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Effect of Biannual Shearing on Body Weight and some Wool Characteristics of Barki Ewes under Semi-Arid Conditions

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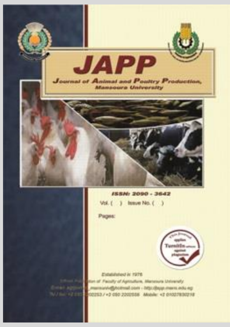

ABSTRACT

Eighteen adult non-pregnant; non-lactating Barki ewes, aged 3-4 years with initial body weight of 36.71 ± 4.798 (kg) were randomly divided to three groups (n=6). The first group (G1) was kept unshorn along two years (spring 2016 to spring 2018), the second group (G2) was shorn once in the common time of spring (2017) while the third (G3) was shorn biannually in spring and autumn (2017) to investigate the effects of biannual shearing on body weight, some fleece traits, wool production and some wool traits. Mid-side samples of about 200 gram of wool were taken from each animal just before 2018 shearing to determine the studied wool traits. No significant differences were detected among G1, G2 and G3 in final body weight. Biannual shearing improved ($P<0.05$) the body weight gain, wool yield, cotting grade, the uniformity of fiber diameter in G3 fleeces compared with the corresponding values of G1 and G2. Moreover, G2 and G3 produced more clean wool, higher percentages of fine fibers, stronger staples with higher elongation rate than G1 ($P<0.05$). Mean fiber diameter, Kemp score, prickle factor and medullation index declined ($P<0.05$) in G2 and G3 compared with G1. The results indicated that biannual shearing as a management procedure could be conducted with no expected negative effects on most of the wool traits. It might also be useful in improving body weight gain, clean wool production, wool yield, uniformity of fiber diameters, staple strength and elongation rate.

Keywords: sheep, shearing, wool production, fiber diameter, staple strength

INTRODUCTION

Annual spring shearing (once a year) is a traditional procedure followed by sheep breeder in Egypt. It is preferred by the sheep owners to avoid wool cutting during the cold climate and the subsequent possible health disorders in winter cold climate and to decrease the heat stress on animals during the hot summer of Egypt (Taha *et al.*, 2018). More than one shearing a year is very rare procedure and there are some doubts about its importance as a farm management tool due to the lack information about it.

Although fleece is important to maintains homeothermy under hot and cold conditions due to the extremely low thermal conductivity of wool that maintains a high thermal gradient between atmosphere and the skin (Piccione and Caola, 2003), shearing was found to alter the thermoregulation and the homeostasis mechanisms of sheep (Pennisi *et al.*, 2004; Casella *et al.*, 2016) as it stimulates adaptive thermogenesis by stimulating nervous responses to modify the thermoregulation and energy saving mechanisms that related to climatic adaptability (Aleksiev, 2009). Rather than there are evidence that shearing could evoke metabolic responses to maintain thermoregulatory mechanisms (Piccione *et al.*, 2008), motivates feed intake of sheep (Avondo *et al.*, 2000; Revel *et al.*, 2000) and stimulate lamb growth rate and might reflect positively on lamb's performance (Mclean *et al.*, 2015). Meanwhile, shearing is considered as one of the most effective stressors that face sheep (Dikmen *et al.*, 2011; Sanger *et al.*, 2011; Hristov *et al.*, 2012).

In New Zealand and Australia, most of long wool sheep herds are shorn twice a year and sometimes more frequent for reasons of ease of management and to improve the income of the breeders (Sumner and Scott, 1990) and to increase the possibility of producing more wool (Campbell and Poynton, 1994).

Generally, there are scanty information about the influence of the shearing frequency on wool production and wool traits. More frequent shearing may promote wool growth to different extents that depend on the breed (McGuirk *et al.*, 1966 on Merinos and Bigham, 1974 on Romneys). In long wool breeds, multiple shearing occasionally results in more wool growth but it usually improves the wool produced grade to match the premium carpet wool grade (Reid and Sides, 1984; Campbell and Poynton, 1994).

