FEEDING MANAGEMENT OF SMALL RUMINANTS AS A STRATEGIC TOOL TO MITIGATE THE NEGATIVE IMPACT OF CLIMATE CHANGES IN ARID REGIONS OF EGYPT: A CASE STUDY OF SHAMI GOATS

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SUMMARY

No doubt evaluating the productivity of goats based on the evaluation of different feeding strategies allows goat farmers to understand better the promising feeding programs, which is reflected in the productivity of their animals. In the northeastern part of Egypt, some modifications have been made to the prevailing situation, where goat management was attempted to develop to explain goat feeding systems under drought and salinity, especially Shami goats. This study was conducted in a particular unit for producing improved small ruminants and economically high-quality diets under the authority of the Agricultural Directorate in El-Tor city to indicate the possibility of application of some feeding programs as a strategic tool to mitigate the negative impact of drought on the productivity of goats in arid regions of Egypt. Data were collected as part of the "Improving utilization range of animals and plants in Southern Sinai" project sponsored by the National Research Centre. The feeding strategy included different diet formulations, in which the goats were blocked into three feeding programs such as conventional, cut-&-carry and complete ration. All groups were fed rations at 3, 4 and 5% of body weight at breeding, pre, and pro-kidding stages, respectively. Goats in the first group (G1) were fed with a widespread feeding program practiced by smallholder Bedouins under a zero-grazing system (conventional). Both goats in the other groups (G2 and G3) were fed with non-conventional feed resources such as Acacia (*Acacia saligna*) for G2 and olive pulp for G3 in addition to the concentrate feed mixture (CFM). Total dry matter intake (TDMI), body weight changes as productive, linear body, reproductive measurements and economic benefits were recorded at the different physiological stages of the experimental goats. The 1st group contained a reasonable level of crude protein (9.03%), while G2 increased crude protein to 14.2%. The level of CP of G3 containing CFM plus olive pulp was slightly increased (11.39%) compared to those observed in G1. Goats under the late gestation stage consumed about 715 and 667g from concentrates which represented about 60% of the total dry matter intake for G2 and G3, respectively. DMI of Acacia and olive pulp were increased gradually through the first period of study, from breeding to kidding, then became higher at the pre-and pro-kidding. The 2nd group was significantly heavier ($P<0.05$) than G1 and G3 at the different physiological stages (32.18 kg) followed by G3 and which was (29.99 and 29.74 kg). The changes in body weight were positive during the period from breeding to kidding and negative during the period from kidding to weaning for the three groups. Moreover, during the period from breeding to weaning, there were no losses of the weight of G2 and G3 although there were losses of the weight of G1 only. The body weight change in this period showed, a high change in G2 (3.64 kg), followed by G3 (0.78 kg) and G1 which was negative (-0.79 kg). Goats fed on the three experimental diets recorded similar body height, length, and heart girth. The overall mean value of body height, body length and heart girth for goats was 64.46, 77.54 and 76.17 cm, respectively. The birth weight of kids varied insignificantly among all groups. In addition, it could be observed that the live weight of kids at birth was higher in G1 (2.02 kg) than in the corresponding G2 (1.98 kg) and G3 (1.92 kg). Weaning weight showed a different trend for kids, it was 10.10, 13.86 and 11.52 kg for G1, G2 and G3, respectively. It could be observed that G2 had the highest value for reproductive performance, birth type and biological evaluation. On the other hand, goats fed Acacia plus concentrate (G2) indicated more net return value (1.95 LE/h/d), compared with G1 (- 0.07 LE/h/d) and G3 (0.96 LE/h/d). Based on the previous results it could be concluded that all parameters for assessing the productivity of goats in the cut-and-carry feeding program showed promising results when compared with other groups. Accordingly, we conclude that a feeding program as a strategic tool is up-and-coming and can be applied to reduce the negative effects of drought on goat productivity.

Keywords: *Feeding, climate, goats, desert, strategy, reproductive and Egypt*.

INTRODUCTION

Climate changes are expected to pose main threats and risks to sustainable settings in agricultural districts (Broom *et al*., 2013) and the livelihood of farmers in Third World countries (Kibria, 2016). He also recorded that, with expected higher temperatures due to climate change, small ruminants are likely to experience increased physiological stress, stress-related deaths, weight loss, decreased reproduction, and milk yield reduction. The damage to grassland is apparent in many parts of desert Egypt due to excessive grazing, low erratic rainfall and long drought periods (El-Shesheny *et al*., 2014). The National Statistics of the Food and Agricultural Organization of the United Nations reported a decrease in small ruminant numbers in Egypt from 2015 – 2020 (FAOSTA, 2020). From our prior literature, goats in Egypt play an important role in animal production, which can be best exploited to escape from the poverty trap, especially for farmers in rural areas (Abd-Allah *et al*., 2019). In the desert areas of Egypt, the goat is the most important small ruminant species for economic development and livelihood security for the Bedouin districts. Its population in Egypt is estimated at 1.7 million (FAOSTA, 2020). Major constraints to goats' productivity in desert areas have been identified, where the females are not exposed to heat and so do not breed. Of course, pregnant animals will be giving birth to very weak kids. During very long dry, goats will die with the smallest, weakest, and oldest dying at first. In situations where drought is predictable, researchers should develop new strategies for keeping animal feed and knowledge induction is of great significance in this status. And therefore, no single strategy will be suitable to solve this problem. Each situation will require a unique set of strategies. Of the previous strategies suggested, supplementary feeding programs were suggested as good or suitable to support the essential nutritional requirements for various animal productivity (El Shaer, 1981 and El Shaer *et al*., 1986). In this study, we focused on Shami goats (El Araieshi as it is called in the Egyptian dialect) are the common and favorable breed in Sinai as they are more adapted breed to the harsh environment, feed shortage and drought stresses. So, several strategies have been done to increase the feed resources available for small ruminants from desert plants. Concentrates are preferred to roughages for drought feeding because of higher nutrient density and ease of transport. It is possible to make full feeds for use during droughts by adding some concentrate ingredients. Biologically, using complete feeds with an adequate mix of roughage and concentrates can help animal's better use locally available crop residues and agricultural by-products. Such approaches supply an adequate number of roughages during drought emergencies, including growing shrubs and palatable plants (such as Acacia spp.) that retain their leaves into the dry season and so can be lopped for fodder. According to Ghani *et al*. (2015), these range plants are acceptable to be used as forage as their contents are high in energy and protein which can help the goats to get enough nutrients from their diets. Several agricultural and agro-industrial by-products can be used as supplements based on their availability and ease of use. Olive pulp can be used as a supplement during the dry period and during drought. Good quality olive pulp can be produced from a continuous cold process of olive oil production in the study areas. Therefore, the objective of this study is to identify the best strategies that if comprehensively applied, it is possible to make a rapid and important contribution to improving the productive and reproductive performances of goats. Accordingly, a strategy will be applied dependent on improving the practices, technologies such as supplementary feeding and improving the diet quality by implementing proper feeding programs, as such strategies can improve goat productivity raised on grazing ranges of Sinai as far as supplemental feeding and mitigate the negative impact of climate change in dry areas in Egypt.

