A COMPARISON OF LOCALLY AVAILABLE FEED-STUFFS FOR SHEEP PRODUCTION

By

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ABSTRACT

Two lamb-fattening experiments were conducted at the American University of Beirut Farm during the years 1961-62 and 1962-63. The animals used in both experiments were of the local fat-tailed Awasi breed of sheep. The objectives of these experiments were to compare different locally available feed-stuffs for fattening lambs. In the first experiment two concentrate mixtures were tested, when wheat stubble was fed as the sole roughage. In the second experiment the nutritive value of dried beet pulp, and the extent to which it can replace corn in lamb-fattening rations, was tested.

The results of the first experiment indicated that corn could be partially and effectively replaced by dried beet pulp; and that wheat stubble could be utilized as the sole roughage for fattening lambs when they are fed an adequate concentrate mixture.

The results of the second experiment showed that lambs receiving a concentrate mixture containing 40% dried beet pulp did better in almost all criteria studied than those receiving either 20% dried beet pulp and 20% corn or 40% corn in their concentrate mixtures. They had a better rate of daily gain, a higher total gain, a better dressing per cent and a better feed efficiency as compared to lambs in the other two groups, though the differences between the three groups were statistically non-significant. Male lambs in all the groups, however, gained significantly better than the ewe lambs.

Gains obtained were most economical in the case of lambs receiving 40% dried beet pulp in their concentrate mixture. These lambs also yielded the highest amount of gross profits for covering labor, housing, interest

and net profit.

It was concluded that dried beet pulp can effectively substitute corn upto a level of 40% in the concentrate mixtures for fattening lambs.

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INTRODUCTION

Lamb and mutton are the meats highly demanded in Lebanon as compared to beef, pork or poultry. As a result of this situation, lamb and mutton are more highly priced than beef or poultry. According to an estimate on sheep production (Cummings, 1962), 50% of the revenue from sheep in the Near East area arises from the sale of lamb and mutton meats, 40% from milk and 10% from wool. Good sheep industry is associated with an abundance of pastures which, unfortunately, are very limited in Lebanon since land is subjected to intensive agriculture and is quite expensive. The sheep industry in Lebanon is dependent on village flocks and on sheep imported from Syria by the nomadic Bedouin tribes.

The use of wheat or barley straw as the only roughage for feeding sheep is a standard practice among sheep owners. Since the production of high quality roughages is very limited due to a shortage in water-supply and an ignorance of the cultural practices pertaining to the production of crops such as alfalfa, the feeding of good quality roughages to sheep is very costly and limited. Roughages form about one-half by weight of the total rations used for lamb-feeding. As such, the roughage part of the lamb-feeding rations costs more per unit of TDN contributed than the concentrate portion.

Cereal grains are extensively grown by Lebanese farmers especially in the Beka'a and Akkar areas. Stubble fields left after harvest are usually rented out to nomadic Bedouins at very nominal rates: i.e. at about L.L. 1 per sheep. The feeding value of stubbles depends on the amount of grain left in the field after the crop has been harvested. Since good quality roughages are costly, the utilisation of cereal stubbles as the only roughage in the ration of fattening lambs which are given an adequate concentrate mixture was seen feasible.

A pilot experiment was conducted at the American University of Beirut Farm in the Summer of 1961-62 to study the utilisation of wheat stubbles as the only roughage for fattening lambs which are also fed a concentrate supplement.

Another aspect of fattening lambs is the utilisation of industrial by-products such as sugar beet pulp, which is obtained in the manufacture of sugar from sugar beets. This by-product is not currently used to a great extent in Lebanon, but is exported to other countries at very low prices relative to its feeding value. The acreage of sugar beet production in Lebanon has been low for the past several years, even though the Beka'a plain is considered a potential beet-growing area due to its suitable soil and favorable climate. This lag in sugar beet production was mainly due to absence of a sugar beet factory in the area, and the fact that beets had to be transported to Syria for the manufacture of sugar. However, with the construction of a sugar beet factory in the Beka'a plain in 1958, beet production has increased gradually from 3,000 tons grown on 1300 dunums to 24,500 tons produced on 7,800 dunums in 1961 (Worzella _et al._, 1962). In the U.S.A. sugar beets are grown as a principal cash crop in 22 states (Beet Belt) and are processed in 66 factories scattered from the East Coast to the West Coast. In those areas beet by-products have been the main factor in the economic production of meat, as the sugar beet crop, in addition to producing sugar, produces by-products in the form of beet tops, beet pulp and molasses which have a high feeding value for livestock (Maynard and Knaus, 1959).

In discussing the net energy value of the sugar beet crop, the same authors report, "In terms of its sugar for human consumption and its by-products for livestock feeds, the sugar beet produces far more food per acre than any other farm crop ." The statement "The by-products alone from an average acre of beets will produce as much or more livestock feed than an entire average acre yield of grain or hay," is substantiated by the 10-year average crop production figures on irrigated land for Northern Colorado cited by Maynard and Knaus (1959). The authors' tabulations showed that between 1947-1956, by-products from the average 16.0 ton beet crop provided approximately 3518 therms of net energy as livestock feed, compared to only 3243 therms from an average acre of corn, 2152 from the average acre of alfalfa and 1677 from that of barley. This was in addition to 8518 therms provided through 300 lbs. of refined sugar for human consumption.

Considering the low price of dried beet pulp in Lebanon (L.L.0.13/kg.), as compared to corn (L.L.0.24/kg.), a need was felt to study the replacement value of beet pulp for corn since this would mean a reduction in the feed cost to sheep owners. So an experiment was designed and conducted on three groups of Awasi lambs to see whether beet pulp could replace all the corn or half of the corn in lamb-fattening rations. Three adequate concentrate mixtures, one containing 40% corn, the second 20% corn and 20% dried beet pulp and the third 40% dried beet pulp, were computed with almost the same crude protein and net energy content, and fed to the three groups of lambs. The results obtained from this feeding trial are discussed in the following pages.

REVIEW OF LITERATURE

Roughages for Fattening Lambs

According to Morrison (1957), a ration containing corn grain and alfalfa or clover hay is excellent for fattening lambs, and may be taken as a standard with which to compare other rations. The daily gains expected when lambs are fed this ration are about 0.34 lbs. Cummings (1962) undertook a study on Awasi lambs at the American University of Beirut Farm to determine: (i) the economics of feeding lambs weaned at three months of age on suitable concentrate - roughage rations, (ii) the effects of reducing the proportion of roughage in the ration below that considered desirable in other lamb feeding studies and (iii) the relative value of rations made up primarily of locally grown feeds. The lambs were divided into three lots, according to weight, sex and condition. Lot I received a well-balanced concentrate mixture along with alfalfa and tibin (wheat straw). Equal amounts of roughage and concentrate were fed. Lot II received the same concentrate and roughage, but in a concentrate to roughage ratio of 3:1. Lot III received a common concentrate mixture containing 20% of the total protein as urea and the lambs were supplemented with vitamin A and D. Tibin was fed as the only roughage and the concentrate to roughage ratio was 1:1. At the end of the experimental period, it was found that the relative feed intake for lot I was 56% concentrate and 44% roughage; 79% concentrate and 21% roughage for lot II; and 65% concentrate and 35% roughage for lot III. The average daily gains in the three lots were 0.31 lbs., 0.35 lbs. and 0.30 lbs. respectively. Lot II lambs made the fastest and most economical gains, although two lambs from this group died from entero-toxemia. Lot I and III made about the same gains, due to the fact that those in lot III consumed a greater percentage of concentrate to compensate for the poorer roughage. No difference, however, was found as far as carcass evaluation was concerned. The results showed that it was profitable to feed lambs after early weaning to desirable market weights of 80-90 lbs. by utilizing a well-balanced concentrate mixture and limiting the roughage intake to 20%.

Cox (1948) conducted many trials on several concentrate: roughage ratios with different feeds, and concluded that sheep ate more by weight of the bulkier than of the concentrated rations when fed ad libitum, but the TDN consumed was highest in the concentrated rations. The author also stated that an optimum physical balance between roughage and concentrate exists in rations for fattening lambs; with an increase in the bulky constituents of a ration, gains and feed efficiency increased upto a certain level, after which, a further increase caused a reduction in gains and feed efficiency. Gains made by lambsare not always positively correlated after an increase in either the dry matter intake or the total digestible nutrients consumed from rations with improper roughage: concentrate ratio (Cox, 1948).

Ahmad, Qazi and Schneider (1962) compared cottonseed hulls with chickpea straw as a roughage in rations with and without sugar beet pulp for fattening sheep in Pakistan. The authors concluded that the lambs receiving the cottonseed hulls gained on an average 0.35 lbs. daily, while those on chickpea straw gained only 0.17 lbs. per day; the difference being statistically significant. On the other hand no significance was found in daily gains between lambs receiving the same roughage but different concentrates. It was recommended that beet pulp might be added in the rations of fattening lambs to replace more expensive feeds. Similarly, a significant difference was found in average carcass weights between lambs on cottonseed hulls and chickpea straw and on rations containing beet pulp and no beet pulp. Schneider, Qureshi and Khan (1961) had earlier tried to establish an optimum proportion of concentrate to roughage for lambs. The rates of gain with different rations tended to vary with the level of concentrates fed. The highest average daily gain (0.38 lbs.) was recorded in the group receiving a concentrate to roughage ratio of 4:1, followed respectively by those with a 2:1 ratio, 1:1 ratio, 1:2 ratio and 1:4 ratio. The difference in daily gain among the various rations was found to be highly significant.