The current study aimed to compare the effects of biannual shearing, un-shearing and traditional annual shearing on body weight, wool production and some fleece and wool traits of Barki ewes reared under the semi-arid desert conditions of the northwest coastal belt of Egypt.

MATERIALS AND METHODS

This study was carried out in Maryout Research Station (32º N Latitude, 35 km southwest of Alexandria), belonging to Desert Research Center, Ministry of Agriculture and Land Reclamation. This location represents the semi-arid desert conditions of the northwest coastal belt of Egypt.

Eighteen adult non-pregnant, non-lactating Barki ewes, aged 3-4 years with average initial body weight of 36.71 ± 4.798 (kg) were used in this study. Animals were apparently healthy and free of internal and external parasites. Animals were housed in sheltered semi-open pins and fed concentrate feed mixture (0.5 kg head-1 day-1) consisted of 50% cottonseed cake, 15% yellow corn, 18% wheat bran,

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11% rice polish, 3% molasses, 2% limestone and 1% common salt. The concentrate mixture contained 60% TDN and 14% CP. Berseem hay (*Trifolium alexandrinum*) was offered *ad.Lib*. Drinking access was available twice a day.

Animals were randomly divided to three groups (n=6). Ewes of G1 were kept unshorn along the period of two years (spring 2016 to spring 2018), the second group (G2) was shorn once in the common time of spring (2017) while the third (G3) was shorn biannually in spring and autumn (2017). Then the three groups were shorn at the same time in spring (2018).

Live body weight of the experimental animals was recorded in the early morning before feeding and drinking to the nearest 0.1 kg by digital balance. The initial body weight was recorded at the beginning of the experiment before shearing in 2017. Final body weight was recorded before shearing the three groups of animals in 2018. Body weight change was recorded by subtracting the final from the initial body weight.

Before 2018 shearing, coat depth, cotting grade and Kemp score were assessed on six positions of ewe's bodies (withers, back, hip, shoulder, mid-side and britches) and their mean values were calculated for each ewe. Coat depth was measured by a graded millimeter ruler placed vertically on the skin. Cotting grade was assessed as a score of four grades 1, 2, 3 and 4 to represent no felting, low, medium and high felting grades. Kemp score was assessed as a score of four grades 1, 2, 3 and 4 to represent no Kemp, low, medium and high Kemp content grades.

Annual wool production of G1 was expressed by dividing the fleece weight earned in 2018 on two to assess the average yearly production since ewes of G1 maintained their fleeces from 2016 till 2018. For G2 ewes, wool production was expressed as their fleece's weights in 2018 as they were shorn once in spring 2017. While for G3 ewes, wool production was the summation of their fleece weights collected in both autumn 2017 and spring 2018. Clean wool production was calculated by multiplying the values of wool production to assess yield percentage of each wool sample.

Wool samples (about 200 g/ewe) were obtained from the left mid-side position of each ewe during the experimental period to record wool measurements. After shearing of the experimental ewes, greasy fleeces were weighed using digital balance to nearest 10 grams. The greasy samples were scoured to estimate wool yield percentage by dividing the weight of the scoured sample on the weight of the greasy samples and multiplying to 100 (Chapman, 1960; I.W.T.O., 1971).

Fiber diameter was measured by utilizing Image Analyzer (Zen, 2012) from unless than 300 fibers of each sample. Average fiber diameter and its standard deviation were calculated for each sample. Prickle factor represented the percentage of fibers with fiber diameter > 30 µm (Naylor, 1992).

Not less than 300 fibers from each sample were used to estimate fiber type ratio where A small snippet was placed on black velvet and visually divided into four types of fiber, i.e. fine (non-medullated), coarse (medullated), heterotype fibers and Kemp and the percentage of each type was calculated (Guirgis, 1967). Medulation index (MI) was calculated by multiplying the percentage of each fiber type by the type score (1, 2, 3 and 4 are the scores given to fine, coarse, heterotype and kemp, respectively), summing the resulted values then dividing the sum by 10 according to Guirgis (1973).

