Tropentag 2014, Prague, Czech Republic
September 17-19, 2014

Conference on International Research on Food Security, Natural Resource Management and Rural Development
organised by the Czech University of Life Sciences Prague

Evaluation of Performance and Estimation of Genetic Parameters for Milk Yield and Some Reproductive Traits in Sheep Breeds and Crosses in the West Bank

Muayad Salman[a] and Jihad Abdallah[b]

[a] Ministry of Agriculture, State of Palestine. Email moayednas@yahoo.com.
[b] An Najah National University, Faculty of Agriculture, State of Palestine.

Introduction

Sheep is the major small ruminant in Palestine and contributes a larger source of meat and milk as compared to goat. Awassi represents the major sheep breed in the west Bank (68%), while Assaf and other breeds and crosses ranked second (32%) (PCBS, 2007).In 1999, an intergovernmental agreement for a regional agricultural program was signed by Egypt, Israel, Jordan, and the Palestinian Authority with Denmark as initiator and main funder. A full plan of activities was prepared on six main subjects, small ruminants was one of the main activities.
Phase II of the Middle East Regional Agricultural Program (MERAP) started in the West Bank in 2004/2005 by selecting several sheep farms as demonstration farms (Demo Farms). Under the project, several farms with 50 or more ewes in the following locations of the West Bank were selected as Demo farms: Betqad (BEQ), Hebron (HEB), Jenin (JEN), Qalqeelia (QAL), Ramallah (RAM), Jerusalem (JER), = Bethlehem (BET), Dora (DOR), and Nablus (NAB).
Sheep breeds, lines, and crosses, in these farms were: Local Awassi (AW), Improved Awassi (IA), Assaf (AF), crossbred between Assaf and local Awassi (XB), and one farm had a flock Afec Awassi (AA) with the Booroola fecundity gene (FecB+ Awassi, Gootwine, et al 2001). Demo farms were monitored, data were recorded, and farmers received management advices. In this study we undertake the analysis of the data collected from the demo farms under the MERAP in the West Bank. The aims of this analysis were to evaluate sheep productivity and compare milk and prolificacy of sheep breeds under farm conditions in the West Bank, and to estimate genetic parameters (heritability and repeatability) for milk production and prolificacy traits of ewes, in the West Bank.

Material and Methods

All Demo farms records were validated and stored by technicians of the ministry of agriculture using the on-farm ‘Ewe and Me’ software. Traits of milk yield included total milk yield from lambing to last test date (TMY), total milk yield from lambing to 150 days of lactation (TMY120), and total milk yield from lambing to 150 days of lactation (TMY150). TMY through the lactation was calculated by using the Fleischmann method (Ruiz et al., 2000):

$$TMY= y_1 t_1+ \sum((y_i + y_{i+1})/2)(t_{i+1} – t_i))$$

Where y_1 is the daily milk yield at first milk recording; t_1 is the interval (in days) between lambing and first recording; y_i is the daily milk yield of the ith milk recording , and (t_{i+1} - t_i) is the time interval (in days) between record i and record (i+1), (i=1,………… k).
Reproductive traits included number of lambs born per ewe lambing (NLB), number of lambs born alive per ewe lambing (NLBA), and lambing interval (LI). Lambing interval was calculated as the number of days between two consecutive lambings.

Single-trait (univariate) analyses was performed, for breed evaluation, the following fixed-effects model was used : **Y = Xb + e** **(1)**

Where Y is a vector of observations on ewes for the given trait, b is a vector of fixed effects to be estimated, e is a vector of residuals containing all effects unexplained by the model, and X is a design (incidence) matrix relating fixed effects to observations. The fixed effects included for milk traits were: location-breed (LB), parity (PR), year-season of lambing (YS), treatment for induction of estrus (TRT: natural or PMSG sponges), number of lambs born per lambing ewe (NLB), number of milking tests (NMT), and lactation length (LL). For prolificacy traits, the fixed effects were: LB, PR, YS, and TRT. Least squares means were obtained for location-breed and pairwise comparisons of means were made using the LSD test.

For estimation of genetic parameters, two analyses were performed for each trait:

1. A fixed-effects model as in (1) was first performed within each breed to determine the significant factors for inclusion in the genetic parameters' estimation model. The fixed-effect factors investigated were the same as before except that location-breed was replaced by location whenever applicable. All fixed-effects analyses were performed using SPSS v12.1 for windows.
2. A mixed-model (fixed and random effects) for estimation of genetic parameters. The model in matrix notation is: **Y = Xb + Za +Wp+ e** (2)

Where Y, b, e and X are as defined earlier, a is a vector of random animal effects (breeding values), p is a vector of random permanent environmental effects of ewes and Z and W are incidence matrices relating observations to random animal effects and random permanent environmental effects, respectively.

