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Promoting the Reproductive Performance and Economic Indices of Zandi Ewes under an Accelerated Lambing System

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M Khojastekey, SHAR and M Kalantar conceived and designed the experiments and wrote the article. MK performed the experiments. JZA and SK assisted in data analysis. SHAR, MAH and RK helped in preparation of manuscript.

Key words
Accelerated lambing system, Reproductive performance, Zandi ewe

ABSTRACT

This study was conducted to investigate the promotion of reproductive performance and economic indices performance of Zandi ewes under an accelerated lambing system (3 times lambing in two years). A total of 289 ewes from 3 to 4 years old, with mean body weight of 50±5 kg and BCS range from 2.5 to 3, were randomly allocated between two experimental groups as follow:1) in control group 98 ewes were exposed to rams all year-round without any hormonal treatment.2) in treatment group 191 ewes were exposed to rams 3 times in two years by means of hormonal treatment. In the second group ewes were treated with progesterone sponge for 14 days prior to the mating and received 400 IU of PMSG at sponge removal. Reproductive, productive and economic records of ewes were collected for two years and data were analyzed. According to the results, there were significant differences between treatment and control group in fecundity rate (249 vs.147%), prolificacy rate (264 vs.178%), lamb born crop (9.9 vs. 5.9 kg), weaning rate (206.28 vs.111.22%), fertility rate (198.95 vs.123.47%), parturition mean (2.11 vs.1.44 head) and lamb weaned crop (37.5 vs. 20.9 kg) respectively($P<0.05$). By means of accelerated lambing method overall profits of the herd, based on the prices in the market in years 2013 and 2019, increased 18.36 and 45.52 dollars/ewe, respectively. The results of this study showed that zandi ewes have a good function in accelerated lambing system due to their specific physiological characteristics. According to the current conditions of Iranian economy, using this method to increase livestock profit is quite cost effective.

INTRODUCTION

Although some sheep breeds are un-seasonal breeders and have an unlimited breeding season (Hotzel *et al*., 2003; Akoz *et al*., 2006; Menassol *et al*., 2012), most of Iranian sheep are seasonal breeders. Due to the sensitivity to daylight, seasonal sheep breeds are more likely to fertile in the autumn than spring (Khojastekey *et al*., 2006). Zandi sheep is a dual purpose breed which reared to produce meat and pelt. It is kept in the central area of Iran, and originally had related to famous Iranian pelt breed, Karakul sheep. The reproductive activity of Zandi sheep is not limited to a specific season and can reproduce throughout the year. This makes this breed more suitable for an accelerated lambing program (Khojastekey *et al*., 2006). Accelerated lambing refers to ewes lambing more frequently than once per year. The most accelerated lambing systems commonly used are three lamb crops per ewe every two years (Gül and Keskin, 2010). Such intensive reproductive management can reduce maintenance costs of breeding stock per offspring reared, will often increase net return and will provide a more uniform supply of lamb throughout the year (Zeleke *et al*., 2005; Gabr *et al*., 2016). But some factors such as breeding season and sheep breed characteristics, rearing conditions as well as adequate nutrition and skilled management affect the success of the accelerated breeding program (Zarkawi, 2001; Van Lier *et al*., 2017; Zaborski *et al*., 2019). Usually, different breeds of sheep have their own

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physiological characteristics, and therefore, have different reproductive performances (Pala, 2002; Lupi *et al*., 2015).

Production of three lambs in two years is an attempt to reduce the lambing intervals to eight months, or 1.5 lambing per ewe per year. This system is generally characterized by a fixed mating and lambing schedule such as May mating/October lambing, January mating/ June lambing and September mating/February lambing. It can also be modified slightly to 7-7-10 or 7-8-9 month intervals to better fit climatic, management and feed resources (Hotzel *et al*., 2003; Gül and Keskin, 2010). As our knowledge, yet no experiment has been conducted to investigate using of accelerated lambing system in Zandi sheep, so the present study was designed to evaluate the reproductive performance and economic indices of Zandi ewes under an accelerated lambing schedule based on three lamb crops per ewe every two years.