About 10 staples were taken at random from each greasy wool sample were used to measure staple length using a millimeter ruler on a black velvet covered board without stretching the staple (Guirgis 1973). Wool staple lengths were measured to the nearest 0.1 cm to calculate the average staple length of each sample. Agritest staple breaker (Agritest Pty. Ltd.) was used to measure staple strength (N/Ktex), point of staple break (%) and staple elongation (%). Ten regular staples were taken randomly from each wool sample to estimate these tests according to the method of Caffin (1980) that adopted on length basis by El-Gabbas *et al.* (1999).

Data were statistically analyzed using proc GLM of SAS (2013) program according to Steel and Torrie (1980), to test the differences between groups. Between means differences were estimated by Duncan multiple test.

RESULTS AND DISCUSSION

Live body weight:

Although the differences in final body weight were not significant among the experimental groups (Table 1), body weight change in G3 (1.75 ± 0.201 kg) was higher (P<0.05) than those of G1 (0.81 ± 0.201 kg) and G2 (1.33 ± 0.201 kg).

Shearing was found to improve the appetite of shorn sheep as well as the digestibility of dry matter intake; resulting in a higher live body weight gain (Manika, 1964). In coincidence, in two groups of lambs under overnight fasting conditions, Mclean *et al.* (2015) reported a significant increase in weight gain of shorn compared with unshorn lambs. This might be referred to an induced improvement in metabolic rate (Blaxter *et al.*, 1959), increase feed intake (Birrell, 1989; Keady and Hanrahan, 2012) or increase feed conversion ratio induced by multiple shearing (Muslemipur and Golzar, 2016). The results might indicate an effective motivating role of biannual than annual shearing on body weight gain.

Table 1. Initial body weight, final body weight and body weight change of the experimental groups.

	G1	G2	G3	SE
Initial body weight (kg)	37.10	36.28	36.75	2.080
Final body weight (kg)	37.91	37.61	38.50	1.971
Body weight change (kg)	0.81b	1.33b	1.75a	0.201

Means with different superscripts in the same row differ significantly (P<0.05)

Wool yield:

Wool production did not significantly differ among the experimental groups (Table 2). Although frequent shearing was reported to occasionally evoke the greasy wool production (Sumner and Scott, 1990; Campbell and Poynton, 1994; McGregor and Butler, 2008), nutritional and environmental conditions were suggested as limitations that could prohibit the effect of frequent shearing on greasy fleece weight (Campbell and Poynton, 1994). This might explain the absence effect of the biannual shearing on greasy wool production in the current work.

Wool yield was higher (P<0.05) in G3 (50.49 %) than in G1 (37.89 %) and G2 (43.04 %). The difference between G1 and G2 was not significant. Consequently, G3 produced higher (P<0.05) amount of clean wool (751.40 ± 59.487 g) than G1 (555.487 ± 59.487 g). Clean wool production of G2 (613.39 ± 59.487 g.) did not significantly differ than that of G1 and G2. These results may indicate to the impact of biannual shearing on improving the clean wool production of Barki ewes by increasing clean wool yield (%). Consistently, frequent shearing was found to increase clean yield of wool (McGuirk *et al.,* 1966; Bigham 1974) and Mohair (McGregor and Butler, 2008).

Keeping G1 ewes unshorn might increase fiber loss due to normal shedding (Shlinck and Dollin, 1995) rather than the effect of exposure to weathering conditions and higher content of dust, vegetable matters and other contaminates (Wheeler *et al.,* 1977) and consequently it decreases the yield obtained.

Table 2. Wool production, wool yield and clean wool production of the experimental groups.

