



UNIVERSITI PUTRA MALAYSIA

**EFFECTS OF ENERGY SUPPLEMENTATION AND BREED OF SIRE
ON THE REPRODUCTIVE PERFORMANCE OF ZEL EWES AND
CARCASS QUALITY OF FATTENED LAMBS**

MOKHTAR MOHAJER

FP 2011 45

**EFFECTS OF ENERGY SUPPLEMENTATION AND BREED OF SIRE ON
THE REPRODUCTIVE PERFORMANCE OF ZEL EWES AND CARCASS
QUALITY OF FATTENED LAMBS**

By

MOKHTAR MOHAJER

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfilment of the Requirements for the Degree of Doctor of Philosophy**

April 2011

DEDICATION

To my family that I owe them every single moment of my life



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

EFFECTS OF ENERGY SUPPLEMENTATION AND BREED OF SIRE ON THE REPRODUCTIVE PERFORMANCE OF ZEL EWES AND CARCASS QUALITY OF FATTENED LAMBS

By

MOKHTAR MOHAJER

April 2011

Chairman: Professor Abdul Razak Alimon, PhD

Faculty: Agriculture

A series of experiments were conducted to examine the effect of supplementary dietary energy during pre-mating period and late pregnancy on the reproductive performance of Zel ewes mated to Zel or Shal rams, and their effects on the carcass quality of fattened lambs. In the first experiment, in a 2×2×2 factorial design experiment, 184 Zel ewes received diets containing 11.5 % crude protein, but with either 2.0 Mcal/kg metabolizable energy (ME), (NDE: normal dietary energy) or 2.3 Mcal/kg ME (HDE: high dietary energy) for 28 days before mating with either Zel or Shal rams. They were also treated with two levels of PMSG hormone, either 300 or 500 IU upon CIDR removal for estrus synchronization. Either Zel or Shal rams were exposed to the ewes at the rate of 1 ram: 10 ewes for 72 hours, 36 hours after the time of CIDR removal. Blood samples were collected from the ewes at the time of CIDR insertion, 7 days after CIDR insertion, at the time of CIDR withdrawal, 36 hours after CIDR withdrawal and 120 hours after ram introduction for FSH, insulin and progesterone analysis. Ewes on high dietary energy (flushing treatment) showed

significantly higher ($P < 0.05$) fertility, prolificacy, lambing rate and twinning rate compared to the NDE, 85.71 vs 79.34%, 132 vs 109, 113 vs 87% and twinning 32.05 vs 9.58%, respectively. The effect of PMSG (300 and 500 IU) showed a trend of increased fertility, 82.41 vs 82.60%, for prolificacy, 132 vs 109%, for lambing rate, 113 vs 87%, and for twinning, 32.05 vs 9.58%, respectively, with increasing dosage of PMSG, but were not significant. However, the effect of sire breed was significant. Ewes bred with Shal rams showed higher fertility, prolificacy, lambing rate, and twinning rate. It was suggested that increasing energy before mating (flushing) and using Shal rams to fertilize Zel ewes would increase the reproductive performance of Zel ewes. In the second experiment, 184 Zel ewes were used in an experiment to examine the effect of increasing dietary energy of ewes during the last 8 weeks of pregnancy. Ewes were mated to either Zel or Shal rams and allowed to be on a NDE (11.5% CP and 2.1 Mcal/kg ME) for three months after weaning followed by either the NDE or a diet with 2.3 Mcal/kg ME (HDE) for 8 weeks before parturition. The results showed that the mortality rates of lambs born to ewes fed on HDE diets were significantly lower than those fed the NDE. Increasing the energy level during the last 8 weeks before lambing increased lamb birth weight and weaning weight. Ewes mated to Shal rams bore lambs that were higher in birth weights, weaning weights and also mortality. The increase in mortality was probably due to difficult birth attributed to increased twinning rate and also lamb birth weight.

