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Effect of Vitamins AD_3E Injections on Reproductive Performance and Net Cash Revenue from Awassi Sheep Raised under Semi-intensive System

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Abstract. The effect of Vitamins AD_3E injection on fertility and prolificacy was studied on Awassi ewes reared under semi-intensive system of production. Ewes from sixteen flocks selected at the northern, middle and southern part of Jordan for this study during five successive mating seasons (1993-1998). Ewes in each flock were divided into control and treatment group. The treated group received two intramuscular shots of 200,000 I.U. of vitamin A, as AD_3E solution 2-3 weeks before mating and another shot two months later. The treated groups showed a significant increase ($P<0.05$) in fertility and lambing rates compared with the control group. The average fertility rate was 82.1% and 74.1% for the treated and control groups, respectively. The lambing rate increased from 77.9% to 86.7% as a result of the treatment. No significant differences ($P> 0.05$) were detected in birth and weaning weights of lambs from the control and treated ewes. The average incremental net revenue due to vitamin AD_3E injection was 3.72 JD/ewe. Therefore, this technique is recommended for use at a wider scale by sheepherders.

Introduction

Sheep production in Jordan depends on natural pasture and crop residues as the main feed resources. The quality and quantity of herbage in these pastures deteriorate between June and September. Sheep maintained on these pastures at this time are likely to be undernourished. Unfortunately, the mating season in ewes coincides with this period of inadequate nutrition [1]. Since vitamin A is found in green roughages and stored in the liver for 3 to 4 months [2], sheep kept on crop residues exhibit a deficiency in Vitamin A and other nutrients during the mating resulting into poor reproductive performance [3].

Vitamin A is required for normal epithelial cells, which line to cover body surface or cavities- respiratory, urogenital and digestion tract [3], and it is essential for

ovarian activities, reproductive hormones, and fertilization rate [4,5]. Abi Saab and Hamaden [6] reported low fertility and twinning rates together with prolonged lambing season for Awassi ewes in Lebanon. Sets of solutions for improving sheep fertility in Jordan were introduced to sheepherders over the past eight years [7,8]. One of these solutions was the injection of vitamin A, in a form of vitamin AD_3E solution, to Awassi ewes prior and during the mating season.

The main objective of this study was to evaluate the effect of injecting ewes with vitamin AD_3E prior to the mating season on reproductive performance and net cash revenue as a new practice introduced by Mashreq and Mashreq/ Maghreb projects[1].

Material and Methods

Approximately 34 ± 10 Awassi ewes were randomly selected from each of 16 flocks located at the northern, middle and southern part of Jordan before the mating season with a total number of 1114 Awassi ewes during the five studied seasons (Table 1). All ewes were reared under semi-intensive system and eartagged, half of them were injected with vitamins AD_3E. Vitamins AD_3E were injected 2-3 weeks before mating season (June-September) using 200,000 I.U. of Vitamin A in a form of AD_3E solution. A second similar injection was repeated two months later. Sheep were fed *ad-libitum*, according to the traditional semi-intensive system on cereal stubble and crop residues. The implementation was done through a close cooperation between researchers, extensionists and farmers. Farmers were given the main role, followed by the extensionists.

Table 1. Summary of Vitamins AD_3E treatments in Jordan during the 1992-1998 seasons

Seasons	Treat-ments	No. Flocks	No. of Ewes	Ewes giving birth	Ewes giving twins	No. of born lamb	Mortality	Avg. weaning weight/ewe exposed
1992/1993	Control	6	167	125	4	129	6	14.48
1993/1994	Control	4	115	97	9	106	4	16.48
1994/1995	Control	2	85	63	3	66	4	14.03
1996/1997	Control	3	150	103	3	106	9	12.49
1997/1998	Control	1	25	14	0	14	2	9.27
1992/1993	AD_3E	6	165	141	4	145	8	15.94
1993/1994	AD_3E	4	144	124	13	137	9	17.02
1994/1995	AD_3E	2	88	70	2	72	3	15.46
1996/1997	AD_3E	3	150	112	8	120	6	14.55
1997/1998	AD_3E	1	25	20	0	20	3	13.31

[1] Mashreq project (1989-1994) with the title of "Increased Productivity of Barley, Pasture and Sheep in the Critical Rainfall Zones of Syria, Jordan and Iraq", thereafter known as the "Mashreq Project".The Mashreq/Maghreb project (1995-2003) with the title "The Development of Integrated Crop/Livestock Production in low Rainfall Areas of the Mashreq and Maghreb regions".