	G1	G2	G3	SE
Wool production (g)	1462.50	1411.66	1483.33	86.900
Wool yield (%)	37.89 ^{b}	43.04 ^{b}	50.49 ^{a}	2.395
Clean wool production (g)	555.487 ^{b}	613.39 ^{ab}	751.40 ^{a}	59.487

Least square means with different superscripts in the same row differ significantly (P<0.05)

Coat characteristics:

Coat depth was the lowest (P<0.05) in G3 (2.52 ± 0.184), ranked the 2nd in G2 (3.86 ± 0.184) and the highest of G1 (4.96 ± 0.184). However, coat of G3 was in proper depth to provide enough protection for ewe's bodies as stated by El-Ganaieny *et al.* (1992). Cotting grade was improved (P<0.05) by adding extra shearing time. It was lowest in G3 than G2 (0.77 ± 0.196) than G2 (1.91 ± 0.196) while G1 had the highest cotting grade (3.08 ± 0.196). Lower cotting grade is an indicator to lack of loose, broken and shed fibers in the fleece (Ryder 1984). Moreover, it might consider as an advantage since it means lower matting of wool fibers and less opening processes during wool manufacture processing (Guirgis, 1973; Taha *et al.,* 2006).

Kemp score was lower (P<0.05) in G3 (1.55± 0.238) than in G1 (2.36 ± 0.238) while Kemp score of G2 (1.77 ± 0.238) did not differ than those of G1 or G3. The lower Kemp score is more desirable trait as particularly when companied with higher fleece opening (Guirgis *et al.,* 1982).

Table 3. Coat depth (cm), cotting grade, Kemp score of the experimental groups.

	G1	G2	G3	SE
Coat depth (cm)	4.96^{a}	3.86^{b}	2.52^{c}	0.184
Cotting grade	3.08^{a}	1.91^{b}	0.77^{c}	0.196
Kemp score	2.36^{a}	1.77^{ab}	1.55^{b}	0.238

Means with different superscripts in the same row differ significantly (P<0.05)

Wool characteristics:

Mean fiber diameter (MFD) was thinner (P<0.05) in G2 (32.18 ± 2.067 µm) and G3 (29.68 ± 2.067 µm) than in unshorn G1 (36.74 ± 2.067 µm) but the difference between G2 and G3 was not significant (Table 4). In coincidence, Bigham (1974) reported a little effect of frequent shearing compared with annual shearing on wool mean fiber diameter. Variability of fiber diameter in the three group's fleeces was expressed as the standard deviation of fiber diameter (Lupton, 1995) where G3 had the lowest (P<0.05) standard deviation of fiber diameter (FDSd) compared with G1 and G2. The corresponding values were 27.63 ± 2.125, 21.32 ± 2.125 and 12.67 ± 2.125 µm for G1, G2 and G3, respectively. The FDSd is a measurement of fiber diameter variation within a normal distribution which has been standardized with 66% of fibers isolated within one FDSd from FD value and 95% within two FDSd (Greef, 2006). Wool MFD and FDSd are considered as two main traits in judging wool grade and end product quality (El-Gabbas *et al.*, 2009) and they are highly correlated (Lupton 1995).

Fiber diameter frequency distributions of G1, G2 and G3 were illustrated in Figure (1). The frequencies of fiber diameters of G1 distributed at wider range than those of G2 and G3. In coincidence with the lowest MFD and FDSd of G3 (Table 4), the frequencies of the finer fiber diameters were higher than those of G2 and G3 and the frequency distribution was concentrated at the right side of the histogram which indicate lower expected MFD and FdSd of G3.