The third experiment conducted were to examine the effect of energy level, sire breed, sex, duration of fattening on lamb performance and carcass quality. In $2 \times 2 \times 2 \times 3$ factorial design experiment 120 male and female lambs born from Zel ewes mated to Zel or Shal rams were selected and given diets containing 2.2 or 2.5 Mcal/kg ME. Equal number of male and female lambs were divided into three

groups and fattened for 60, 80 or 100 days. At the end of each fattening period they slaughtered and carcass characteristics determined. The final live weights, average daily gain (ADG), hot carcass weight (HCW) of Zel lambs were significantly ($P<0.05$) lower than the crossbred (Zel \times Shal) lambs. In general, the live weight, ADG and HCW of male lambs were higher ($P<0.05$) than those of female lambs, but these difference were not significant. Lambs fed HDE diets had higher ($P<0.05$) live weight, ADG and HCW than those of the NDE. As expected the live weight, ADG and HCW of lambs slaughtered at 60, 80 and 100 fattening duration were increased with increasing duration of fattening. Total bone, fat and meat carcasses of Zel lambs were significantly ($P<0.05$) lower than crossbred (Zel \times Shal) lambs. From the results of this study it can be concluded that increased lamb production with improved lamb carcass characteristics can be achieved by increasing the energy level 3 weeks before mating to achieve high lambing rate and reduced mortality at birth. Increasing energy levels 8 weeks before parturition was also shown to improve lambing rate, twinning rate, increased lamb birth weight but may result in an increased mortality of lambs at birth. Zel ewes mating to Shal rams was produced bigger and heavier lambs at birth but may result in increased mortality due to difficult birth. Crossbred lambs show an increased rate of growth and higher carcass to liveweight ratio, and may be an option to increase lamb meat production on individual lamb basis. Also, it can be concluded that quality carcasses can be obtained by fattening crossbred lambs for duration of 80 days.

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

**KESAN PENAMBAHAN TENAGA DAN BAKA PEMBIAK JANTAN
KEATAS PRESTASI PEMBIAKAN BIRI-BIRI BETINA IRAN ZEL DAN
KUALITI KARKAS ANAK PENGGEMUK**

Oleh

MOKHTAR MOHAJER

April 2011

Ketua: Profesor Abdul Razak Alimon, PhD

Fakulti: Pertanian

Beberapa eksperimen telah dijalankan untuk menentukankesan penambahan tenaga dalam makanan sebelum pengawanan dan lewat kebuntingan keatas prestasi pembiakan biri-biri betina baka Zel yang dikawinkan dengan biri-biri jantan baka Zel atau baka Shal, dan kesan keatas kualiti karkas anak biri-biri penggemuk. Dalam experimen 1, rekabentuk factorial $2 \times 2 \times 2$ desain, 184 biri-biri betina diberi makanan mengandungi 11.5 % protein kasar, dengan tenaga metabolisme 2.0 Mkal/kg (NDE) atau 2.3 Mkal/kg (HDE) 28 hari sebelum dikawinkan dengan pejantan baka Zel atau baka Shal. Biri-biri betina juga diberi rawatan hormone PMSG pada dos 300 IU atau 500IU selepas CIDR dikeluarkan untuk tujuan pingsinkronian estrus. Samada pejanta baka Zel atau bakab Shal dicampurkan dengan biri-biri betina selama 120 jam pada kadar 1 pejantan setiap 10 betina, 36 jam selepas CIDR dikeluarkan. Sampel darah diambil dari biri-biri betina semasa CIDR dan selepas 36 jan CIDR dikeluarkan, 120 jam selepas pejantan dicampurkan, untuk tujuan penganalisan FSH, insulin dan progesterone. Biri-biribetina yang diberi makanan bertenaga tinggi (HDE) menunjukkan fertility, prolifikasi, kadar beranak dan kadar kembar yang lebih tinggi ($P < 0.05$) dari biri-biri NDE, masing

