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The T.M.E. system of feed evaluation

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The T.M.E. system of feed evaluation

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SUMMARY

The true metabolizable energy (TME) system of feed evaluation is attracting attention throughout the world. Precision feeding, a procedure for placing a known quantity of a feedingstuff in the crop of a bird, is fundamental to the group of bioassays which form this system of feed evaluation. In this Bulletin the 'Introduction' explains the principles of the system and includes a diagram showing the partition of energy within the bird. The section entitled 'Bioassay Procedures' describes the basic methodology. Sub-sections contain a list of precautions together with detailed descriptions of the precision feeding technique, a recently developed method for excreta collection, and the design and construction of cages for adult cockerels. The section on 'Feed Composition' consists primarily of a table listing the proximate compositions, gross energy, TME and TME_n values of samples of many feedingstuffs. The primary purpose of the Bulletin is the 'Bibliography' which contains references to all known publications concerned directly, or indirectly, with assays based on precision feeding.

RÉSUMÉ

Le méthode d'évaluation des aliments par le calcul de l'énergie métabolisable véritable (EMV) attire actuellement l'intérêt des gens. Le gavage, méthode qui consiste à introduire une quantité déterminée d'aliments dans le jabot d'un oiseau, est un élément essentiel de l'ensemble des épreuves biologiques qui constituent la methode. Dans l'introduction nous expliquons la méthode et présentons un diagramme de la répartition de l'énergie chez l'oiseau. Nous passons ensuite à la description des épreuves et traitons, dans les sous-sections, des précautions à prendre ainsi que

la méthode de gavage; d'une méthode de collecte des excréments récemment mise au point et des cages destinées aux coquelets adultes. La partie traitant de la composition des aliments comprend essentiellement un tableau indiquant la composition approximative ainsi que les valeurs en énergie brute, en EMV et en EMV_n d'échantillons de plusieurs types d'aliments. La bibliographie constitue l'essentiel de ce bulletin; elle donne les titres de toutes les publications connues traitant directement ou indirectement des épreuves basées sur le gavage.

PREFACE

This Bulletin updates an earlier publication (Animal Research Centre Technical Bulletin No. 3, 1981) for which there has been a large demand. The need for a new printing provided an opportunity to extend and modify the text and contents, thus responding to many enquiries about the TME system of feed evaluation.

The arrangement of the Bulletin has been changed, somewhat, to accommodate additional information on excreta collection, precautions to be observed in TME-type assays, and a description of the design and construction of cages for adult cockerels. A significant addition is a table of feed composition. The bibliography has been updated by the addition of more than a hundred and forty references.

Assays based on precision feeding continue to arouse a considerable amount of interest in both the industrial and scientific communities. At the time of writing some 104 laboratories in 39 countries are known to be using or evaluating the TME bioassay. Several feed manufacturers are using TME or TME_n data for poultry feed formulation.

The Animal Research Centre plans to maintain an up-to-date list of all relevant literature, and supplements to this Bulletin will be prepared when appropriate. To help keep the bibliography complete, readers are encouraged to send references and reprints to the author. The Bulletin should be useful to those working with the TME system whether they be teachers, students, research scientists or feed formulators.

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ACKNOWLEDGEMENTS

The author wishes to thank D. Balnave, University of Sydney, Australia; N. Dale, Avicultura Professional, Georgia, U.S.A.; I.C. Edmundson, Poultry Research Centre, Massey University, New Zealand; C. Fisher, ARC Poultry Research Centre, United Kingdom; and J.J. du Preez, University of Stellenbosch, South Africa, for providing references to TME-related publications. The idea to use colostomy bags to collect excreta came originally from J.K. Rayton, Bangkok, Thailand and useful suggestions regarding application of adhesives were provided by J.W. Scace, 3M Canada Inc., Ottawa, Canada. The preliminary drawings for the figures illustrating cage design and construction were prepared by F. Nachbaur; final drawings and all photographs were prepared by Research Program Service, Agriculture Canada, Ottawa. The compilation of the table on feed composition could not have been accomplished without the technical help of S. Tobin; the proximate analyses were made by the Chemistry and Biology Research Institute, Agriculture Canada, Ottawa. Finally, my thanks to D. Leger who obtained the information on cage design and provided valuable editorial assistance.

DISCLAIMER

INTRODUCTION

The true metabolizable energy (TME) system of feed evaluation comprises bioassays for TME, true available amino acids (TAAA), true available lipids (TAL) and true available minerals (TAM). Each assay involves corrections for metabolic plus endogenous losses which are body maintenance costs. The assumption that such losses come directly from the feed is erroneous. The importance of making corrections for metabolic fecal and endogenous urinary nitrogen ($F_mN + U_eN$) losses, during the evaluation of dietary proteins, has been recognized for many years (Mitchell, 1924, J. Biol. Chem. 58:873); however, the use of similar corrections in energy bioassays is comparatively recent.

The term TME was defined by Harris (1). The effect of metabolic fecal plus endogenous urinary energy ($F_mE + U_eE$) losses on apparent metabolizable energy (AME) values was described, with theoretical data, by Guillaume and Summers (2). The late appearance of a TME bioassay perhaps reflects a lack of confidence in the ability to estimate $F_mE + U_eE$. The correction of excreta energy (FE + UE) values to zero nitrogen balance ($FE_n + UE_n$) controls much of the variation in estimates of $F_mE + U_eE$ (more correctly $F_mE_n + U_eE_n$).

The development of the TME bioassay was fortuitous. A study of variation in AME values among birds and days revealed a 'saw-tooth' effect. The observations for a particular bird tended, on successive days, to be alternatively higher and lower than average (8). Investigation of the cause of the variation demonstrated the profound effect of feed intake on AME values (3). This led to the development of the bioassay (9). The assay has undergone several modifications and the methodology has been extended to other nutrients.

The assays usually involve precision-feeding a fasted bird with a known quantity of the test feedingstuff and quantitatively collecting the resulting excreta. Each feedingstuff is fed at two, or more, levels of input to establish the relationship between nutrient input and output. For simplicity and convenience one input level is usually zero. Recent work, much of which is in press, shows that fasted birds tend to catabolize more body protein than fed birds. This affects energy excretion and introduces a bias into the TME bioassay. Similarly, the loss of body protein as energy-containing excretory products is affected by the amount and quality of the protein in the test feedingstuff, a secondary cause of bias. The problem is controlled by correcting the excreta energy outputs of both fed and unfed birds to zero nitrogen balance. The correction, which is strongly recommended, is described later. There is no evidence that similar corrections are required in the TAAA, TAL and TAM assays.

A schematic representation of the partition of ingested feed energy by the bird is presented as Figure 1. The terminology and abbreviations are those published by the National Research Council of the United States (248) but the partition differs inasmuch as the F_mE + U_eE are included as part of the net energy for maintenance. The figure helps to explain the differences between AME and TME and shows that feces and urine contain energy components which are derived from the body rather than the feed.

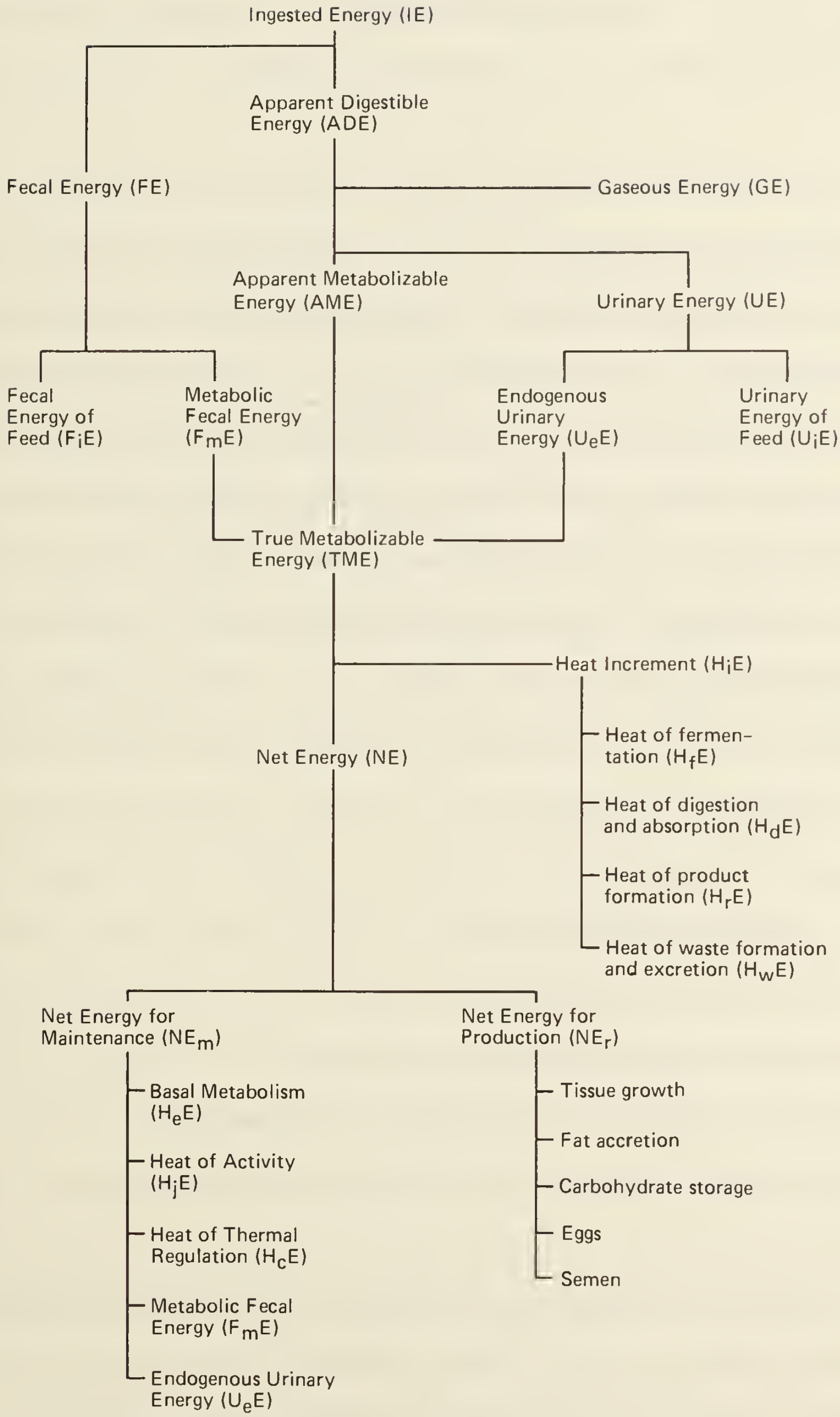

Figure 1. The partition of ingested feed energy in the bird (taken from reference 296).