MATERIALS AND METHODS

Ethics statement

All animal procedures were performed according to guideline down by the Iran council on Animal care and the protocols were approved by experimental Animal Management (EAMC) of Animal Science Department, Agriculture and Education Research Center of Qom, Agriculture, Education and Extension Organization, Iran.

Experimental procedure

During 20 Feb 2012 to 20 Dec 2013. A total number of 289 Zandi ewes (3 to 4 years old), with mean body weight 50±5 kg and BCS in range of 2.5 to 3 were randomly allocated between two experimental groups. All animals were kept under semi-intensive conditions and were grazed on natural grass hay (mainly on wheat and barley leftover hay) through the year. Animals were fed by supplemental diet when needed to meet the nutrient requirements according to different stages of production period. Also, additional supplementation of barley meal (300gr/head/day) was fed to ewes for both two weeks before and after mating. Feed ingredients were analyzed prior to the experimental feed formulation according to the (Table I). Nutrient requirements of ewes in different stages were considered according to recommendations of NRC (2007), as noted in Table II.

Treatments/ Experimental groups

Experimental groups were as follow: 1) in the first group 98 ewes were exposed to rams all year-round without any hormonal treatment (as control group). 2) in the second group 191 ewes were exposed to rams three times in two years by means of hormonal treatment (as treatment group). Each group contained ewes with similar age, body weight, and BCS. Ewes in the second group were treated with progesterone sponge for 14 days prior to the mating date and received 400 IU of PMSG at sponge removal. The joining and lambing dates for treatment group are shown in Table IV. Reproductive and productive records of ewes and their lambs were collected through the two years (Feb 2012 to Dec 2013). Lambs were weighted at birth and weaning day (at 90 days of age) respectively.

Table I. Approximate analysis of feed ingredients.

Ingredient	DM %	CP %	TDN	DP	ME (Mcal/ kg)	Ca %	P %
Natural grass	28	11.5	56	7.2	2.13	0.15	0.07
Alfalfa hay	87	14	59	12.8	1.41	1.25	0.21
Corn silage	27	8.5	52	7.1	2.31	0.29	0.24
Wheat straw	85	4.2	62	2.8	1.55	0.24	0.1
Wheat bran	87	15.7	71	13.5	2.37	0.12	1.21
Barley grain	86	11.6	79	11.1	3.13	0.04	0.34
Soybean meal	90	42.8	85	38	2.35	0.04	0.61

DM, Dry matter; CP, Crude protein; TDN, Total digestive nutrients; DP, Digestible protein; ME, Metabolazable energy; Ca, Calcium; P, Phosphorus

For different stages of production period diet compositions were balanced which depicted through the Table III. Throughout the experiment TMR diets and fresh water were offered to ewes ad libitum.

Table II. Nutrient requirements of ewes in different stages of production period.

Items	Different stages of production period*					
	I	II	III	IV	V	VI
Dry matter intake (kg/day)	1.01	1.16	1.00	1.09	1.40	0.91
TDN (kg/day)	0.93	0.61	0.66	0.72	0.74	0.49
Metabolisable energy (Mcal/day)	1.92	2.21	2.8	2.61	2.68	1.75
Crud protein (%DMI)	10	8.3	10	14.31	11	7.6
Digestible protein (g/day)	55	64	68	105	104	47
Calcium (g/day)	2.4	3.8	5.5	4.1	3.9	2
Phosphorus (g/day)	1.8	2.8	3.5	3.4	3.6	1.5
Vitamin A (IU/kg diet)	2350	2850	2550	2850	2550	2350
Vitamin E (mg/kg diet)	15	22	18	22	18	15

*Different stages of production period including: I) flashing, mating and pre-pregnancy, II) Early pregnancy, III) Late pregnancy, IV) Early lactation, V) Late lactation, VI) Drying period.