masing 85.71 vs 79.34%, 132 vs 109, 113 vs 87% and twinning 32.05 vs 29.58%. Kesan rawatan PMSG (300 and 500 IU) menunjukkan tren peningkatan kesuburan (82.41 vs 82.60%), prolififikasi (132 vs 109%), kadar beranak (113 vs 87%) dan kembar (32.05 vs 9.58%) dengan pemberian dos yang tinggi (500IU) tetapi tidak signifikan. Walau bagaimana pun, kesan baka pembiak adalah signifikan. Biri-biri betina yang dikawinkan dengan pejantan Shal menunjukkan kesuburan, prolififikasi, kadar beranak dan kadar kembar yang lebih tinggi. Dalam eksperimen kedua, 184 biri-biri betina Zel telah digunakan untuk menentukan kesan pemberian penambahan tenaga semasa 8 minggu terakhir kebuntingan. Biri-biri betina yang telah dikawinkan dengan pejantan Zel atau Shal diberi makanan NDE (11.5% CP and 2.1 Mkal /kg ME) untuk 3 bulan selepas dikawinkan dan seterusnya diberi makanan NDE atau diet tenaga tinggi, 2.3 Mcal/kg ME (HDE), selama 8 minggu sebelum dijadualkan beranak. Keputusan menunjukkan kadar mortality anak yang diberi HDE adalah lebih rendah dari yang diberi NDE. Meningkatkan tenaga semasa 8 minggu terakhir bunting meningkatkan berat lahir dan berat sapih anak biri-biri. Biri-biri betina Zel yang dikawinkan dengan pejantan Shal menghasilkan anak yang lebih tinggi dalam berat beranak, berat sapih, dan juga mortaliti. Peningkatan kematian mungkin disebabkan kesukaran beranak disebabkan peningkatan kadar kembar dan juga berat anak yang tinggi. Eksperimen ketiga yang dijalankan adalah untuk menentukan kesan aras tenaga, baka pejantan, gender, jangkamasa penggemukan keatas prestasi anak dan kualiti karkas. Dalam eksperimen rekabentuk factorial $2 \times 2 \times 2 \times 3$, 120 anak biri-biri jantan dan betina dihasilkan dari ibu baka Zel yang dikawinkan dengan pejantan Zel atau Shal telah dipilih dan diberi makanan diet mengandungi samada 2.2 atau 2.5 MKal/kg ME. Anak jantan dan betina dibahagi kepada tiga kumpulan dengan setiap satu kumpulan digemukkan untuk

samada 60, 80 atau 100 hari. Pada akhir setiap jangkamasa penggemukan anak biri-biri disembelih dan cirri cirri karkas ditentukan. Berat badan waktu sembelih, peningkatan berat badan harian (ADG), berat kakas panas (HCW) anak biri-biri dari baka pejantan Zel adalah lebih rendah ($P < 0.05$) dari anak kacukan (Zel \times Shal). Pada keseluruhannya, berat badan, ADG dan HCW anak biri-biri jantan adalah lebih tinggi ($P < 0.05$) dari yang betina, tetapi perbezaan ini tidak signifikan. Anak biri-biri yang diberi makan diet HME mempunyai berat badan, ADG dan HCW yang lebih tinggi ($P < 0.05$) dari yang diberi NDE. Sebagai dijangka, berat badan, ADG dan HCW anak biri-biri yang disembelih pada 60, 80 and 100 hari penggemukan meningkat mengikut peningkatan jangkamasa. Jumlah tulang, lemak dan daging karkas dari anak biri-biri Zel adalah lebih rendah ($P < 0.05$) dari anak yang kacukan (Zel \times Shal). Dari keputusan kajian ini boleh dirumuskan yang untuk meningkatkan produksi daging biri-biri dengan kualiti karkas yang tinggi boleh dicapai melalui pemberian diet bertenaga tinggi 3 minggu sebelum biri-biri ibu dikawinkan untuk menghasilkan kadar beranak yang tinggi dan juga pengurangan mortality anak semasa dilahirkan. Peningkatan tenaga diet 8 minggu semasa bunting sebelum beranak juga boleh meningkatkan kadar beranak, kadar kembar dan berat lahir. Pejantan baka Shal menghasilkan anak biri-biri yang lebih besar dan berat tetapi boleh menyebabkan kesukaran beranak dan peningkatan mortality. Anak biri-biri kacukan Zel \times Shal menunjukkan peningkatan kadar pertumbuhan dan nisbah karkas:berat badan yang tinggi, dan ini juga boleh menjadi opsiyen sebagai satu kaedah meningkatkan produksi daging biri-biri secara individu. Juga boleh dirumuskan yang karkas yang berkualiti boleh didapati dengan meningkatkan jangkamasa penggemukan dari 60 hari kepada 80 hari.

ACKNOWLEDGEMENTS

Thanks god for his mercy and guidance that helped me in conducting this study and in the preparation of this thesis.

I would like to thank Universiti Putra Malaysia (UPM), Jihad-e-Agriculture Organisation Golestan Province of Iran (JAOGPI), Agriculture Reserch Center Golestan Province (ARCGO).

I would like to express my appreciation and gratitude to my supervisory committee, my supportive chairman Professor Dr. Abdul Razak Alimon and co-supervisors Associate Professor Dr. Halimaton Yaakub, Professor Dr. Amir Niasari-Naslaji for guidance, suggestion and encouragement throughout this project. All their invaluable help is greatly appreciated.

