# GRADING OF LAMB AND MUTTON CARCASSES

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SUMMARY

The New Zealand export and local consumption grading systems for lamb and mutton carcasses are described in relation to the objectives of a grading system. Export grading results on 1,272 lamb carcasses have been used to illustrate objectively the differences between grades in the 1965-6 and 1966-7 seasons prior to amalgamation of the two North Island Prime grades. The effectiveness of the lamb export grading system is discussed and the introduction of a new Prime grade containing the fatter carcasses is suggested.

THE OBJECTIVES of a carcass grading system can be twofold (Kirton, 1966a). One objective common to all systems is to classify carcasses so that purchasers may be able to rely on getting an article always answering the same description by reordering from the same grade. In the meat industry this classification is usually done on the basis of age, weight, shape (conformation), composition (fat cover) and sex. The New Zealand grading systems for lamb and mutton achieve some success in this regard. The second objective is to allow for differences in quality between the different grades, where quality can be defined as one or more of cutability, red meat content, or eating quality. Some grading systems achieve the second objective to an extent but by and large the names or descriptive terms applied to the various grades tend to rank the carcasses in the opposite order to any scientific measurements of meat yield and can mislead customers and butchers who mainly accept the names at face value (Kirton, 1969).

Two meat grading systems exist in New Zealand. In the "local consumption" system, the grading is carried out by meat inspectors of the Department of Agriculture according to specifications laid down by the N.Z. Standards Institute (Anon., 1962). The Standards Association of N.Z. is currently revising these standards. Under the export system, carcasses are graded by employees of the freezing works who are checked for uniformity by Supervising Meat Graders of the N.Z. Meat Producers' Board (Smith-Pilling, 1959) to maintain standards which have no written specification.

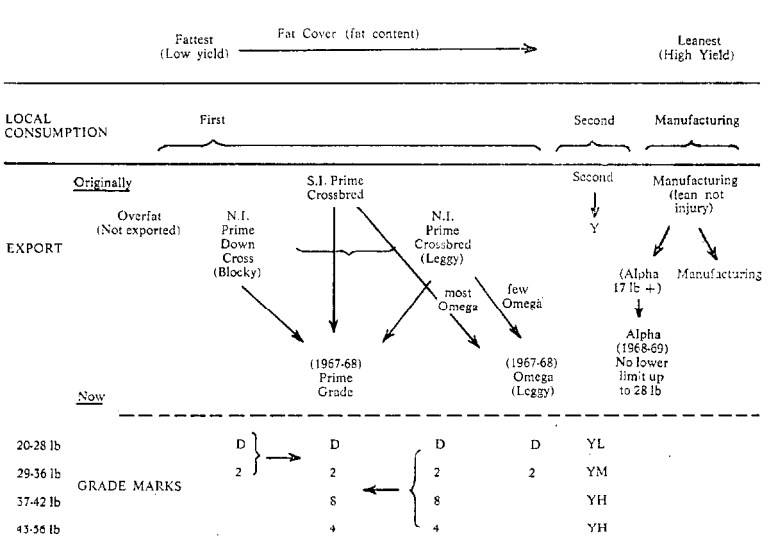
As carcass grading is done subjectively, grade parcels with a given name may slowly change in content with

time, either unconsciously, or in response to market pressures, to the extent that meaningful market information is available and can reach those responsible for laying down grade standards. Objective information on the composition of carcasses in the different lamb and mutton grades in New Zealand has been given by Clarke and McMeekan (1952), Barton (1960), Kemp and Barton (1966), and for New Zealand lamb carcasses graded by United States grade standards by Kemp and Barton (1969). Such studies are dependent on the size and accuracy of the samples taken. Results could be influenced by the method of selection in experiments where meat trade members have been involved in the selection process or where samples are taken over a short period in the season.

The basic factors taken into account in lamb grading, the grade names and an indication of some recent changes are given in Table 1. For local consumption, the fat cover of carcasses and for export, the fat cover and the weight

TABLE 1: NEW ZEALAND LAMB CARCASS GRADES

(Sheep less than 12 months of age)



are the main bases for classification with conformation ("legginess") being of importance in the Omega grade. The latter comprised only 0.1% of North Island and 1.8% of South Island lamb carcasses in the 1967-8 season (Ormond and Vogtherr, 1969). The numbers of grades in use are also indicated in Table 1. A recent survey has suggested that the descriptive terms and striping system used in local consumption grading are misleading butchers and consumers (Kirton, 1969). Another criticism that can be made of this system is that the only place for overfat lamb carcasses is in the first grade. However, the current review of this system may result in a solution to some of these problems.