Table III. Ingredients and chemical composition of experimental diets.

Items	Different stages of production period*					
	I	II	III	IV	V	VI
Natural grass	20	20	10	14	10	20
Alfalfa hay	20	20	10	10	10	20
Corn silage	5	15	29	25	28	5
Wheat straw	24.5	19.7	4.7	4.5	4.5	48.5
Wheat bran	11	14	0	0	0	0
Barley grain	13	10	44.5	34.5	43.5	5
Soybean meal	5	-	0	10	2	0
Common salt	0.5	0.3	0.3	0.5	0.5	0.5
Vitamin and mineral premix	1	1	1	1	1	1
DCP	0	0	0.5	0.5	0.5	0
Total	100	100	100	100	100	100
Calculated nutrients composition (% DM)						
Dry matter (kg/kg)	1.00	1.00	1.00	1.00	1.00	1.00
TDN (kg)	0.93	0.61	0.66	0.74	0.91	0.52
Metabolizable energy (Mcal/kg)	2.19	2.22	2.7	2.6	2.65	1.85
Crud protein (%)	12.08	10.75	10.7	14.02	11.4	8.2
Digestible protein (g)	77	64	68	110	119	49
Calcium (g)	3.7	3.6	4.7	4.7	4.65	3.6
Phosphorus (g)	2.9	2.8	3.2	3.5	3.24	1.5

*Different stages of production period including: I) flashing, mating and pre-pregnancy, II) Early pregnancy, III) Late pregnancy, IV) Early lactation, V) Late lactation, VI) Drying period; **Each kg of experimental diets generally contained 30 ppm Mn, 42.5 IU Vitamin E, 1200 IU Vitamin A, 150 IU Vitamin D, 0.5 ppm Se, 25 ppm Zn, 2.8 ppm I, 0.6 ppm Co, 0.7 ppm.

Table IV. Joining and lambing dates in treatment group.

Lambing date	Joining date	Sponges removal	Synchronization date	Number of ewes	Trial phases
Aug 2012	5 Mar	4 Mar	20 Feb 2012	191	1
Apr 2013	16 Nov	15 Nov	1 Nov 2012	155	2
Dec 2013	20 Jul	19 Jul	5 Jul 2013	149	3

Calculating the reproductive traits

Reproductive traits calculated using the following formulas:

Mean of parturition= number of lambing in 2 years / number of mated ewes

Fecundity rate= (number of lambs born in 2 years/ number of ewes in group) ×100

Fertility rate = (number of lambed ewes in 2 years/ number of ewes in group) ×100

Prolificacy rate = (number of lambs born in 2 years / number of lambed ewes in group) ×100

Weaning rate = (number of lambs weaned in 2 years / number of lambed ewes in group) ×100

Lamb born crop= Total birth weights of lambs born per ewe in 2 years

Lamb weaned crop = Total weaning weights of lambs born per ewe in 2 years

Twinning rate = (number of twin lambing / total lambing in group) ×100

Ewe mortality rate = (number of dead ewes / number of ewes in group) ×100

Student's test was used for statistical analysis of quantitative data and Mann-Whitney's test was used for non-parametric data in SPSS (16).

Economic comparisons

Economic information was recorded for two groups during two years of experiment (2012-2013) and also for current prices at 2019. This information includes the cost of progesterone sponge, PMSG hormone, labor costs, animal feed costs and the price of weaned lambs which was inquired from the local markets. So, with assuming the same reproduction performance of ewes in years 2013 and 2019, two economic comparisons between experimental groups were carried out with respect the changing the economic indices from 2013 to 2019.

RESULTS AND DISCUSSION

Some descriptive characteristics of Zandi ewes in two control and treatment groups are shown in Tables V.

Table V. Descriptive characteristics of Zandi ewes in two experimental groups.

