analysis for male dairy cattle in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 1..... 363

C.13 Ex-ante simulation analysis for female dairy cattle in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 2..... 364

C.14 Ex-ante simulation analysis for male dairy cattle in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 2..... 365

C.15 Ex-ante simulation analysis for female dairy cattle in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 3..... 366

C.16 Ex-ante simulation analysis for male dairy cattle in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 3..... 367

C.17 Ex-ante simulation analysis for female dairy cattle in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 4..... 368

C.18 Ex-ante simulation analysis for male dairy cattle in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 4..... 369

C.19 Ex-ante simulation analysis for female dairy cattle in Peninsular

Malaysia, thousand heads, 1997-2015, SCENARIO 5..... 370

C.20 Ex-ante simulation analysis for male dairy cattle in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 5..... 371

C.21 Ex-ante simulation analysis for female buffalo in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 1..... 372

C.22 Ex-ante simulation analysis for male buffalo in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 1..... 373

C.23 Ex-ante simulation analysis for female buffalo in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 2..... 374

C.24 Ex-ante simulation analysis for male buffalo in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 2..... 375

C.25 Ex-ante simulation analysis for female buffalo in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 3..... 376

C.26 Ex-ante simulation analysis for male buffalo in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 3..... 377

C.27 Ex-ante simulation analysis for female buffalo in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 4..... 378

C.28 Ex-ante simulation analysis for male buffalo in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 4..... 379

C.29 Ex-ante simulation analysis for female buffalo in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 5..... 380

C.30 Ex-ante simulation analysis for male buffalo in Peninsular Malaysia, thousand heads, 1997-2015, SCENARIO 5..... 381

D.1 The estimated coefficients of beef supply in Peninsular Malaysia..... 382

E.1 Total discounted investment cost and savings of importation in Peninsular Malaysia, RM million, 1997-2015, SCENARIO 1..... 383

E.2 Total discounted investment cost and savings of importation in Peninsular Malaysia, RM million, 1997-2015, SCENARIO 2..... 384

E.3 Total discounted investment cost and savings of importation in Peninsular Malaysia, RM million, 1997-2015, SCENARIO 3..... 385

E.4 Total discounted investment cost and savings of importation in Peninsular Malaysia, RM million, 1997-2015, SCENARIO 4..... 386

E.5 Total discounted investment cost and savings of importation in Peninsular Malaysia, RM million, 1997-2015, SCENARIO 5..... 387