In spite of its subjective nature, the export grading system seems to be relatively satisfactory, having moved away from the use of misleading grade names and including a subdivision of grades on the basis of weight (Table 1). Thus a British butcher can specify that he wants YM carcasses and will know without inspection that he is getting lean carcasses in the weight range of 29 to 36 lb. As lamb is still mainly sold in carcass form, the relative prices paid overseas for the respective grades can be reflected in the prices paid to New Zealand farmers, thus indicating the type of carcass the market requires. There is some evidence that this is now starting to happen.

TABLE 2: NEW ZEALAND HOGGET AND MUTTON GRADES

| | Fat Cover (fat content) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Fattest (low yield) | | | | Leanest (high yield) | | |
| LOCAL CONSUMPTION | Hogget | Mutton | First grade Third | First | Second | Third | Manufacturing (includes ram carcass) |
| | | | Prime | | F.A.Q. (second) | | |
| EXPORT | Manufact. | | Hogget | Wether | Ewe | Hogget | Wether | Ewe | Manufact. (includes ram carcass) |
| under 49 lb | | | H1 | 1 | 1E | HX | 1X | 1XE | |
| 49-56 lb | | | H7 | 7 | 7E | HX | 2X | 2XE | |
| 57-64 lb | | | | 3 | 3E | | 3X | 3XE | |
| 65-72 lb | | | | 9 | 9E | | 3X? | 3XE? | |
| 73-80 lb | | | | 5 | 5E | | 3X? | 3XE? | |
| over 80 lb | | | | 0 | 0E | | | | |

Hoggets have not more than two permanent incisors and carcasses weighing not more than 56 lb for export. An upper weight does not apply for local consumption.

The grading systems for hogget and mutton are presented in Table 2 where it can be seen that the fat cover, and for export, the weight, are taken into consideration. Some further confusion in the local consumption naming system is also highlighted.

## LAMB GRADING STUDIES AT RUAKURA

A large number of lambs are slaughtered annually at Ruakura from progeny test experiments in which the chemical composition of all carcasses is determined and other measurements are taken. The carcasses are also graded for export and independently for local consumption by an experienced grader from an export works who also is experienced in grading for "local consumption". The resulting data permit the regression of carcass composition and other measurements on carcass weight within grade. This gives an alternative method to the sampling procedure adopted by other workers in objectively describing what the current grading system is achieving, and what recent changes to the system have accomplished.

The reservations to this approach will come from the fact that, even although a large number of lambs are involved, their breed composition is probably not completely typical of the national lamb kill and secondly that all lambs in any season will be graded by one grader.

Data are presented from 1,272 lamb carcasses measured and analysed in the 1965-6 and 1966-7 slaughter seasons, as described by Kirton and Pickering (1967). All carcasses were graded for export under the North Island system and also for local consumption in the second season. For the export grading system the results will be presented on two bases. The first designated "actual grader's grade" is based on the grader's visual asssesment of the carcasses without allowing for the weight limits such as the 8.85 kg (20 lb) lower limit and 16.55 kg (36 lb) upper limit based on works' carcass weight (hot — 4½%), for the old Prime Down Cross grade. The upper weight limit did not apply when Clarke and McMeekan (1952) reported results on carcass grading. The second, designated "corrected grade" is the commercial grade a farmer would have received from a freezing works with the weight range restrictions for the various grades in operation. At the Ruakura abattoir, carcasses are not on the scales at the time of grading as they are in a commercial meat works, making possible the above distinction. Data are presented separately for the Prime Down Cross (Down) and Prime Crossbred