BIOASSAY PROCEDURES

General

The assays of the TME system have several procedures in common and may be performed simultaneously providing there are sufficient excreta available for the physical and chemical analyses. Birds are fasted, to empty their alimentary canals of feed residues, and then precision-fed a known quantity of the material to be assayed. Each bird is placed in a wire cage, where water is available ad libitum. The time is recorded and the excreta are collected quantitatively for a predetermined period of time. One bird in each replication is unfed and serves as a negative control for the estimation of metabolic plus endogenous losses. The excreta, together with samples of the test materials, are assayed for gross energy, amino acids, lipid or mineral elements as appropriate. The basic calculation is as follows:

$$TX = IX - (FX + UX) + (F_mX + U_eX)$$

where: TX is the true available nutrient X;

IX is the amount of X placed in the fed bird;

(FX + UX) is the amount of X excreted by the fed bird; and

$(F_mX + U_eX)$ is the amount of X excreted by the unfed bird.

The preferred bird is a dubbed adult cockerel of an egg-laying strain, which has never had access to grit. Other birds may be used but chicks have limited feed capacity, while fasted laying hens often produce shell-less eggs which tend to break and contaminate the excreta. Laying birds may be useful in assays for TAM where a high mineral requirement is desirable (298), but this is an atypical situation. Grit is avoided because it may be retained in the gizzard and voided on an irregular basis. Grit in excreta damages grinding equipment and introduces major errors into short-term mineral balances.

All birds used in an assay must have been maintained on the same diet. The composition of the diet is not of critical importance providing that it allows the birds to satisfy their nutrient requirements. Many laboratories feed a 15% protein laying hen diet during the maintenance period between assays. The preliminary fast is usually for 24 hours but a longer period may be required if the maintenance diet contains substantial quantities of indigestible materials. Where uncertainty exists it is advisable to measure the gut-clearance time of the maintenance diet before embarking on a series of assays.

As the input of test material increases, the effects of experimental errors are reduced but the possibility of regurgitation increases; 30 to 40 g is usually satisfactory. Large inputs, particularly of bulky feedingstuffs can lead to crop impaction. Impacted birds have extended feed residue retention times and consequently may yield misleading data. An exception to the foregoing is the TAM bioassay in which the input of the test mineral should be no greater than the bird's requirement. Unlike amino acids, lipids and other energy sources, excess minerals are voided as excreta.

Initially, it was recommended that the test material be pelleted but this is not necessary if the stem of the feeding funnel has an internal diameter of about 1.0 cm; however, care must be taken to avoid loss of feed by adherance to the funnel. Very dusty or hygroscopic materials are best fed in conjunction with a carrier, such as 90% ground maize plus 10% of vegetable oil; this makes it necessary to assay the carrier.

Test materials are weighed prior to an assay and held in containers until used. Clear polypropylene containers (130 ml) with close fitting lids such as are used for urine samples are satisfactory. Sub-samples of the test materials must be weighed for dry matter determination at the same time as the containers are being prepared. The timing is important because it avoids errors associated with water uptake or loss by the test materials. Subsequent analytical data describing the test materials should be expressed on the basis of dry matter.

Birds are housed and maintained in individual wire cages of the lower level of a two-tier system. Cage design and construction are described later (page 27). Water is provided by a nipple system and feed is available in a trough running the full length of each block of cages. At the start of an assay, fasting is initiated by removal of the feed trough. Under other management systems, such as when water is provided in troughs, it is important that feed in the water system or adhering to the cage be removed.

Fasted birds are taken from the lower tier of cages, given the appropriate treatment, and then housed in alternate cages of the upper tier. The technique of precision feeding is described later. The upper cages are used only during excreta collection periods and are scrupulously cleaned prior to each assay. Excreta collection trays are placed under each bird. The trays, preferably made of smooth plastic, are larger than the bottom of each cage thus reducing the chance of excreta loss. A new development in excreta collection technique is described later (page 22).

Handling of birds causes losses of scale and feathers making quantitative excreta collection difficult. Blowing scale off the excreta collection trays an hour after housing reduces the problem. Excreta are collected at about 24 and again at exactly 48 hours after housing. A single 48 hour collection may be satisfactory but the double collection is favoured because it reduces excreta deterioration and contamination. When the assays were first described a collection period of 24 hours was suggested but subsequent work showed this to be insufficient for clearance of the residues of some test materials. Excreta adhering to the cage must be removed and excreta must be washed from any feathers trapped on the excreta collection tray. The trays must be checked for regurgitated feed which, if present, invalidates the use of the bird in the assay. The two excreta samples from each bird are frozen, dried, equilibrated with atmospheric moisture, weighed, pooled, ground, mixed and assayed. Freeze-drying is preferred because it leaves the excreta in a sponge-like, easy-to-grind form. For the TME, but probably not for the TAAA or TAL, assay the excreta may be oven-dried without affecting the final values (92). In some laboratories the excreta from several birds are pooled to reduce the analytical work. The procedure should not alter the estimated TME, TAAA, TAL or TAM values but it does restrict the ability to assess variation and to make comparisons between samples (303).

Recent work has demonstrated the advisability of correcting TME values to zero nitrogen balance (TME_n). As a first step in the calculations the excreta energy output (FE + UE) is corrected to zero nitrogen balance ($FE_n + UE_n$), as follows:

$$(FE_n + UE_n) = (FE + UE) + k(IN - FN - UN)$$

where: k is a constant which estimates the gross energy content of the excretory products resulting from the catabolism of a unit weight of body nitrogen;

IN is the nitrogen input as test material; and

FN and UN are the fecal and urinary nitrogen outputs.

For unfed birds, IN is zero. In most assays the term k(IN - FN - UN) is negative; consequently, $(FE_n + UE_n)$ is usually smaller than (FE + UE). The nitrogen corrected energy excretion of an unfed bird is better described as $(F_mE_n + U_eE_n)$. TME_n values are calculated as follows:

$$TME_n = IE - (FE_n + UE_n) + (F_mE_n + U_eE_n)$$

where: IE is the amount of energy, as test material, placed in the bird.

There is no evidence that similar corrections are required in any of the other bioassays of the TME system.

Precautions

The following is a list of precautions to be observed if high quality assay data are to be obtained. The list concludes with the most common causes of abnormally large and small values.

1. Assay birds must be in good health.
2. All assay birds must be fed the same maintenance diet between assays.
3. Assay birds should be grit-free.
4. Test materials must be assayed for dry matter at the time that they are weighed into containers in preparation for feeding to

the birds.

5. Dusty and hygroscopic test materials should be fed in conjunction with a carrier; the carrier must also be assayed.
6. Assay birds must be fasted for sufficient time to allow all feed residues to be voided.
7. Feed removal for fasting must be total. Feed adhering to the cage and usually ignored by the bird will be eaten if no other is available.
8. Birds must have continuous access to fresh water.
9. Excreta trays must be checked for regurgitated feed which, when found, eliminates the bird from the assay.
10. The excreta collection period must be exactly the same for all birds in an assay.
11. When using adult cockerels, and feed inputs of 30 to 40 g, an excreta collection period of 48 hours should be sufficient. For other birds and inputs a preliminary experiment may be necessary to establish the length of the collection period.
12. Excreta collection must be quantitative. Feathers must not be included and scale is to be avoided as much as possible.
13. Dried excreta should be equilibrated with atmospheric moisture or be held in such a manner that its moisture content remains constant between weighing and analysis.

Abnormally large values may result from:

a. incomplete clearance of the residues of the test material, check for crop impaction;

b. incomplete excreta collection, excreta may have been voided beyond the collection tray;

c. unobserved regurgitation beyond the collection tray causing excreta output to be too small;

d. errors in weighing, preparing or administering the test material; and

e. analytical errors.

Abnormally small values are obtained when:

a. the preliminary fast is inadequate and residues of the maintenance diet are assumed to be derived from the test material;

b. the bird has access to feed during the fast;

c. regurgitated feed is mixed with the excreta;

d. scale or feathers are included with the excreta; and

e. preparatory and analytical errors.