Item	Control	Treatment
Number of ewes in group	98	191
Number of lambed ewes	84	180
Number of lambing in 2 years	121	380
Number of lambs born in 2 years	144	476
Number of lambs weaned in 2 years	109	394

Mean of some reproductive performances of Zandi ewes in two control and experimental groups also are shown in Tables VI.

Table VI. Mean of reproductive performance of Zandi ewes in two experimental groups.

Item	Control	Treatment	P-Value
Mean of parturition	1.44±0.06	2.11±0.05	0.000
Fertility rate%	123.47±7.68	198.95±6.17	0.000
Fecundity rate%	147.94±9.75	249.21±9.44	0.000
Prolificacy rate%	178.43±8.90	264.44±8.81	0.000
Weaning rate%	111.22±8.19	206.28±8.41	0.000
Twining rate%	12.69+0.03	21.28+0.02	0.002
Lamb survival rate%	75.10+4.74	82.77+5.20	0.04
Lamb mortality rate%	24.90±0.06	17.23±0.07	0.002
Ewe survival rate%	82.65+5.32	83.77+5.11	0.74
Ewe mortality rate%	17.35+0.05	16.23+0.04	0.65
Ratio of male lamb%	48.61+0.04	48.32+0.02	0.89

As shown in Table VI, the survival rates of ewes (83.77 vs. 82.65) was equal in two groups (P>0.05), while ewes that adapted with accelerated lambing system had higher parturition mean (2.11 vs. 1.44, P<0.001), fecundity rate (249.21% vs. 147.94%, P<0.001), prolificacy rate (264.44% vs. 178.43%, P<0.001), Fertility rate (198.95% vs. 123.47%, P<0.001), weaning rate (206.281% vs. 111.22, P<0.001), twinning rate (21.28 vs. 12.69, P<0.002) and lamb survival rate (82.77 vs. 75.10, P<0.05) in comparison with control group.

In Table VII, some productive traits of two control and treatment groups are shown. Although the birth weight of lambs in control and treatment group was equal (4.03 vs. 4.00 kg, P>0.05), but the weaning weight of lambs was higher in control group than treatment group (19.4 vs. 18.2, P<0.05). Contrariwise, both lamb born crop (9.9kg vs. 5.9 kg) and lamb weaned crop (37.5 kg vs. 20.9 kg) were statistically higher in treatment group than control group (P<0.001).

Table VII. Productive traits of Zandi ewes in two experimental groups.

Item	Control	Treatment	P-Value
Lamb birth weight	4.03±0.05	4.00±0.03	0.37
Lamb weaning weight	19.40±0.36	18.20±0.21	0.02
Lamb born crop	5.90±0.37	9.91±0.36	0.000
Lamb weaned crop	20.92±1.61	37.52±1.50	0.000

Results of present study showed that using accelerated lambing schedule in Zandi ewes with hormonal treatment had positive effect to increase lamb crop. According to previous studies estrus synchronization in accelerated lambing system helps to increase the estrous detection efficiency, reduce the inter-parturition interval directly, and increases the parturition rate in the fixed period of time (Schoeman and Burger, 1992).

Accelerated lambing program is a proven system that provides an immovable, year-round supply of lamb while increasing ewe productivity and production efficiency (El-Saied *et al*., 2006; Gül and Keskin, 2010). This type of production system has evolved from efforts in some regions that have sought to overcome the seasonal constraint in lamb production occurring with traditional, annual lambing systems (Kridli *et al*., 2006; Cameron *et al*., 2010).

Kusakari and Ohara (1999) demonstrated that the use of accelerated lambing system in comparison with the natural lambing system increased the parturition rate in Suffolk ewes (2.78 vs. 1.96). Also, El-saied *et al*. (2006) reported that the average interval between successive lambing of ewes was significantly shorter in the accelerated lambing system than natural lambing system. Accelerated lambing systems are defined by the birth interval of an individual ewe of less than 12 months, with the majority of systems striving for ewes to lamb every 7 to 10 months (8 months in medium scale). Therefore, ewes on these systems give birth at different periods from year to year thereby creating a year-round supply of lamb. This program also creates an even cash flow for the farm, which is not possible with traditional, annual production, and allows for opportunities to borrow capital for expansion efforts (Kridli *et al*., 2006; Gül and Keskin, 2010; Van Lier *et al*., 2017). These results are in line with results of the present study.