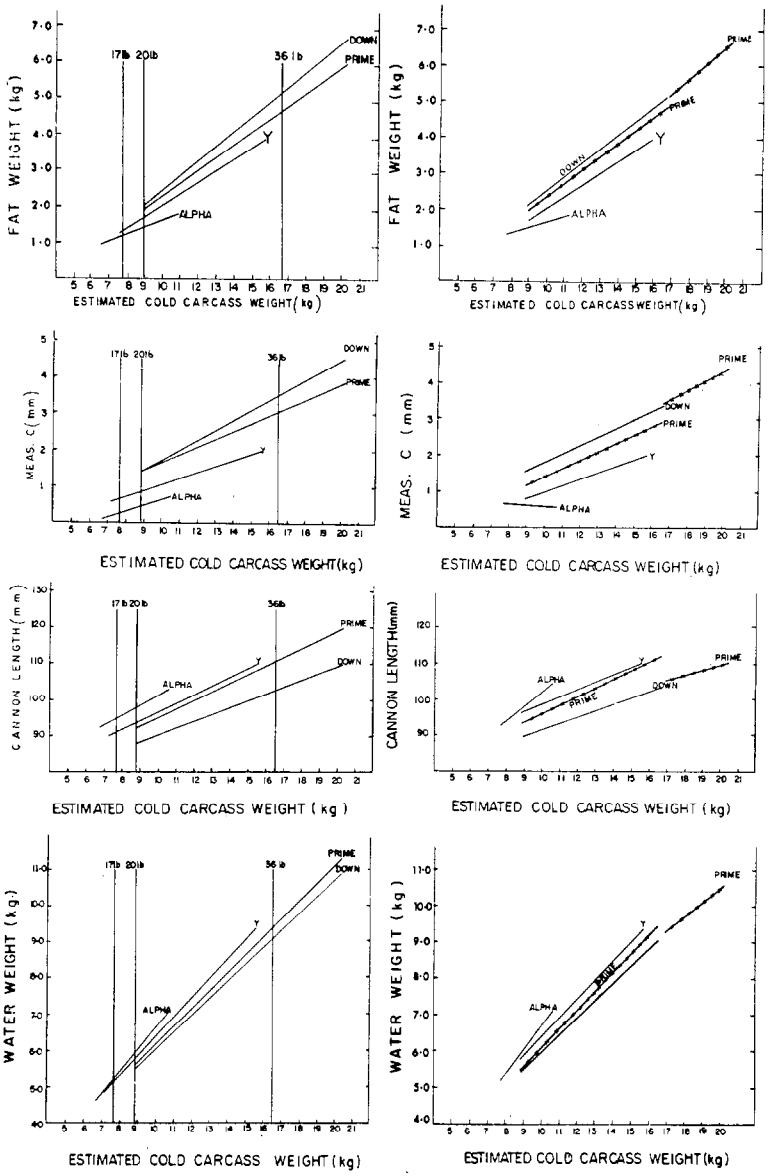



FIG. 1: *Within-grade relationships between estimated cold carcass weight (works carcass weight) and other carcass measurements for "actual grader's grade" (left) and "corrected grade" (right). Actual regression equations used presented in appendix.*

(Prime) grades, which were amalgamated into one Prime grade in 1967-8, to examine the effect of this change in grading system.

Regression equations of carcass measurements on carcass weight were calculated within each of the four grades and are shown in Fig. 1 for "actual grader's grades". A comparison of these regressions indicates the discrimination made by the grader for carcasses of the same weight. Data for both seasons have been pooled since equations calculated within grades for each season did not differ significantly. Linear regressions fitted the data as well as when logarithms are used. Regressions differed significantly between grades ($P < 0.01$).

Application of weight restrictions to obtain "corrected grades" implied the grader was called on only to discriminate over part of the range of carcass weight — regression lines were calculated for Prime Down Cross and for Prime Crossbred over this weight range and a further Prime Crossbred regression for carcasses exceeding the weight limit.

Means for the carcass measurements classified on the basis of "actual grader's grade" are given in Table 3. Analysis of variance showed differences between grades to be highly significant ($P < 0.01$). These results show that the Down type carcasses are heaviest and fattest followed by the Primes, then Y's, with the Alphas being lightest and leanest. Measurements of leg length (F and T) and cannon bone (left fore metacarpal) length, which have been shown by Kirton and Pickering (1967) to be good indices of carcass conformation, are also shown.