The assays are simple and relatively fast. However, like all assays they require care and attention to detail if high quality data are to be obtained.

Precision Feeding

The purpose of precision feeding is to ensure that a known quantity of a feedingstuff enters the alimentary canal of a bird at a known time. The procedure avoids the need to recover waste feed, prevents feed selection and eliminates variation in intake among birds. All of these problems are encountered when birds ingest feed voluntarily.

Precision feeding involves insertion of a tube from the beak, via the oesophagus, into the crop, causing feed to move through the tube, and removal of the tube. The initial method developed at the Animal Research Centre used a simple glass tube into which pelleted feed was placed and then pushed into the crop with a glass rod. From this was developed a glass funnel and metal plunger. With experience came the ability to insert tubes with larger diameters and an effective device was prepared by taping a glass powder funnel to a piece of 1.2 cm diameter copper water pipe. A metal rod was used as a plunger. Today, a stainless steel funnel is used with a stem 40 cm long, an external diameter of 1.2 cm and an internal diameter of 1.1 cm. The plunger consists of a 1.0 cm diameter aluminum rod to which a 3.0 cm diameter spherical knob is attached. A plastic sleeve is rivetted to the rod to prevent the plunger from projecting more than 0.5 cm beyond the end of the funnel. Ease of operation demands that the funnel be light in weight and well balanced. Heavy funnels, particularly those with uneven weight distribution, are difficult to control when in the bird. Plastic funnels have the advantage of light weight but many possess electrostatic properties which make quantitative feed delivery impossible. Some of the feeding devices used in this laboratory are shown in Figures 2 and 3.

Successful precision feeding depends upon control of the bird. A simple, rapid technique used at the Animal Research Centre is as follows. The operator sits on a stool, or chair without sides, and crosses his left leg over his right. A bird is taken with both hands and placed with the keel (breast bone) pushed into the groove formed by the left thigh and abdomen of

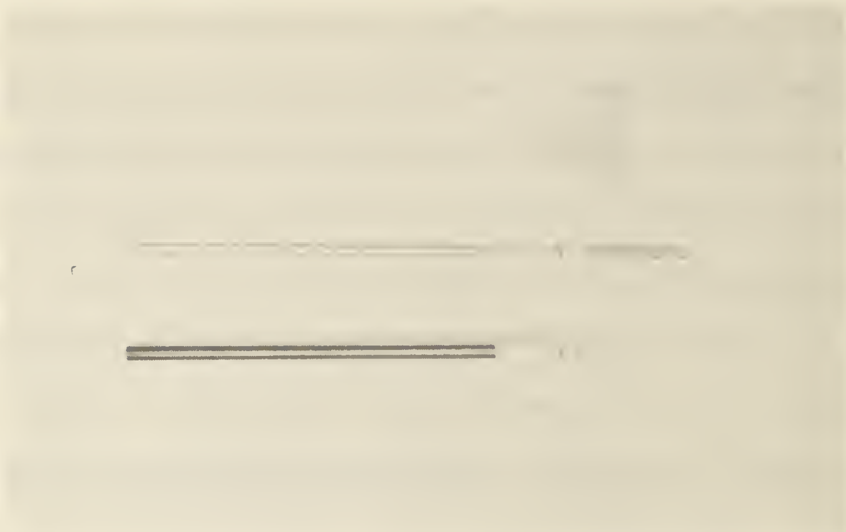

Figure 2. Some early feeding devices: (A) glass funnel and rod, (B) copper water pipe attached to a glass powder funnel and an aluminium plunger, (C) simple glass tube and rod.

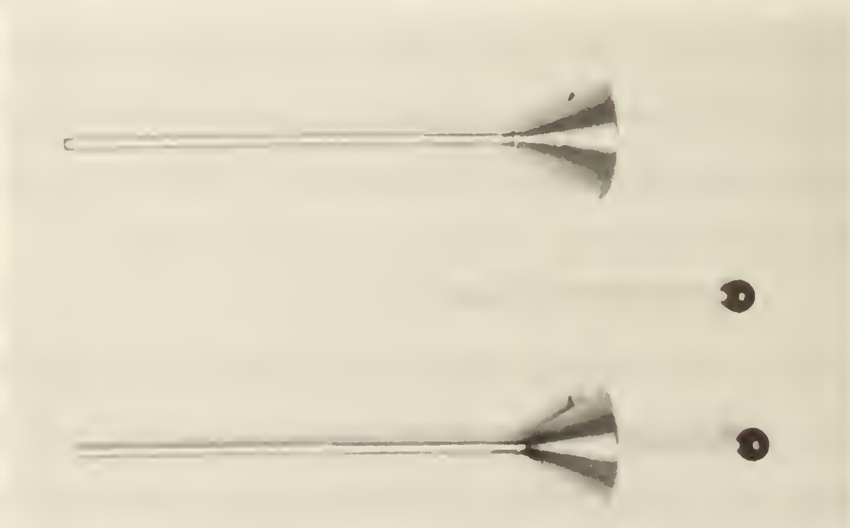

Figure 3. Stainless steel funnels with aluminium plungers. Note plastic sleeve on plunger which controls penetration beyond the end of the funnel.

the operator. The body of the bird is at 45 degrees from vertical. The legs of the bird project to the left and are unable to gain leverage on anything. The bird is firmly held in place with the elbow of the left arm, and the beak is grasped from above the head with the left thumb and forefinger. The neck of the bird is slightly extended, the beak is opened and the stem of the funnel is inserted. The funnel should move down the oesophagus and into the crop with a minimum of effort. If a blockage is encountered, wait a few seconds for the bird to swallow or relax. If this is unsuccessful, remove the funnel and try again. Feed is poured into the funnel from a container held in the right hand and pushed into the crop by a second operator. If the funnel tends to move out of the bird as feed is pushed down, the end of the funnel is in the oesophagus not the crop. Deposition of feed in the oesophagus can lead to regurgitation. The funnel is withdrawn using the right hand. The left hand is moved to the neck of the bird and gentle pressure is applied to the oesophagus. This, coupled with rotary withdrawal of the funnel, removes feed particles which may have adhered to the outside of the stem of the funnel. The complete operation usually takes less than one minute per bird.

The precision feeding technique is illustrated in Figures 4 to 11. A six-minute, 16 mm colour, sound film entitled "Poultry Force Feeding - An Experimental Technique" is available by writing to: Communications Branch, Agriculture Canada, Ottawa, Ontario, Canada, K1A 0C7.

Figure 4. Bird is placed at 45° angle with keel in groove formed by the operator's thigh and abdomen.

Figure 5. The legs project and cannot gain leverage on anything. The bird is held in place by the left elbow.

Figure 6. The beak is opened from above using the thumb and forefinger of the left hand.

Figure 7. The neck is slightly extended and the stem of the funnel inserted.

Figure 8. The inserted funnel is held in place by the thumb and forefinger.

Figure 9. Feed is poured into the funnel, note the position of the bird with the legs projecting to the left.

Figure 10. Feed is pushed down the funnel by a second operator. Note that the first operator helps to hold the funnel in place.

Figure 11. The funnel is removed with a rotary action, pressure is applied to the oesophagus with the left hand to dislodge feed particles adhering to the stem of the funnel.

Excreta Collection

A recent development, which owes much to an idea of J.K. Rayton, simplifies and improves the collection of excreta. In brief, a colostomy bag is attached over the cloaca of the bird at the start of the excreta collection period and is removed, with the excreta, 48 hours later. The technique, which may be described as a non-surgical extension of the procedure of R.M. Blakely (Can. J. Anim. Sci. 43:386, 1963), is described below.

Birds are prepared by clipping the feathers surrounding the cloaca, close to the skin. Electric sheep shears are useful and fast but a pair of scissors is adequate. The clipped area is approximately rectangular (8 x 10 cm) and extends from the base of the tail to a point about 8 cm ventral to the cloaca. The birds are usually prepared several days before an assay. If adult cockerels are used it may be necessary to trim their spurs to prevent damage to the bags.

Immediately prior to excreta collection a self-adhesive, plastic colostomy bag is prepared. A 14 x 20 cm bag with a 3 to 5 cm diameter opening is suitable. The paper backing which protects the adhesive surface, surrounding the hole, is removed. Supplementary adhesive is applied 1 cm in from the exterior edge of the adhesive surface. The hole in the bag is centred over the cloaca and the bag is affixed to the bird by gently pressing the adhesive-coated surface to the skin for about 10 seconds. Care is required to ensure a complete seal and to avoid adhesive touching the cloaca. The walls of the bag are separated, to permit excreta to fall to the bottom of the bag. The bird is placed in a cage which is free of sharp points which might puncture the bag. In housing the bird, care is taken not to stress the bond between the bag and the bird.

At the end of the collection period the bag is carefully removed and the skin surrounding the cloaca may be treated with an anti-irritant. The top of the bag is folded so that the adhesive around the hole forms its own seal. The bags and contents are frozen and stored. Later the frozen bags are opened and the excreta freeze-dried in situ. However, if the excreta are very wet they are best transferred to another container for storage and processing. Figures 12 to 23 illustrate the procedure.

There are many brands of colostomy bags available which appear to vary in strength. Among a limited range tested, one labelled 'Coloset (Z.O.)', distributed by Canadian Howmedica Ltd., 90 Woodlawn Road West, Guelph, Ontario, Canada, has proved to be satisfactory. Although several adhesives were tested only two were found to be satisfactory: Kamar Adhesive, Kamar Inc., Box 26, Steamboat Springs, Colorado, U.S.A., 80477; 3M Scotch Brand Adhesive EC847, 3M Canada Inc., London, Ontario, Canada, N5V 2Z6.