According to the results of the present study, the higher prolificacy rate of ewes in treatment group can be a result of a number of factors such as increase in the ovulation rate (Van Lier *et al*., 2017), improve the embryonic survival rate (Akoz *et al*., 2006) and increase in the lambing rate (kusakari and Ohara, 1999).

Reproductive enhancing technologies such as controlled intra-vaginal drug releasing devices known as CIDR that provide a sustained dose of progesterone to female animals may be used to synchronize breeding and improve conception rates during the breeding season (Knights *et al*., 2001). Enhancing technologies have been demonstrated to be effective in improving breeding synchronization, but their ability to improve conception rates above that exhibited by vasectomies teaser rams is less certain (Knights *et al*., 2001, 2002; Cameron *et al*., 2010). The use of teaser male animals to enhance

reproductive efficiency of female sheep is commonly known as the ram effect (Knights *et al*., 2002). This type of bio-stimulation manner of reproduction is especially effective in improving conception in ewes on the start point of the normal breeding season but is not as effective in improving conception in sheep that may be inside the non-breeding season (Ucar *et al*., 2005; Gabr *et al*., 2016; Van Lier et al., 2017).

Zeleke *et al*. (2005) had reported that use of 300 IU PMSG preferably 24 h prior to or at progestagen sponge withdrawal is essential to obtain better fertility rates and litter size in Dorper ewes. Zarkawi (2001) demonstrated that the prolificacy and twinning rate was increased in Awassi ewes due to the relevance of using both MAP and PMSG. Either, kusakari and Ohara (1999) reported that the accelerated lambing system with hormonally treatment could result in greater lamb production than natural lambing system. They reported the prolificacy of ewes that were involved in the accelerated lambing system was more than that in the control group (224% vs. 159%). These results are consistent with the results of present study. In contrary, Ucar *et al*. (2005) reported that administration of progestogen sponge and PMSG prolonged the duration of estrus period but had no marked effects on the non-return rate, lambing rate and litter size of Tuj ewes mated after breeding season.

Results of the present study showed that, the higher fecundity rate of hormonal treated ewes in comparison with control group may be related to the higher ovulation rate (Akoz *et al*., 2006), the higher fertility rate (Boscos *et al*., 2002) the higher embryo-fetal survival rate (Kridli *et al*., 2006) and the higher lambing rate (Kusakari and Ohara, 1999). Some reports demonstrated that use of hormone therapy (Kridli *et al*., 2006) and accelerated lambing system (Schoeman and Burger, 1992) could result in the higher lamb crop and fecundity rate. These reports are in agreement with the results of current study.

According to the results of present study, ewes that involved in the accelerated lambing system had a higher lamb born crop and lamb weaned crop than those reared under traditional lambing system ($P<0.001$).The higher lamb born crop and lamb weaned crop in treatment group can be related to the higher lambing rate (Pala, 2001), higher lamb production (Menegatos *et al*., 2006), higher lamb growth rate (Lupi *et al*., 2015) and higher fertility rate (Boscos *et al*., 2002). In the accelerated lambing system, hormonal treatment of ewes and their preparation for successive pregnancies, increase the number of lambs born and lambs weaned per mated ewe, and consequently increase the lamb crop (Gabr *et al*., 2016). In the contrary, there are some reports such as Gül and Keskin (2010) cited that because of mating season could affect negatively fertility, fecundity and litter size of ewes, the three lambing in two years schedule did not increase the lamb crop in Awassi ewes.