Shrewsbury and co-workers (1942) conducted a study to determine the deficiencies of oat straw as a roughage for breeding sheep. The results indicated that protein is one of the limiting factors. The main outward manifestations of oat straw deficiency were a reduced milk production and a slow growth and finish of lambs. The average daily gain of lambs on oat straw was 0.30 lbs. as compared to 0.48 lbs. for lambs on alfalfa hay. Garrigus (1951) found that lambs on corn and alfalfa hay gained 0.38 lbs. per head daily and produced good + grade carcass, while those on corn and cottonseed hulls gained only 0.34 lbs. but produced the same grade of carcass.

The growth and appetite of sheep on high-fiber, low-protein diets supplemented with urea and molasses were studied by Williams and co-workers (1959). Feed consumption was significantly greater and weight loss significantly less in wethers given poor quality oat straw, supplemented with urea and molasses, than when only oat straw was given. A digestibility trial showed that the digestibility of dry matter, crude protein and ether extract of oat straw was not improved by the addition of urea and molasses, however the digestibility of crude fiber was much improved. In another study, lamb performance, as measured by gain and feed efficiency, declined as the level of roughage was increased from 60 to 90%. This trend was also reflected in dressing percentages (Botkin and Paules, 1962).

Feeding Value of Dried Beet Pulp for Fattening Lambs and Sheep

Dried beet pulp is the dried residue from sugar beets which have been cleaned from crowns, leaves and sand and extracted in the process of manufacturing sugar (Feed Bag Buyer's Guide, 1962). The average analysis of dried beet pulp is as follows:

Crude protein	9.0%
Fat	0.6%
Fiber	19.0%
Ash	3.5%
Nitrogen-free extract	58.0%
Calcium	0.65%
Phosphorus	0.10%

Maynard and Knaus (1959) reported that dried beet pulp is a bulky concentrate that has consistently shown a higher fattening value than grain, when fed in combination with grains, bran or mill feed or with corn fodder or corn silage. It should, however, never be fed as the only carbohydrate concentrate in livestock rations as under such conditions it only returns about 75% of its value. Where cattle and lambs are self-fed, it is especially valuable as it guards against indigestion and bloat. A ton of beets will produce approximately 4.5% of its weight, or 90 lbs. of dried beet pulp, containing 90% dry matter.

Maynard (1935) conducted some early trials to determine the value of different sugar beet by-products in fattening lambs. The highest average daily gains (0.30 lbs.) were obtained in lambs (lot I) receiving 0.75 lbs. of dried beet pulp with basalration of barley, alfalfa hay and salt. Lambs (lot II) receiving 0.50 lbs. of pellets consisting of compressed beet pulp, molasses and bone meal in addition to the basal ration had a daily gain of 0.29 lbs. The cost of 100 lbs. of gain was also lower for lot I.

The results of a three-year comparison trial between wet beet pulp and dried molasses beet pulp for fattening lambs conducted by Ingraham (1936) indicated that wet pulp fed lambs did better with an average daily gain of 0.32 lbs. than those receiving the dried beet pulp, which had an average daily gain of 0.27 lbs. The cost of 100 lbs. of gain was also lower for the group receiving the wet pulp. The same researcher reported in 1942 that the inclusion of dried beet pulp in a self-fed ration for fattening lambs produced greater gains than ground alfalfa, but at an increased cost.

Miller, Hermes and Jones (1940-41) compared the feeding value of pressed beet pulp, beet pulp silage and molasses dried beet pulp. Lambs fed ensiled pulp produced somewhat better gains than those on pressed pulp and dried pulp. The rate of gain was lowest for the control group receiving only grain and hay. The cost per 100 lbs. of weight gains was lowest in the group receiving ensiled pulp and pressed pulp as compared to lambs in the dried pulp or control groups. The carcass grades were almost equal in the three pulp groups, but lowest in the controls.

Clark et al. (1945) conducted feeding trials to determine the most practical rations for fattening lambs in Montana. Rations with and without beet by-products were tested. A comparison of dry and wet beet pulp when combined with oats and alfalfa as compared to oats and alfalfa alone, showed that dried beet pulp produced the highest gains in three out of four trials, with an average daily gain of 0.44 lbs. The cost in dollars per 100 lbs. of gain for the groups receiving wet beet pulp, dried beet pulp and oats and alfalfa alone were $6.78, $7.12 and $8.04 respectively. Similar results were obtained in another comparison, when barley was substituted for oats in the ration. A ration consisting of 50% oats and 50% dried molasses beet pulp proved to be superior to a ration composed of 75% oats and 25% dried pulp. The former ration resulted in faster growth rate (0.43 lbs. per day) and lower cost per 100 lbs. of gain ($8.28) than the latter (0.39 lbs. per day and $8.68 respectively).

Quayle and Paules (1951) reported trials on fattening lambs on home-grown feeds for three years. Lambs receiving only barley and alfalfa made the lowest daily gains (0.21 lbs.) and had the highest cost per 100 lbs. of gain ($31.76) in the year 1947-48. By adding wet beet pulp, the rate of gain increased nearly 15% (0.24 lbs.) and the cost was reduced to $21.84. It was calculated that one ton of wet pulp replaced 155 lbs. of barley and 599 lbs. of alfalfa hay. In the second year 1948-49, lambs on barley and alfalfa hay made slightly higher gains than those supplemented, in addition, with wet pulp. However, the addition of the wet pulp reduced the feed cost per unit of gain, and one ton of pulp replaced 57 lbs. of barley and 1537 lbs. of alfalfa hay. In the third year 1949-50, similar results to those of the first year were obtained.

In the trials conducted by Thomas *et al.*, (1953) the most efficient gains were made by lambs fed equal parts of oats, barley and dried beet pulp, with alfalfa hay given free-choice. Lambs fed a ration of equal parts of barley, dried beet pulp and chopped alfalfa made slightly faster gains than those fed a ration of equal parts of oats, barley and chopped alfalfa.

Feeding tests conducted at the Colorado Agricultural Experimental Station (Maynard and Knaus, 1959) showed that dried beet pulp and dried molasses beet pulp, when fed in standard rations, have proved practically equal in feeding value. According to a summary of 42 fattening tests conducted on cattle and lambs, each ton of dried beet pulp when fed with grain and alfalfa replaced 1782.2 lbs. of corn and 835.0 lbs. of alfalfa. This means that each lb. of dried beet pulp replaced 0.89 lb. of grain and 0.42 lb. of alfalfa or was approximately equivalent to 1.15 lbs. of grain. The high fattening value of dried beet pulp is partly due to its ability, when mixed with grain, to keep fattening animals on feed without any setbacks, and thereby produce steady and uninterrupted gains. According to the same authors, the importance of dried beet pulp among livestock feeds is unique, as its crude fiber is highly digestible for ruminants, so much so that the digestibility of its crude fiber almost ranks with the digestibility of the NFE fraction of some grains such as barley and oats. This is probably due to the fact that its crude fiber content is derived entirely from the vegetable fiber of the sugar beet. Beet pulp has another very useful property: ie., it improves the digestibility of other feeds mixed with it. When one ton of dried molasses beet pulp is fed as the only concentrate to sheep, the TDN content is found to be 1448 lbs. However, when it partially replaces grain and hay, its TDN content is elevated to 1848 lbs., this being due to the physiological effect of beet pulp when mixed with other feeds (cited by Maynard and Knaus, 1959).

There have been some feeding trials for fattening sheep in industrial residues in Russia. Khudaybergnov (1960) reported that the addition of beet pulp in the ration of sheep produced better gains. He recommended the organization of inter-Kolkhoz fattening bases at the sugar plants for the most profitable utilisation of beet pulp and industrial cotton residues.

Darroch, Nordskog and Van Horn (1950) studied the effect of feeding a beet pulp supplement to range ewes on their lamb and wool production. The supplement was given to the ewes prior to breeding season, during the breeding season, and during early and late pregnancy. The following results were reported:

(i) Light ewes gained more weight during the pre-breeding and breeding periods than the heavier ewes.

(ii) Early lambing ewes produced a heavier fleece.

(iii) There was little effect on birth weight of lambs, mortality at birth, or weaning weight.

(iv) Increased fertility of the ewes was achieved when the supplement was given during the pre-breeding and breeding periods.

(v) There was a better survival rate of lambs produced by the supplemented ewes.

Michaux (1951-52) conducted digestibility trials on sheep to assess the digestibility of cellulose and pectic substances in hay, straw, sugar beet pulp and apple pulp. Sugar beet pulp and apple pulp gave the highest digestibility values for both pectic substances and cellulose, viz., 88-93% and 69-83% respectively. The results of metabolism studies also agree with those of feeding trials; that dried sugar pulp has an energy value equal to that of oats (Broster, 1960).

Incidence of Urinary Calculi

Lindley et al. (1953) noticed the appearance of urinary calculi in one ram fed a basal ration containing wheat straw, beet pulp, linseed oil meal, oats and wheat. Taysom et al. (1953) also reported that a ration containing either 25% or 40% molasses dried beet pulp was conducive to the production of urinary calculi in sheep. Twenty-four lambs, of a total of thirty two, receiving a ration containing at least 25% beet pulp developed urinary calculi. At a later date, Elam, Schneider and Ham (1956) confirmed these findings by experimentally producing urinary calculi in wether lambs fed on beet pulp. There were 26 lambs with urinary calculi out of 40 lambs receiving beet pulp in their ration, while only 10 cases were observed in the control group. The same workers in 1957 reported contradictory findings to their previous ones, viz., that beet pulp or its ash did not influence the incidence of urinary calculi in sheep.