The data collected were: number of ewes exposed to the rams, number of ewes lambing, type of birth, birth weight, number of weaned lambs, weaning weights at 75 days weaning age, and additional costs associated with the treatment. The collected data were used to calculate fertility, prolificacy, mortality, twinning, lambing rates and net cash revenue. Fertility rate is defined as number of ewes lambing out of ewes exposed to rams. Twinning rate is defined as a number of ewes giving twin lambs out of number of ewes lambed. Prolificacy is defined as number of lambs born out of number of ewes lambed. Lambing rate was defined as number of lambs born out of ewes exposed to rams. Mortality rate is defined as number of lambs died prior weaning out of lambs born.

Partial budget [9] was used for the evaluation of the economic profitability of the treatment. The net incremental return was calculated according to Kay [10] as (additional return + reduction of some costs) – (additional costs + reduction of some returns), for each head of sheep.

Data on reproductive performance averages of the five breeding seasons (1993–1998) were analyzed by analysis of variance using SPSS® 9.0 statistical package. The dependent variables were fertility rate, twinning rate, lambing rate, mortality rate, and prolificacy rate, initial lamb weight, weaning weight as well as total returns. The independent variables were treatment, location, treatment x location, season, season x treatment, season x location and season x treatment x location interactions. Least Significant Differences (LSD) were used to compare between means. Significance was declared at $P < 0.05$ unless otherwise noted.

Results and Discussions

Vitamin A and E are essential for ewe's conception and consequently has a major effect on the birth rate [11]. The effect of Vitamin A is more pronounced in drought years and in the absence of green forage. In general this is the case with sheep grazing the rangeland and stubble residue. The results (Table 2) indicated that the AD_3E treated groups had significantly better ($P<0.05$) fertility and lambing rates than the control group. Vitamin AD_3E injections caused an increase in the lambing rate from 77.9% for the control group to 86.7% for the treated group, whereas the fertility rate increased from 74.1% to 82.1%. As reported by Nör and Ströbel [12] the average lambing rate for Awassi ewes in Jordan is 80%. Thomson [13] and ACSAD [14] reported that lambing rate for Awassi ewes ranged from 82 to 90% with an average of 86.7%. The injection of vitamins AD_3E caused an increase of 8.8% in lambing rate compared with the control groups and the present lambing rate is higher than that reported by Nör and Ströbel [12]. Moreover, the treatment increased the fertility of ewes by 8.0% compared with the control. Vitamins AD_3E injection did not cause a significant ($P>0.05$) changes in prolificacy, twinning, and mortality rates. Similarity the treatment did not affect the birth, weaning weights and weaning weights/ewe (Table 2). According to ACSAD [14],

the birth and weaning weights of Awassi lambs ranged from 4 to 4.2 kg and 19 to 22.3 kg, respectively. These results compare favorably with the present results.

Table 2. Effect of vitamins AD_3E injections on the reproductive performance of Awassi ewes, birth and weaning weight of their newborns

Parameter	Treatment				Significance P- value
	Control		AD_3E		
	Mean	SEM*	Mean	SEM*	
a) Ewe:					
Fertility rate	74.1	2.3	82.1	2.0	0.01
Lambing rate	77.9	3.1	86.7	2.9	0.05
Twinning rate	4.3	1.0	5.3	1.6	0.58
Prolificacy	104.6	1.0	105.3	1.6	0.72
Mortality rate	1.8	0.3	1.8	0.2	0.88
b) Newborn:					
Birth weight (kg)	4.1	0.1	4.1	0.1	0.86
Weaning weight (kg)	19.2	0.2	19.3	0.1	0.83
Weaning wt./ewe	14.2	0.6	15.7	0.5	0.10

*SEM= Standard error of mean

The effect of farm locations on reproductive performance of Awassi ewes injected with vitamins AD_3E is shown in Table 3. Except for mortality rate, there was no significant location effect ($P>0.05$) on all reproductive indicators as a result of using vitamins AD_3E injections. The mortality rate was significantly ($P<0.05$) higher in the northern compared with the southern and middle parts of Jordan, the same trend was also found for the control groups but with higher values. Moreover, the ewes from the control group at the southern part of Jordan showed significant differences ($P <0.05$) on the fertility, lambing and prolificacy compared to the ewes from the northern and middle parts (Table 4). The lambs from the control and injected groups in the middle part had significantly ($P<0.01$) heavier weaning weights than lambs from the northern and southern parts of Jordan (Tables 3 and 4).

