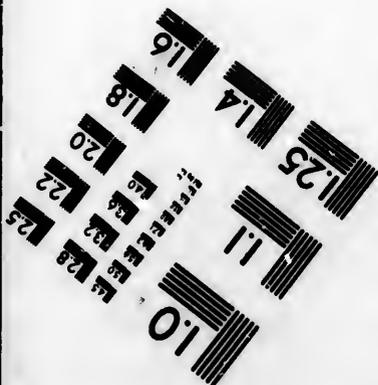
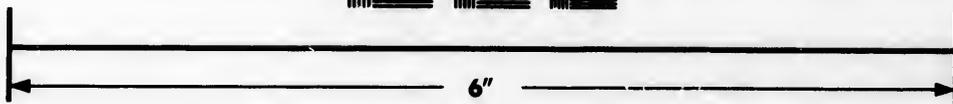
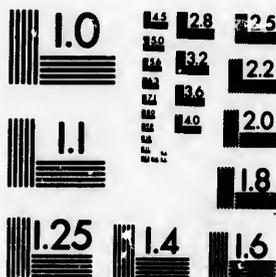


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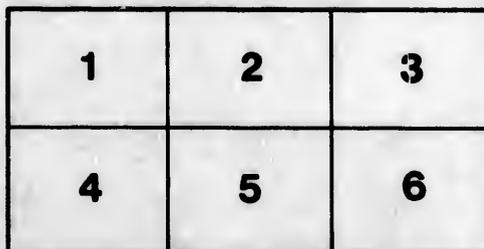
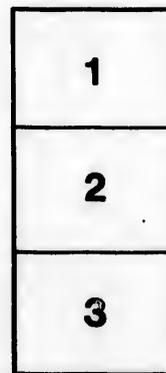
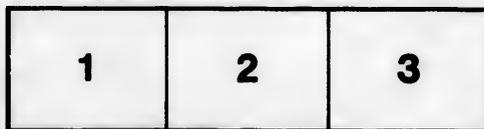
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BULLETIN LXXVII.

FATTENING LAMBS.

BULLETIN LXXVIII.

FATTENING LAMBS FOR THE BRITISH MARKET.

BY THOMAS SHAW, PROFESSOR OF AGRICULTURE, AND
C. A. ZAVITZ, B.S.A., EXPERIMENTALIST.

PUBLISHED BY THE DEPARTMENT OF AGRICULTURE

August 15th, 1892.

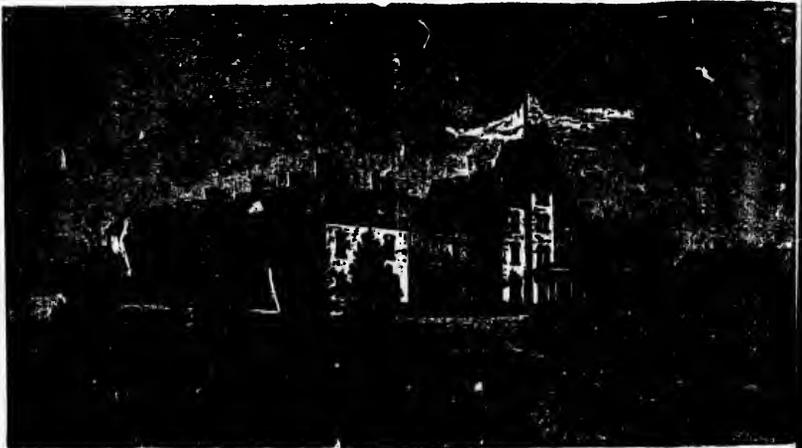
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BULLETIN LXXVII.

FATTENING LAMBS.

A large acreage of rape has been grown at this station for two years past. It has been grown for the two-fold purpose of cleaning the land and of providing pasture for sheep and lambs in the autumn. The growth of the rape has necessitated the purchase of a large number of lambs during both seasons to feed it off. For this purpose 666 lambs were purchased in the autumn of 1891 and brought to the station. There was also the further object in view of continuing the fattening process in different ways during the winter months as might be thought best. In the Annual Report for 1891, p. 139, the number purchased is given as 676, but the reference there includes ten lambs bought of necessity and sold again without bringing them to the station, on the ground of unsuitability. They are in no way mixed up with the lot in this bulletin.