The Feeding Value of Dried Beet Pulp for other Classes of Livestock

Dairy Cattle

Henderson and Teagne (1933) were among the early research workers who compared wet and dry beet pulp for milk production. Experiments conducted on cows showed that there was no appreciable difference in the value of wet and dry beet pulp in respect to milk production, palatability, maintenance of body weight or amount of water consumed. A similar comparative feeding trial between ensiled and dried sugar beet pulp fed to milking cows by Grashuis and Van Koetsveld (1954) showed that there was no measurable difference in the performance of the two groups getting ensiled and dried sugar beet pulp. The butterfat of milk from cows on ensiled beet pulp, however, had a higher Reichert-Miessl number. The iodine number was low in both groups, being slightly lower in the group receiving ensiled beet pulp.

According to Maynard and Knaus (1959) the use of dried beet pulp at 25 to 50% of the grain ration for dairy cows increased milk yield from 13 to 15%. These workers cited a typical example of this effect in a high-producing commercial herd in Montana. The annual production in this herd per cow was 13,735 lbs. of milk and 500 lbs. of butterfat. When twelve lbs. of dried molasses beet pulp was included in the cow ration to replace six lbs. of mill feed, half a lb. of molasses, and ten lbs. of alfalfa hay, the annual production per cow increased to 15,616 lbs. of milk, an increase of 13.7%. It is agreed upon by several workers including C.F. Huffman of Michigan State University (cited by Maynard and Knaus, 1959), that dried beet pulp possesses a higher feeding value than its digestible nutrient content would indicate. Huffman also stated the following, "We have demonstrated that beet pulp is a good source of an unidentified lactation factor. This factor is equally valuable whether dried beet pulp is fed to dairy cows, sheep or beef cattle, for it insures an adequate milk supply to give young lambs or calves a flying start."

A study conducted to compare the milk production value of barley, dried beet pulp, molasses dried beet pulp, and another by-product "Concentrated Steffen-Filtrate Dried Beet Pulp," showed that each of the various pulps was fully equal to barley in the replacement of approximately 25% of the energy of a basal ration, consisting of 70% alfalfa hay and 30% barley (Ronning and Bath, 1962).

Beef Cattle

Gardner and Hunter-Smith (1932-33) conducted early trials for determining the value of sugar beet pulp for baby beef, and reported that for all practical feeding purposes molasses pulp, plain pulp, and crushed oats had equal feeding values, and that they were interchangeable. The authors further recommended that these feeds can be used in amounts to provide upto half the starch equivalent in the ration of baby beef. According to Singleton and Ensminger (1944) beet by-products furnish a desirable substitute for a part of the grain ration for beef cattle. The addition of beet pulp reduced the incidence of bloat, and did not adversely influence the quality and finish of steers grading good and commercial which were fattened for a 120-day period. Dried molasses beet pulp may be fed satisfactorily in amounts upto 50% of a ration of corn, barley or wheat for fattening cattle, with pulp having a replacement value of 75% (Singleton et al., 1945).

Harris and Cotton (1952) reported that the substitution of corn by some beet pulp in a ration resulted in increased gains and lower cost of fattening cattle.

Swine

Sykes (1936) conducted some trials in which dried sugar beet pulp replaced 20% barley meal or 10% barley meal and 10% flaked corn in swine rations. Although some difficulty was experienced in getting the pigs to consume the full allowance of feed containing 20-25% pulp, the animals fed pulp showed satisfactory weight gains. Differences in carcass quality between control and experimental animals were not significant.

Horses

Seidler and Zolkiewski (1956) did some work on substitute feeding of work horses. Part of the oats fed to working geldings was replaced by feeding of a not more than 5 kgs. mixture of one part horse-beans and four parts of dried beet pulp. All the animals on this mixture performed well when compared to those getting oats. Weight changes were also similar in all the groups. It was also found that to replace one kg. of oats, 0.8 kg. of dried beet pulp was required.

MATERIALS AND METHODS

General Experimental Plan

Two lamb-fattening experiments were conducted at the American University of Beirut Farm in order to study the economy of lamb production in Lebanon under typical farm conditions. The American University Farm is situated in the Beka'a plain, where the climate is hot and dry in Summer but cold and rainy in Winter. One experiment was conducted in the Summer of 1961-62, while the other was conducted during the latter part of Spring and the early Summer of 1962-63.

Lambs used in both experiments were of the local fat-tailed Awasi breed. The experimental animals in the first experiment consisted of castrated and docked male lambs, while those used in the second experiment were both intact male and female lambs. Ewe lambs were included in the second experiment in an effort to determine the effect of sex on daily rate of gain. The average age of lambs used in the first experiment was 157 days with a range from 137 to 173. Lambs used in the second experiment were weaned at the age of two months, and their average age at the start of the experiment was 76 days with a range from 63 to 88.

The experimental animals were weighed at the start of the experiment and every two weeks thereafter until the end of the experimental period. The animals were then slaughtered and graded. The dressing percentage was calculated on the basis of cold weight, which was obtained after cooling the carcasses for a period of one week at a temperature of 32°F. The carcasses were assigned a numerical score ranging from one to five, depending on their grade. A score of one was given to utility grade, while a score of five was given to the highest grade obtained, namely choice. Economy per lamb was calculated at the conclusion of the experiment by the American and the Lebanese systems of marketing lambs. In the American system, the carcasses are priced according to their grades whereas in the Lebanese system, a fixed price is paid on basis of live-weight regardless of the quality.

The data for both experiments were statistically analyzed. In the first experiment a "t" test was used, whereas in the second experiment an analysis of variance was run. Standard deviations were also calculated for the results obtained for certain important criteria which were studied.

EXPERIMENTAL RESULTS

Experiment I

Purpose

The experiment was designed to study the value of two different concentrate mixtures, when wheat stubble was the only source of roughage.

Procedure

Twenty wethers of the Awasi breed were selected from the flock maintained at the American University of Beirut Farm. They were divided into two groups, A and B, in such a way that the heavier lambs were placed in group A and the lighter ones in group B. The average age in days for the two groups was almost identical. Prior to the start of the experiment, the lambs were shorn, dipped for control of ectoparasites and treated for worms with phenothiazine.

Feeding Methods

Lambs were allowed to graze on a nearby stubble field. A period of one week was allowed as an adjustment period, to adapt the animals to stubble grazing. Two concentrate mixtures were formulated (Table 1), with one having corn as the major energy ingredient (Ration A), and the other having dried beet pulp as one of the major energy sources (Ration B). The cost per lb. of ration A and B was P.L. 9.1 and 8.1 respectively.

The experiment was conducted for a period of ten weeks. The animals were taken to the wheat stubble field (39 dunums) at about 7 o'clock in the morning and brought back to the pens after five hours of

Table 1. Composition of the experimental rations* - Experiment I.

Ingredient	Amount lbs.	Crude protein lbs.	T.D.N. lbs.	Net energy Cal.
Ration A				
Barley	25	2.2	19.7	17,625
Yellow corn	35	3.1	28.0	28,035
Dried beet pulp	10	0.9	6.9	7,050
Cottonseed oil meal	10	4.0	6.8	6,330
Soybean oil meal	6	3.0	4.5	4,656
Molasses	10	0.3	5.4	5,610
Steamed bone meal	2	-	-	-
Ground limestone	1	-	-	-
Mineralized salt	1	-	-	-
Total	100	13.5	71.3	69,306
Ration B				
Barley	37	2.9	29.2	26,085
Dried beet pulp	32	2.8	22.1	22,560
Cottonseed oil meal	10	4.0	6.8	6,330
Soybean oil meal	7	3.5	5.5	5,572
Molasses	10	0.3	5.4	5,610
Steamed bone meal	2	-	-	-
Ground limestone	1	-	-	-
Mineralized salt	1	-	-	-
Total	100	13.5	69.0	66,157

* Vitamin A was added to both rations at the rate of 1,500 I.U./lb., and vitamin D_2 at the rate of 200 I.U./lb.

grazing. They were watered and held in the shaded pens for about two hours, after which they were again taken to the stubble field for three hours of grazing. The concentrate mixtures were fed to both groups in the afternoon upon return from the field. The following rates of concentrate feeding were followed for both groups:

2.0 lbs. per lamb per day for the first 2 weeks,

2.5 lbs. per lamb per day for the next 4 weeks,

3.0 lbs. per lamb per day for the last 4 weeks.

The weigh-backs of feed refused were recorded daily for each group.

Results

Data on the average age, birth weight, total weight gain, and daily weight gain during the experimental period for each group are presented in Table 2. The results obtained showed that group A lambs receiving the ration A with corn as the major energy ingredient did better than group B lambs receiving concentrate B, in which dried beet pulp constituted a high percentage. The total average gain in group A for the experimental period was 28.0 lbs., and in group B was 25.4 lbs. Similarly the average daily gain was 0.40 ± 0.07 lbs. in group A and 0.36 ± 0.09 lbs. in group B. It is possible that the average gain of group B is reduced on account of the fact that two lambs in group B were sick and did not grow at a normal rate for several days.