MATERIALS AND METHODS

The study area:

This study was carried out during the period between 2020 and 2021 at a special unit for producing improved sheep and goats and economically high-quality rations under the authority of the Agricultural Directorate in El-Tor City, South Sinai Governorate with the National Research Centre. South Sinai is a part of the Sinai Peninsula, located in the northeastern part of Egypt and has an east-west extension of about 100 Km. From north to south, it is approximately 130 Km. South Sinai Governorate covers an area of 30.000 Km2 (7,140 feddan) and is geographically isolated from the Egyptian mainland by the Suez Canal and the Gulf of Suez in the west, at 28°14'30"N and 33°37'20" E. Located at an elevation of 1108.73 meters (3637.57 feet) above sea level (Figure 1).

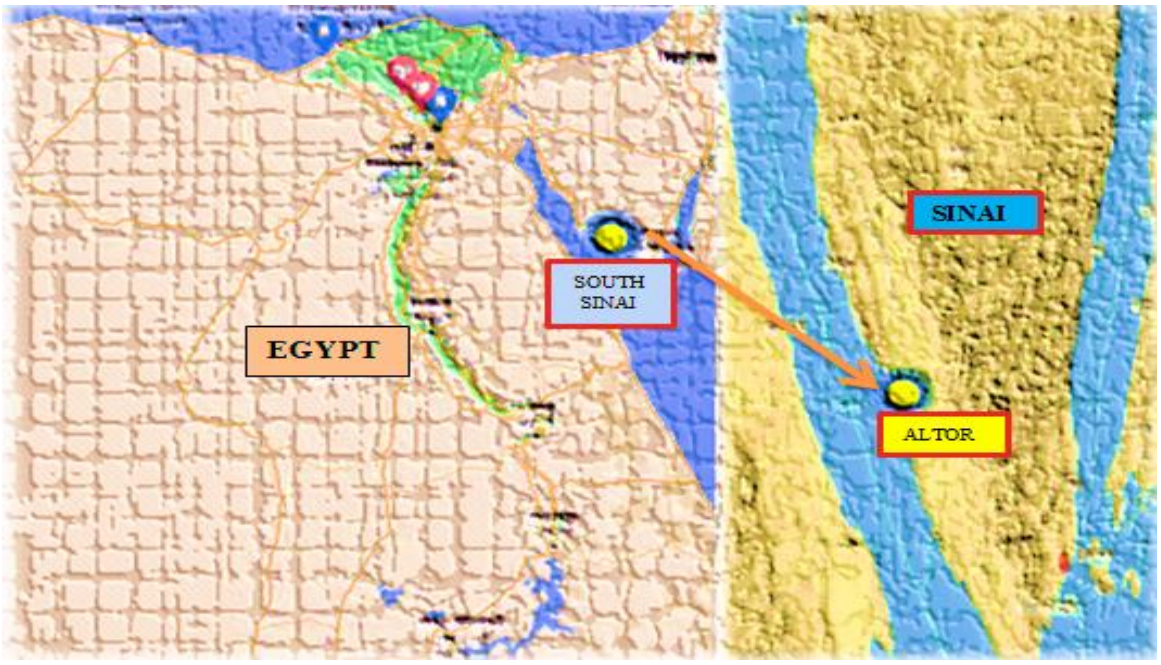


Figure (1): Location of the study. *The yellow spot indicates the area under study.

Environmental conditions:

South Sinai is characterized by an arid to extremely arid climate and irregular rainfall. The drought of Sinai has existed for millennia and will continue. Goats in this feeding strategy lived in two major seasons, from the start of summer to the end autumn with high temperatures and long days. At the start of this season, there was an increase in temperature (31.06ºC) that produced heat stress (Figure 2).

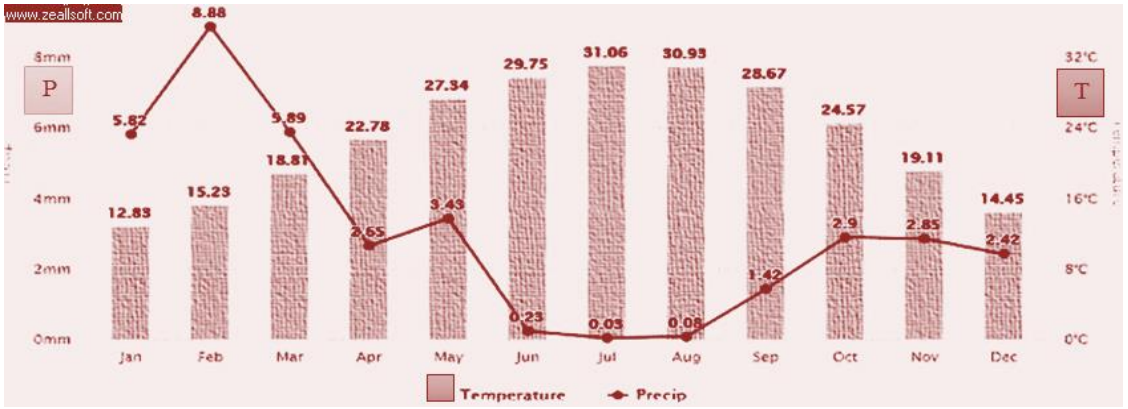


Figure (2). The mean monthly temperature and precipitation of South Sinai in one year.

Temperatures are high in South Sinai. The average minimum and maximum temperatures recorded in the district range from 9.5 – 24.8°C to 20.9 – 33.3°C, respectively. The second seasonal period began at the start of winter to the end of spring with short days. At the start of this season, there was a decrease in temperature (12.83ºC) that produced cold weather. The mean annual precipitation ranges from as low as 10 millimeters in the southwest to about 30 millimeters in the north. Heavy rain storms happen about once every 5 years, although this is not a constant average. The feed intake from Acacia and olive pulp was available at different seasons of study.

Experimental design:

Fifteen female goats were raised in a semi-closed farm system, aged 3-4 years were randomly distributed into three groups, 5 females each, all experimental females were mated by the same buck aged

3-5 years on average. The experiment was conducted during three physiological stages; the first stage covered the first 16 weeks of pregnancy, the second covered the last 4 weeks of pregnancy and the third stage covered the time from kidding to weaning (90 days later). The does were ear-tagged and weighed, and the mean live body weight (LBW) of the does at the beginning of the study was 28.33, 29.05 and 27.99 kg for G1, G2 and G3, respectively.

Breeding program:

At the start of the breeding season (from the mid of July), a mating plan of experimental does was designed. Teaser bucks were used to detect does in estrus twice daily (at 8 a.m. and 5 p.m.) for 30 minutes. A doe that stood and permitted the teaser buck to mount her was considered in heat. Goats showing heat signs in the morning were mated at the same time and repeated in the evening with the same buck and vice versa. The births occurred from January to February. Health management practices including treatment with the necessary medication against endo-and-ecto parasites (Ivermectin 1.0 ml/50 kg body weight subcutaneously injected), Clostridia infection, anemia and minerals/vitamins deficiencies were carried out on the goat kids.