The location had an effect on birth weight of newborn lambs for the control and treated groups. The newborn lambs from treated ewes and the control at the northern part tend to have a significant ($P <0.09$) heavier birth weight than lambs born at the southern and the middle parts of Jordan. On other hand, the weaning weights of lambs from the middle part were significantly ($P<0.01$) heavier than the weaning weights of lambs from the northern and southern parts of Jordan for both groups the treated and the control (Tables 3 and 4).

Table 3. Effect of locations on the reproductive performance parameters of Awassi ewes injected with vitamins AD_3E and birth, weaning weights of their newborns

Parameter	Location						P-value
	North		Middle		South		
	Mean	SEM*	Mean	SEM	Mean	SEM	
a) Ewe:							
Fertility rate	80.7	4.4	85.8	3.6	79.5	2.9	0.39
Lambing rate	88.3	9.4	90.1	4.6	82.3	2.4	0.53
Twinning rate	8.7	5.5	4.7	1.9	3.8	1.6	0.51
Prolificacy	108.7	5.5	104.7	1.9	103.7	1.6	0.51
Mortality rate	2.7^{a}	0.2	1.5^{b}	0.4	1.5^{b}	0.4	0.10
b) Newborn:							
Birth weight (kg)	4.4^{a}	0.3	3.9^{b}	0.1	4.1^{b}	0.1	0.09
Weaning weight (kg)	19.1^{a}	0.3	20.0^{b}	0.2	18.8^{a}	0.3	0.01
Weaning wt./ewe**	15.2	1.5	17.2	1.0	14.5	0.3	0.14

*SEM= Standard Error of means.
** Sum of body weights of weaned lambs divided by the total number of ewes.
^{a,b} Means within a row that differ are significantly different.

Table 4. Effect of locations on the reproductive performance parameters of Awassi ewes raised under semi- intensive system and birth, weaning weights of their newborns (Control)

Parameter	Location						P-value
	North		Middle		South		
	Mean	SEM*	Mean	SEM	Mean	SEM	
a) Ewe:							
Fertility rate	74.8^{ab}	7.4	80.0^{a}	2.4	67.4^{b}	0.6	0.05
Lambing rate	80.3^{ab}	9.9	85.6^{a}	3.0	68.8^{b}	1.3	0.05
Twinning rate	6.4	3.0	5.4	1.3	1.7	1.1	0.15
Prolificacy	106.4^{a}	2.9	106.4^{a}	0.8	101.6^{b}	1.2	0.06
Mortality rate	2.3	0.8	1.3	0.5	1.8	0.4	0.34
b) Newborn:							
Birth weight (kg)	4.5^{a}	0.4	3.8^{b}	0.1	4.1^{ab}	0.1	0.09
Weaning weight kg)	18.7^{a}	0.2	20.3^{b}	0.1	18.6^{a}	0.1	0.01
Weaning wt./ewe**	13.9^{b}	1.9	16.2^{a}	0.8	12.4^{b}	0.2	0.03

*SEM= Standard Error of means.
** Sum of body weights of weaned lambs divided by the total number of ewes.
^{a,b} Means within a row that differ are significantly different.

Wide discrepancies on the effect of vitamins A and E injections on the reproductive performance of farm animals were well reported in literatures. Raasch [15] reported a little effect of supplemental vitamin A and E on overall reproductive efficiency of ewes mated on pasture or in drylot under the Iowa State environmental conditions. The

importance of vitamin A for reproduction was clearly shown in a study with ewes fed a diet deficient in vitamin A and carotene for three months. Vitamin A deficiency caused a low conception rate and none of the offspring produced were survived beyond five days of age. Raasch [16] concluded that research in the area of vitamin A and E supplementation must be directed to explore frequency, timing, and amount of vitamins added which may alter the reproductive performance of the ewes. Despite the adverse consequences of feeding diets deficient in vitamin A and E on reproduction, researchers have not had consistent success in increasing reproductive efficiency by supplementing standard diets with vitamins.