A similar trend was noticed when the carcass data in both groups was examined (Table 3). The dressing percentage was a little higher in group A (52.7), as compared to group B (51.8). The average carcass grade in the case of group A was good +, with a score of 4.4, while that in group B was good -, with a score of 2.3.

Table 2. Age, birth weight, initial weight, final weight and daily gains of lambs at the end of ten-week feeding trial - Experiment I

Lamb No.	Age (days)	Birth wt. (lbs.)	Initial wt. (lbs.)	Final wt. (lbs.)	Total gains (lbs.)	Daily gains (lbs.)	Corrected daily gains* (lbs.)
Group A							
E 3	173	10.0	80.0	112.0	32.0	0.46	0.45
E 12	167	9.5	86.5	117.0	30.5	0.43	0.41
E 18	165	11.5	93.0	123.5	30.5	0.43	0.39
E 20	164	12.0	97.0	119.5	22.5	0.32	0.26
E 22	163	10.0	84.0	107.0	23.0	0.33	0.31
E 38	156	11.5	91.0	124.5	33.5	0.48	0.44
E 39	155	10.0	85.0	121.0	36.0	0.51	0.49
E 41	155	9.0	90.5	120.0	29.5	0.42	0.39
E 48	149	11.0	77.0	98.0	21.0	0.30	0.29
E 53	137	11.0	77.0	102.5	25.5	0.36	0.35
Average	158	10.5	86.1	114.5	28.0	0.40 ± .07	0.38 ± .07
Group B							
E 6	170	12.0	67.5	100.0	32.5	0.46	0.48
E 15	166	8.0	64.5	80.0	15.5	0.22**	0.25
E 19	164	9.0	75.0	107.0	32.0	0.46	0.46
E 28	160	8.0	54.0	69.0	15.0	0.21**	0.27
E 33	159	8.5	61.0	92.0	31.0	0.44	0.48
E 43	152	7.0	66.0	94.5	28.5	0.41	0.44
E 47	151	8.5	70.0	96.0	26.0	0.38	0.40
E 49	149	9.0	69.5	91.5	22.0	0.31	0.33
E 50	148	9.5	63.0	88.0	25.0	0.36	0.40
E 52	142	9.0	70.0	97.0	27.0	0.38	0.40
Average	156	8.8	66.0	91.5	25.4	0.36 ± .09	0.39 ± .08

* Corrected daily gains calculated by use of regression of daily gains on initial weight.

** Lambs Nos. 15 and 28 suffered from acute bronchitis and were treated with antibiotics.

Table 3. Dressing percentage and grades of lamb carcasses - Experiment I.

Lamb No.	Live weight (lbs.)	Weight of cold carcass (lbs.)	Dressing %	Carcass Grade	Carcass Score
Group A					
E 3	112.0	55.5	52.4	Good +	4
E 12	117.0	60.3	51.5	Choice	5
E 18	123.5	64.1	51.9	Choice	5
E 20	119.5	64.0	56.1	Choice	5
E 22	107.0	54.5	52.2	Good +	4
E 38	124.5	64.9	52.1	Choice	5
E 39	121.0	62.3	52.3	Choice	5
E 41	120.0	62.0	52.5	Choice	5
E 48	98.0	51.5	53.9	Good	3
E 53	102.5	52.5	52.5	Good	3
Average	114.5	59.4 ± 5.2	52.7 ± 1.3	Good +	4.4
Group B					
E 6	100.0	50.3	50.3	Good	3
E 15	80.0	41.5	53.9	Good -	2
E 19	107.0	55.3	51.7	Good	3
E 28	69.0	34.5	52.3	Utility	1
E 33	92.0	46.6	50.6	Good -	2
E 43	94.5	49.0	54.4	Good	3
E 47	96.0	49.3	51.3	Good -	2
E 49	91.5	46.0	51.7	Good -	2
E 50	88.0	45.0	51.4	Good -	2
E 52	97.0	49.3	50.8	Good	3
Average	91.5	45.7 ± 5.7	51.8 ± 1.3	Good -	2.3

Table 4. Concentrates consumed, and their cost/100 lbs. of gain - Experiment I.

Group	Total concentrate consumed (lbs.)	Total gain (lbs.)	Cost/100 lbs. gain L.L.*	Concentrate/100 lbs. gain (lbs.)
A	1731	280.0	56.00	618.0
B	1629	245.5	52.00	641.0

* Lebanese pounds.

In Table 4 data are presented on the amount of feed consumed and the cost per 100 lbs. of gain in both groups. The cost per 100 lbs. of gain was less in group B by L.L. 4.00 as compared to group A, since ration B was cheaper than ration A by P.L. 1.0. The concentrates consumed per 100 lbs. of gain were higher for group B (641.0 lbs.) than for group A (618.0 lbs.).

When the economy of fattening was calculated according to the American system (Table 5), it was found that the margin left for labor, housing, interest,and net profit per lamb was L.L. 24.25 in group A, as compared to L.L. 9.56 per lamb in group B. On the other hand there was a difference of only L.L. 0.10 per lamb in favour of group A, when the economy was calculated according to the Lebanese system of lamb marketing (Table 6).

Table 5. Economy per lamb in L.L. when carcasses evaluated on basis of U.S.A. grades* - Experiment I.

Description	Group A		Group B	
	Income	Expenses	Income	Expenses
Value of carcass	100.27		68.20	
Value of fleece	3.50		3.00	
Value of heart, liver, kidney & brain	3.00		3.00	
Value of tail fat	0.53		0.41	
Total	107.30		74.61	
Price of lamb		66.30		50.86
Cost of concentrates		15.75		13.19
Cost of stubbles		1.00		1.00
Total		83.05		65.05
Left for labor, housing, interest, net profit, etc.		24.25		9.56

* Rates of different grades:

Choice at L.L. 1.82/lb.
Good + at L.L. 1.70/lb.
Good at L.L. 1.59/lb.
Good - at L.L. 1.48/lb.
Utility at L.L. 1.36/lb.

Table 6. Economy per lamb in L.L. on basis of live weight* (as in Lebanon) - Experiment I.

Description	Group A	Group B
Value of live-weight	88.17	70.07
Expenses	83.05	65.05
Left for labor, housing interest, net profit, etc.	5.12	5.02

* Rate: L.L. 0.77/lb. of live-weight.

Experiment II

Purpose

The results of the previous experiment indicated that corn could be partially and effectively replaced by dried beet pulp in lamb-fattening rations. This experiment was designed to study the extent to which dried beet pulp could be substituted for corn in lamb-fattening rations.

Procedure

Thirty-six ram lambs and eighteen ewe lambs of the Awasi breed were selected from the 1962-63 lamb crop at the American University of Beirut Farm. These lambs were weaned at the age of two months, and were fed a concentrate mixture containing 18.1% crude protein. The mixture had the following composition:

Barley	40%
Sorghum	20%
Soybean oil meal	23%
Wheat bran	15%
Salt	1%
Bone meal, steamed	1%

Vitamins A and D were added at the rate of 125 I.U. and 80 I.U. per lb., respectively. The experimental lambs were kept on this concentrate mixture for several weeks prior to the start of the experiment. All the lambs were vaccinated against entero-toxemia with an initial dose on April 10, 1963, and another dose one week later. They were randomly assigned to three groups C, C + B and B, with the result that each group had twelve ram lambs, and six ewe lambs of approximately the same age and same initial weight.

Table 7. Composition of experimental rations - Experiment II.

Ingredients	Experimental rations		
	C	C + B	B
Yellow corn	40	20	-
Dried beet pulp	-	20	40
Cottonseed oil meal	20	20	20
Barley	18	18	18
Molasses	10	10	10
Wheat bran	10	10	10
Bone meal, steamed	1	1	1
Common salt	1	1	1
	100	100	100
Calculated analysis* (%)			
Crude protein	15.31	15.33	15.35
Total digestible nutrients	71.56	69.54	67.52
Calcium	0.46	0.59	0.74
Phosphorus	0.69	0.64	0.61
Net energy (Cal./lb.)	699	691	683
Vitamin A (I.U./lb.)	1126	726	326

* Calculated from Morrison's Feeds and Feedings. 22nd Ed. 1957.

Feeding Methods

Three concentrate mixtures were formulated as presented in Table 7. The three groups were fed equal amounts of corn silage as the only roughage. The whole daily allowance of silage was fed in the morning, whereas half of the concentrate allowance was fed in the morning with the remainder fed in the afternoon. Fresh drinking water was available at all times.

Daily feed allowance of silage and concentrate was restricted to the amount consumed. Hence, differences in gain would be due to differences in the nutritive value of the three rations. Since it was attempted to feed the animals to the limit of their appetite, weigh-backs could not be completely avoided. Since the main concern of this experiment centered upon the detection of any differences in the nutritive value of the three concentrates, silage intake by the three groups for the whole experimental period was made uniform. The concentrate consumption for the same period among the three groups was variable, however.

Upon the completion of the experimental period of twelve weeks, the lambs were weighed and their final weights recorded. Ten ram lambs from each group were slaughtered at the end of the experimental period and the carcass data recorded. Blood and liver samples were taken from each lamb for vitamin A analysis. The nasal cavities and the frontal sinuses of all the slaughtered lambs were opened and examined for the presence of the larvae of the "Nasal Fly" (*Oestrus ovis*). This examination was necessitated by the fact that animals in all three groups had outward signs of infestation manifested by frequent sneezing and shaking of the head. The kidneys were examined for the presence of urinary calculi since there are some observations indicating that the feeding of beet pulp increases the formation of calculi (Lindley et al., 1953, Taysom et al., 1953 and Elam et al., 1956).