Supplemental diets and animal management:

The feeding strategy included different diet formulations, in which the goats were blocked into three feeding programs as follows: Group 1/ Conventional feeding program: The feed ingredients are 30% of ground corn, 30% of wheat bran and 40% of bean straw, ingredients were given separately. Group 2/ Cut-and-carry feeding program: Fresh grass (Acacia) is cut daily and fed directly to experimental goats. The feed ingredients are 40% Acacia as a cut and carried fodder; with 60% of the concentrate feed mixture (CFM). Group 3/ Complete feeding program: The feed ingredients are 60% commercially formulated CFM and 40% olive pulp in a mesh form diet. All groups were fed at 3, 4 and 5% of body weight at breeding, pre and pro kidding, respectively. Concentrate feed mixture (CFM), formed from 17% wheat bran, 25% cottonseed meal, 50% yellow corn, 5% bean peels, 1.7% limestone, 0.3 Vit. and Min. and 1% salt. Chemical analysis of ingredients and experimental diets is presented in Table (1). Acacia was collected daily from the experimental farm in El-Tor City, South Sinai. The trees (Acacia) had been planted in 2015 through a project entitled (Technology Transfer for the Development of Small Ruminants in Southern Sinai). The olive pulp was produced from a continuous cold process of olive oil production in the study area. Freshwater was available continuously during the experimental period.

Measurements:

Proximate chemical analysis:

Before the implementation of the feeding trial was conducted, diets were collected and ground through a 1-mm sieve screen to evaluate dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), crude fiber (CF) and ash contents according to A.O.A.C. (2000). The chemical composition of feed ingredients and tested diets are shown in Table (1).

Table (1): Chemical analysis of feed ingredients and the tested diets.

Content	DM	OM	CP	CF	EE	Ash
CFM	85.40	93.33	13.75	9.39	5.40	6.67
Ground corı	90.66	98.57	8.80	2.20	4.20	1.43
Wheat bran	90.43	94.66	11.84	10.80	2.67	5.34
Olive pulp	89.14	90.50	7.85	28.45	14.92	9.50
Acacia	90.03	82.91	14.84	26.83	4.84	17.09
Bean straw	88.00	91.10	7.02	41.00	1.10	8.90
Diet1	89.13^{a}±0.20	94.48^{a}±0.35	9.00^{c} ±0.77	32.22^{a}±1.37	2.52^{c}±0.70	5.52^{c} ±0.79
Diet2	87.25^{b}±0.87	89.15^{c}±1.23	14.19^{a}±0.91	16.36^{b}±0.80	5.18^{b}±1.76	10.85^{a} ±0.45
Diet3	86.89^{b} ±1.10	92.19^{b}±1.30	11.39^{b}±1.34	17.01^{b}±0.75	9.20^{a}±0.47	7.81^{b}±1.39

a,b and c Values in the same column with different superscripts are different (P < 0.05).

Body measurements:

The linear dimensions measured included, the following 3 linear body measurements; namely, body height (BH), body length (BL) and heart girth (HG). The height measurement (cm) was done using a graduated measuring stick. The measurements were taken in the morning, with the animals standing on a flat surface with heads held up and held by two field assistants. All measurements were carried out by the

same researcher (the first author) in order to avoid individual variations. It should be noted that caution was taken when making these measurements on pregnant goats, especially in the last period of pregnancy.

Productive measurements:

The live body weight of does was monthly recorded at different physiological stages (from breeding to weaning). Kids were weighed within 24 h. after birth and thereafter at biweekly intervals up to weaning (90 days of age).

Reproductive measurements:

The conception rate, prolificacy, fertility rate, fecundity and twining rates were taken according to the following equations:

- Conception rate (%) = (No. of does conceived/ No. of does mated) × 100.
- Prolificacy (%) = (No. of kids born/No. of does kidded) × 100.
- Fertility rate (%) = (No. of does kidded / No. of does mated) × 100.
- Fecundity rate (%) = (No. of kids born/No. of does mated) × 100.
- Twining rate (%) = (No. of twining birth /No. of kidded) × 100.

Birth weight of kids at birth was recorded and after then on a biweekly basis until weaning.

Biological evaluation:

Kilograms of kids born/does kidding, kilograms of kids weaned/does kidding, percentage of kids weaned/does join and percentage of kids weaned/does kidding.

Economic efficiency:

The economic efficiency was calculated as feeding cost during the eight months according to the Egyptian local market prices. The cost of the experimental diets was estimated as the total prices of concentrate feed mixture, ground corn, wheat bran, and bean straw, respectively. The Acacia and olive pulp as sourced locally within the experimental farm in the study area were available free for this research. while one Kg live body weight of kids sold for 70 LE. All the kids after 3 weeks were fed with their respective dams during the day and they were always moving about with their dams during the night.

Statistical analysis:

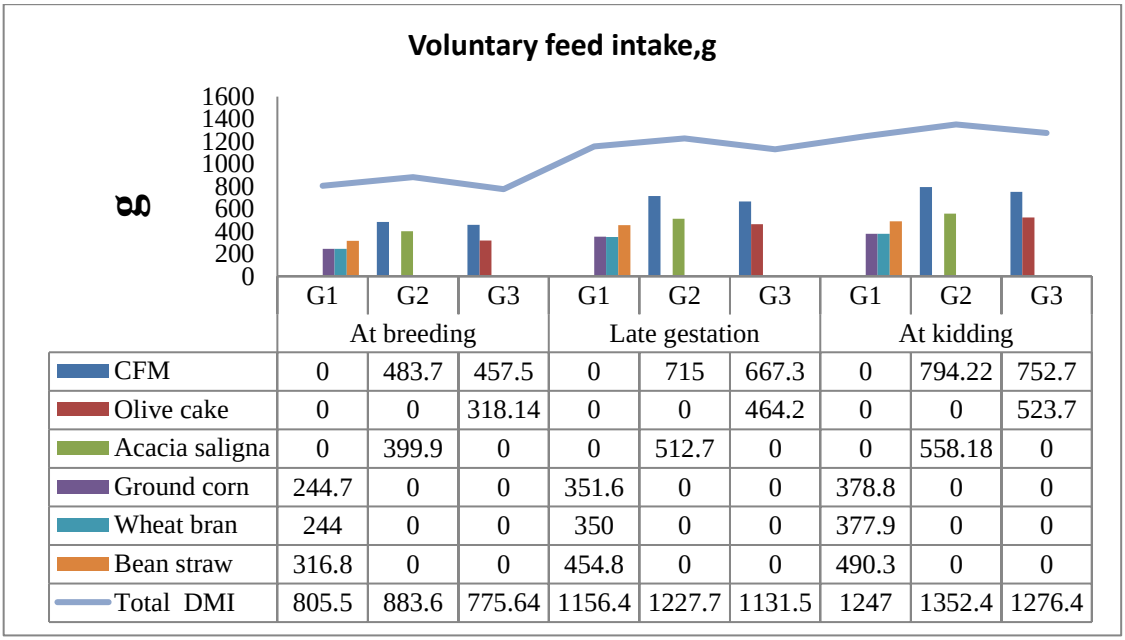
Data were compiled, tabulated, and analyzed using Statistical Package for Social Sciences SPSS 17.0 software using parametric tests (2008). One-way ANOVA was used to compare the means of different factors in goats of the different groups. Differences among means were ranked using Duncan's New Multiple Range Test (Duncan, 1955). All analyses were carried out in triplicates and the differences were considered significant at ($P<0.05$).