The procedure is still under development but is described here to stimulate ideas and suggestions for improvements. Excreta collected in colostomy bags are free of scale and feathers and are not diluted with water during collection. The latter reduces drying time and effectively increases drying capacity. Some time is required to prepare birds and to afix and remove bags but this is more than offset by the time saved in making a single rapid collection.

Figure 12. Colostomy bag showing adhesive surface, walls separated.

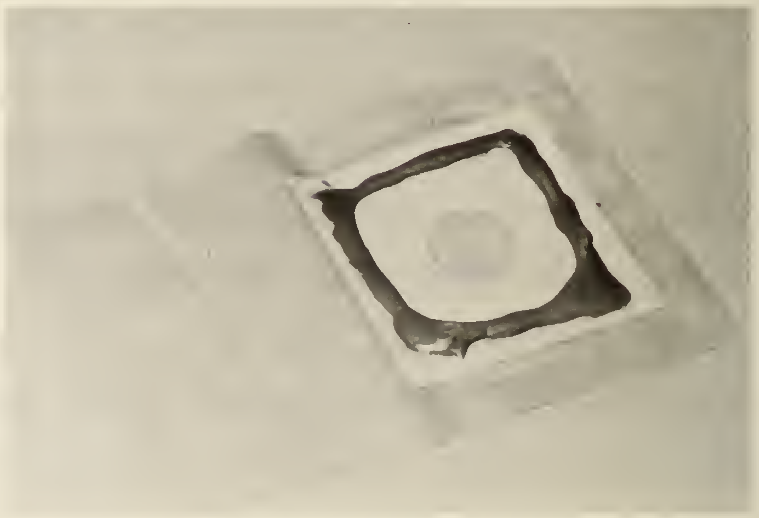

Figure 13. Colostomy bag with supplementary adhesive.

Figure 14. Centering of bag over cloaca.

Figure 15. Pressing the adhesive-coated surface of the bag into place.

Figure 16. Ensuring that bond is complete around the cloaca.

Figure 17. Separating the walls of the colostomy bag (note the adhesive surface bonded to the bird).

Figure 18. Rear view of bird with bag attached (note the trimmed spurs).

Figure 19. Bird with bag attached ready to return to cage.

Figure 20. Rear view of bird showing excreta accumulated over 48 hours.

Figure 21. Removal of bag with excreta.

Figure 22. Bag sealed by folding the top over.

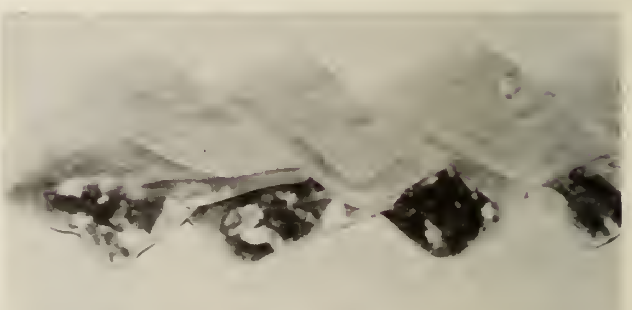

Figure 23. A group of bags ready for storage and subsequent processing.

Cage Design and Construction

The cages used to house the adult cockerels have the following dimensions: depth (front to back) 40.6 cm, height 50.8 cm and width 30.5 cm. Figures 24 to 32 describe the cage and its assembly; all dimensions are in centimetres. The back, top and floor of a row of 10 cages is fabricated from a single piece of wire mesh approximately 1.3 m wide x 3.05 m long (Fig. 24). The wire is 2.03 mm diameter (14 gauge). The mesh is a 5.1 x 2.5 cm grid welded at each corner. The internal partitions and ends are made of the same material (Fig. 25). The cage front, also 3.05 m in length, is made from 4.11 mm diameter (8 gauge) wire and is shown in Fig. 26. Details of the cage door are shown in Fig. 27, which also shows the assembled door and front. The door opening of 23 x 28 cm provides adequate access to remove the birds.

Figure 28 shows the cage fronts and doors being joined to the cage body and partitions. The assembled cages are shown in Fig. 29. The cages are set up in a double deck arrangement (Fig. 30) and the droppings board is placed horizontally to hold the excreta collection trays. Water is available from a nipple system on the top of the cages. Figures 31 and 32 illustrate the cages in use.

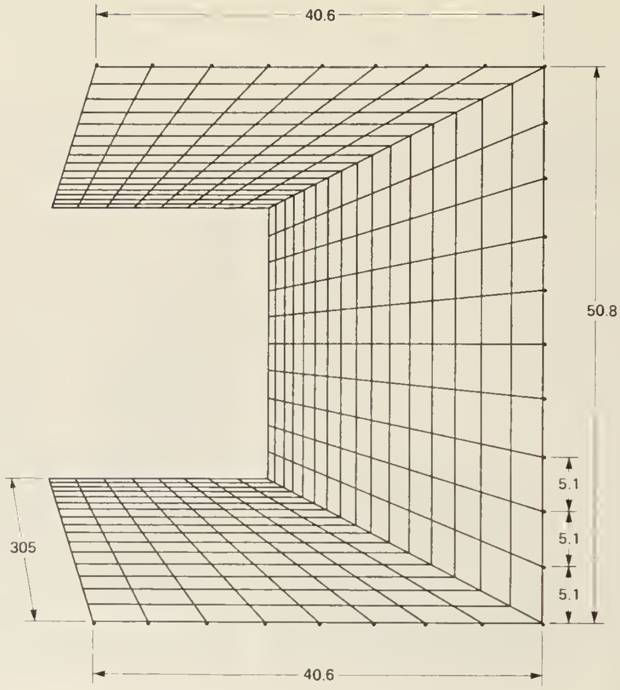

Figure 24. End view of the single piece of wire mesh which is folded to create the body (top, back and bottom) of a row of 10 cages.

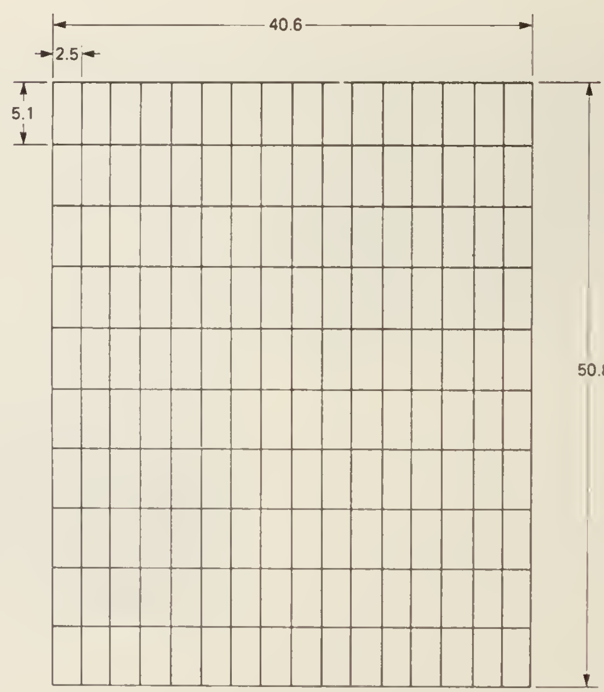

Figure 25. A typical cage partition or end. Partitions are located at 30.5 cm intervals and are welded in place.

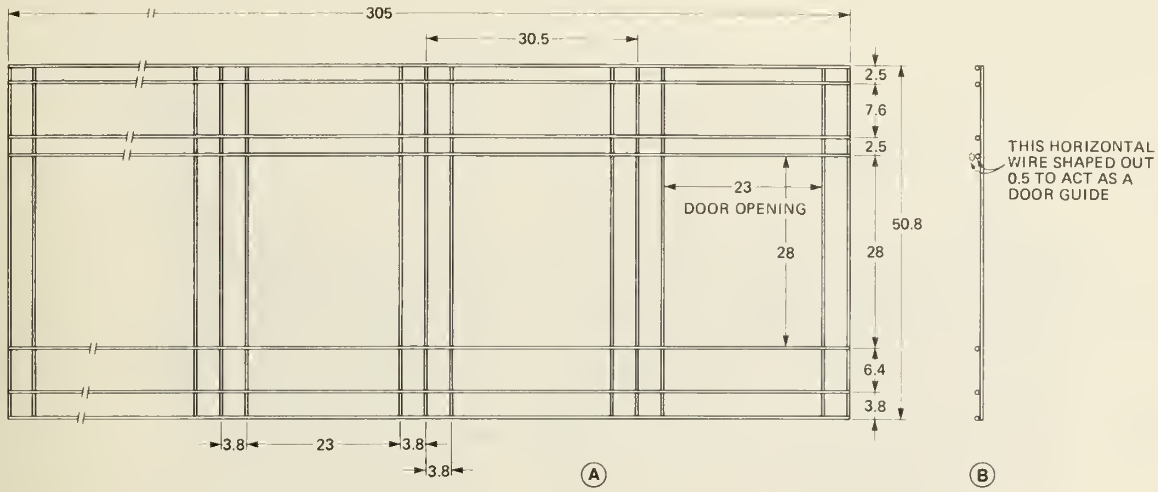

Figure 26. A. The front for a row of cages.