Results

Tables 8a, 8b and 8c show data regarding age, total gains and daily gains of lambs in groups C, C + B and B respectively at the end of the twelve-week feeding trial. The results indicated that lambs in group B receiving 40% dried beet pulp in their concentrate gained the most during the experimental period, with an average gain in weight per lamb of 33.5 lbs. Group C + B which received 20% dried beet pulp and 20% corn in their concentrate, averaged 32.1 lbs. of total gains. The lowest gains which averaged 31.5 lbs. for the whole feeding period were obtained by lambs in group C receiving 40% corn in their concentrate. It was also observed that male lambs had a greater rate of gain than the ewe lambs in all three groups.

A similar pattern to that of total gain was also obtained for daily gains. The daily gains for groups B, C + B and C were 0.40, 0.38 and 0.37 lbs. respectively. The daily gain of males was also higher than that of females in all three groups.

In Tables 9a, 9b and 9c the weights of cold carcasses, the dressing percentages and the carcass grade of groups C, C + B and B are presented respectively. Lambs slaughtered from group B had an average cold carcass weight of 40.0 lbs. and a dressing percentage of 49.9. The carcasses averaged grade "good" and were given a numerical score of

Table 8a. Age, birth weight, initial weight, final weight, total gain and daily gain of lambs (Group C) at the end of twelve-week feeding trial - Experiment II.

Lamb No.	Age at start (days)	Birth wt. (lbs.)	Initial wt. (lbs.)	Final wt. (lbs.)	Total gain (lbs.)	Daily gain (lbs.)
Males						
F 11	84	10.5	45.0	72.0	27.0	0.32
F 15	82	11.5	36.5	77.5	41.0	0.49
F 16	81	9.0	49.0	80.0	31.0	0.37
F 19	80	11.8	66.0	88.0	22.0	0.26
F 23	79	10.0	45.5	65.0	19.5	0.23
F 32	75	10.8	46.5	80.0	33.5	0.40
F 42	72	8.0	29.5	56.0	26.5	0.31
F 47	70	9.0	39.5	79.5	40.0	0.48
F 55	68	9.5	30.5	70.5	40.0	0.48
F 60	65	6.2	34.0	70.5	36.5	0.43
Average	75.6	9.6	42.2	74.4	31.7	0.38
Females						
F 18	81	9.5	36.0	70.5	34.5	0.41
F 33	75	11.5	52.0	84.5	32.5	0.39
F 35	74	9.5	44.0	67.5	23.5	0.28
F 38	74	9.5	49.5	86.0	36.5	0.43
F 39	73	9.5	24.5	58.0	33.5	0.40
F 48	70	9.5	35.5	61.5	26.0	0.31
Average	74.5	9.8	40.2	71.3	31.1	0.37
Total Average	75.2	9.7	41.1	72.9	31.5	0.37 ± .08

Table 8b. Age, birth weight, initial weight, final weight, total gain and daily gain of lambs (Group C + B) at the end of twelve-week feeding trial - Experiment II.

Lamb No.	Age at start (days)	Birth wt. (lbs.)	Initial wt. (lbs.)	Final wt. (lbs.)	Total gain (lbs.)	Daily gain (lbs.)
Males						
F 2	88	9.0	44.5	74.0	29.5	0.35
F 7	86	9.3	44.0	81.5	37.5	0.45
F 13	83	6.5	31.5	66.0	34.5	0.41
F 14	83	9.5	38.5	81.0	42.5	0.51
F 20	80	11.5	52.0	82.5	30.5	0.36
F 24	79	8.5	27.0	73.5	46.5	0.55
F 29	75	7.5	39.0	53.5	14.5	0.17
F 31	75	7.5	36.0	76.5	40.5	0.48
F 44	71	9.0	42.0	74.5	32.5	0.39
F 53	68	10.0	38.5	82.5	44.0	0.52
F 58	66	7.0	26.0	50.0	24.0	0.29
Average	77.6	8.7	38.1	72.3	34.2	0.41
Females						
F 6	86	8.0	36.0	69.5	33.5	0.40
F 17	81	10.2	56.0	80.5	24.5	0.29
F 36	74	10.0	44.5	74.0	29.5	0.35
F 41	72	10.2	51.0	68.0	17.0	0.20
F 50	70	7.0	30.5	62.0	31.5	0.37
F 51	70	10.0	37.5	71.0	33.5	0.40
Average	75.5	9.2	42.6	70.8	28.2	0.34
Total Average	76.9	8.9	40.5	71.8	32.1	0.38 ± 0.1

Table 8c. Age, birth weight, initial weight, final weight, total gain and daily gain of lambs (Group B) at the end of twelve-week feeding trial - Experiment II.

Lamb No.	Age at start (days)	Birth wt. (lbs.)	Initial wt. (lbs.)	Final wt. (lbs.)	Total gain (lbs.)	Daily gain (lbs.)
Males						
F 5	86	84	27.0	62.5	35.5	0.42
F 10	85	8.0	47.5	96.0	48.5	0.58
F 12	84	9.5	40.0	64.0	24.0	0.29
F 21	79	10.0	44.0	73.5	29.5	0.35
F 27	76	8.0	50.5	79.5	29.0	0.34
F 30	75	8.5	37.5	80.5	43.0	0.51
F 37	74	9.5	41.5	64.0	22.5	0.27
F 43	72	7.5	30.0	73.5	43.5	0.52
F 46	71	7.5	36.5	76.0	39.5	0.47
F 56	67	10.8	34.5	78.5	44.0	0.52
F 59	66	8.5	47.0	91.0	44.0	0.52
F 62	63	12.0	52.0	99.0	47.0	0.56
Average	74.8	9.0	40.7	78.2	37.5	0.45
Females						
F 8	86	9.0	46.0	72.5	26.5	0.31
F 9	85	7.5	32.0	58.5	26.5	0.31
F 26	76	9.0	43.5	68.5	25.0	0.30
F 34	74	11.5	53.0	74.0	21.0	0.25
F 45	71	7.0	42.0	65.0	23.0	0.27
F 49	70	9.0	36.5	68.0	31.5	0.37
Average	77.0	8.8	42.2	67.7	25.6	0.30
Total Average	75.5	9.0	41.2	74.7	33.5	0.40 ± 0.1

Table 9a. Dressing percentage and carcass grade (Group C) - Experiment II.

Lamb No.	Live weight (lbs.)	Weight of cold carcass (lbs.)	Dressing %	Carcass Grade	Carcass Score
F 11	72.0	35.2	49.0	Good -	2
F 15	77.5	36.5	47.1	Good -	2
F 16	80.0	39.0	48.7	Good -	2
F 19	88.0	45.5	51.7	Good +	4
F 23	65.0	33.0	50.8	Good -	2
F 32	80.0	39.0	48.7	Good -	2
F 42	56.0	27.0	48.2	Utility	1
F 47	79.5	39.5	49.7	Good	3
F 55	70.5	34.0	48.2	Good -	2
F 60	70.5	32.5	46.1	Good -	2
Average	73.9	36.1 ± 5.0	48.8 ± 1.5	Good -	2.2

Table 9b. Dressing percentage and carcass grade (Group C + B) - Experiment II.

Lamb No.	Live weight (lbs.)	Weight of cold carcass (lbs.)	Dressing %	Carcass	
				Grade	Score
F 2	74.0	37.5	50.7	Good -	2
F 7	81.5	40.5	49.7	Good +	4
F 13	66.0	32.0	48.5	Good -	2
F 14	81.0	39.7	49.1	Good +	4
F 20	82.5	44.5	53.9	Good +	4
F 24	73.5	32.2	43.9	Good -	2
F 29	53.5	26.7	50.0	Good -	2
F 31	76.5	37.0	48.4	Good -	2
F 44	74.5	37.2	50.0	Good	3
F 53	82.5	41.5	50.3	Good	3
Average	74.5	36.9 ± 5.3	49.4 ± 2.5	Good	2.8

Table 9c. Dressing percentage and carcass grade (Group B) - Experiment II.

Lamb No.	Live weight (lbs.)	Weight of cold carcass (lbs.)	Dressing %	Carcass Grade	Carcass Score
F 10	96.0	49.5	51.6	Good	3
F 12	64.0	32.2	50.4	Good -	2
F 21	73.5	35.5	48.3	Good +	4
F 27	79.5	40.5	50.9	Good	3
F 30	80.5	39.7	49.4	Good -	2
F 37	64.0	34.0	53.1	Good -	2
F 46	76.0	37.0	48.7	Good -	2
F 56	78.5	37.5	47.8	Good	3
F 59	91.0	46.0	50.5	Good	3
F 62	99.0	48.0	48.5	Good +	4
Average	80.2	40.0 ± 5.9	49.9 ± 1.6	Good	2.8

2.8. Group C + B had a lower average cold carcass weight of 36.9 lbs., a slightly lower dressing percentage of 49.4, but a similar carcass grade and score to that of group B. Group C lambs had the poorest carcasses. The lambs averaged a cold carcass weight of 36.1 lbs., a dressing percentage of 48.8 and a "good -" grade with a numerical score of 2.2.