Factors other than dietary vitamin supplementation may play role in obtaining positive result. These include the timing of injection, amount of the vitamins, breed and age of ewes, which should be considered.

The total net cash revenue in this study is a product of lamb weaning weight and its sale price. The additional return is the difference between the total return with treatment and total return without treatment. The incremental cost associated with treatment was very low, the average cost of Vitamin AD_3E injections is 0.02 JD/ewe, whereas there was no direct additional cost of labor, and therefore was neglected from the analysis. Moreover, there was no reduced income as a result of the treatment. The return from lambs' sale per ewe has increased from 27.7 ± 5.7 JD/ewe in the control group to 31.4 ± 4.8 JD/ewe in the treatment group. The average additional net returns for five years per treated ewes was 3.72 JD/ewe ($P<0.07$) as shown in Table 5.

Table 5. The effect of vitamins AD_3E injection on farmers' net revenue

Season	Total returns JD/ewe				Net additional revenue (JD/ treated ewe)
	AD_3E		Control		
	Mean	SD*	Mean	SD	
1992/1993	31.89	4.51	28.95	5.36	2.93
1993/1994	34.05	7.29	32.51	6.11	1.54
1994/1995	30.92	1.64	28.05	5.54	2.87
1996/1997	29.10	2.28	24.99	1.91	4.12
1997/1998	26.62	NA	18.55	NA	8.07
Average	31.45	4.78	27.73	5.66	3.72

* Standard deviation.

It is clear that, the use of Vitamins AD_3E treatment on Awassi ewes during regular mating season increases farmers' income. This additional income was achieved from the increase in the average fertility rate by 8.0% and lambing rate by 8.8% with a very minor additional cost. Sheepherders may use vitamin AD_3E injection before the regular mating season without additional investments and no skilled labor is required.

In conclusion, it is clear that the injected Awassi ewes with vitamin AD_3E outperformed the control ewes in fertility and lambing rates. The treatment increased the farmers' net income and highly recommended for use especially in drought years.

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تأثير حقن فيتامينات AD_3E في الكفاءة التناسلية وصافي العائد النقدي لأغنام العواسي المرباة تحت نظام الإنتاج شبه المكثف

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ملخص البحث. تمت دراسة تأثير حقن فيتامينات AD_3E في الأداء التناسلي لأغنام العواسي بهدف زيادة خصوبة الأغنام ورفع نسبة الولادات والتوائم. اختبرت النعاج من ١٦قطيعاً من الأغنام المرباة تحت النظام شبه المكثف خلال خمسة مواسم تناسلية في الفترة ما بين (١٩٩٣-١٩٩٨) في شمال ووسط وجنوب الأردن. قسم كل قطيع إلى مجموعتين، مجموعة الشاهد ومجموعة المعاملة. أعطيت مجموعة المعاملة حقنتين عضليتين بمقدار مائتين ألف وحدة دولية من فيتامين A على شكل محلول AD_3E. الحقنة الأولى أعطيت قبل ٢-٣ أسابيع من موسم التزاوج وأعطيت الثانية بعد شهرين. أظهرت المجموعة المعاملة فروقات معنوية ($P<0.05$) عن مجموعة الشاهد في معدل الخصوبة ونسبة الولادات، ولم تكن معنوية ($P>0.05$) في نسبة التوائم. حيث كان معدل الخصوبة لمجموعة المعاملة ٨٢,١٪ مقارنة مع ٧٤,١٪ لمجموعة الشاهد. وازداد معدل الولادات من ٧٧,٩٪ في مجموعة الشاهد إلى ٨٦,٧٪ في المجموعة المعاملة. ولم يكشف عن أية فروقات معنوية في وزن الميلاد والفطام للحملان المولودة في مجموعة الشاهد ومجموعة المعاملة (٤,٠٦ و ٤,١ كجم ؛ ١٩,٣٤ و ١٩,٣٢ كجم على التوالي). بلغ صافي العائد الإضافي نتيجة حقن فيتامينات AD_3E في المتوسط ٣,٧٢ دينار/نعجة. لذا يوصى بنشر هذه التقنية بين المربين.