Genetic parameters for milk and prolificacy traits were estimated within each breed (except AA because of the small number of available records). Iteration for variance components and estimation of genetic parameters was carried out using derivative-free REML (Restricted Maximum Likelihood) procedure implemented in the MTDFREML programs of Boldman et al. (1993).

Results and Discussion

The results of milk traits showed that Breed within Location (LB), Parity (PR), and year season of lambing (YS) had high significant effects on all milk traits ($P < 0.001$), while the effect of number of lambs born (NLB) was not significant ($P > 0.05$) for any milk trait. The effect of lactation length (LL) was highly significant ($P < 0.001$) on TMY, while number of milking test (NMT) was not significant ($p > 0.05$). For prolificacy traits, LB, PR, and YS had significant effects ($P < 0.05$) for all studied traits, while treatment (TRT) was significant for number of lambs born Alive (NLBA) only.

Milk performance of the same breed in different locations (figure 1.) showed that there were significant differences. Awassi in Hebron produced more milk than Awassi in Jerusalem, and Assaf in Jenin produced more milk than Assaf in other locations, while Awassi X Assaf crossbred in the North of the West Bank (Jenin and Nablus) produced more milk than in the South of the West Bank (Bethlehem, Dora, Hebron, and Jerusalem).

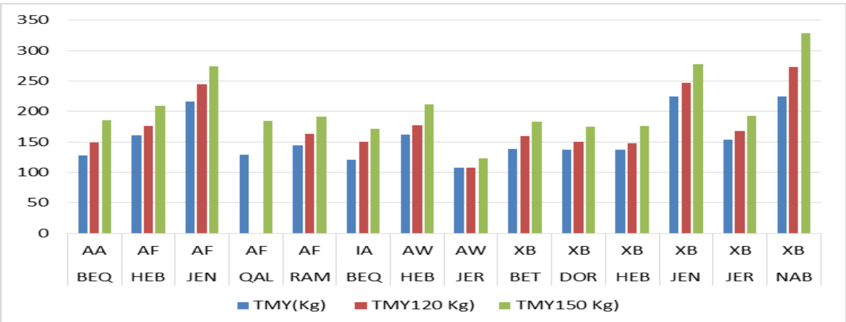

Figure 1: Least squares means of milk traits (kg) by location-breed.

Least squares means of TMY for year-season of lambing are presented in figure 2. Awassi X Assaf crossbred had the highest milk production over most of the period of the project followed by Assaf breed.

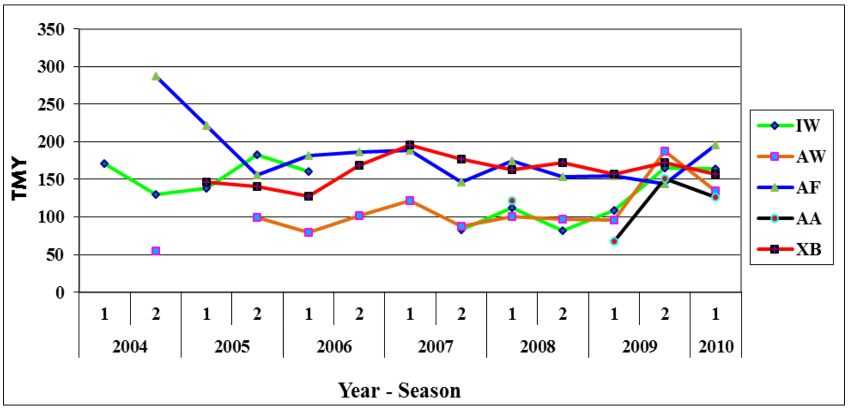

Figure 2: Least squares means of TMY by year-season of lambing

The average NLB in Improved Awassi (figure 3) was 1.25 lambs per ewe lambing which is less than the estimate of 1.28 reported by Gootwine and Pollott (2000). The same authors reported an average of 1.60 lambs per ewe lambing for the Assaf breed, while in this study Assaf produced an average of 1.21 to 1.38 lambs per ewe lambing. Gootwine et al., (2001) reported that the estimated number of lambs born per ewe lambing for Afec Awassi was 2.0, which is higher than the estimate of 1.66 found herin. The superiority of Afec Awassi and Assaf in NLB was slightly offset by the somewhat higher stillbirth rates than the other breeds (only Afec Awassi significantly differed from the other breeds in NLBA). Least square means of NLB traits by year-season of lambing are presented in (figure 4.). There were fluctuations of breed prolificacy across year seasons of lambing.