The particulars relating to the purchase of these lambs are summarized as below :

Date of purchase.	Where bought.	Cost when laid down at the station.
Aug. 29,	200 lambs in Eastern Ontario.....	\$ 669 10
Sept. 14,	200 lambs in Prince Edward Island.	552 61
Oct. 7,	162 lambs in Prince Edward Island	483 98
" 20,	104 lambs in Toronto	391 65
Total.....		2,097 34

The cost of the purchase and carriage of the 362 lambs from Prince Edward Island to Guelph averaged 95c per head, or 49½ per cent. of the purchase price of the lambs, the distance being from 1,100 to 1,200 miles between the two places.

The chief of the reasons which led to the purchase of the lambs at so great a distance include the following :

1. To encourage in all parts of the Dominion the finishing of lambs in finer form than is usual. In nearly all parts of Canada, and more especially in the outlying portions, it is the practice to put lambs upon the market in the late summer or the early autumn months, with no other finish than that furnished them by pastures which are oftentimes ill-adapted to the purpose.

2. To demonstrate that such lambs as we have at present can be so handled that they will bring a price much in advance of that ordinarily obtained for them. When nearly all farmers who own lambs sell them in an unfinished condition, and at or near the same time, the price received for them is in consequence discouragingly

low. But while we seek further improvement in the mode of handling such lambs as we have, we are convinced at the same time that every reasonable effort should be made to improve the breeding of our lambs, which manifestly is far from what it ought to be.

3. To demonstrate the helpfulness of rape as an aid in fattening lambs, whether they are to be sold at the close of the pasturing season or carried on into the winter months and sold in completer form and at higher prices. The growing of rape in Ontario is as yet understood by but a limited number of farmers, while in the other provinces of the Dominion it is known to scarcely any extent.

Character of the lambs. The lambs purchased in eastern Ontario were a fairly good lot though small in size, as will be seen by reference to the average weights given below. The lambs from Prince Edward Island were light and small. Some of them showed traces of the Down cross. Those purchased in the Toronto market were larger in body than the lambs bought in eastern Ontario, and leaner in flesh. They were much mixed in breeding and variable in character. In the lots from Prince Edward Island and Toronto were 164 rams. These were all castrated soon after their arrival, and but one died in consequence of the operation.

Management on arrival. The lambs bought in eastern Ontario which arrived at the station on August 29th, were weighed singly on September 2nd, and were ear-tagged at the same time. On September 16th they were put upon the rape. The first lot from Prince Edward Island arrived September 14th, and were put upon the rape September 17th. On September 26th they were ear-tagged and weighed singly. Owing to the long transit to which they had been subjected, it was thought unfair to weigh them sooner. The second lot from Prince Edward Island arrived October 7th, and were ear-tagged and weighed and put upon the rape October 15th. Those bought in Toronto which arrived October 21st were weighed on their arrival and were at once put upon the rape, with the exception of the newly castrated rams. The lambs of the previously mentioned lots were fasted from 15 to 18 hours before they were weighed.

The average weight of the lambs in each group when weighed at the dates mentioned, and the average cost per pound of live weight when laid down at the farm, are given in Table 1.

Date of weighing.	Place where bought.	Average weight of each lamb.	Average cost of each lamb.	Average cost per lb. of live weight.
		lb.	\$ c.	c.
Sept. 2..	Eastern Ontario	67.54	3 35	4.96
Sept. 26..	Prince Edward Island	53.18	2 76	5.19
Oct. 15..	Prince Edward Island.....	59.70	2 99	5.08
Oct. 20..	Toronto.....	77.74	3 76	4.83

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Average cost of ch lamb.	Average cost per lb of live weight.
\$ c.	c.
3 35	4.96
2 76	5.19
2 99	5.08
3 76	4.83

The prices paid, therefore, including the cost of purchasing and of transit were relatively dear. The prices given for lambs when the first three lots were purchased were comparatively high, hence the serious losses to dealers who were bound to lift the lambs before the holiday season. The lambs were allowed to remain upon the rape until it was all eaten. They had access at will to an old pasture, a part of it being woodland, the thick underwood of which afforded some protection for the lambs in times of the early snows. As many as 500 fed in one field at one time and these are the lambs shown in the sketch published in the Annual Report for 1891, p. 103.