RESULTS AND DISCUSSION

Voluntary feed intake during pregnancy and lactation period:

The nutrient composition of feedstuffs and feed intake by the goats have been considered during the formulation of the experimental diets. Three feeding programs such as conventional (G1), cut & carry (G2) and complete feed (G3) were applied during three different physiological stages in the present study. The proximate analyses (Table, 1) indicated that the addition of CFM in G2 and G3 might increase protein content more than in G1. The conventional diet contained a reasonable level of crude protein (9.00%) while the inclusion of CFM at 60 % and Acacia at 40 % in the G2 increased crude protein to 14.2%. However, the level of CP in G3 containing CFM plus olive pulp at the same ratio in G2 was slightly increased (11.39%) as those observed in G1. So, the feeding programs were different in quality values, due to wide variations in the chemical composition of the experimental diets. Olive pulp had lower contents of CP than Acacia. During late gestation, sufficient nutrients through a proper feeding program are very important as preparation for kidding seasons. Within the late gestation stage, protein is one of the most important nutrients needed by pregnant goats, which might be attributed to the higher growth of the fetus and embryonic fluids. In this case, animals having the highest productivity should have access to high-quality diets and supplemented feed to meet the essential requirements for different physiological stages. Goats under the late gestation stage consumed about 715 and 667g from concentrates which represented about 60% of the total dry matter intake for G2 and G3, respectively. Similar results were obtained by Crabtree and Williams (1971); Jones, (1972) and Vallentine (1990), in which they concluded that additional

concentrates provided to does at the time of feeding roughage may enhance the growth of rumen bacteria, digestion rate and digest passage. DMI drastically increased when the goat moved from the breeding stage to late gestation and after parturition to weaning. Also, all goats under study increased their DMI at the different programs in the second stage of the study, this indicated that does increased their intake to achieve their metabolic needs. Several researchers have indicated that concentrated diet supplementation during the gestation period had an impact on growth and improved goats' productivity (Totanji and Lubbadeh, 2000 and Madibela and Segwagwe, 2008). The chemical composition of such range plants may vary from season to season and is subject to several factors. The total DMI of the Acacia plant during the whole experiment by goats was recorded as a difference among the three physiological periods. DMI of Acacia during the first period, from breeding to kidding (Figure 3) was increased gradually, then became higher at late gestation, indicating that diets had the same acceptability. Moreover, goats in G2 consumed higher amounts of Acacia diet (513 g) at late gestation compared to those fed at the start of breeding (400 g) as a result of the increase in body weight (33.91 kg). Similarly, goats in G3 consumed higher amounts of olive pulp (464 g) at late gestation. The effect of feeding level could be related to higher nutrient reserve during late gestation and or higher intake of concentrate after kidding. Good quality crude protein that the concentrates offer in G2 and G3 improves the nutrition of most of the goats.



	G1	G2	G3	G1	G2	G3	G1	G2	G3
	At breeding			Late gestation			At kidding		
CFM	0	483.7	457.5	0	715	667.3	0	794.22	752.7
Olive cake	0	0	318.14	0	0	464.2	0	0	523.7
Acacia saligna	0	399.9	0	0	512.7	0	0	558.18	0
Ground corn	244.7	0	0	351.6	0	0	378.8	0	0
Wheat bran	244	0	0	350	0	0	377.9	0	0
Bean straw	316.8	0	0	454.8	0	0	490.3	0	0
Total DMI	805.5	883.6	775.64	1156.4	1227.7	1131.5	1247	1352.4	1276.4

Figure (2): Voluntary feed intake of goats from the three experimental diets.

Body weight:

All management practices were the same for the goats except for feeding programs which is the only factor that can affect the goat body weight differences in this study. Table (2) demonstrates the effects of feeding programs on the body weight of goats at different physiological stages. It has been observed that there was no significant difference in the live body weight of does at the start of the study (at breeding). However, it has been observed that there was a significant ($P<0.05$) increase in live body weight of does in G2 (33.91 kg) than in G1 (31.67 kg) when supplemented rations were provided during late gestation. Results presented in Table (2) indicated a significant difference ($P<0.05$) in the live body weight of the three experimental groups at pro kidding stage. Means of body weight were significantly heavier ($P<0.05$) in G2 (32.18 kg) than in G3 at the different physiological stages (29.99 kg) followed by G1 which was 29.74 kg. While, the value obtained at the kidding weight of goats was higher than goats at different physiological stages (34.14 kg) and this could be explained due to the fast growth rate of fetal during the final six weeks of pregnancy.

Consequently, it was concluded that the application of convenient feeding programs as shown in the second and third groups give promising result because adequate feeding prevents large losses in body weight at different stages, which is reflected in the productivity of Shami goats, which can be adopted by the Bedouins in breeding programs to improve their animal's productivity. The higher body weight of all

goats observed at pre-kidding could be associated with the interaction between the level of supplementation and the number of fetuses as reported by Ivey *et al*. (2000).

Table (2): Means of live body weigh of does at different production stages.