Efficient feeding systems are critical for any sheep production system, whether it be a grazing program, in farm feeding such as total mixed ration feeding program and using balanced rations. This especially applies to accelerated production due to the higher nutritional requirements of the sheep. Grazing programs can easily meet the nutritional requirements of highly productive sheep for at least part of the production cycle but must be carefully managed to meet the higher requirements of the pre-breeding period, late pregnancy and lactation period that collectively constitutes about half of the cycle (Menassol *et al*., 2012; Lupi *et al*., 2015).

The chief barriers to accelerated success are poor and variable out-of-season breeding success due to low ram fertility and libido or fault mating activity, lack of an adequate plane of nutrition prior to and during the breeding season, and finally ewe genetic potential with the capacity to breed out-of-season (Knights *et al*., 2002; Ungerfed *et al*., 2004).

Economic comparison

Due to perform the economic comparisons between control and experimental group some aspects are presented as below. At first, average price of commodity and/or services during the implementation period is presented in Table VIII.

Table VIII. Average price of commodity/services during the experimental period (Based on US dollar).

Commodity/Services	Price based on 2013	Price based on 2019
Sponge and accessories	1.41	3.7
Labor cost per each ewe	0.31	0.5
value of 1kg live weight of lamb	1.41	3.5

Note: The above figures are presented based on the average annual price and current rates at the experiment site of Qom province (QARC) in Iran.

Then the list of additional costs in the experimental group during the experimental period is presented in Table IX. Also, the average income in the experimental and control groups is presented in Table X.

At the end the difference profit of each ewe in the control and experimental group for a 24-month period based on prices in 2013 and 2019 is also presented in Table XI.

Table IX. List of the additional costs in the experimental group during the experimental period (based on US Dollar).

Time/year	Number of ewe	2013			2019		
		Hormone/ sponge	Labor	Total	Hormone/sponge	Labor	Total
First step (2012)	191	269.31	59.21	328.52	706.7	95.5	802.2
Second step (2012)	155	218.55	48.05	266.6	573.5	77.5	306.6
Third step (2013)	149	210.09	46.19	256.28	551.3	74.5	138.6
Total	495	697.95	153.45	851.4	1831.5	247.5	2079
Number of ewes	191	191	191	191	191	191	191
Additional costs per ewe	-	3.65	0.8	4.46	9.59	1.29	10.88

Note: The costs are presented based on the average annual price and current rates (for 2013 and 2019) of Qom province in Iran.

Table X. Average income in the experimental and control group in a 24-month period (Based on US dollar).

Time/year	2013		2019	
	Control	Treatment	Control	Treatment
Number of lamb weaned	109	394	109	394
Average weaning weight	19.38	18.26	19.38	18.26
Price of 1kg live weight of lamb	1.41	1.41	3.5	3.5
Lamb sales income	2978.51	10144.16	7393.47	25180.54
Number of ewe	98	191	98	191
Total income per each ewe	30.39	53.11	75.44	131.84

Note: The above incomes are presented based on the average annual price and current rates (for 2013 and 2019) of Qom province in Iran.

Table XI. Difference of profit per ewe in the control and experimental group for a 24-month period in 2013 and 2019 (Based on US dollar).

Time/year	2013		2019	
	Control	Treatment	Control	Treatment
Total income per each ewe	30.39	53.11	75.44	131.84
Total cost per each ewe in treatment group	0	4.46	0	10.88
Income after subtracting the cost of synchronization	30.39	48.65	75.44	120.96

Note: The above figures are presented based on the average annual price and current rates (during 2013-2019) at the experiment site of Qom province (QARC) in Iran.

Comparison of profit

Tables VIII through XI allow to calculate the cost and income of the two groups of ewes and also to analyze the profitability as difference profit index through the data presented. In order to recommend an applied reproductive strategy for ranchman, it is necessary to providing some essential information on the productive and reproductive performance of livestock. This will determine the cost-effectiveness or lack of use resulting from the application of the method used.