The rape crop included 40 acres grown in drills and 6 acres grown as a catch crop after winter wheat. A crop of rye cut for fodder and for the silo in June preceded the 40 acres of rape grown in drills. (See Annual Report for 1891, p. 53.)

Winter quarters. A lot of 100 lambs were shorn Oct. 13th to 16th and put into winter quarters at night and on stormy days. They were pastured on rape on fair days and had the same carted to them on stormy days. Another lot of 20 lambs were separated on Nov. 28th to be fed for experiment as shorn against unshorn. Full particulars will be given regarding these two lots in future bulletins.

The remainder were put into winter quarters on Dec. 10th. We found it necessary to provide additional shelter. For this purpose old fence lumber was used. Sheds were erected involving but little cost and labor. Each shed had a yard in front and there were more than 150 lambs in each shed. They were too much crowded or doubtless they would have done better.

The lambs were weighed on Dec. 10th. We were strongly advised to sell them at that time, but owing to a glut in the market we could not obtain an offer of more than $4\frac{3}{8}$ cents per pound for immediate shipment. On January 1st 1892 we refused an offer of $5\frac{1}{2}$ cents per pound live weight on the whole lot to be delivered at once. The difference between the first and second of these offers in the aggregate value of the lambs is \$575, not taking into the account food, manure and attendance for the 21 intervening days. The aim therefore should be when fattening lambs to have them ready for market at that season of the year when good prices are given. In future, this season is more likely to be the months coming after the opening of the year rather than those preceding it.

Food and Feeding. The food given to the lambs consisted of hay, some oats in the sheaf, roots and a grain ration of oats and peas fed whole. The lambs in the experiments already mentioned were given in addition a small proportion of bran and some ensilage. The hay was clovery and it was fed uncut. The roots were sliced and they consisted of turnips only. But two feeds were given per day and water was given in troughs daily. Salt was liberally supplied.

Estimated value of the Food. The fodder, the grain and the roots were estimated at the current market values in Guelph, less the cost of marketing from an Ontario farm under average conditions. (See Bulletin LXVIII, p. 5.) The home value, therefore, put upon the hay was \$9 per ton, the unthreshed oats \$6, the roots sliced 6 cents per bushel, the oats 26 cents, and the peas 50 cents. The bran was valued at \$14 per ton and the silage at \$2.

Food consumed. The amount of food consumed by the lambs, not including the rape, from the time they reached the farm until they were delivered for shipment, and the respective values of the same are as follows :

Food.	Value.
Hay, 54,396 lb	\$244 78
Oats in sheaf, 4,040 lb	12 12
Oats, 57,332 lb	438 42
Peas, 11,458 lb	105 03
Bran, 3,212 lb	22 48
Roots, 128,774 lb	128 77
Silage, 9,050 lb	9 05
Total	\$960 65

Disposal of the Lambs. The lambs were delivered for shipment as stated in Table II below :

Dates of sales.	Markets.	No. of lambs in each sale.	Weight of each group sold.	Price per lb.	Total value of each group.
			lb.	c.	\$ c.
January 8	Buffalo	160	13,573	5½	746 51
March 8	Ontario	50	3,340	5½	187 87
March 9	Halifax	126	11,450	5½	644 06
April 12	Halifax	63	5,900	6	354 00
May 9	England	99	13,103	7	917 21
April 26	Ontario	99	8,660	6	519 60
April 12	Halifax	20	2,738	7	191 66
	Ontario	26	68 50
	Ontario	17 (skins)	12 75
	Died on transit or strayed.	6
Total					\$3,642 16