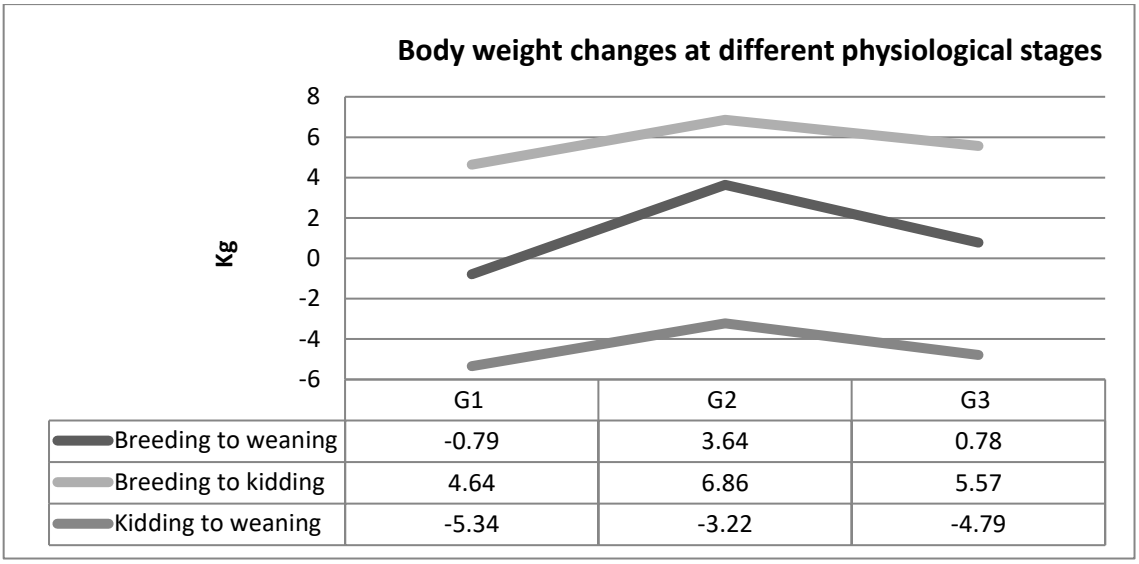
Physiological stages	Experimental groups			M±SE
	G1	G2	G3	
At breeding (Kg)	28.33±3.19	29.05±1.59	27.99±2.32	28.45 ^{C} ±2.26
Late gestation (Kg)	31.67 ^{b} ±3.52	33.91^{a} ±0.37	31.56 ^{b} ±1.57	32.38 ^{B} ±2.52
At kidding (Kg)	32.97 ^{b} ±2.52	35.91 ^{a} ±2.37	33.56 ^{b} ±1.57	34.14 ^{A} ±2.96
After kidding (Kg)	28.19±2.80	29.34±3.63	28.08±2.02	28.53 ^{C} ±2.58
At weaning (Kg)	27.54 ^{c} ±3.80	32.69 ^{a} ±2.30	28.77 ^{b} ±2.66	29.66 ^{C} ±2.62
M±SE	29.74 ^{B} ±2.96	32.18 ^{A} ±2.04	29.99 ^{B} ±2.54	

A,B and C values in the same row with different superscripts are different (P < 0.05).
a, b and c values in the same column with different superscripts are different (P < 0.05).

During pre-kidding or late gestation stage, providing adequate nutrients through proper feeding program is very important especially to the improved goats as preparation for breeding purpose. The decrease in body weight after kidding and during early lactation was observed in all groups but the lower value was reported for G1 (28.19 kg) may be a result of the mobilization of body reserves as reported by Eknæs *et al*. (2006) and Ngwa *et al*. (2009). A slight increase in body weight through weaning recorded in this study (29.66 kg) may be translated into higher milk secretion. During the early months after kidding, the doe tends to mobilize body tissues for maintenance and production, if they consume less dry matter feeds (Tovar-Luna *et al*., 2010). This may result in weight loss of doe if the dietary supply of nutrients is inadequate.

Body weight changes during pregnancy and lactation period:

Body weight change is among the indicators which frequently being evaluated in animals to evaluate their productivity. Changes in live body weight of does during pregnancy in all experimental groups are shown in Figure (3). Pregnancy intervals were calculated to the nearest week from the actual kidding date of each doe. Change in body weight was positive during the period from breeding to kidding and negative during the period from kidding to weaning for all groups. Despite the negative change in body weight during the second period, there was a positive live weight at kidding. This may be due to the fetal weight increase. The body weight changes of all goats at the different stages of the study showed the highest in G2 which was 3.64 kg, followed by G3 which was 0.78 kg. This is because the G2 diet formulation has the highest CFM and Acacia (Acacia Saligna.) proportions which have a high crude protein percentage as compared to the olive pulp as supplemented with G3. Acacia has high crude protein and no negative effects on feed intake and weight gain; thus, It is suitable for replacement as part of the concentrated feed mixture. The body weight change of the goat is influenced by the nutrition and management system (Christopher, 2012). Higher quality of feed (as the feed consists of a high value of crude protein) will show a better body weight change. These findings are in accord with those recorded by Oyeyemi and Akusu (2002) who showed that nutrition has an important effect on body weight changes at different periods of gestation and during the pre-weaning period. Goats in G1 showed the lowest value of body weight change at the different periods of the study which was negative (-0.79 kg). Body weight changes at different periods of gestation and during the pre-weaning period were affected by feeding programs. Supplemented goats with concentrate diets (G2 and G3) showed that adequate feeding prevents large losses in body weight at the time of kidding and therefore reduces losses in body weight at weaning. The results of this study also showed positive utilization of the supplementation feeds. Goats in G2 recorded also the highest value of body weight change at the kidding stage (6.86 kg) followed by G3 which was 5.57 kg. This means that the higher requirements during late pregnancy and pro-kidding forced the goats to mobilize fat from their body reserves as an energy source. These results are inconsistent with Chiboke *et al*. (1988) and Chowdhury *et al*. (2002). The increase in the growth rate of Black Bengal goats was by supplying the highest protein supplementation (Shahjalal *et al*. 1997). Goats in G1 showed the highest negative value of body weight change at the last weaning which was -5.34 kg. Comparable results were recorded by Joshi *et al*. (2004) and Tedonkeng-Pamo *et al*. (2006) who noticed lower body weight changed according to the pregnant dam feed condition. These results also are in line with those reported by Ebro *et al*. (1998) and Totanji and Lubbadeh (2000) on Shami goats. This is because, good body conditions of the animal during late pregnancy have positive effects on early lactation milk yield (Morand-Fehr *et al*., 2000).



	G1	G2	G3
Breeding to weaning	-0.79	3.64	0.78
Breeding to kidding	4.64	6.86	5.57
Kidding to weaning	-5.34	-3.22	-4.79

Figure (3): Body weight changes for experimental groups at different stages.

Body measurements:

The body measurements of goats which could be a feature of consideration for judging the influence of dietary status are presented in Table (3). The average body height in (G1) was found to be 64.35, 62.72and 66.96 Cm and in (G2) was 66.76, 63.53 and 65.56 cm, while in (G3) was 63.33, 60.43 and 61.54 cm. The average body length in (G1) was 76.77, 77.66, and 77.45 Cm, and (G2) was 78.76, 77.56 and 79.56 Cm, while in (G3) were 75.76, 77.09 and 77.34 Cm. The average heart girth in (G1) was 74.45, 75.66 and 76.01 Cm and in (G2) was 75.67, 77.65 and 77.04 cm, while in (G3) was 74.77, 76.45 and 77.89 cm. Goats fed on an Acacia diet and supplemented with the highest level of CP indicated similar body height and length. Mean values of heart girth also were not significantly affected by the increased level of CP. The overall mean value of body height for goats was 63.90 cm, whereas for body length value was 77.54 cm.