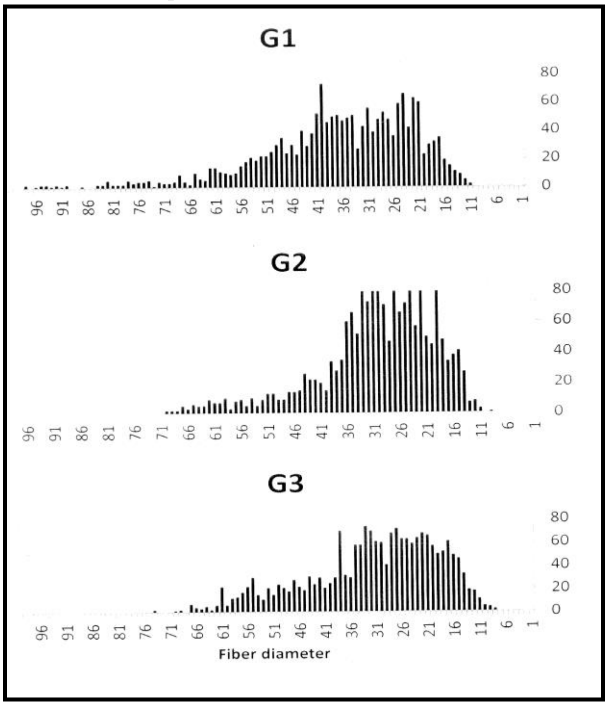

Figure 1. Fiber diameter frequency distribution of G1, G2 and G3.

Prickle factor represents the percentage of fibers with diameter of more than 30 µm that could cause skin irritation (Kenins 1992). Prickle factor of a wool sample expresses the sensation of skin distortion arises from the incidence of coarse fibers (Lamb 1997). It declined (P<0.05) in G3 (32.39 ± 1.942 %) compared with G1 (43.53 ± 1.942%) while PF of G2 (38.13 ± 1.942%) did not significantly vary from those of G1 and G3. The PF changed among groups as it was tracking the changes in MFD and FDSd since it was reported to be highly correlated with fiber diameter (Hansford, 1992) and positively related to the FDSd (De Groot, 1992; Lupton, 1995).

Medullation index is an easy indicator to the content of medullated fiber in the fleece, it declined (P<0.05) in G2 (13.66 ±0.385) and G3 (13.13 ± 0.385) than its value in G1 (15.05 ±0.385) in coincidence with the changes in mean fiber diameter. Biologically, medullated fibers act to enhance heat dissipation throughout the body coat (Govindiah and Nagarcenker, 1983) and it varies due to the changes in the activity cycle of skin follicles (Ansari-Renani, 2008). In this respect, Bigham (1974) revealed that shearing stimulate wool growth and alter wool follicle activity cycle. Therefore the result of the current search might indicate a possible effect of shearing and biannual shearing on the wool follicle activity of Barki sheep and its fleece content of medullated fibers.

Table 4. Mean fiber diameter (MFD), standard deviation of fiber diameter (FDSd), prickle factor (PF) and medullation index (MI) of the experimental groups.

	G1	G2	G3	SE
Mean fiber diameter (µm)	36.74 ^{a}	32.18 ^{b}	29.68^{b}	2.067
Standard deviation of fiber diametr (µm)	27.63^{a}	21.32^{a}	12.67^{b}	2.125
Prickle Factor (%)	43.53^{a}	38.138^{ab}	32.39^{b}	1.942
Medullation Index	15.05^{a}	13.66^{b}	13.13^{b}	0.385

Means with different superscripts in the same row differ significantly (P<0.05)

Fiber types percentages:

The percentages of fine fibers were higher (P<0.05) in G2 (69.56 ± 3.169) and G3 (70.43 ± 3.169) than in G1 (54.67 ± 3.169), while the percentages of coarse fibers showed an opposite trend, being higher in G1 (44.03 ± 3.336) than in G2 (29.90 ± 3.336) and G3 (29.18 ± 3.336) (Table 5). The higher content of coarse medullated fibers is mainly related to the thermoregulatory role of sheep fleeces as these fibers acts to increase fleece openness and facilitate heat dissipation from the skin surface. Moreover, medullated fibers add additional air spaces in the fleece that help in protecting animals of overheating stress (Guirgis and El-Ganaieny, 1998). Therefore the higher content of coarse fibers in G1 fleece may indicate that it had lower thermoregulatory capacity that stimulated the incidence of coarseness in their fleeces.