Table 4 presents means for the "corrected grades" on the two years' carcasses. Overall grade differences remained significant ($P < 0.01$). The removal of carcasses of over 36 lb from the Downs and their placement with the Primes has lowered the mean carcass weight of the Downs and increased that of the Primes. Application of the lower weight limits to the Y and Alpha grades has increased the mean weights of these grades and transferred some carcasses to the Manufacturing grade not represented in the table. All grades are adequately represented in the sample.

However, in terms of seeing how the grading system sorts out the carcasses, a more useful presentation of the data is given in Fig. 1 which relates various carcass measurements to carcass weight within the four main export grades then in use. The actual regression equations are given in Appendix 1. Except for the Down grade which has an upper weight restriction for "corrected grade",

TABLE 3: GRADING INFORMATION ON LAMB CARCASSES CLASSIFIED ON "ACTUAL GRADER'S GRADE"

| *Grade* | *No. of Carcasses* | *% of Total* | *Cold Carcass wt. (kg)* | *Fat wt. (kg)* | *C (mm)* | *F (mm)* | *T (mm)* | *Cannon Length (mm)* | *Water wt Hot ccs (kg)* |
|---|---|---|---|---|---|---|---|---|---|
| Prime Down Cross | 535 | 42.1 | 14.20 | 4.15 | 2.86 | 226 | 165 | 98.2 | 8.00 |
| Prime Crossbred | 255 | 20.0 | 13.18 | 3.48 | 2.37 | 241 | 172 | 102.5 | 7.72 |
| Y | 428 | 33.6 | 10.84 | 2.29 | 1.16 | 236 | 164 | 98.8 | 6.82 |
| Alpha | 54 | 4.2 | 8.26 | 1.28 | 0.37 | 235 | 159 | 96.8 | 5.63 |

TABLE 4: GRADING INFORMATION ON LAMB CARCASSES CLASSIFIED ON "CORRECTED GRADE"

| *Grade* | *No. of Carcasses* | *% of Total* | *Cold Carcass wt. (kg)* | *Fat wt. (kg)* | *C (mm)* | *F (mm)* | *T (mm)* | *Cannon Length (mm)* | *Water wt Hot ccs (kg)* |
|---|---|---|---|---|---|---|---|---|---|
| Prime Down Cross | 468 | 37.4 | 13.72 | 3.94 | 2.70 | 225 | 163 | 97.5 | 7.80 |
| Prime Crossbred | 322 | 25.8 | 14.08 | 3.93 | 2.71 | 240 | 173 | 102.8 | 8.08 |
| Y | 391 | 31.3 | 11.08 | 2.37 | 1.19 | 237 | 166 | 99.4 | 6.95 |
| Alpha | 69 | 5.5 | 8.53 | 1.42 | 0.63 | 232 | 158 | 95.5 | 5.71 |

in all cases the regressions depicted have as their upper limit the heaviest carcass of the appropriate grade in the present sample. For "corrected grade", a second Prime regression line was necessary to describe the carcasses above 36 lb in weight because of the placement of Down type carcasses in the Prime grade over this weight limit.

The regression of fat (ether-extract) and measurement C on carcass weight within "actual grader's grade" given in Fig. 1 shows that the grader on a subjective basis has on average sorted out carcasses into groups differing in fat content and fat cover with the Down grade being the fattest and the Alpha the leanest. Ulyatt and Barton (1963) have shown that water weight is a good indicator of muscular tissue weight. The regression of water weight on carcass weight indicates that the water picture is the opposite to the fat picture.

Unfortunately, as can be seen in Fig. 1, some of the useful sorting that a grader is able to do has been undone by placing weight restrictions on the various grades. The placement of the heavier and fatter Down type carcasses weighing over 36 lb into the Prime grade has increased the fatness of this grade at heavier weights. When Y type carcasses weighing less than 20 lb are placed with even leaner Alphas, this increases the fatness of the Alphas at the lighter end of the "corrected grade" scale and in the case of measurement C makes the regression not significant.