The overall mean value of heart girth for goats was 76.17 Cm. The observations of the current investigation are somewhat different from those reported by Alsheikh (2013) who recorded low means of BH, BL and HG, 57.21, 31.66 and 41.76 Cm, respectively, in Shami goats in the same environmental conditions in Sinai, Egypt. The diversity in various body measurements in different studies on Shami goats may be due to the difference in the climate, size of the data set, and other management practices. Also, our results are higher than those reported by Moaeen-ud-Din *et al*. (2006) who reported 70.23 cm BH, 64.97 Cm BL and 61.29 Cm HG, for crossbred Shami goats.

Reproductive performance:

The effect of feeding strategy on the reproductive performance of Shami goats in the current study is presented in Table (4). The useful effects of feed quality on reproductivity reflect the importance of feeding programs on goat production systems. The data showed that most of the reproductive parameters differed among the three tested groups due to different feeding intakes. Data in Table (4) showed that the conception rate was different in the two supplemented groups. The highest conception rates (100%) were obtained in the supplemented goats (G2) that had been offered concentrate diets supplemented with Acacia contained a high amount of CP (Table, 4) compared with the supplemented group with olive pulp (G3) (80%) which contains a medium amount of CP. The mean values of the gestation period of supplemented feed groups were 148.58 and 149.53 days for the supplemented group (G2 and G3), respectively. The data revealed in Table (4) indicated that the average gestation period of the experimental goats fed with a conventional diet was 149.96 days, also show that the gestation period of goats belonging to different supplementation groups was significantly different ($P<0.05$). Nonetheless, it was observed that goats supplemented with Acacia were mated and gave birth within a shorter time compared with the other groups. No clear impact was shown in the goat kidding rate and fertility (80%) as a result of an increased level of CP. Feeding programs, the mother's body weight and the management system are the most important factors in improving the kidding rate (Sachadeva *et al*., 1973). Additionally, the increased level of CP had a positive effect on fecundity and prolificacy values. A lower fecundity rate was noticed in the first group (100%) compared with the second group (140%).

Table (3): Means of body measurements of does experimental groups at different physiological stages.

Item	Stages	Experimental groups			Means	SEM	Sig
Body conformation (cm)		**G1**	**G2**	**G3**			
Body height (BH)	**At breeding**	64.35^{b}	66.76^{a}	63.33^{b}	64.81	0.765	*
	Late gestation	62.72^{c}	63.53^{b}	60.43^{c}	62.22	0.643	*
	At kidding	66.96^{a}	65.56^{b}	61.54^{c}	64.68	0.564	*
Means		64.67	65.28	61.76	63.90	0.539	Ns
Body length (BL)	**At breeding**	76.77^{b}	78.76^{a}	75.76^{c}	77.09	0.356	Ns
	Late gestation	77.66	77.56	77.09	77.43	1.07	Ns
	At kidding	77.45^{ab}	79.56^{a}	77.34^{b}	78.11	0.735	*
Means		77.29	78.62	76.73	77.54	0.654	Ns
Heart girth (HG)	**At breeding**	74.45	75.67	74.77	74.96	0.673	Ns
	Late gestation	75.66	77.65	76.45	76.58	0,467	Ns
	At kidding	76.01^{b}	77.04^{ab}	77.89^{a}	76.98	0,347	*
Means		75.37	76.78	76.37	76.17	0.879	Ns

*a, b and c values in the same column with different superscripts are different (P < 0.05)., NS: Not significant, * (p<0.05)*

Data in Table (4) showed that prolificacy rates were different in all experimental groups. The prolificacy ratio estimated in the present study for G1 (125%) was lower than those reported for other groups (175% and 150%) of G2 and G3, respectively. The current results are compatible with the previous studies that were done by Abd-Allah, (2014); (Bushara *et al*. 2010), Kudouda (1985) and Acero-Camelo *et al* (2008), who reported that supplementation improved prolificacy positively. Ikwuegbu and Ofodile (1994) and Gubartalla *et al* (2002) findings are inconsistent with the present results.

Table (4): Effect of different feeding programs on some reproductive traits of experimental does groups.

Item	Experimental groups		
	G1	**G2**	**G3**
No. of does mated	5	5	5
No. of does conceived	4	5	4
No. of does kidded	4	4	4
Conception rate,%	80	100	80
Gestation period, day	149.96^{a}	148.58^{b}	149.53^{a}
Kidding rate,%	80	80	80
Fertility rate,%	80	80	80
Fecundity rate, %	100	140	120
Prolificacy rate, %	125	175	150
No. of alive kids after 1 day of birth	5	7	6
Single rate, %	75	25	50
Twinning rate, %	25	75	50
Triplets rate (%)	0	0	0

a and b Values in the same row with different superscripts are different (P < 0.05).

These findings agree with Oyeyemi and Akusu (2002) who reported that high prolificacy was observed in the highly supplemented. The positive impacts of the type of concentrate diets reflect the importance of the plane of nutrition on goat reproduction, especially prolificacy. Sachadeva et al (1973) advocated that the level of feeding goats affects prolificacy. Abd-Allah et al., (2015) and Greyling, (1988) recorded that goats are considered the most prolific ruminants under tropical and subtropical conditions and most of them can breed in every part of the year. The increased level of CP had drastically improved the No. of alive kids at birth which are important reproductive characteristics. In the first group, the average number of alive kids after one day of birth (5) was lower than reported in other groups (7) and (6) for G2 and G3, respectively. The responses of the type of births of Shami goats to a different feeding program in either G1 and G2 or G3 are shown in Table (4). The type of birth of the three experimental feeding programs were 75, 25and 50 for singles and 25, 75 and 50 for twins. No triplet rates were recorded in Shami in the present study. Whereas the does in G2 showed a high twining rate (75%) as compared with other groups. Similar observations by El-Hag *et al* (2000) that Shami in Oman showed a high twining rate (80%) as compared with other goat breeds. Also, Abd-Allah *et al*; (2015), studied the twinning rate of two breeds of goats (Baladi and Boer) in Egypt and they found that the Boer breed has a higher twinning rate (66%) as compared with the Baladi breed (55%). This was attributed at the time to the good nutrition of the Boer goats. In addition, it could be observed that G2 had the highest value of reproductive performance (conception rate, parity type and reproductive ability). the second program (Acacia and Concentrates) is considered one of the most important feeding programs that can be included in the good management system for goats and then recommended as a promising strategy to mitigate the bad effects of climate change.