The lambs which are represented as having been sold at a low price in the home market were ill-doers. From the 23 lambs which died on transit or afterwards, the only revenue was that obtained from the skins of 17 head, while they are all charged against the experiment. It will also be observed that the price received increases with the advance of the season. The figures in the right

and the roots less the cost of the sheep. (See also upon the value of the cull lambs not yet delivered and those sent to England. The price put upon the latter, as stated in the table is 7 cents per pound, since we refused an offer of that amount from Mr. L. O. Barber, Guelph, on April 12th for immediate shipment. At that date Mr. Barber, who bought all the different lots except the culls, paid us 7 cents per pound for a lot of 20 lambs very similar in quality. We refused the offer for the reason that the lambs had been fed for the British market.

by the lambs, the farm until values of the

Value.
\$244 78
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\$960 65

for shipment

Price per lb.	Total value of each group.
c.	\$ c.
5 1/2	746 51
5 3/4	187 87
5 1/2	644 06
6	354 00
7	917 21
6	519 60
7	191 66
.....	68 50
.....	12 75
.....	<hr/>
.....	\$3,642 16

sold at a low price for 23 lambs which were obtained from the farm and charged against the price received in the right

hand column of Table II, as also those previously given relating to the cost of the lambs have been compiled from the books of the bur-sar, from which source they can easily be verified. This is mentioned because of statements made more than once that feeding these lambs was a losing game. The only exceptions are found in the case of ten cull lambs not yet delivered and those sent to England. The price put upon the latter, as stated in the table is 7 cents per pound, since we refused an offer of that amount from Mr. L. O. Barber, Guelph, on April 12th for immediate shipment. At that date Mr. Barber, who bought all the different lots except the culls, paid us 7 cents per pound for a lot of 20 lambs very similar in quality. We refused the offer for the reason that the lambs had been fed for the British market.

Table III contains a financial summary covering the whole trans-action :

Cost of the lambs when bought.....	\$2,097 34
“ shearing 120 lambs	5 40
“ food, including rape and pasture	1,316 25
“ attendance.....	125 00
Total cost.....	<hr/> \$3,543 99
Value of lambs when sold.....	\$3,642 16
“ “ wool.....	56 60
“ “ manure	577 12
Total value	<hr/> \$4,275 88
Gain.....	731 89
“ per lamb	1 10

The net cash actually received for the 99 lambs shipped to Eng-land would reduce the above gain by \$132.10.

The 120 lambs included in the item cost of shearing were shorn for experimental purposes. All the food given to the lambs from first to last is charged against them. The estimate put upon the rape was the cost of the cultivation as given on page 6, Bulletin LX. This makes the cost of growing the rape \$8.46 instead of \$11.77 as stated in the aforementioned bulletin, owing to the difference in the amount of the manure applied. The cost of producing the six acres grown as a catch crop was estimated at \$1.20 per acre, as nearly all of it was sown broadcast and after the necessary autumn plowing of stubble land. It should be remembered that all the rape grown was a second crop taken from the land during 1891, and that the cultivation given to it left the land in a very clean condition. The whole time of one person was occupied in caring for the lambs, but more than one-half of it was taken up with those under experiment. But we have charged a little more than half the wages actually paid, against the lambs, to make sure no undue favor would be shown where the exact apportionment is an uncertain element.

The manure was valued at half a cent per day per lamb. This estimate is much lower than the value put upon the manure produced by sheep and lambs by experiment stations which have made this question the subject of careful investigation. But we desire to put these things moderately, as samples of the manure made by the lambs sent to England are now being analysed, we hope to speak more authoritatively in reference to this matter in the following bulletin. As in former bulletins, no account is taken of interest on money, rent of land, exhaustion of natural fertility, or of the increased value resulting from the cleaner tillage of the land.

We now give a concise summary statement of the whole transaction without considering the value of the rape eaten, the cost of attendance or the value of the manure :

Total cost of 666 lambs when laid down	
at Guelph	\$2,097 34
Cost of shearing	5 40
" food	960 65
	Total cost
	\$3,063 39
Total value of 666 lambs	3,698 76
Net gain on 666 lambs	635 37
" per lamb	0 95

CONCLUSIONS.