For graphical purposes, cannon length was chosen as a representative measurement which illustrates differences in carcass conformation with particular reference to leg length. Figure 1 shows that on visual appraisal the grader has sorted out carcasses into groups differing in conformation, with the Down type carcasses being "blockiest" and the Alphas the "leggiest". The Primes and Y's which are intermediate in conformation have similar cannon lengths. With the weight limits in effect Fig. 1 also shows that the location of the heavier Down type carcasses in the Prime grade has resulted in the over 36 lb Prime carcasses having their conformation more closely resembling that which would be described by the extension of the regression line for Down carcasses. Thus heavyweight Primes differed in conformation from the lightweight Primes.

Table 5 gives the sex-rearing ranks of the lambs in the various grades and for comparative purposes the percentage distribution in the various grades should be related to the overall distribution of the carcasses in the sample which is given in the right-hand column. The figures show

that a higher proportion of singles are placed in the prime grades and a higher proportion of twins appear in the leaner Y and Alpha grades. Separate regressions of fat weight on carcass weight were calculated for both wether and ewe lambs within each grade. Within every grade ewe lambs were significantly fatter than the wether lambs when compared at the same carcass weight. In general terms, the difference was in the order of 1 to 2% carcass fat and resulted in, as an example, wether Down carcasses having the same composition as ewe Prime carcasses.

The relationship between export and local consumption grading for one season is presented in Table 6. The data show that almost without exception carcasses grading Prime for export were placed in the first grade for local consumption. Approximately one-third of the carcasses which graded Y for export were placed in the first grade for local consumption, the remainder being placed in the second grade. Just over half of the carcasses in the export

TABLE 5: DISTRIBUTION OF LAMB SEX/REARING RANKS IN THE CORRECTED GRADES
(Percentages totalling down)

| *Sex* | *Rearing Rank* | *Prime Down Cross* | *Prime Crossbred* | *Y* | *Alpha* | *Total No.* | *%* |
|---|---|---|---|---|---|---|---|
| Ewe | Single | 31.0 | 30.7 | 22.3 | 17.4 | 343 | 27.4 |
| | Twin | 20.1 | 14.0 | 26.6 | 33.3 | 266 | 21.3 |
| Wether | Single | 27.6 | 34.5 | 22.8 | 10.1 | 336 | 26.9 |
| | Twin | 21.4 | 20.8 | 28.4 | 39.1 | 305 | 24.4 |
| Total No. | | 468 | 322 | 391 | 69 | 1250 | (100%) |

TABLE 6: RELATIONSHIP BETWEEN EXPORT CORRECTED GRADE AND LOCAL CONSUMPTION GRADE FOR LAMB CARCASSES
(1966 only)

| *Export Grade* | *Prime Down Cross* | | *Prime Crossbred* | | *Y* | | | *Alpha* | |
|---|---|---|---|---|---|---|---|---|---|
| *No. carcasses* | *246* | | *158* | | *211* | | | *45* | |
| *Local Grade* | *1st* | *2nd* | *1st* | *2nd* | *1st* | *2nd* | *Manuf.* | *2nd* | *Manuf.* |
| No. carcasses | 245 | 1 | 156 | 2 | 66 | 144 | 1 | 25 | 20 |
| % carcasses | 100 | — | 99 | 1 | 31 | 68 | | 56 | 44 |

Alpha grade were placed in the local second grade, the remainder grading manufacturing. These results may be interpreted as indicating that a lower level of fat cover is required for the various local consumption grades than for the approximately equivalent export grades.

## DISCUSSION

As fat cover is an important factor taken into consideration in the New Zealand lamb export grading system, one measure of this, namely, measurement C which is common to the present experiment and those of Clarke and McMeekan (1952; North Island carcasses) and Kemp and Barton (1966) warrants discussion. The Down carcasses of both Clarke and McMeekan, and Kemp and Barton were much fatter than those in the present experiment (about 1.5 residual standard deviations). In contrast, the Prime carcasses of Kemp and Barton were also very much fatter than those of Clarke and McMeekan which in turn were very slightly fatter than those in the present experiment. As the tendency with time has been to attempt to reduce the average fat cover, no explanation can be given for the very much fatter Prime carcasses of Kemp and Barton.

If measurement C of Clarke and McMeekan (1952) is related to the present results for "actual grader's grade", which is comparable with the export grading system in 1952, then both the Downs at all weights and the Primes at higher weights had a higher fat cover in the earlier experiment.