My sincere thanks to my colleagues Mr. Allahyar Nazemi, Dr. Abbas Ali Norinea, Mr. Akbar Esfandiari, Mr. Rahmat Camiei, Mr. Vahid Kazemi, Mr. Mohsen Delam and Mr. Abdolhakim Toghdari for their valuable assistance and suggestions.

I am sincerely grateful to my family members for their love, endless support, encouragement, understanding, and reassurance during my study.

I certify that an thesis Examination Committee has met on **14. 04. 2011** to conduct the final examination of Mokhtar Mohajer on his Doctrine of Philosophy thesis entitled “effect of energy supplementation and breed of sire on reproductive performance of Iranian Zel ewes and the carcass quality of fattening lamb” in accordance with Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U. (A) 106] 15 March 1998. The Committee recommends that the student be awarded the degree of Doctor of Philosophy (PhD).

Members of the Examination Committee are as follows:

Chairman, Jothi Malar Panandam, PhD

Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Examiner 1, Awis Qurni Sazili, PhD

Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Examiner 2, Shanthi Ganabadi, PhD

Associate Professor
Faculty of Veterinary Medicine
Universiti Putra Malaysia
(Internal Examiner)

Examiner 3, Phillips Clive, PhD

Professor
Center for Animal Welfare and Ethics
School of Veterinary Science
Universiti of Queensland (Australia)
(External Examiner)

SHAMSUDDIN SULAIMAN, PhD

Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

This thesis was submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

Abdul Razak bin Alimon, PhD

Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Halimatun binti Yaakub, PhD

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Amir Niasari-Naslaji, PhD

Professor
Faculty of Veterinary Medicine
University of Teheran, IRAN
(Member)

Mohammad Reza Kiyanzad, PhD

Associate Professor
Animal Science Research Institute, IRAN
(Member)

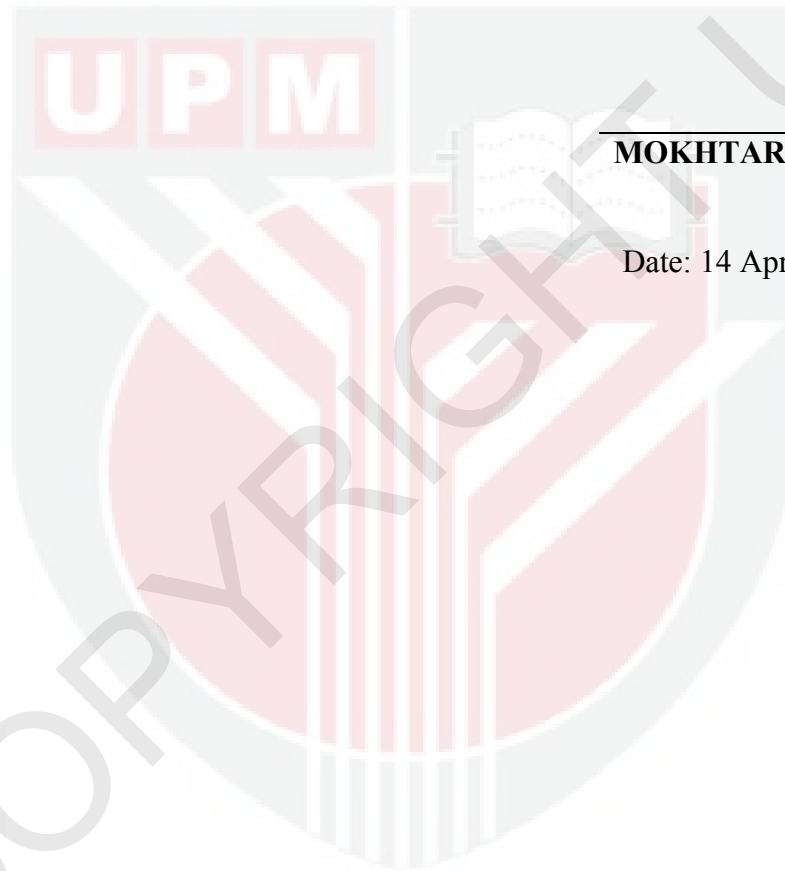
HASANAH MOHD GHAZALI, PhD

Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

DECLARATION

I declare that the thesis is my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or other institutions.