1. That the average grade lamb of the Dominion is an animal much inferior to what it ought to be and to what it may be made.
2. That rape furnishes an excellent pasture for fattening lambs and an easy means of manuring the land.
3. That pasturing lambs on rape is an excellent preparation for winter fattening.
4. That it is easily possible to fatten a large number of lambs upon the food grown upon a limited area when the work is judiciously done.
5. That where the facilities are at hand one attendant can care for a large number of lambs fattened on the lines followed in this experiment.
6. That in fattening lambs it is important to be able to carry them on past that autumnal season when the market is most liable to be glutted.
7. That in fattening lambs a substantial profit may be made even from such lambs as we have, when the work is done on the lines indicated in this bulletin.

BULLETIN LXXVIII.

FATTENING LAMBS FOR THE BRITISH MARKET.

This experiment commenced with the arrival of the lambs at the farm in the months of September and October, 1891. The whole lot of lambs purchased are more fully described in bulletin LXXVII which treats of "fattening lambs." It closed when the lambs were sold in Liverpool shortly after the middle of May of the present year. They left the farm for the British market on May 11th. It was intended to be substantially a repetition of the experiment the particulars of which are given in Bulletin LXIX. The principal objects of the experiment were to ascertain, (1), whether lambs can be fattened at a profit in the autumn and winter for the English market, and (2), whether the average grade lambs of Ontario and Prince Edward Island are suitable for the purpose.

THE ANIMALS SELECTED. The lambs from which those intended for shipment were selected were purchased by Mr. J. E. Storey, the farm foreman, in the eastern part of Ontario, and in Prince Edward Island. There were purchased in all 666 grade lambs, of which 200 came from eastern Ontario, 362 from Prince Edward Island, and 104 from Toronto. The selections for this experiment were made from the eastern Ontario and Prince Edward Island lambs, 55 from the former lot and 45 from the latter. The lambs were a mixed lot and somewhat below the average of Canadian grade lambs in quality, as will be apparent from the weights given further on. They evidently possessed but little improved blood, and were considerably below what the standard lamb of Ontario should be. In selecting, the preference was given to those having dark faces, although a considerable number were not of this class.

CONDITIONS GOVERNING THE EXPERIMENT. The lambs selected from the lot purchased in eastern Ontario were weighed on September 1st, two days after their arrival at the farm. Thirty-seven of those selected from Prince Edward Island were weighed September 26th, twelve days after their arrival, and the remaining from the same place on October 15th, eight days after their arrival. The average weight of the Ontario lambs was 77.5 lb., and of those from Prince Edward Island 67.9 lb. They were all ear-tagged on their arrival at the farm, hence the behavior of each

lamb. This manure pro- which have on. But we the manure sed, we hope matter in the is taken of ertility, or of the land. the whole ten, the cost

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May 11th, exclusive of a very limited quantity of rape given them for a limited period at the first, was :

Grain.....	1.68 lb.
Roots and ensilage.....	2.54 "
Hay.....	1.27 "
<hr/>	
Total.....	4.87 lb.

ESTIMATED VALUE OF THE FOOD. The food was estimated at the current market values in Guelph, less the cost of marketing from an Ontario farm under average conditions (see Bulletin LXVIII). The home value put upon the food by this mode of reckoning was: Oats 26 cts. per bushel; peas 50 cts.; bran \$14 per ton; roots, sliced, 6 cts. per bushel; ensilage \$2 per ton; and hay \$9 per ton. It will be observed that in all probability a profit has already been made on the marketable food used, providing it has been grown upon the farm, as in this experiment the food was charged at the full market values, less the cost of marketing from an average Ontario farm. This profit would be represented by the difference between the cost of growing the food and the market value put upon it.

WEIGHTS. Table I gives a summary and an analysis of weights :

	The lambs from Eastern Ontario.	The lambs from P. E. Island.	The whole lot of 100 lambs.
	lb.	lb.	lb.
Total aggregate weight at commencement.....			7,322
" aggregate weight at close.....			13,218
" increase in weight.....			5,896
Average individual weight at commencement .	77.50	67.90	73.20
" " the close	134.90	128.80	132.20
" " increase			58.96
" " daily increase.....			.25
" increase per month	6.78	9.99	8.39
" " " while on rape.....			8.51
" " " on a winter ration			7.72
" " " without fleece.....			7.40
" " " with fleece.....			7.85

It will be observed that the lambs brought from Prince Edward Island increased more rapidly in weight than those from eastern Ontario, although they were lighter at the outset. They were some-

what leaner in flesh when the experiment started, and this may furnish the explanation. In any case the gains were very satisfactory for the food consumed.