In a recent report on the New Zealand export lamb grading system, Smallfield (1965) commented that the "North Island Downs, once a premium grade, have lost favour on account of past experience of excessive fat . . ." and later that "Unfortunately Down conformation is often accompanied by excessive fat . . ." The present results confirm that Down type carcasses on average are the fattest with the worst offenders being the female carcasses in that grade. Historically, the separation of Downs and Primes occurred only in the North Island and in the South Island they have always been included in the one Prime grade. As a result of the Smallfield report (*loc. cit.*) the New Zealand Meat Producers' Board amalgamated the North Island Down and Prime grades in the 20-36 weight range because it was argued that the Down carcasses that were receiving overseas criticism could be hidden amongst the Primes. A further development was the formation of

a new, very "leggy" grade called Omega which in 1967-8 comprised 0.7% of the New Zealand export lamb kill (Ormond and Vogtherr, 1969).

If it is accepted that one of the purposes of grading is to sort carcasses out into recognizable types with differences in quality between types (grades) so that wholesaler, retailer and/or consumer preferences can be communicated back to the producer, then it can be argued that the reaction to the apparent unpopularity of some carcasses in the Down grade may not have been the best one. A better response might have been to sort out Down type carcasses over the whole lamb carcass weight range in both the North and South Islands and then make sure that the relative prices paid for the different grades overseas were reflected in the schedule prices paid to New Zealand farmers. Thus, if there really was discrimination against Down type carcasses overseas, this fact could be indicated back to the producer. However, in this regard there was, in fact, no difference between the prices received from the Prime and Down carcasses of the same weight range in our main market in the U.K. according to quotations in the *N.Z. Meat Producer* up to the time that the Down grade was discontinued.

Although the New Zealand export lamb grading system is well understood and accepted by importing countries (Smallfield, 1965), the question may still be asked as to how effective the carcass graders really are in separating carcasses into distinctive types. With regard to conformation, Fig. 1 showed that on "actual grader's grade" a reasonable separation of carcasses could be achieved when judged by cannon bone length. However, the amalgamation of the North Island Down and Prime grades in 1967-8 would blur the effectiveness of this separation, and the addition of the Omega grade will give an additional leggy grade. If in future a higher proportion of New Zealand lamb carcasses are marketed in the form of cuts rather than carcasses, then conformation may cease to have any importance as conformation bears little relationship to any objective measurement of carcass quality (Kirton and Pickering, 1967).

The regression of fat weight on carcass weight based on "actual grader's grade" resulted in the best separation of carcasses on the basis of composition. These regressions were used to estimate the potential of our grading system as judged by their use in calculating the carcass composition of different grades at selected weights (Table 7). The results show that the mean separation of Downs

TABLE 7: ESTIMATED[1] PERCENTAGE FAT CONTENT OF LAMB CARCASSES IN DIFFERENT GRADES

| *Actual Grader's Grade* | *Carcass Weight (lb)* | | | |
|---|---|---|---|---|
| | *20* | *28* | *36* | *50* |
| Down | 22.8 | 28.0 | 30.8 | 33.6 |
| Prime | 21.4 | 26.1 | 28.5 | 31.0 |
| Y | 19.1 | 22.8 | 24.8 | 26.9 |
| Alpha | 15.8 | 16.8 | — | — |

[1] Estimated from regressions of carcass fat (ether-extract) on carcass weight within the various "actual grader's grades".

and Primes on the basis of composition has been only marginal in comparison with the separation of the Prime and other grades justifying their current placement on this basis in one Prime grade. The data presented suggest that current grades will separate carcasses on the basis of composition.

More disquieting is a comparison of the present data with those in Table 11 of Kemp and Barton (1966). In most grades containing carcasses under 37 lb, their lambs were 3 to 4% fatter than those in the present experiment. Their Alpha carcasses approximated the fat content of the Y grade carcasses in the present experiment. Differences between the means of groups of carcasses in different locations of the order mentioned suggest some inconsistencies in the grading system.