Data regarding average feed consumption, cost of feed per lamb, and feed cost per 100 lbs. of gain are presented in Table 10. Two male lambs in group C died during the experimental period. The cause of death was suspected to be entero-toxemia. One male lamb from group C + B was excluded from the experiment due to his inability to stand and walk to the feed trough. No similar situations occurred in group B, in which all the lambs thrived well during the total experimental period.

The average silage consumption per lamb for the total experimental period was almost identical for all three groups; however, concentrate consumption varied slightly. Group C lambs had a lower concentrate intake of 2.7 and 3.4 lbs. than lambs in groups C + B and B respectively. This difference in concentrate consumption was a result of the occasional but partial refusal of the feed by group C lambs.

The cost of feed consumed per lamb during the experimental period was lowest for group B (L.L. 13.90), intermediate for group C + B (L.L. 15.34) and highest for group C (L.L. 16.60). This result was due to the fact that concentrate B was the cheapest of the three concentrates fed (Table 10). On the basis of feed cost per 100 lbs. gain, the most economical gains were produced by group B at a cost of L.L. 41.49. The most expensive gains, however, were obtained by group C at a cost of

Table 10. Average feed consumption per lamb for the experimental period, and feed cost per 100 lbs. of gain - Experiment II.

Group	No. of animals	Average feed consumed (lbs.)		Cost of feed (L.L.)			Average weight gains	Feed cost/ 100 lbs. of gain (L.L.)
		Concentrate	Silage	Concentrate*	Silage**	Total		
C	16	162.96	107.02	14.67	1.93	16.60	31.50	52.70
C + B	17	165.66	106.43	13.42	1.92	15.34	32.10	47.79
B	18	166.36	106.58	11.98	1.92	13.90	33.50	41.49

* Concentrate C at P.L. 9.0 per lb.
Concentrate C + B at P.L. 8.1 per lb.
Concentrate B at P.L. 7.2 per lb.

** Corn silage at P.L. 1.8 per lb.

L.L. 52.70. Group C + B was intermediate in this respect.

The economics of lamb production calculated on the bases of carcass grades and also live-weight are presented in Tables 11 and 12. The calculations in Table 11 indicate that the amounts in Lebanese Pounds left for labor, interest, housing, and net profit were highest for group B lambs, intermediate for group C + B lambs, and lowest for group C lambs, and of the magnitude of L.L. 24.01, 18.18 and 10.76 respectively.

When the economy per lamb was calculated on the basis of live-weight (Table 12), the returns covering labor, housing, interest, and net profit were L.L. 11.90, 8.77 and 7.88 for groups B, C + B and C respectively.

Data on the effect of age on feed efficiency is given in Table 13. It is evident from Table 13 that less feed was consumed per lb. of gain when the animals were young than when older. With increase in age, there was a decrease in the efficiency of feed utilisation. This finding is to be expected since the deposition of body fat which occurs with increasing age is more costly than the deposition of lean meat which occurs earlier. During the third two-week experimental period, group C lambs made negative gains, which were probably related to the poor quality corn which was fed during that period.

Data on vitamin A content of blood serum and liver of slaughtered animals are presented in Tables 14 and 15. A large variation within the group was observed for serum and liver vitamin A. Lambs in group C which theoretically should have had the highest vitamin A content in their blood serum because of the nature of the ration they were fed, had only 63.2 micrograms per 100 ml., as compared to values of 60.4 and 73.9 micrograms per 100 ml. for groups C + B and B respectively.

Table 11. Economy per lamb in L.L. when carcasses evaluated on basis of U.S.A. grades* - Experiment II.

Description	Group C		Group C + B		Group B	
	Income	Expenses	Income	Expenses	Income	Expenses
Value of carcass	52.98		58.67		63.60	
Value of fleece	2.50		2.50		2.50	
Value of heart, liver, kidneys & brain	3.00		3.00		3.00	
Value of tail fat	0.53		0.53		0.53	
Total	59.01		64.70		69.63	
Cost of lamb		31.65		31.18		31.72
Cost of concentrate		14.67		13.42		11.98
Cost of silage		1.93		1.92		1.92
Total		48.25		46.52		45.62
Amount left for labor, housing, interest and net profit		10.76		18.18		24.01

* Rates of different grades:

Choice at L.L. 1.82 per lb.
Good + at L.L. 1.70 per lb.
Good at L.L. 1.59 per lb.
Good - at L.L. 1.48 per lb.
Utility at L.L. 1.36 per lb.

Table 12. Economy per lamb in L.L. on basis of live-weight* (as in Lebanon) - Experiment II.

Description	Group C		Group C + B		Group B	
	Income	Expenses	Income	Expenses	Income	Expenses
Value of live-weight	56.13		55.29		57.52	
Total	56.13		55.29		57.52	
Cost of lamb		31.65		31.18		31.72
Cost of concentrate		14.67		13.42		11.98
Cost of silage		1.93		1.92		1.92
Total		48.25		46.52		45.62
Amount left for labor, housing, interest and net profit		7.88		8.77		11.90

* Rate: L.L. 0.77 per lb. of live-weight.

Table 13. Effect of age on feed efficiency - Experiment II.

Two-week experimental period	Feed consumed per lb. of gain					
	Group C		Group C + B		Group B	
	Concentrate	Silage	Concentrate	Silage	Concentrate	Silage
1	2.7	2.0	2.4	1.8	2.9	2.0
2	4.1	2.7	5.0	3.3	4.3	2.8
3	-*	-*	7.1	4.3	4.7	3.6
4	2.8	1.9	5.1	3.5	5.0	3.5
5	7.7	4.8	5.2	3.0	7.4	4.4
6	7.5	3.9	21.9	11.5	6.6	3.2
Average	5.17	3.40	5.16	3.32	4.97	3.18

* Negative gain during the third two-week period.

Table 14. Blood serum vitamin A of groups C, C + B and B lambs in micrograms per 100 ml. - Experiment II.

Group C		Group C + B		Group B	
Lamb No.	Vitamin A	Lamb No.	Vitamin A	Lamb No.	Vitamin A
F 11	81.4	F 2	26.2	F 10	82.8
F 15	30.3	F 7	69.0	F 12	81.4
F 16	71.6	F 13	67.6	F 21	57.9
F 19	57.9	F 14	28.9	F 27	95.2
F 23	53.8	F 20	69.0	F 30*	-
F 32	42.7	F 24	42.7	F 37	27.6
F 42	75.9	F 29	48.3	F 46	57.9
F 47	75.9	F 31	67.6	F 56	55.2
F 55	100.7	F 44	71.6	F 59	85.5
F 60	41.4	F 53	113.1	F 62	121.4
Average	63.2 ± 21.7		60.4 ± 25.3		73.9 ± 26.3

* Sample lost due to breakage of serum tube.

Data on the hepatic liver storage of groups C, C + B and B lambs are presented in Table 15. Lambs in group B had the lowest vitamin A levels, while those in group C + B had the highest. The values for group C lambs were slightly lower than those of group C + B. The mean vitamin A storage values expressed in micrograms per gram of fresh liver for groups B, C and C + B were 149.2 $\pm$ 40.9, 210.2 $\pm$ 125.2 and 220.3 $\pm$ 68.8 respectively. It is evident from the standard deviations obtained that a large variation occurred within each group, and in particular within group C. The values for all animals however, were within the normal range reported in the literature.

The nasal cavities and the frontal sinuses of all slaughtered animals were thoroughly examined for the presence of larvae of the "Nasal Fly" (Oestrus ovis). Most lambs in all groups were found to be harboring the larva but with different degrees of infestation. There appeared to be however no correlation between the number of larvae present and the gains obtained by lambs during the experimental period.

The kidneys of slaughtered lambs were also examined for the presence or absence of urinary calculi. All examinations in this respect were found negative.

The analysis of variance of daily gain for the three groups of lambs is presented in Table 16. A statistical difference at the 1% level of probability was found between sexes; there was no difference however between the three groups namely C, C + B and B.

Table 15. Hepatic vitamin A storage of groups C, C + B and B lambs in micrograms per gram of fresh liver - Experiment II.

Group C		Group C + B		Group B	
Lamb No.	Vitamin A	Lamb No.	Vitamin A	Lamb No.	Vitamin A
F 11	262.3	F 2	235.5	F 10	178.4
F 15	160.7	F 7	257.1	F 12	149.6
F 16	83.2	F 13	214.6	F 21	163.2
F 19	189.5	F 14	365.5	F 27	110.3
F 23	93.3	F 20	149.2	F 30	120.5
F 32	130.3	F 24	144.7	F 37	97.1
F 42	416.9	F 29	253.6	F 46	143.2
F 47	393.3	F 31	184.0	F 56	116.8
F 55	81.9	F 44	145.6	F 59	181.6
F 60	290.9	F 53	253.4	F 62	231.4
Average	210.2 ± 125.2		220.3 ± 68.8		149.2 ± 40.9

Table 16. Analysis of variance of daily gain - Experiment II.

Source of variance	d.f.	S.S.	M.S.	F.
Between sexes	1	0.0683	0.0683	7.9*
Between groups within sex	4	0.0404	0.0101	1.2
Within groups within sex	45	0.3923	0.0087	

* Significant at 0.01 level of probability.

GENERAL DISCUSSION

Wheat Stubble as the Sole Roughage for Fattening Lambs

Wheat stubble is a term used in reference to straw which is left above the soil after wheat has been harvested. It is commonly used by villagers and Bedouins for grazing their sheep during the summer months.