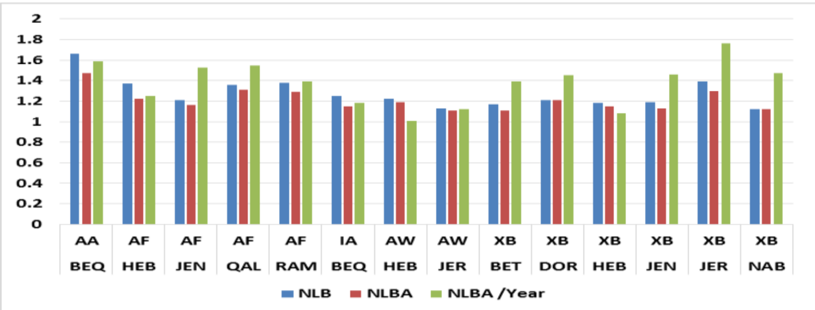

Figure 3. Least squares means of prolificacy by location breed.

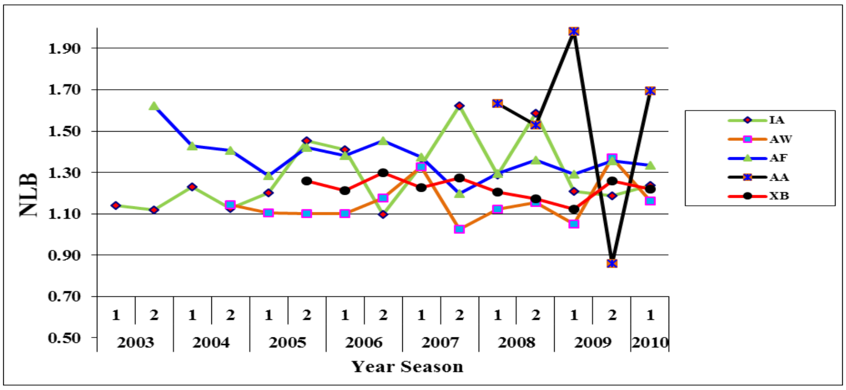

Figure 4. Least squares means of NLB by year-season of lambing

Variance components and genetic parameters (heritability (h^2) and repeatability (r)) for milk and reproductive traits were estimated within each breed. For milk traits **(Table 1)**, there were convergence problems whereby additive and permanent environmental effects were difficult to separate except for IA. In addition, the estimates of genetic parameters had large standard errors.

Table (1) Estimates of genetic parameters of milk traits.

Breed	TMY		TMY120		TMY150	
	heritability (h^2)	repeatability (r)	heritability (h^2)	repeatability (r)	heritability (h^2)	repeatability (r)
IA	0.10±0.15	0.31±0.22	0.06±0.14	0.36±0.22	0.15±.15	0.30±0.22
AW	0.02±0 .73	0.11±1.03	0.16±1.67	0.16±1.18	0.16±1.73	0.16±1.68
AF	0.01±0.10	0.09±0.10	0.02±0.002	0.1±0.1	0.02±0.110	0.08±0.11
XB	0.00±0.45	0.00±0.74	0.00±0.50	0.02 ±0.71	0.00±0.45	0.03±0.64

Variance components and genetic parameters for reproductive traits are in (**Table 2).** The estimates found in this study for prolificacy traits and lambing interval are in agreement with estimates in the literature; estimates of heritability and repeatability for reproductive traits are generally small due to large contribution of environmental effects.

Table (1) Estimates of genetic parameters of prolificacy traits and lambing interval.

Trait	IA		AW		AF		XB	
	heritability (h^2)	repeatability (r)	heritability (h^2)	repeatability (r)	heritability (h^2)	repeatability (r)	heritability (h^2)	repeatability (r)
NLB	0.08±0.09	0.16±0.12	0.09± 0.62	0.09 ±0.88	0.02±0.55	0.04±0.77	0.00±0.13	0.04±0.18
NLBA	0.05 ±0.08	0.07±0.12	0.15±0.78	0.15 ±1.11	0.02±0.536	0.05±0.75	0.00±0.12	0.05±0.18
LI	0.00±0.150	0.06±0.21	.03±1.048	0.03±1.5	0.00±0.05	0.00±0.05	0.00±0.40	0.25±0.57

This is the first time that genetic parameters are estimated for Palestinian sheep populations. These estimates were based on smaller data sets than generally used in other studies. In addition, good proportion of ewe data had missing pedigree information (sire and dam identification). Therefore, before implementation of any selection program, these estimates should be reinvestigated using larger data sets and better recorded data.

Conclusions and Outlook

Levels of milk production for local Awassi were greater than milk production of the breed in previous studies but were lower than the production of the breed in other countries. While, performance of Assaf, Improved Awassi, and Afec Awassi was lower than in other countries. Prolificacy of Awassi sheep was slightly greater than reported in previous studies, while it was less for Improved Awassi, Assaf, Afec Awassi, and Awassi X Assaf crossbred. Prolificacy was highest for the Afec Awassi strain which carries the Booroola fecundity gene.

The results of this study indicate that Assaf and Awassi x Assaf sheep are the recommended breeds for raising in the Northern areas of the West Bank. Before the implementation of selection programs, genetic parameters in sheep breeds of the West Bank should be re-investigated using larger data sets and complete records (performance and pedigree).

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