As it has been documented that lamb carcasses containing up to 47% fat may be graded Prime for export and as carcasses containing down to 43% fat may be graded overfat and rejected for export (Kirton, 1966b), it would seem that a case might be made for the formation of an additional export grade which might replace the Down grade that was abolished in 1967-8 and would include the fattest of the carcasses that are at present placed in the current Prime grade. The formation of such a grade should improve the effectiveness of the grading system with regard to sorting carcasses into groups differing in composition and could be justified if there were enough such carcasses to warrant forming an additional grade. The proportion of these fatter Prime carcasses should be established before any decision is made to establish any new grade. The formation of a grade comprising the fatter Primes would improve the quality of the remaining carcasses in the Prime grade in line with market requirements (Smallfield,

1965) and presumably the fatter Prime carcasses would fetch a lower price which would discourage their production.

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## APPENDIX 1

**Regression equations relating various measurements to works carcass weight (Hot carcass minus 4½%) within grades where X = carcass weight (kg)**

| *Y* | *Grade** | *Coefficent ± S.E.* | *Constant* | *R.S.D.* |
|---|---|---|---|---|
| ACTUAL GRADER'S GRADE | | | | |
| Fat weight (kg) | Down | 0.407 ± 0.010 | — 1.62 | 0.46 |
| | Prime | 0.373 ± 0.014 | — 1.43 | 0.42 |
| | Y | 0.320 ± 0.010 | — 1.17 | 0.33 |
| | Alpha | 0.194 ± 0.037 | — 0.33 | 0.24 |
| C (mm) | Down | 0.28 ± 0.02 | — 1.08 | 1.1 |
| | Prime | 0.22 ± 0.03 | — 0.49 | 1.0 |
| | Y | 0.17 ± 0.02 | — 0.63 | 0.7 |
| | Alpha | 0.16 ± 0.07 | — 0.97 | 0.5 |
| Water weight (kg) | Down | 0.471 ± 0.008 | 1.31 | 0.37 |
| | Prime | 0.495 ± 0.011 | 1.20 | 0.33 |
| | Y | 0.538 ± 0.008 | 0.99 | 0.28 |
| | Alpha | 0.650 ± 0.034 | 0.26 | 0.22 |
| Cannon bone length (mm) | Down | 1.92 ± 0.10 | 71.0 | 4.9 |
| | Prime | 2.43 ± 0.17 | 70.6 | 5.0 |
| | Y | 2.44 ± 0.15 | 72.3 | 5.0 |
| | Alpha | 2.82 ± 0.70 | 73.5 | 4.6 |
| CORRECTED GRADE | | | | |
| Fat weight (kg) | Down | 0.386 ± 0.012 | — 1.36 | 0.44 |
| | Prime I | 0.358 ± 0.017 | — 1.25 | 0.41 |
| | II | 0.424 ± 0.074 | — 1.91 | 0.60 |
| | Y | 0.326 ± 0.011 | — 1.24 | 0.33 |
| | Alpha | 0.157 ± 0.059 | 0.08 | 0.29 |
| C (mm) | Down | 0.23 ± 0.03 | — 0.52 | 1.1 |
| | Prime I | 0.18 ± 0.04 | — 0.04 | 1.0 |
| | II | 0.27 ± 0.16 | — 0.97 | 1.4 |
| | Y | 0.18 ± 0.02 | — 0.80 | 0.7 |
| | Alpha | 0.03 ± 0.11 | 0.85 | 0.6 |
| Water weight (kg) | Down | 0.489 ± 0.010 | 1.08 | 0.35 |
| | Prime I | 0.511 ± 0.013 | 1.00 | 0.32 |
| | II | 0.460 ± 0.059 | 1.48 | 0.48 |
| | Y | 0.533 ± 0.010 | 1.05 | 0.28 |
| | Alpha | 0.667 ± 0.054 | 0.02 | 0.27 |
| Cannon bone length (mm) | Down | 2.03 ± 0.13 | 69.5 | 4.6 |
| | Prime I | 2.62 ± 0.20 | 68.1 | 4.7 |
| | II | 1.70 ± 0.90 | 75.9 | 7.3 |
| | Y | 2.38 ± 0.18 | 73.0 | 5.1 |
| | Alpha | 4.10 ± 0.91 | 60.6 | 4.6 |

*Note: Down = North Island Prime Down Cross grade
Prime = North Island Prime Crossbred grade
Y = Y grade
Apha = Alpha grade
Prime I: Weight range 8.85 to 16.55 kg
Prime II: Weight range 16.56 to 20.25 kg