B. Side view of cage front.

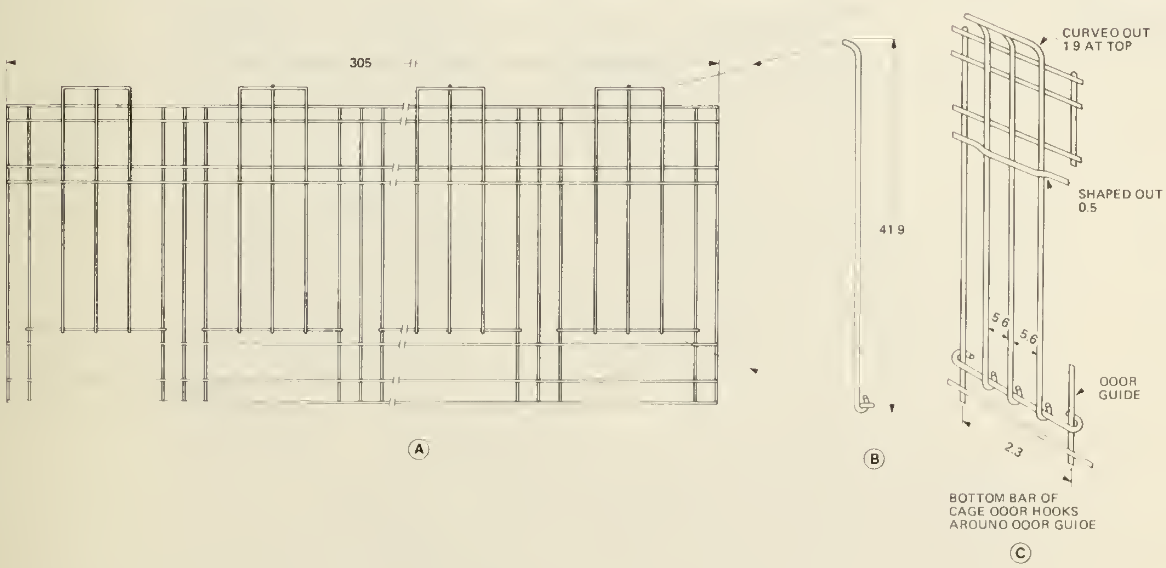

Figure 27. A. The front with cage doors installed.

B. Side view of cage door.

C. Detail of cage door.

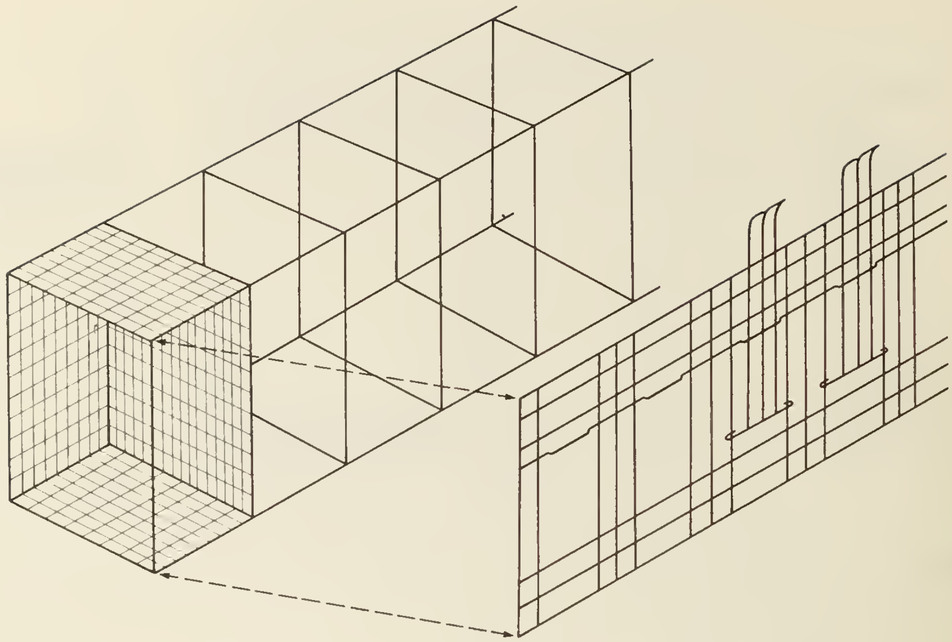

Figure 28. The relationship between the cage body with partitions and the front. For simplicity, only 2 doors are shown on the front.

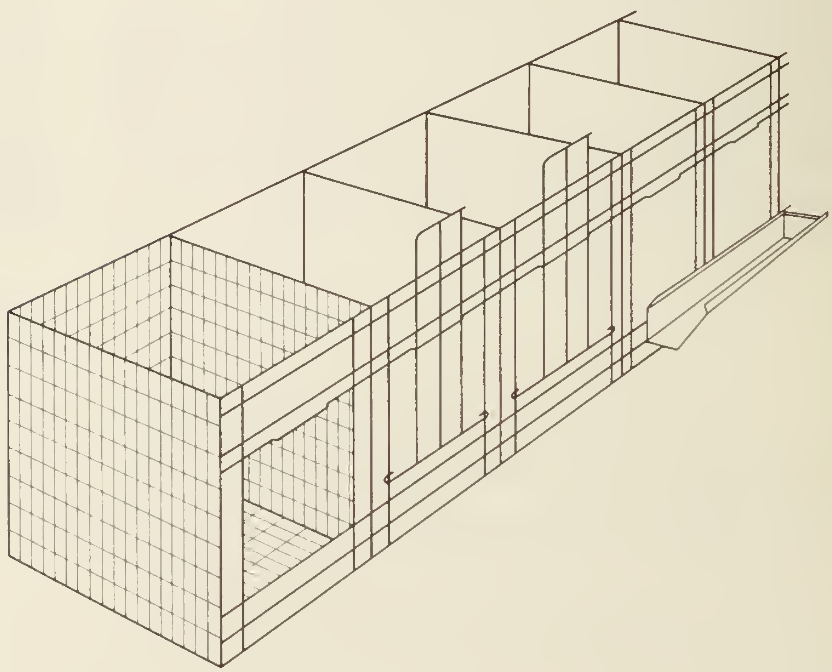

Figure 29. An assembled cage unit with feed trough.

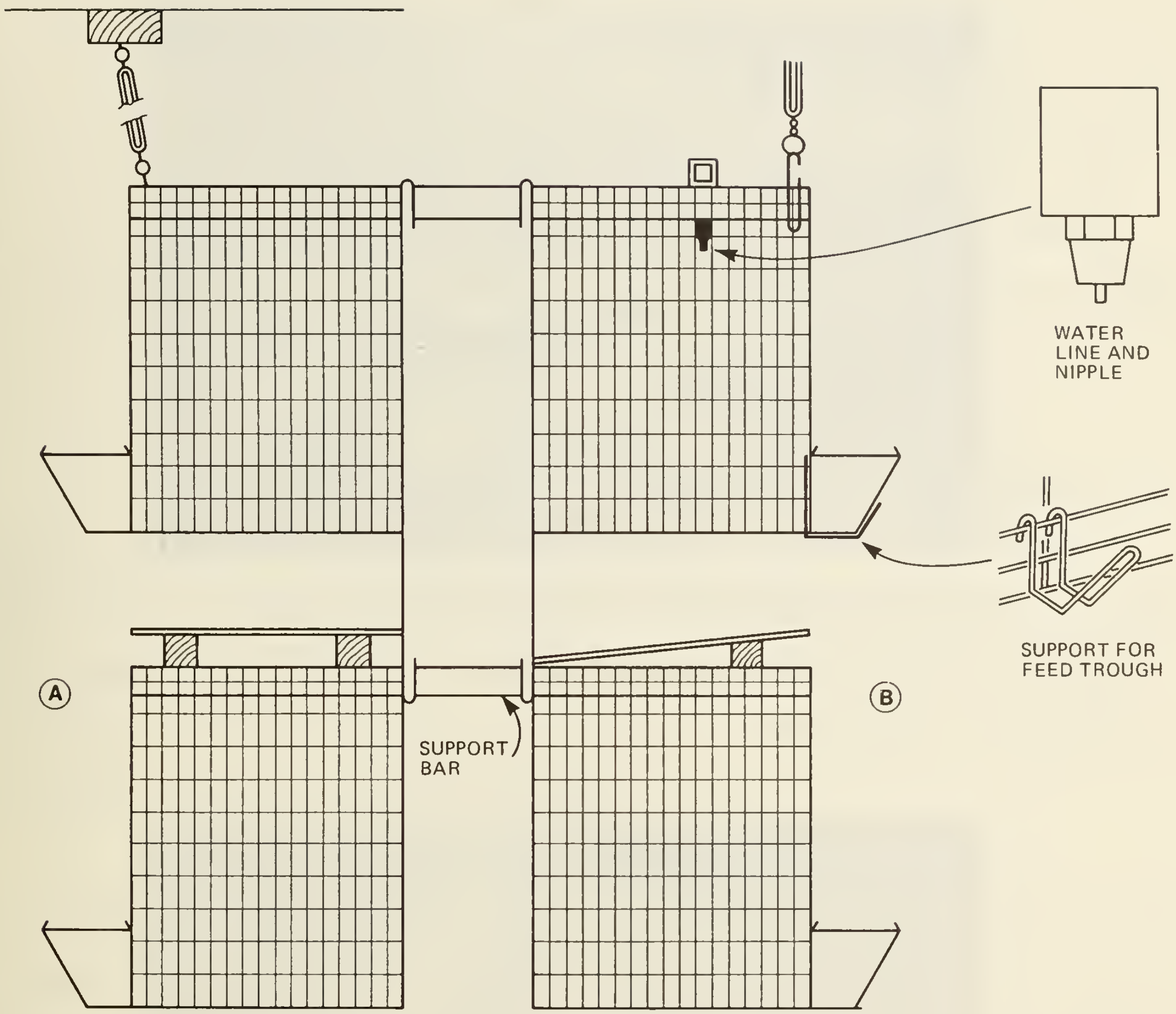

Figure 30 Side view of a 4-row double-deck battery of cages showing, (A) position of droppings board to hold excreta collection trays and (B) normal position of droppings board.