In an effort to study the nutritive value of wheat stubble, two groups of lambs were fed a different concentrate supplement in addition to their grazing on wheat stubble, since the latter is known to be a poor feed when fed alone. Concentrate A had a crude protein content of 13.5% and an estimated net energy of 693 Cal./lb. Concentrate B had also a crude protein content of 13.5%, but an estimated net energy of 661 Cal./lb., which is slightly lower than that of concentrate A. A comparison of the growth rates of the experimental lambs with growth rates published in the literature of lambs on different roughages but approximately similar concentrate supplementation was felt to be a good criterion for evaluating the nutritive value of wheat stubble.

Data on total weight gains and daily gains during the experimental period as presented in Table 2 indicated that lambs in both groups gained at a satisfactory rate. Daily gains of 0.40 and 0.36 lbs. for lambs in groups A and B respectively were slightly higher than 0.34 lbs. (value compiled by Morrison in 1957 from the results of several experiments in which lambs were fed a "standard ration" of corn grain and alfalfa or clover hay). Lambs in group A had a better daily gain (0.40 ± 0.07 lbs.) than lambs in group B (0.36 ± 0.09 lbs.); however, there was no statistical difference between the two groups. It should be pointed out here that lambs E 15 and E 28, which fell sick for several days during the experimental period and gained at a significantly lower rate than the average, have contributed to the lower rate of gain obtained for group B.

The average of the initial weights of lambs in group A was higher than that of group B even though the average age of the two groups was almost identical. This variation in the average initial weights can be attributed to the higher average birth weight of group A lambs (10.5 lbs.) than group B lambs(8.8 lbs.). It should also be mentioned here that the heavier lambs were intentionally allotted to group A, and the lighter lambs to group B in order to reduce the error within the group. The difference in the initial weights however, seems to have not influenced the rate of daily gain, as was evident from the corrected daily gain figures of 0.38 $\pm$ 0.07 lbs. for group A, and 0.39 $\pm$ 0.08 lbs. for group B (Table 2) which were obtained by the use of regression of daily gains on initial weights. No statistical difference was obtained for the corrected values of the two groups.

Another difficulty encountered in planning the first experiment was the unavailability of lambs with an age of approximately 3 months. The available lambs had an average age of about twenty-two weeks, and an average weight of 76 lbs. As a result of the conditions which prevailed, lambs which were selected for experimentation had a short feeding period. Moreover, the daily lamb gains would have been better and more economical had the animals been younger in age.

The comparison of the nutritive value of the experimental rations used in this study with a "standard ration" reported by Morrison (1957) was based on the TDN consumption per 100 lbs. of gain. Since the amount of wheat stubble grazed per lamb per day was not estimated by close observation of the lambs while grazing, a figure of 2 lbs. of wheat stubble was thought to be a reasonable value to use in the calculation of total TDN. The total TDN obtained by each lamb from the grazing of wheat stubble during the ten-week experimental period was calculated to be 50.12 lbs. It was also calculated that group A lambs received 619 lbs. of TDN from the concentrate and stubble consumed to produce 100 lbs. of gain, whereas group B lambs consumed 663 lbs. These figures are a little higher than that calculated by the writer for the ration reported by Morrison (1957). Morrison reported that 387 lbs. of corn and 418 lbs. of alfalfa or clover hay, were consumed by lambs to produce 100 lbs. of gain. These amounts of corn and hay contained 522 lbs. of TDN. This difference in TDN consumption per 100 lbs. of gain between the experimental rations and that reported by Morrison could be due to the use of younger animals in the experiments compiled and studied by the author, and to the nature of the feed consumed. When the cost of alfalfa hay and its availability in Lebanon is compared to that of wheat stubble, it becomes evident that the experimental rations compared favorably with the "standard ration" reported by Morrison in regard to TDN per 100 lbs. of gain. Care should be exercised however in the interpretation of the feed conversion data for two reasons. Firstly it is possible that the stubble intake per lamb per day could have been higher than the amount assumed, and secondly a higher amount of TDN might have been obtained by grazing lambs if the stubble content of wheat kernels was high. The difference between ration A and ration B in respect to the feed conversion efficiency indicated previously, can be attributed to a difference in net energy of 32 Cal./lb.

of concentrate in favor of ration A.

Data on carcass evaluation as presented in Table 3 show a higher cold carcass weight of 59.4 $\pm$ 5.2 lbs. for group A lambs as compared to 45.7 $\pm$ 5.7 lbs. for group B lambs. This difference in weight can be attributed in part to the two concentrate mixtures utilized, but mainly to the fact that lambs in group A had a higher initial weight than lambs in group B. The difference in dressing percent, though slightly in favor of group A lambs, was not statistically significant.

The grading of carcasses of groups A and B on body conformation and fat deposition revealed a higher grade for group A carcasses than those from group B. Group A carcasses averaged "good +" grade, and a numerical score of 4.4 in comparison to a "good -" grade, and a score of 2.3 for group B carcasses. This difference in carcass grades was felt to be due to the higher initial and final weights of group A lambs in comparison to group B lambs.

The economy per lamb evaluated on basis of U.S. grades is presented in Table 5. Though this system of marketing lambs does not exist in Lebanon, it is followed at the American University of Beirut Farm, where the lambs were slaughtered and their carcasses sold. Due to its higher grade and final cold carcass weight, an average carcass in group A sold for L.L. 100.27, whereas that in group B sold for only L.L. 68.20. When the total cost of lamb production was calculated, it was found that a lesser amount of money was spent to produce a lamb in group B than in group A. This difference in cost was partly due to the lower cost of concentrate B, but mainly due to the initial cost of the lambs (Table 5). However, the total amount left for labor, housing, interest, and net profit per lamb was greater for group A than for group B. The most important contributing factor for this difference appeared to be the grade of the carcass. A "good +" carcass was sold at the rate of L.L. 1.70 per lb., whereas a "good -" carcass was sold for only L.L. 1.48 per lb. The better carcass grades obtained in group A do not appear to be influenced only by the difference in net energy and ingredients of concentrates A and B, but also by the higher initial weights of lambs in group A.

When economy per lamb was calculated on the basis of live-weight and external appearance (Lebanese method), the amounts in L.L. left for labor, housing, interest, and net profit were L.L. 5.12 for group A lambs, and L.L. 5.02 for group B lambs. These amounts are significantly lower than those obtained when carcasses were evaluated on the basis of the American grading system. The rate of L.L. 0.77 per lb. of live-weight used to evaluate the lambs was an average figure of year-round prices. Fluctuations in this rate appear to follow the law of supply and demand.

It is apparent therefore, that a grading system for lamb carcasses similar to the American system should be adopted in Lebanon. If lamb carcass evaluation continues on the live-weight basis as it is at present, it is suggested that the slaughter of lambs for market take place at the maximum age of six months.

One can conclude from such a study that the grazing of lambs on wheat stubble supplemented with a concentrate mixture can result in profitable rates of gain. The fattening of lambs beyond six months of age in Lebanon appears to reduce the net profit from earlier feeding.

Nutritive Value of Dried Beet Pulp for Fattening Lambs

The nutritive value of dried beet pulp and the extent to which it could replace corn in the rations of fattening lambs was studied in Experiment II. The three concentrate mixtures, C, C + B and B which were fed, had a crude protein content of 15.31, 15.33 and 15.35 per cent, and a net energy content of 699, 691 and 683 Cal./lb. respectively. Concentrate mixture C contained 40% corn with no beet pulp, whereas concentrate mixture B contained 40% dried beet pulp and no yellow corn. In the C + B mixture 20% corn and 20% dried beet pulp were added. The remaining ingredients in the three concentrate mixtures were similar. Corn silage was fed as the only roughage to the three groups in equal amounts.

Data as presented in Table 8 indicated that lambs in group B receiving 40% dried beet pulp in their concentrate mixture had the highest gain in this feeding trial. Group B lambs showed an average daily gain of 0.40 ± 0.1 lbs., as compared to 0.38 ± 0.1 lbs. for group C + B and 0.37 ± 0.08 lbs. for group C. Total gains for the whole experimental period were also highest for group B (33.5 lbs.), intermediate for group C + B (32.1 lbs.) and lowest for group C (31.5 lbs.). These results compare favorably with those obtained by Clark et al. (1945), who reported that the inclusion of dried beet pulp in a ration of oats and alfalfa produced the highest gains in three out of four trials. The findings of Maynard and Knaus (1959) were also of a similar nature to those obtained in this study. These workers reported that dried beet pulp had a higher fattening value than grain when fed in combination with grain, bran or mill feed, or with corn fodder or corn silage. They also reported that dried beet pulp protects the animal against indigestion and bloat. This might well be true, since lambs in group B, receiving 40% dried beet pulp in their concentrate mixture, did not suffer from any digestive trouble, while two male lambs from group C died during the experimental period. One lamb from group C + B exhibited signs of sickness and was excluded from the experiment.

Although all lambs were vaccinated against entero-toxemia, the cause of death of these lambs was suspected to be this particular disease, often referred to as "overeating disease". Symptoms observed were dullness, anorexia, stiffness of hind legs and inability to stand up. Post-mortem examination revealed the presence of four to five litres of a straw-colored fluid in the abdominal cavity. The lungs were extremely congested, while the heart, liver and spleen showed a lesser degree of congestion.