Table 5. Percentages of fine fibers, coarse medullated fibers, hetero-type fibers and Kemp of the experimental groups.

	G1	G2	G3	SE
Fine (%)	54.67^{b}	69.56^{a}	70.43^{a}	3.169
Coarse (%)	44.03^{a}	29.90^{b}	29.18^{b}	3.336
Hetero-type (%)	0.90	1.72	0.33	0.939
Kemp (%)	1.28	0.52	0.38	0.327

Means with different superscripts in the same row differ significantly (P<0.05)

Staple characteristics and elongation rate:

Staple length differed (P<0.01) among the three groups where G3 had shorter staples (6.61 ± 0.285 cm) than G2 (8.45 ± 0.285cm) and G1 (11.07 ± 0.285cm) and the difference between G1 and G2 was significant (Table 6). In long wool breeds, more than one shearing every year could be an advantage to the breeders in order to shorten the staple length to match the length of premium grades (Campbell and Poynton, 1994). In contrast, the shortest staple length of (G3) in the current work may be concerned a penalty in processing operations when it cut into two parts of shorter length (El-Gabbas *et al.* 1999). Longer staple lengths tends to spin easily, increases strength and evenness of yarns that decreases stoppages compared with shorter staple lengths wools (Wood 2010). Reversely, the more short staples lengths increase fuzziness and piling in apparel fabric surfaces and fiber loss from carpets (Cottle, 2010).

Staple strength was improved markedly (P<0.05) by shearing and biannual shearing where G2 and G3 had higher staple strength than G1. The corresponding values were 42.55 ± 3.299, 49.60 ± 3.299 and 53.91 ± 3.299 N/ktex for G1, G2 and G3, respectively (Table 6). The former results were independent on the effects of poor nutritional, seasonal variations in wool cycle, lambing stress and environmental factors (Hunter *et al.*, 1991; El-Gabbas *et al.*, 1999). The higher strength of G2 and G3 could be due to the higher content of fine fibers in their fleeces that means more keratin substance of the fiber; the less medullated fibers and less air space within the fibers that make fiber easier to break under tension (Bigham *et al.* 1983 and Reis 1992). Improvement in fiber diameter uniformity as the standard deviation of fiber diameter was lower in G2 and G3 than G1 is another expected cause of the improved staple strength of G2 and G3 (Lupton, 1995; Campbell, 2006). The shorter periods in which the fleeces of G2 and G2 maintained on ewes bodies, decreased fleeces exposure to weathering and degradation is another probable explanation to the higher staple strength of G2 and G3 (Shlink and Dollin, 1995; McGregor and Butler, 2008). On the other hand, lower staple strength of G1 might be referred to the incidence of short normally shed fibers during the seasonal moult that contribute to decrease staple strength (Bigham *et al.*, 1983) due to the uniformity of fiber lengths within the staple (Schlink *et al.*, 2000).

Point of staple break represents the point at which the staple will break under tension and controls the length of the remained parts after cutting the staple during processing (Caffin, 1980). Although it was lower (P<0.05) in G2 and G3 (50.56 ± 0.872 and 52.12 ± 0.872 %, respectively) than in G1 (54.15 ± 0.872 %), the differences among groups were in a narrow range where the staples cut near the middle of the staple. This result might consider as another disadvantage of the effect on G3 staples in respect to its lower staple length (El-Gabbas *et al.*, 1999).