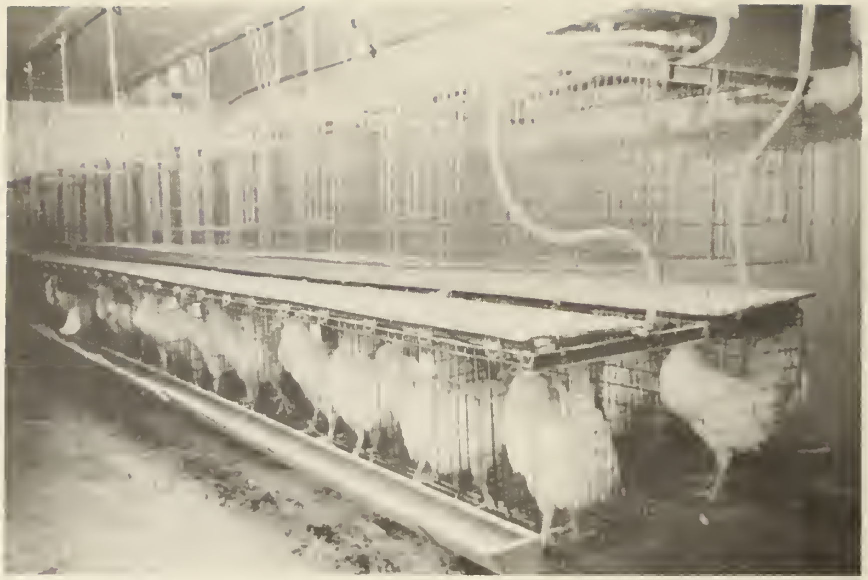

Figure 31. Cages being used to maintain birds between assays.

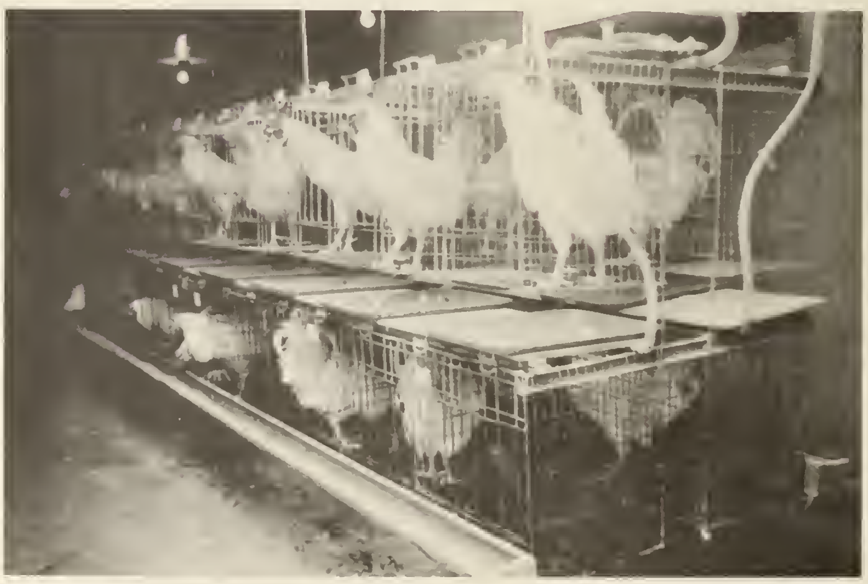

Figure 32. Birds housed in cages of upper tier being used in an assay.

FEED COMPOSITION

The feedingstuffs were assayed for TME and TME_n by the methods herein described. The preliminary fast was 24 hours, the feed input was 30 g of air dry material, and the excreta collection period was 48 hours. The data were all obtained subsequent to the publication of an earlier table (29); however, a few of the data have appeared in research publications from this laboratory.

Most of the feed samples were obtained from commercial sources but some seeds were obtained directly from plant breeders. The descriptions of the feedingstuffs are sometimes less specific than desired; however, the proximate analysis data help to identify their composition. The table (pages 34 to 44) is incomplete but the intention is to add data as they become available and, in due course, to eliminate incomplete lines.

The table comprises mean values for each parameter describing each sample. No attempt has been made to present means for groups of feedingstuffs. Such means are readily calculated but can be misleading particularly if an anomalous sample is included. For example, one sample of rapeseed meal (code no. ·485) having an ether extract content of 10.18% is atypical and its inclusion in th estimation of means questionable.

TABLE

Proximate composition (%), gross and bioavailable energy (MJ/kg) of the dry matter of several feedingstuffs[1]

Code	Description of feedingstuff	Nitrogen	Ether Extract	Crude Fibre	Ash	E	TME	TME_n
476	Alfalfa. dehydrated, meal.	2.84	2.30	25.00	9.09	18.9	6.50	6.13
440	Alfalfa. dehydrated, pellets.	2.33	3.07	27.60	9.26	18.9	4.44	4.39
Ms	Alfalfa. dehydrated, pellets.	2.76	2.30	25.00	9.00	18.9	5.73	-
378	Alfalfa. dehydrated, pellets, (18% protein).	3.01	5.18	26.10	7.78	18.7	5.60	-
372	Alfalfa. dehydrated, pellets.	2.54	3.40	29.10	9.10	18.6	4.92	-
359	Alfalfa. dehydrated, pellets.	3.02	2.61	29.00	9.15	18.8	6.55	-
338	Alfalfa. dehydrated, pellets, (20% protein).	3.62	3.50	21.30	9.49	19.1	6.95	-
339	Alfalfa. dehydrated, pellets, (17%), vegetable fat added.	2.82	2.18	30.10	9.02	18.8	4.91	-
340	Alfalfa. dehydrated, pellets, (22%), preserved with ethoxyquin.	3.80	3.27	20.30	9.20	18.9	7.44	-
341	Alfalfa. dehydrated, pellets, (15%).	2.57	2.06	31.50	7.56	18.8	6.59	-
348	Alfalfa. dehydrated, reground pellets, (15%).	2.68	2.07	26.50	11.12	18.1	4.83	-
349	Alfalfa. dehydrated, reground pellets, (17%).	2.94	2.47	23.80	11.58	18.2	5.63	-
350	Alfalfa. dehydrated, reground pellets, (20%).	3.72	3.29	22.40	12.26	18.2	6.14	-
351	Alfalfa. dehydrated, reground pellets, (22%).	3.72	3.05	19.90	12.80	18.5	6.64	-
607	Alpha-protein. Nutritional Biochemical Corp.	14.39	-	-	2.04	23.0	15.39	14.29
609	Assay protein. Ralston-Purina Ltd.	12.17	-	-	4.86	23.1	18.50	17.76
577	Babassu meal.	3.01	.71	34.60	7.54	18.4	4.64	4.03
578	Babassu meal.	2.96	1.39	42.50	6.65	18.6	4.76	4.18
534	Barley. whole, ground.	2.01	1.00	4.54	2.29	18.3	14.52	13.94
532	Barley. whole, ground, (cv. Leger).	2.04	1.47	5.85	2.72	18.4	13.44	13.09
531	Barley. whole, ground, (cv. Bruce).	2.00	1.65	5.68	2.87	18.2	13.51	13.16
530	Barley. whole, ground, (cv. Vanier).	1.81	1.52	6.37	2.90	18.3	14.04	13.49

cont'd.