TRANSPORTATION. The lambs were put on board the cars at Guelph on May 11th, en route for Liverpool. They left in charge of the farm foreman, Mr. J. E. Storey, who accompanied them as far as Montreal, put them on board an ocean steamer along with the food necessary for the voyage, and secured a competent feeder to care for them on the way.

One of the lot had been sold before the date of shipment to a local butcher, as it was deemed unsuitable for the foreign market. The price obtained was \$5. The whole number sent over therefore was 99. They all stood the voyage well and arrived in Liverpool in good condition.

DISPOSAL OF THE LAMBS. On arriving in Liverpool the lambs were taken in charge by Mr. G. F. Frankland, ex-alderman of Toronto, who found a ready market for them. They brought the highest prices that were then being paid for choice lambs, although the beef market at that time was in a very depressed condition.

In regard to them Mr. Frankland reported: 1. That they sold well in competition with the best mutton of Wales and Scotland. 2. That while sheep brought alive from South America sold for but 6d. per pound, dressed weight, these lambs brought 8½d. per pound. 3. That they were sold to the highest bidder, a leading butcher of Manchester, for £2 7s. 6d. each. 4. That they were carefully examined by dealers who pronounced favorably upon their merits, and that they were much admired by people of various classes. In reference to this Mr. Frankland says, "You would have rejoiced to have seen the droves of good men from 30 to 80 years of age examining your lambs."

VALUES. Table II gives the financial results of the experiment

	Value
Cost of 100 Lambs when landed in Guelph.....	\$ 368
" shearing.....	5
" food.....	380
" attendance.....	25
" shipping to England.....	357
Total cost.....	1,137
Value of 99 lambs in England.....	1,141
" 1 lamb in Ontario.....	5
" wool.....	44
" manure.....	237
Total value.....	1,428
Total gain.....	291
Gain per lamb.....	2

The value put upon the lambs at the commencement of the experiment was the actual cost per pound when laid down at the farm. The actual weights were taken as the basis of computation, and the price per pound charged was the average paid for the lambs from Ontario and Prince Edward Island respectively. The cost of shearing was put at 5 cents per animal.

All the food consumed from the time of the arrival of the lambs at the farm until they landed at the Liverpool docks was charged at market values, less the cost of marketing, as previously stated in detail. The cost of growing the rape was put at \$8.46 per acre. In Bulletin LX. the cost of growing an acre of rape is put at \$11.77. In that estimate however a liberal quantity of manure is supposed to have been used, while in the present instance no manure had been applied to the greater portion of the land for the past six years, and a portion of the rape grown was a catch crop. The basis of computation in both instances is exactly the same. The hay which was the most expensive item of food, was charged at twice the price put upon it in the corresponding experiment of the previous year, owing to the advance in market values. The other food factors were not materially different in price.

The cost of attendance in the corresponding experiment of the previous year was an estimate. In the present instance it is based upon actual experience in caring for the lambs. One man cared for over 600 lambs so long as that number was here on the farm, and about half of his time while thus engaged was spent in work of a purely experimental character. We therefore feel safe in assuming that one man will feed and care for 800 lambs when the food is all prepared. The cost of sending the lambs to England and of selling them there was \$357.69 or \$3.61 per head, which was 56 cents per head less than in the corresponding experiment of 1891. The following are the items:

Railroad freight charges to Montreal	\$61 10
Charges of stock yards	4 91
Wharfage	3 28
Loading on ship	2 25
Caretaker on ship	10 00
Food sent from Guelph	19 98
Hay purchased in Montreal	14 95
One hatchet and one fork	1 15
Expenses Mr. Storey, farm foreman	14 30
Ship's freight and charges including insurance . .	170 10
Market charges	2 43
Keep and lairage, nights	7 05

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Droving	3 03
Dock charges.....	7 29
Dues and entry	2 06
Gifts	1 21
Commission for selling, 9d. each	18 03
Cash to Mr. Frankland.....	14 57
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Total.....	\$357 69

The selling of the lambs in England was purely a commercial transaction and was done on a strictly commercial basis, that is to say, they were sold in the open market and in the ordinary way to the highest bidder.