The results in Table 8 indicated poorest gains for group C lambs receiving 40% corn in their concentrate mixture. This result is puzzling and contrary to what one expects when feeding corn which has a high net energy. It is suspected that the corn quality fed to group C during the third fortnight period of the experiment could have been very poor, since this corn consisted mostly of the bin scrapings. This view is supported by the fact that when a better quality corn was used during the next fortnight period, the lambs gained at a tremendous average rate of 0.74 lbs. daily, and compensated for the negative gains made during the third fortnight (-0.09 lbs. daily).

The analysis of variance in Table 16 showed no statistical difference in the daily rate of gain for the three groups. This finding indicated the absence of a ration effect on rate of daily gain. The observance of a highly significant difference between sexes is due to a difference in the genetic make-up between male lambs and ewe lambs.

Data on dressing per cent and carcass grades presented in Table 9 showed group B lambs to have the highest dressing per cent of 49.9 and "good" average carcass grade. The dressing per cent in group C + B was slightly lower (49.4), but a similar carcass grade as that of group B was obtained. Group C lambs had the lowest dressing per cent of 48.8 and the lowest grade, namely "good -". Similar results were obtained by Miller _et al_. (1940-41) who produced better carcass grades from lambs fed different types of beet pulp than from controls which received only grain and hay. Since grading of carcasses was based on the amount of fat deposited and on body conformation, it could be maintained that dried beet pulp had a higher fattening value when compared to that of grains. This is in agreement with the results of Maynard and Knaus (1959) who found that dried beet pulp had a higher fattening value than grain when fed in combination with grains, bran or mill feed.

The most economical gains were made by lambs in group B, as is indicated in Table 10. Maynard (1935) reported that the highest and most economical average daily gains were obtained when lambs received 0.75 lbs. each, of dried beet pulp with their basal ration of barley, alfalfa hay and salt. Results obtained in this experiment confirm the report by Maynard (1935), since group B lambs which made the most economical gains were receiving each 0.79 lbs. of dried beet pulp daily.

Feed cost per 100 lbs. of gain per lamb in group B, C + B and C were L.L. 41.49, 47.79 and 52.70 respectively. This difference in cost is mostly due to a difference in price between one unit of corn and one unit of beet pulp. Clark _et al_. (1945) reported a feed cost per 100 lbs. of gain of $8.04 (L.L. 24.92) in case of lambs fed oats and alfalfa hay alone, and $7.12 (L.L. 22.07) for lambs fed dried beet pulp in addition to oats and alfalfa. These figures appear to be very low as compared to those obtained in this study. This large difference is probably due to the higher cost of feeds in Lebanon, as most of them are imported from other countries. Also to be considered is the fact that Clark et al. reported their findings in 1945, and world-wide inflation has raised costs tremendously for most commodities during the eighteen years which have passed since. When the results of this experiment and those of Clark et al. (1945) are compared, it becomes evident that in both studies the inclusion of dried beet pulp reduced the feed cost per 100 lbs. of gain.

Data on the economics of lamb production as presented in Table 11 are very encouraging. When carcasses were evaluated on the basis of U.S. grades, the gross profit per lamb in groups B, C + B and C for labor, housing, interest, and net profit, was L.L. 24.01, 18.18 and 10.76 respectively. It is seen from these results that an average lamb from group B yielded more than double the gross profit given by an average lamb in group C.

The difference in the average cold carcass weight (Table 9) between groups B, C + B and C is due to the respective final live-weight obtained in these groups. The difference in grade however was based on the extent of fat deposition and on body conformation.

The economy per lamb when marketing was based on live-weight (Table 12) also indicated a similar pattern as when the carcasses were graded. The gross profits covering labor, housing, interest, and net profit were L.L. 11.90, 8.77 and 7.88 per lamb for groups B, C + B and C respectively.

These amounts are almost half as much as those realized when the carcasses were graded and then marketed. This clearly demonstrates the necessity of introducing a system of marketing lambs on the basis of grades rather than on live-weight as presently done in Lebanon.

In an analysis of feed efficiency for the three groups (Table 13), it was found that group B lambs consumed the least amount of feed (4.97 lbs. of concentrate and 3.18 lbs. of corn silage) to produce one lb. of gain. In comparison, a lamb from group C + B consumed 5.16 lbs. of concentrate and 3.32 lbs. of silage, and that from group C 5.17 lbs. of concentrate and 3.40 lbs. of silage per lb. of gain. The poor feed efficiency found in group C can be attributed to the negative gains produced during the third fortnight of the experimental period which possibly is due to poor quality of the corn consumed during that period. Table 13 also showed that the most economical gains were obtained during the early age of the lambs. The exceptionally low feed efficiency during the last two-week period in case of group C + B, might be attributed to the fact that the feed allowance of this group was reduced during that period in an effort to equalize the amounts of concentrate and silage consumed by each group during the whole experimental period. The two-week gains per lamb during this period were only 0.13 lbs. for group C + B as compared to 3.8 lbs. for group C and 4.6 lbs. for group B.

The vitamin A levels of blood serum and liver of lambs (Tables 14 and 15) indicated that the levels were quite adequate for optimal growth This finding was to be expected since lambs in all three groups received much more vitamin A in their feed than the minimum daily requirement of 1,000 I.U. per 100 lbs. of body weight recommended by the National

Research Council (1949). The results obtained for serum vitamin A appeared to follow a different pattern than those obtained for liver vitamin A in the three groups studied. While serum vitamin A was highest in group B lambs, liver vitamin A was lowest for the same group. This interesting feature substantiates the conclusions in the literature surveyed, that liver vitamin A is a more reliable measure of vitamin A status in the body than serum vitamin A.

Large variations in serum and liver vitamin A levels were observed within the three groups studied. These variations may possibly be attributed to individual variability from one animal to another, since all lambs in the three groups were provided with identical conditions of management.

SUMMARY AND CONCLUSIONS

Two lamb-fattening experiments using the local fat-tailed Awasi sheep were conducted at the American University of Beirut Farm. The purpose of the first experiment was to study the value of two different concentrate mixtures when wheat stubble was the sole source of roughage. The second experiment was designed to study the nutritive value of dried beet pulp, and the extent to which it could replace corn in lamb-fattening rations.

In the first experiment, lambs receiving concentrate mixture A, in which corn constituted one of the major energy ingredients, gained slightly better than lambs receiving concentrate mixture B, in which dried beet pulp was one of the major energy ingredients. Daily gains of 0.40 ± 0.07 lbs. and 0.36 ± 0.09 lbs. were obtained for lambs in groups A and B respectively, this difference in daily gains being statistically non-significant. Since both groups were of similar age but different initial weights, the observed average daily gain figures were corrected by the use of regression of daily gain on initial weight. The corrected daily gain figures of 0.38 ± 0.07 lbs. and 0.39 ± 0.08 lbs. for groups A and B respectively, showed no influence of initial weight on the rate of daily gain.

The dressing per cent and the carcass grades were found to be slightly higher for group A lambs than for group B lambs; however, no statistically significant difference was observed.

It can be concluded from this experiment that:

(i) Dried beet pulp can effectively replace part of the corn in lamb-fattening rations.

(ii) Wheat stubble can be utilized for fattening lambs on condition that it be supplemented with a high-energy concentrate mixture.

In the second experiment, three groups of lambs were fed concentrate mixtures with variable constituents as follows: group C received 40% corn with no dried beet pulp; group C + B received 20% corn and 20% dried beet pulp, and group B received 40% dried beet pulp but no corn. All remaining ingredients were similar in all three concentrates. In addition to the feeding of concentrate mixtures all lambs were fed an identical amount of corn silage for the total experimental period.

Group B lambs obtained the highest daily gains of 0.40 $\pm$ 0.1 lbs., as compared to 0.38 $\pm$ 0.1 lbs. in case of group C + B and 0.37 $\pm$ 0.08 lbs. for group C lambs. The difference, however, between these groups was not statistically significant. Male lambs in all groups had a significantly higher daily gain than ewe lambs.

Lamb carcasses for group B had the highest dressing per cent of 49.9 $\pm$ 1.6 with an average of "good" grade. Carcasses from group C + B had the same grade as that of group B, but a slightly lower dressing per cent of 49.4 $\pm$ 2.5, and carcasses from group C showed the lowest dressing per cent of 48.8 $\pm$ 1.5, with a lower average carcass grade of "good-". The difference, however, between the dressing percentages of the three groups was not statistically significant.

The most economical gains were made by lambs in group B with a feed cost of L.L. 41.49 per 100 lbs. of gain. The highest feed cost per 100 lbs. of gain (L.L. 52.70) was incurred by group C lambs, whereas lambs in group C + B were intermediate in their feed cost, averaging L.L. 47.79.

When the economy per lamb for this experiment was studied on the bases of grades and also live-weight, it was found that group B lambs were the most profitable. Each lamb from group B produced a gross profit of L.L. 24.01 for covering labor, housing, interest, and net profit, when the carcasses were marketed on the basis of U.S. grades. On the other hand, a lamb from group C + B yielded an amount of L.L. 18.18, and that from group C only L.L. 10.76 for covering the same items. On the basis of live-weight, an average lamb from groups B, C + B and C yielded L.L. 11.90, 8.77 and 7.88 respectively, for covering labor, housing, interest, and net profit.

Liver and serum vitamin A were found to be adequate for optimal growth in all lambs, however, wide individual variations existed.

It can be concluded from this experiment that dried beet pulp can be used very effectively to replace an equivalent amount of corn grain comprising upto 40% of the total ingredients in lamb-fattening concentrate mixtures.

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