Code	Description of feedingstuff	Nitrogen	Ether Extract	Crude Fibre	Ash	E	TME	TME_n
529	Barley. whole, ground, (cv. Massey).	2.06	1.56	6.12	3.02	18.4	12.75	12.41
473	Barley. whole, ground, (Quebec grown).	1.81	1.45	6.65	3.06	18.5	14.07	13.29
435	Barley. whole, ground.	2.08	1.58	3.91	2.23	18.6	14.76	14.28
392	Barley. whole, ground, (Ontario grown).	2.21	1.80	4.70	2.39	18.7	14.51	-
367	Barley. whole, ground, (cv. Conquest).	2.01	1.69	5.83	3.20	18.2	14.70	-
498	Barley. hull-less, ground, (cv. Bichita).	2.45	1.49	2.09	1.82	18.5	14.08	13.56
497	Barley. hull-less, ground.	2.04	1.21	2.42	1.77	18.4	14.23	13.77
496	Barley. hull-less, ground.	2.28	1.46	2.57	1.73	18.6	13.65	13.24
495	Barley. hull-less, ground.	2.60	1.74	3.34	2.01	18.7	13.30	13.12
458	Barley. hull-less, ground.	2.64	1.31	2.10	1.63	18.8	14.83	14.39
457	Barley. hull-less, ground.	2.68	1.44	2.07	1.67	18.9	15.18	14.76
456	Barley. hull-less, ground.	2.75	1.14	2.29	1.74	19.0	15.06	14.66
455	Barley. hull-less, ground.	2.73	1.31	2.22	1.71	18.9	15.40	14.93
454	Barley. hull-less, ground.	2.55	1.02	2.16	1.78	18.8	15.30	14.55
453	Barley. hull-less, ground.	2.74	1.56	2.33	1.77	18.9	15.34	14.83
452	Barley. hull-less, ground.	2.43	1.22	2.08	1.54	18.9	15.65	14.99
451	Barley. hull-less, ground.	2.67	1.32	2.09	1.68	18.3	15.10	14.48
450	Barley. hull-less, ground.	2.46	1.25	2.25	1.62	18.9	15.08	14.58
449	Barley. hull-less, ground.	2.78	1.35	2.18	1.73	19.0	14.94	14.46
411	Barley. hull-less, ground.	-	-	-	-	18.8	14.62	-
410	Barley. hull-less, ground.	2.78	1.27	2.92	2.73	18.6	13.95	13.38
409	Barley. hull-less, ground.	2.43	1.22	5.04	2.81	18.5	14.57	13.98
408	Barley. hull-less, ground.	2.83	1.48	2.97	2.86	18.8	13.92	13.45
407	Barley. hull-less, ground, (cv. Kun Lun).	2.63	1.55	2.73	2.40	18.6	14.00	13.34
406	Barley. hull-less, ground.	2.78	1.69	3.70	2.75	18.7	13.27	12.84
405	Barley. hull-less, ground.	2.82	1.32	3.07	2.70	18.8	14.07	13.64
404	Barley. hull-less, ground.	2.96	1.54	2.23	2.71	18.7	15.43	14.83
403	Barley. hull-less, ground.	2.68	1.40	3.38	2.90	18.8	13.48	12.79

Code	Description of feedingstuff	Nitrogen	Ether Extract	Crude Fibre	Ash	E	TME	TME_n
549	Beans. black, ground, (cv. Loop).	3.92	1.23	4.56	4.91	18.4	6.92	7.03
545	Beans. faba, ground, (cv. Herz Freya).	4.38	1.24	9.09	3.38	18.4	12.02	11.22
546	Beans. faba, ground, (cv. Aladin).	4.65	1.09	9.15	3.04	18.6	11.62	11.26
547	Beans. mung, ground.	4.32	.82	5.53	4.42	18.5	12.63	11.97
548	Beans. mung, ground, (cv. Morden 39).	3.99	.87	5.83	8.47	17.7	11.93	11.45
544	Beans. white, ground, (cv. Seafarer).	3.77	1.68	4.69	4.73	18.5	8.56	8.34
617	Blood meal.	15.33	.35	.38	1.54	24.8	17.13	15.74
483	Blood meal.	14.37	2.05	2.28	2.80	24.6	16.52	15.43
484	Blood meal.	15.16	.90	1.38	2.15	24.6	16.38	15.14
618	Blood meal.	15.40	.37	.26	1.40	24.8	17.29	15.96
599	Bone meal.	1.87	6.51	-	77.75	6.4	5.08	5.01
537	Brewer's dried grains.	3.90	6.34	19.76	4.66	20.6	7.87	7.39
562	Brewer's wet grains. (freeze-dried).	4.66	7.58	14.16	4.50	21.4	10.34	9.75
	Brewer's yeast. see Yeast, brewer's							
556	Buckwheat. whole, ground, (cv. Mancan).	2.34	2.61	12.54	2.68	18.7	13.66	12.87
519	Buckwheat. whole, ground.	1.97	2.62	14.04	2.33	18.5	14.06	13.31
	Canola meal. see Rapeseed meal							
606	Casein. vitamin-free, General Biochem.	14.54	-	-	5.70	24.2	20.46	18.66
604	Cellulose. Alphacel, Nutritional Biochemicals Corp.	.16	-	83.29	.28	17.3	0.00	0.00

Code	Description of feedingstuff	Nitrogen	Ether Extract	Crude Fibre	Ash	E	TME	TME_n
543	Cereal offal.	2.87	2.25	2.48	3.23	18.5	15.83	14.98
	Cerelose. see Glucose.							
563	Corn. ground, yellow.	1.32	3.66	2.27	1.27	18.4	16.45	15.92
467	Corn. ground, yellow, No. 3 Ontario.	1.33	4.11	2.08	1.37	18.7	17.38	16.45
468	Corn. ground, yellow, No. 3 U.S.	1.41	4.29	2.17	1.35	18.8	17.56	16.62
469	Corn. ground, yellow, No. 3 U.S.	1.50	4.47	2.28	1.34	18.8	17.06	16.12
470	Corn. ground, yellow, Quebec.	1.36	4.48	2.09	1.19	18.9	17.40	16.58
436	Corn. ground, yellow.	1.35	4.06	2.72	1.49	18.8	16.64	16.09
387	Corn. ground, yellow.	1.76	4.30	2.10	1.70	18.9	17.27	-
380	Corn. ground, yellow.	1.57	3.98	2.34	1.39	18.3	16.77	-
363	Corn. ground, yellow.	2.21	4.87	2.06	1.77	19.0	17.42	-
380	Corn. ground, yellow.	1.57	2.45	3.23	1.52	18.0	17.71	-
536	Corn gluten feed.	3.71	1.57	10.40	7.71	18.5	8.32	8.00
507	Corn gluten feed.	4.05	5.51	8.84	4.94	19.9	11.71	11.00
445	Corn gluten feed. flakes.	3.64	3.31	9.15	5.37	19.5	10.24	9.61
493	Corn gluten meal.	10.18	1.16	1.60	4.10	22.8	17.93	17.17
616	Corn gluten meal.	10.70	1.06	.82	3.73	23.2	17.86	17.27
521	Corn starch, pearled.	.10	.18	.41	.05	17.0	17.55	16.15
600	Corn starch, pearled.	.09	-	-	-	17.2	16.96	16.92
373	Cottonseed meal.	8.22	1.62	11.28	-	19.7	9.78	-
374	Cottonseed meal.	7.38	2.04	14.75	-	19.5	10.35	-
504	Crab meal. New Brunswick.	5.44	2.54	22.46	41.78	11.5	4.05	3.55

Code	Description of feedingstuff	Nitrogen	Ether Extract	Crude Fibre	Ash	E	TME	TME_n
567	Distiller's dried grains.	4.87	13.84	10.24	5.18	23.2	14.82	13.78
510	Distiller's dried grains. corn.	4.77	3.11	10.02	4.38	22.5	13.44	13.32
540	Distiller's dried grains. with solubles.	4.38	7.86	10.47	4.76	21.8	12.69	12.21
501	Distiller's dried grains. with solubles.	4.52	9.21	10.13	4.52	22.2	12.82	12.38
561	Distiller's grains. wet, freeze-dried.	6.68	6.96	21.45	1.07	22.6	11.77	10.69
601	Egg albumen solids. spray dried, pasteurized.	13.26	-	-	7.01	22.0	16.27	15.71
596	Egg white. raw, spray dried.	13.41	-	-	6.56	22.0	16.27	14.80
500	Feather meal.	14.28	3.45	1.16	1.89	24.0	14.61	13.55
478	Feather meal.	14.31	5.60	1.27	1.79	24.2	15.74	13.97
477	Feather meal.	13.76	9.17	1.28	2.52	24.8	17.10	15.30
394	Feather meal.	12.92	5.30	-	3.40	23.3	16.06	-
528	Fish meal. 66%.	10.03	2.03	1.74	31.89	15.8	10.42	9.20
527	Fish meal. 60%.	10.51	5.63	.95	25.67	17.9	12.29	11.01
441	Fish meal. Herring.	10.80	10.51	.96	18.35	21.2	15.80	14.30
398	Fish meal.	10.26	-	-	-	17.2	12.32	11.48
389	Fish meal.	11.70	2.50	-	22.91	18.3	13.30	-
360	Fish meal.	9.69	7.28	.54	24.56	18.3	13.42	-
354	Fish meal. Menhaden.	10.38	11.00	.50	21.42	19.8	14.51	-
353	Fish meal. Menhaden.	10.72	7.92	.40	19.85	20.0	13.84	-
581	Fish solubles.	10.26	12.30	.03	16.18	19.7	14.76	13.35
597	Gelatin. purified protein, Nutritional Biochemicals Corp.	16.62	-	-	.78	21.2	16.12	14.40