The autumn shorn wool averaged 3.41 lb. per fleece, unwashed, and sold for 13 cents per pound. The manure made by the 100 lambs was accurately weighed during the continuance of a sub-experiment which lasted for four months. The quantity for the balance of the time was computed from the data thus furnished. The amount made during the four months was 34.867 tons, which would give 69.516 tons as the amount made during the whole period. The average amount therefore made per day by each lamb was 5.81 lb., which on the basis of the valuation given below would be worth .993 of a cent or practically one cent a day. This includes bedding which was not weighed separately. In the corresponding experiment last year the manure was valued at $\frac{2}{3}$ cts. per day per lamb.

Prof. A. E. Shuttleworth, the chemist of the station, made a careful analysis of the manure and handed to us the following report in regard to the analysis, and also to the value of the manure. Organic nitrogen, 12 lb. per ton, worth 17 cents per pound. Total phosphoric acid, 16.8 lb. per ton, worth 3 cents per pound. Muriate of potash, 19.4 lb. per ton, worth $4\frac{1}{2}$ cts. per pound. The commercial value of the manure therefore is \$3.42 per ton. By commercial value we mean the value based upon the market prices charged for the three ingredients mentioned when purchased in the form of artificial fertilisers. Since we have stated the amount of the manure made the reader is given the opportunity of attaching that value to it which may seem proper to him. And here we desire to emphasize the fact, that these lambs were sold in Liverpool at a cash profit as stated below, without taking into account the value of the manure

The average individual value of the lambs at the commencement of the experiment was.....	\$3 67
The average price for which they sold in Liverpool.	11 53
The average advance in value therefore was....	7 86
The cash profit which they brought in England without accounting for the manure was....	53 67
Or a cash profit per head of.....	54

The variations in the prices offered for lambs during the past season will be clearly apparent from the following statement :

The price offered per pound live weight for our lambs in Guelph

On December 10th, 1891, was.....	4 $\frac{3}{8}$ cts.
On January 1st, 1892	5 $\frac{1}{2}$ cts.

The various lots disposed of brought the prices mentioned on the respective dates given, viz. :

Toward the close of January.....	5 $\frac{1}{2}$ cts.
In February	5 $\frac{3}{8}$ "
Early in April.....	6 "
At Easter	7 "
In England (May).....	8.74 "
Equivalent to, in Canada.....	6 "

The above statement points to the importance of trying to so arrange our plans that we will not of necessity have to sell on a market of slaughter prices. Such a market is manifestly more likely to occur before the holiday season than after it for some years to come, owing to the relatively small number of lambs held over for winter fattening.

CONCLUSIONS.

1. That grade lambs can be purchased in eastern Ontario and Prince Edward Island respectively, shipped westward more than 300 miles in the one case and 1,100 miles in the other, fattened and then disposed of in England at a substantial cash profit.
2. That the average grade lambs of Ontario are well adapted for the above purpose.
3. That lambs shipped to England should sell for an advance of about 2 cents per pound live weight on the prices obtainable in Ontario to secure an equal profit.
4. That lambs may be fattened in winter in considerable numbers with but a small percentage of loss from disease or accident.
5. That grade lambs similar to those fed in this experiment can be fattened in good form in winter, when fed daily the following ration : Grain (oats and peas) and bran in the proportions of 2, 2 and 1-1.06 lb ; roots 2.54 lb. ; and hay 1.27 lb., or a total of 4.87 lb. per day.
6. That the ration given in the above conclusion gave an average daily increase of $\frac{1}{4}$ lb. in live weight.
7. That a ration of rape pasture only, gave a larger increase per day in live weight than the winter ration used in this experiment.

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