MOKHTAR MOHAJER

Date: 14 April 2011

TABLE OF CONTENTS

DEDICATION	Page
ABSTRACT	ii
ABSTRAK	iii
ACKNOWLEDGEMENTS	vi
APPROVAL	ix
DECLARATION	x
LIST OF TABLES	xii
LIST OF FIGURES	xvi
LIST OF ABBREVIATIONS	xviii
	xx

CHAPTER

1	GENERAL INTRODUCTION	1
2	LITERATURE REVIEWS	5
	2.1 Sheep population and mutton production in Iran	6
	2.1.1 Sheep farming in Iran	7
	2.1.2 Nomadic system	7
	2.1.3 Traditional system	7
	2.1.4 Intensive system	8
	2.2 Sheep breeds	9
	2.2.1 Zel	9
	2.2.2 Shal	12
	2.3 Nutrition and reproductive performances of ewes	13
	2.3.1 Feed restriction and fertility	13
	2.3.2 Nutrition and follicle development	15
	2.3.3 Feeding energy supplements to increase ovulation rate	15
	2.3.4 Supplementary feeding (flushing)	16
	2.3.5 Nutrition and embryo mortality	16
	2.3.6 Nutrition and fetal mortality	17
	2.3.7 Estrus synchronization	17
	2.3.8 Hormonal treatments to enhance fertility	18
	2.3.9 Reproductive and metabolic responses to feed restriction and re-feeding	19
	2.3.10 Breed and nutrition interactions	24
	2.3.11 Crossbreeding	24
	2.3.12 Dietary energy and lamb growth	25
	2.3.13 Growth performance and carcass composition of fattening lambs in Iran	26
	2.3.14 Dietary energy and weight gain and carcass characteristics of lambs	27
	2.3.15 Dietary energy and carcass composition	27
2.4	Conclusion	29

3	EFFECT OF ENERGY LEVEL AND DOSAGE OF PMSG ON REPRODUCTIVE PERFORMANCE OF ZEL EWES BRED TO SHAL OR ZEL RAMS	30
3.1	Introduction	30
3.2	Materials and methods	31
3.2.1	Experimental location	31
3.2.2	Animal management and experimental design	32
3.2.3	Synchronisation protocols	33
3.2.4	Mating	34
3.2.5	Measurements	35
3.2.6	Blood Sampling	35
3.2.7	Statistical analysis	36
3.3	Results	36
3.3.1	Reproductive parameters	37
3.3.2	Insulin and reproductive hormones	40
3.4	Discussion	41
3.5	Conclusion	48
4	EFFECT OF DIETARY ENERGY LEVEL DURING LATE PREGNANCY ON REPRODUCTIVE PERFORMANCE OF ZEL EWES BRED WITH EITHER ZEL OR SHAL RAMS	49
4.1	Introduction	50
4.2	Materials and methods	50
4.2.1	Experimental procedures	51
4.2.2	Statistical analysis	51
4.3	Results	51
4.3.1	Ewe weight	51
4.3.2	Lamb birth weight	52
4.3.3	Lamb mortality at birth	55
4.3.4	Lamb weaning weight	55
4.3.5	Twinning	55
4.4	Discussion	55
4.5	Conclusion	60
5	EFFECT OF FATTENING DIETARY ENERGY LEVEL ON PERFORMANCE OF ZEL AND SHAL SIRE MALE AND FEMALE LAMBS	
5.1	Introduction	61
5.2	Materials and methods	62
5.2.1	Experimental location	62
5.2.2	Experimental design	63
5.2.3	Statistical Analysis	64
5.3	Results	64
5.3.1	Ram	64
5.3.2	Sex	68
5.3.3	Dietary energy supplementation	68
5.4	Discussion	68
5.5	Conclusion	72

6	EFFECT OF DIETARY ENERGY LEVEL, SEX AND DURATION OF FATTENING ON CARCASS CHARACTERISTICS OF LAMBS SIRED BY ZEL OR SHAL RAMS	
6.1	Introduction	73
6.2	Materials and methods	74
	6.2.1 Experimental location	74
	6.2.2 Animals	74
	6.2.3 Fattening period	75
	6.2.4 Carcass measurements	76
	6.2.5 Statistical analysis	77
6.3	Results	77
	6.3.1 Ram and carcass characteristics	77
	6.3.2 Sex and carcass characteristics	78
	6.3.3 Dietary energy and carcass characteristics	84
	6.3.4 Fattening periods and carcass characteristics	84
6.4	Discussion	85
6.5	Conclusion	90
7	GENERAL DISCUSSION AND CONCLUSION	91
	REFERENCES	98
	APPENDICES	118
	BIODATA OF STUDENT	127
	LIST OF PUBLICATIONS	128