Elongation rate was improved (P<0.05) in G2 and G3 compared with G1, being 20.42 ± 1.523, 26.47 ± 1.523 and 29.55 ± 1.523 (%) in G1, G2 and G3, respectively. This result indicates improvement of stretching ability and elasticity of G2 and G3 due to annual and biannual shearing. Higher estimates of elongation rate were reported to be related to higher staple strength values (El-Gabbas *et al.*, 2009). Shearing was found to improve elongation rate of Barki ewes (Taha *et al.*, 2018). The results of the current work might indicate to additional improve due to the additional shearing.

Table 6. Staple length, staple strength, point of staple break and staple elongation rate of the experimental groups.

	G1	G2	G3	SE	Significance
Staple length (cm)	11.07^{a}	8.45^{b}	6.61^{c}	0.285	P<0.01
Staple strength (N/k.tex.)	42.53^{b}	49.60^{a}	53.91^{a}	3.299	P<0.05
Point of break (%)	54.15^{a}	50.56^{b}	52.12^{b}	0.872	P<0.05
Elongation rate (%)	20.42^{b}	26.47^{a}	29.55^{a}	1.523	P<0.05

Means with different superscripts in the same row differ significantly (P<0.05)

CONCLUSION

Biannual shearing could be conducted with no negative effects on most of the wool traits. This management procedure might also be useful in improving body weight gain, wool yield and hence wool production. It also might help in increasing the uniformity of wool fiber diameter distribution and staple strength and elongation rate. The precaution detected in this study was the shorter staple lengths gained by biannual shearing that could be cut into two shorter parts during processing. Therefore, further investigation might be needed to adjust the prober shearing interval.

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تأثير الجز مرتين في العام على وزن الجسم و بعض صفات الصوف في الأغنام البرقي تحت الظروف شبه الجافة

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مركز بحوث الصحراء – القاهرة

أجري البحث على 18 من نعاج البرقي جميعها غير حامل و غير مرضعة بمتوسط عمر 3-4 سنوات وذات متوسط وزن جسم(36.71 ± 4.798) كجم حيث قسمت عشوائياً لثلاث مجاميع متساوية العدد (ن=6). المجموعة الأولى (ج1) أبقيت دون جز لمدة عامين من ربيع 2016 حتى ربيع 2018، المجموعة الثانية (ج2) تم جزها في الموعد التقليدي لربيع 2017 بينما المجموعة الثالثة (ج3) تم جزها مرتين الأولى في الربيع ثم جزها مرة اضافية في خريف نفس العام 2017 . بالرغم من عدم ظهور فرق معنوي بين المجموعات الثلاثة في وزن الجسم النهائي فإن ج3 حققت زيادة معنوية في وزن الجسم مقارنة بكلا من ج1 و ج2. كما أدى الجزمرتين لتفوق ج3 معنويا في محصول الصوف النظيف وتقليل درجة تلبد الصوف و مقياس ألياف الكمب مقارنة بالمجموعتين الآخرتين. بينما أدى الجز مرتين في العام لنعاج ج3 لانخفاض معنوي في متوسط قطر الألياف و معامل الوخز و دليل النخاع مقارنة بـ ج1 و لكن دون فرق معنوي عن ج2. بالاضافة لما سبق فقد ظهر تحسن معنوي في تجانس أقطار ألياف الصوف نتيجة الجز مرتين في العام حيث انخفض الانحراف القياسي لأقطار اللياف عن قيمة متوسط قطر الألياف في ج3 مقارنة ب ج1 و ج2. أدى الجز مرتين في العام لانخفاض في طول الخصلة للصوف الناتج من نعاج ج3 مقارنة بنعاج ج2 التي أنتجت بدورها خصلات صوف أقصر من تلك المنتجة من المجموعة ج1 و كان الفرق معنوياً بين المجموعات الثلاث. بالرغم من ذلك فقد أنتجت ج3 خصلات صوف أقوى و ذات معامل استطالة أكبر من كلا المجموعتين الآخرتين و لكن دون فرق معنوي عن القيم التي حققتها ج2 حيث كانت ج2 و ج3 أعلى معنويا في تلك القيم مقارنة بـ ج1.