In this experiment, as shown earlier, the experimental group has better yield in productive and reproductive performances than control group, and differences are significant. But the fundamental question remains whether it is economically feasible to use the accelerated lambing method in the herd undergoing trial? To answer this question, it is important to note that, all breeding conditions were the same in both control and experimental groups and their only difference was in the application of reproductive treatments including hormonal synchronization costs. So, to make comparisons economically, the difference in the additional costs incurred in the experimental group and the difference in the income from the two groups were considered as the basis of comparisons. Accordingly,

the additional cost incurred in the experimental group compared to the control group is presented in Table IX.

The prices and costs in Table IX, include the figures which have been used at each stage of the experiment on the ewes whether in the control group or in the experimental group. Also, the offered prices are based on the final average price of the used commodity/services during the experimental period (2013-2019).

In a 24-month period of experiment, 495 pieces of Progesterone sponge were used for 495 ewes. Totally, in year of 2013, the amount of 4.46 $ and in year of 2019 (if assuming the same function), 10.88 $ for each ewe in experimental group compare to the control group more cost has been spent.

Because sheep keepers usually do not sell their new born lambs, so the weaning time is determined as the basis of selling lambs in herd and the total weight of lambs weaned per ewe was the basis for economic comparisons between the control and the experimental group. As shown, in Table XI, total earning per ewe in 2013 was 30.39 $ for the control group and was 48.65 $ for the experimental group. If assuming the same function for all ewes in 2019, and regarding the price change of the relevant products/services and incomes, eventually we receive 75.44 $ per ewe in control group and 120.96 $ per ewe in experimental group. Therefore, the difference in income between the two groups (taken into account expenses for synchronization per each ewe) in 2013 was 18.36 $ and in 2019 was 45.52 $, respectively.

Fogarty and Mulholland (2013) showed that ewes under an accelerating reproduction system had 47% more lambing rate than ewes under a conventional reproduction system. As well as, total lamb crop per ewe at the desired time for the first group was 31.1 kg and for the second group was 21.5 kg respectively.

Study of de Nicolo *et al*. (2008) showed that using an accelerated laming system in Romney sheep resulted in 16% more lamb production efficiency as well as 12 kg more total lamb live weight per each ewe than a conventional reproduction program, and this had a direct impact on the net profit of the herd.

Morel *et al*. (2004) showed that using a lambing program under an accelerating system than a normal system resulted in increasing the net profit in the range of 26-56% due to more lamb production efficiency based on different conditions and different scenarios.

The results of the present study indicated that, based on the results of ewe productive and reproductive efficiency during 2012-2013, launching an accelerated lambing program for Zandi sheep in Qom province of IRAN has been successful and increased the profitability of the farmers during implementation period. This increase in economic returns even in bad conditions could be expected, as in 2019, despite the more unfavorable conditions the returns were better than before. Therefore, the farmers and breeders can do this protocol in an appropriate manner up and it will end with a favorable economic outcome. In other words, by accelerated lambing method overall profits of the herd, based on the prices of the market in years 2013 and 2019, increased 18.36 and 45.52 $/ewe, respectively. The results of this study showed that zandi ewes have a good function in the accelerated lambing system due to their specific physiological characteristics. So, it can be stated that, using this method to increase herd net profit is quite cost effective.

CONCLUSION

According to the results of the present study use of accelerated lambing program (in this case 3 times lambing in 2 years) with estrus synchronization and PMSG administration, was effective in increasing parturition mean, prolificacy rate, fecundity rate, lamb born crop and lamb weaned crop in Zandi ewes, while it hadn't any negative significant effect on ewe's survival rate, and this method can increase the economic performance of Zandi sheep herds. In conclusion, accelerated lambing program will increase lambing frequency, providing a more uniform supply of lambs throughout the production cycle. It is possible when a number of factors are available such as capability of ewes to breeding throughout the production cycle, also feed must be available to handle ewes and lambs. Other critical factors are included high-level management, marketing, and production skills.

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Statement of conflict of interest

The authors declare that there is no conflict of interest.

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