Biological evaluation for different feeding programs:

Results of the biological performance of goats under the different feeding programs are presented in Table (5). The ability of the doe to conceive and deliver live kids represents the first measurable component of doe reproductive performance. Differences in kids' live body weight at birth and weaning were observed among the different groups. Kids of G2 showed heavier live body weight at birth and weaning. Also, kids weaned/do kidding follow the same trend. In addition, it could be observed that the live weight of kids at birth recorded higher values in G1 (2.02 Kg) than the corresponding G2 (1.98 Kg) and G3 (1.92 Kg), respectively, (Table, 5). These differences may be due to a decrease in twining rate observed in G1. Kids of G1 have high body weight at birth and decline at weaning because of inadequate nutrition. Weaning weight showed a different trend of kids was 10.10, 13.86 and 11.52 Kg for G1, G2 and G3, respectively. These results might be referred to as feed differences since G2 is considered a heavier group in comparison with other groups. However, G3 indicated intermediated values and favored reproduction as a biological tool to improve live body weight and management. However, the total weight of kids at weaning was higher for G2 (71.52 Kg) compared with both the other two groups i.e., G1 (50.45 Kg) and G3 (53.90 Kg). This is evident again because of the higher weight gain of G2 goat kids whose dams were fed both the concentrate diet and Acacia. From these results, it can be deduced that the concentrate diet improved volatile fatty acids production from rumen degradation which allowed the goat dams to have enough energy that made them to produce more milk for their kids. The concentrate diets improved the rumen microbial environment which led to the liberation of nutrients from the forages (Dutta *et al*; 1999).

Table (5): Biological evaluation for different feeding programs.

Items	Experimental groups			SEM	Sig.
	G1	G2	G3		
No. of alive kids at birth	5	7	6	-	-
No. of alive kids at weaning	5	6	5	-	-
No. of dead kids during suckling up to weaning	-	1	1	-	-
No. of kids weaned/does kidding	1.25	1.5	1.25	-	-
Live weight of kids at birth, Kg	2.02	1.98	1.92	0.434	Ns
Live weight of kids at weaning, Kg	10.09	11.92	10.78	0.564	Ns
Total weights of kids at birth, Kg	10.10^{c}	13.86^{a}	11.52^{b}	0.876	*
Total weights of kids at weaning, Kg	50.45^{b}	71.52^{a}	53.90^{b}	1.05	*

*a, b and c values in the same column with different superscripts are different (P < 0.05)., NS: Not significant, * (p<0.05)*

The higher weaning weight of kids in G2 may be due to the mothers being fed the experimental diets enriched with protein because the concentrates are higher in nutrients compared with conventional diets.

The higher weaning weight of the kids may be used as a measure of the milk production performance of the goat because all the kids depend majorly on the milk for the weaning period of their lives when the study was carried out in all the programs. These values especially in G1 indicated that goats are adapted to the harsh environment of the area of study, but they are of low productivity compared with other groups. These values suggest that by improving feeding management, it is possible to substantially improve the productivity of goats. The basic strategy is to ensure a feed supply that can be sustained on a year-round basis, which means complete use of the total feed resource base. This includes the use of conventional feeds, palatable trees (such as Acacia spp.) and agro-industrial by-products (such as olive pulp).

Economic evaluation for dose affected by different feeding programs:

Economic evaluation in terms of net revenue per doe over feeding programs was calculated to estimate if the feeding program through pregnancy and lactation is affected on economic evaluation for does feasible or not. Thus, the live-weaned kids were considered as the main product of experimental does. The cost benefits were calculated by subtracting the total feeding cost from the total return and are presented in Table (6).

Table (6): Economic evaluation for dose affected by different feeding programs.

Item	Experimental groups		
	G1	G2	G3
Voluntary intake, g/doe/d			
CFM	-	629.00	557.00
Ground corn	308.30	-	-
Wheat Bran	307.45	-	-
Bean Straw	399.10	-	-
Olive pulp	-	-	413.48
Acacia	-	473.35	
Total DMI, g/ doe /d.	1014.85	1102.35	970.48
Feed cost, LE/doe			
CFM	-	3.02	2.76
Ground corn	1.54	-	-
Wheat bran	1.41	-	-
Bean Straw	0.80	-	-
Olive pulp	-	-	0.21
Acacia	-	0.24	-
Total feed cost, LE/doe/d	3.75	3.26	2.97
Total feed cost, LE/doe/240d	900.00	782.20	712.80
Weaning live return*, LE/doe/240d	882.80	1251.60	943.20
Net return per doe, LE over feeding cost**	-17.20	469.40	230.40

G1: Conventional feeding program; G2: Cut and carry feeding program; G3: Complete feeding program; The price was calculated due to the local market (2020- 2021) as follows; Ground corn: 5000, Wheat bran, 4600, Bean straw: 2000, CFM was 4800 (LE/ton). The cost of cutting and carrying Acacia and Olive pulp was calculated at 500 (LE/ ton), the live weaned kids were considered as the production of goats and given 70 (LE / Kg) weight.

**= (No. of kids weaned/does kidding) X (Live weight of kids at weaning, kg) X 70 LE.*

The one kg live weight for 3 months is assumed to be LE 70 according to the Egyptian local prices (2021). The higher feed cost/h/day (LE) was recorded by goats fed on conventional diets (G1) (900.0 LE/doe), due to their higher DMI/h/day (1014.85 g/h/d), while a vice versa result was expected for (G3) (2.97 LE/doe) due to their lower daily feed intake (970.50 g/h/d). On the other hand, goats fed Acacia with concentrate indicated more net return value (1.95 LE/h/d), compared with G3 (0.96 LE/h/d). From these results, we conclude that supplemented groups were economic, as a result of the low cost of feeding, especially in the G2 with an increase in weaning weight and decreased twins. As for the G1 (-0.07 LE/h/d) as a result of the decrease in twin cases with a decrease in weaning weight, it led to economic inefficiency for female goats during pregnancy and lactation. The results confirm the benefits of the cut-and-carry program as a good managerial process to improve the performance of Shami goats (Table, 6). This study shows that feeding programs as a strategy are a strong means of improving goats' performance on CFM with supplementation because the goat dams fed supplemented diets gave superior performance compared with other dams despite traditional feed composition. It was also a perfect approach because the high cost associated with the use of conventional feeding programs and finished feed was also attenuated with the use of rangelands and agro-industrial by-products in this study.

CONCLUSION

In conclusion, the search for strategies that mitigate and adapt to the adverse effects of climate change on goat production in Egypt is very important, since a large part of the goat herds in desert regions are exposed to substantial fluctuations in environmental conditions. Feeding strategies aimed at utilizing other available feed resources where the traditional feed for goats is included during the hot dry summer season when rangeland deteriorates drastically. Based on the previous results it could be concluded that all parameters for assessing the productivity of goats in the cut-and-carry feeding program had shown promising results when compared with other programs. On the other hand, the other programs showed a slight positive adjustment in reproductive performance during the different physiological stages in the present study, which makes it acceptable for application in this study area. Accordingly, from this study, we conclude that feeding programs as a strategic tool are highly promising and can be applied to reduce the negative effects of drought on goat performance.

Ethical approval

Ethical approval for this study was obtained from the Medical Research Ethics Committee, National Research Centre as part of the project entitled "Improving utilization range of animal and plants in Southern Sinai" under registration number (19-451)

Availability of Data and Materials

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Conflict of interest

The authors declare that there is no conflict of interest concerning this article.

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Authors contributions:

All authors contributed to the study's conception and design. SA wrote the main manuscript, prepared Figures, drafted, corrected the manuscript, and analyzed the data. Data collection and experimental study were performed by SA, HA, and MI. All chemical analyses were performed by AA; FM and MS revised the manuscript. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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إدارة تغذية المجترات الصغيرة كأداة استراتيجية للتخفيف من الأثر السلبي للتغيرات المناخية في المناطق القاحلة في مصر: دراسة حالة للماعز الشامي

صبري عبد الله، هاشم عبد الرحمن؛ فاطمة سلمان؛ عبد المجيد عبيدو؛ ممدوح محمد ومحسن شكري

قسم الإنتاج الحيواني، المركز القومي للبحوث، 33 شارع البحوث، ص.ب: 12622، الدقي، الجيزة، مصر.

مما لا شك فيه أن تقييم إنتاجية الماعز بناءً على تقييم الاستراتيجيات الغذائية المختلفة يتيح لمربي الماعز فهم أفضل لبرامج التغذية الواعدة، وهو ما ينعكس على إنتاجية حيواناتهم. في الجزء الشمالي الشرقي من مصر، تم إجراء بعض التعديلات على الوضع السائد بمدينة الطور بمحافظة جنوب سيناء ، حيث تمت محاولة تطوير إدارة الماعز لشرح أنظمة تغذية الماعز في ظل الجفاف والملوحة، وخاصة الماعز الشامي. أجريت هذه الدراسة بوحدة خاصة لإنتاج المجترات الصغيرة المحسنة والعلائق ذات الجودة الاقتصادية المرتفعة تتبع مديرية الزراعة ، لتوضيح إمكانية تطبيق بعض برامج التغذية كأداة استراتيجية للتخفيف من الأثر السلبي للجفاف على إنتاجية الماعز في المناطق القاحلة بمصر. تم جمع البيانات كجزء من مشروع بحثي تحت عنوان" تحسين الاستفادة من الحيوانات والنباتات الرعوية في جنوب سيناء ". الممول من المركز القومي للبحوث. تضمنت استراتيجية التغذية تركيبات غذائية مختلفة، حيث تم وضع الماعز على ثلاثة برامج غذائية مثل البرنامج الغذائي التقليدي، وبرنامج القطع والحمل، وبرنامج العليقة الكاملة. تم تغذية جميع المجموعات بنسبة 3، 4 و5٪ من وزن الجسم خلال مراحل التلقيح، ما قبل وبعد الولادة، على التوالي. تمت تغذية الماعز في المجموعة الأولى (G1) ببرنامج تغذية واسع النطاق يمارسه البدو أصحاب الحيازات الصغيرة في ظل نظام الرعي الصفري (التقليدي). تم تغذية الماعز في المجموعتين الأخيرتين (الثانية والثالثة) بمواد علفية غير تقليدية مثل الأكاسيا (Acacia Saligna) للمجموعة الثانية وتفل الزيتون للمجموعة الثالثة بالإضافة إلى خليط العلف التجاري المركز. تم تسجيل كمية المادة الجافة المأكولة الكلية، التغيرات في وزن الجسم، القياسات التناسلية والفوائد اقتصادية في المراحل الفسيولوجية المختلفة. احتوت المجموعة الأولى على مستوى مناسب من البروتين الخام (9.03%)، بينما زادت المجموعة الثانية من البروتين الخام إلى 14.2%. ومع ذلك، فإن مستوى البروتين الخام في المجموعة الثالثة المحتوي على الأعلاف المركزة بالإضافة إلى تفل الزيتون ارتفع الى (11.39%) مقارنة بتلك التي لوحظت في المجموعة الأولى. استهلكت الماعز في المرحلة الأخيرة من الحمل حوالي 715 و667 جرامًا من المركزات والتي تمثل حوالي 60٪ من إجمالي المادة الجافة المتناولة للمجموعة الثانية والثالثة على التوالي. ارتفع مؤشر المادة الجافة المأكولة لنبات الأكاسيا وتفل الزيتون تدريجياً خلال الفترة الأولى من الدراسة، من مرحلة التلقيح إلى مرحلة الولادة، ثم أصبح أعلى في مرحلة ما قبل وبعد الولادة. المجموعة الثانية كانت أثقل معنويا ($P<0.05$) من المجموعة الاولى والثالثة في المراحل الفسيولوجية المختلفة (32.18 كجم) تليها المجموعة الثالثة والتي كانت 29.99 و29.74 كجم. كانت التغيرات في وزن الجسم إيجابية خلال الفترة من التلقيح إلى الولادة وسلبية خلال الفترة من الولادة إلى الفطام للمجموعات الثلاثة. كما أنه خلال الفترة من التلقيح إلى الفطام لم يكن هناك فقدان في وزن المجموعة الثانية والثالثة بالرغم من وجود فقدان في وزن المجموعة الاولى فقط. أظهر التغير في وزن الجسم خلال هذه الفترة تغيراً عالياً في المجموعة الثانية (3.64 كجم)، يليه المجموعة الثالثة (0.78 كجم) والمجموعة الاولى الذي كان سلبياً (-0.79 كجم). سجلت الماعز التي تم تغذيتها على العلائق التجريبية الثلاثة نفس ارتفاع الجسم والطول ومحيط الصدر. كان متوسط القيمة الإجمالية لارتفاع وطول الجسم ومحيط الصدر للماعز 64.46 و77.54 و76.17 سم على التوالي. اختلف وزن الجداء عند الولادة بشكل طفيف بين جميع المجموعات. بالإضافة إلى ذلك، يمكن ملاحظة أن الوزن الحي للجداء عند الولادة كان أعلى في المجموعة الأولى (2.02 كجم) منه في المجموعة الثانية (1.98 كجم) والمجموعة الثالثة (1.92 كجم) على التوالي. وأظهر وزن الفطام اتجاهاً مختلفاً للجداء إذ بلغ 10.10، 13.86 و11.52 كجم للمجموعات الاولى، الثانية والثالثة على التوالي. ويمكن ملاحظة أن المجموعة الثانية كان له أعلى قيمة للأداء الإنجابي ونوع الولادة والتقييم البيولوجي. ومن ناحية أخرى، أظهرت الماعز التي تم تغذيتها على الأكاسيا مع المركزات (المجموعة الثانية) زيادة في صافي قيمة العائد (1.95 جنيه/رأس/يوم)، مقارنة بـ المجموعة الأولى (- 0.07 جنيه/ رأس / يوم) والمجموعة الثالثة (0.96 جنيه/ رأس /يوم). وبناء على النتائج السابقة يمكن استنتاج أن جميع معايير تقييم إنتاجية الماعز التي تم تغذيتها على الأكاسيا أظهرت نتائج واعدة بالمقارنة مع المجموعات الأخرى. وعليه نستنتج من ذلك أن برنامج التغذية كأداة استراتيجية واعد ويمكن تطبيقه للحد من الآثار السلبية للجفاف على إنتاجية الماعز.

الكلمات الدالة: *التغذية، المناخ، الماعز، الصحراء، الاستراتيجية، التكاثر، مصر.*