Code	Description of feedingstuff	Nitrogen	Ether Extract	Crude Fibre	Ash	E	TME	TME_n
605	Glucose. (D-dextrose anhydrous).	.05	-	-	-	15.6	15.57	15.50
Ms	Glucose. (monohydrate).	-	-	-	-	15.4	15.89	-
328	Glucose. (monohydrate).	-	-	-	-	16.0	15.74	-
557	Lathyrus Sativus. ground.	4.54	.60	7.69	3.44	18.4	11.81	11.30
558	Lathyrus Cicera. ground.	4.22	.63	6.17	6.35	17.7	11.68	11.33
559	Lentils. ground, (cv. Laird).	3.97	.74	5.39	9.31	17.3	12.34	11.82
560	Lentils. ground, (cv. Eston).	4.18	.84	5.49	3.48	18.5	12.76	12.23
512	Linseed meal.	6.48	2.80	12.35	6.26	19.6	8.44	7.86
506	Linseed meal.	5.99	4.36	12.80	7.88	19.8	9.06	8.02
499	Linseed meal.	5.84	6.67	11.38	6.03	20.4	9.20	8.62
432	Lupin seed. (from New Zealand).	4.93	5.72	17.06	3.72	19.7	9.45	8.89
482	Meat meal.	8.45	13.01	2.58	23.03	19.1	12.90	11.58
481	Meat meal.	8.55	12.88	2.97	25.26	19.0	12.51	11.74
480	Meat meal.	8.55	10.73	2.79	25.48	18.6	12.79	11.64
479	Meat meal.	8.95	9.96	2.83	26.84	17.8	12.80	11.15
444	Meat meal.	7.44	11.82	2.93	34.18	16.4	10.66	9.66
397	Meat meal.	8.64	12.60	-	24.81	19.5	13.13	-
362	Meat meal.	8.44	9.86	4.34	25.90	17.7	11.38	-
370	Meat meal.	6.60	13.20	1.20	43.33	-	-	-
371	Meat meal.	7.17	10.09	1.99	40.17	-	-	-
598	Milk. skim, spray dried powder.	5.62	-	-	8.45	18.0	11.92	11.19
570	Millet. ground, (from Indiana).	1.91	3.83	9.81	3.31	18.8	15.52	14.65
580	Milo. ground.	1.89	3.24	2.88	1.58	18.6	16.68	16.09

Code	Description of feedingstuff	Nitrogen	Ether Extract	Crude Fibre	Ash	E	TME	TME_n
442	Molasses. dried.	.77	.44	12.70	11.09	16.2	6.82	6.89
595	Oats. whole, ground, (cv. Donald).	1.85	3.40	14.55	2.65	19.2	13.50	13.04
594	Oats. whole, ground, (cv. Woodstock).	2.34	3.88	14.52	3.56	19.3	13.38	12.70
533	Oats. whole, ground.	1.89	5.30	11.71	2.78	19.5	13.32	12.90
437	Oats. whole, ground.	1.61	4.76	14.54	2.93	19.8	12.79	12.92
421	Oats. whole, ground.	-	-	-	-	19.8	14.68	-
420	Oats. whole, ground.	-	-	-	-	19.8	13.78	-
388	Oats. whole, ground.	2.10	4.10	10.51	3.01	19.3	14.30	-
382	Oats. whole, ground.	2.51	4.20	9.49	3.03	18.5	14.34	-
365	Oats. whole, ground, (cv. Harmon).	1.97	5.22	10.84	3.34	19.2	13.13	-
364	Oats. whole, ground, (cv. Hinoat).	2.64	3.98	11.92	3.03	19.3	13.01	-
593	Oats. hull-less, ground.	3.06	4.99	2.94	2.36	19.7	16.60	16.01
592	Oats. hull-less, ground.	3.00	5.40	2.70	2.30	19.7	16.78	16.24
591	Oats. hull-less, ground.	2.98	5.51	2.70	2.26	19.8	16.47	15.88
590	Oats. hull-less, ground.	3.09	5.99	2.91	2.28	19.8	16.55	16.03
589	Oats. hull-less, ground, (cv. Terra).	2.91	4.82	2.85	2.37	19.5	16.32	15.76
426	Oats. hull-less, ground.	2.62	5.54	2.27	2.11	19.8	17.02	16.41
424	Oats. hull-less, ground.	2.62	5.70	1.95	2.27	19.9	17.24	16.45
423	Oats. hull-less, ground.	3.12	5.01	2.27	2.53	19.8	16.51	15.91
422	Oats. hull-less, ground.	2.83	5.37	2.26	2.53	19.9	16.94	16.09
385	Oat groats. ground, Eastern Canada.	2.40	2.28	3.44	4.38	19.8	16.90	-
384	Oat groats. ground, Western Canada.	2.12	2.24	3.70	6.57	19.8	17.74	-
425	Oats. wild, dehulled, ground.	2.90	8.53	3.47	2.31	21.1	17.88	16.89
573	Peanut hulls. ground.	1.39	1.85	53.87	9.09	18.8	4.55	4.48
352	Peanut hulls. ground, (skins).	2.46	16.40	11.60	2.56	22.0	13.68	-
575	Peanut meal.	8.60	.68	7.41	4.95	19.6	12.17	11.15

Code	Description of feedingstuff	Nitrogen	Ether Extract	Crude Fibre	Ash	E	TME	TME_n
550	Peas. whole, ground, (cv. Triumph).	3.99	.95	6.27	2.90	18.4	13.20	12.83
551	Peas. whole, ground, (cv. Trapper).	4.17	1.08	7.29	3.00	18.6	12.74	12.08
552	Peas. whole, ground, (cv. Tara).	3.61	.95	7.76	3.13	18.3	12.81	12.52
553	Peas. whole, ground, (cv. Century).	4.31	.95	6.47	2.74	18.5	12.69	12.21
517	Peas. whole, ground.	3.88	1.05	7.39	3.10	18.3	12.69	12.06
494	Potato waste. dried, ground.	1.39	7.41	4.37	3.02	19.4	15.53	15.14
386	Potato waste. dried, ground.	1.21	7.02	3.97	4.02	18.8	15.71	-
518	Poultry by-product meal.	10.65	12.82	2.68	13.31	22.2	15.60	14.33
502	Poultry by-product meal.	10.47	16.36	1.66	13.50	22.9	16.90	15.48
524	Rapeseed. whole, ground, (cv. Candle).	3.56	27.07	24.44	4.19	28.0	15.19	14.60
523	Rapeseed. whole, ground, (cv. Tower).	3.60	31.97	22.21	3.92	28.6	16.95	16.31
303	Rapeseed. whole, ground, (cv. Tower).	-	-	-	-	27.9	19.70	-
526	Rapeseed dockage.[2]	2.47	9.12	20.35	7.21	19.9	9.48	8.95
		-	-	-	-	20.2	4.77	-
522	Rapeseed meal (Canola).	6.76	2.32	13.26	7.06	19.8	9.62	8.86
488	Rapeseed meal.	6.52	2.14	11.32	7.71	19.8	9.13	8.52
487	Rapeseed meal.	6.46	2.81	12.51	7.09	20.0	9.42	8.99
486	Rapeseed meal.	6.78	2.70	12.14	5.68	20.0	9.88	9.17
485	Rapeseed meal.	5.59	10.18	11.12	7.14	21.1	11.20	10.65
443	Rapeseed meal.	5.88	2.39	12.73	7.37	19.9	9.06	8.29
395	Rapeseed meal.	6.30	4.01	10.57	7.90	19.8	10.24	-
322	Rapeseed meal. (cv. Tower).	-	-	-	-	19.9	12.80	-
525	Rapeseed. small seed screenings.[3]	3.17	14.27	17.82	5.15	22.5	14.61	13.78

Code	Description of feedingstuff	Nitrogen	Ether Extract	Crude Fibre	Ash	E	TME	TME_n
579	Rice bran.	2.33	16.18	11.22	10.40	10.4	14.22	13.55
571	Rice bran. polish.	2.32	13.26	5.16	8.05	20.2	15.13	14.78
587	Rye. whole, ground.	2.02	1.03	2.78	1.62	18.4	14.52	14.01
586	Rye. whole, ground, (cv. Puma).	1.91	1.16	3.14	1.94	18.3	13.93	13.62
585	Rye. whole, ground, (cv. Cougar).	1.75	1.16	3.14	1.73	18.3	14.36	13.91
584	Rye. whole, ground, (cv. Musketeer).	1.88	1.05	3.04	1.66	18.2	14.09	13.87
582	Rye. whole, ground, (cv. Kodiak).	1.96	1.13	3.18	1.89	18.3	14.12	13.51
555	Rye. whole, ground, (cv. Puma).	2.17	1.21	2.50	1.72	18.3	14.40	13.94
554	Rye. whole, ground, (cv. Carman).	2.42	1.49	3.36	1.75	18.4	14.99	14.41
390	Rye. whole, ground, (cv. Gazelle).	1.95	1.30	2.60	1.61	18.3	15.31	-
568	Screenings. No.1 feed.	2.46	3.09	4.98	2.22	19.0	14.54	13.71
569	Screenings. feed.	1.79	1.60	14.81	6.31	18.1	8.91	8.62
576	Sesame seed meal.	7.50	4.71	7.83	12.88	18.7	10.68	9.50
447	Soybeans. whole, seed.	6.29	20.75	5.93	5.01	23.8	12.85	12.13
448	Soybeans. whole, rolled seed.	6.45	20.59	6.07	5.02	23.5	14.83	13.94
383	Soybean flakes. solvent extracted, raw.	8.65	1.06	4.42	6.42	19.8	9.87	-
446	Soybean hulls. ground.	2.66	2.50	35.68	4.84	18.2	4.62	4.21
608	Soybean meal.	7.50	1.26	9.42	6.35	19.5	11.23	10.42
492	Soybean meal.	8.28	.66	4.02	6.69	19.7	12.02	11.22
491	Soybean meal.	8.13	3.90	4.28	6.57	20.0	12.17	11.46
490	Soybean meal.	7.87	1.48	5.52	6.48	19.7	11.37	10.60
489	Soybean meal.	7.89	6.13	3.54	6.48	20.7	13.57	12.84
399	Soybean meal.	8.85	-	-	-	19.9	12.80	12.10
393	Soybean meal.	9.10	.60	4.31	6.70	19.8	12.84	-
368	Soybean meal.	-	-	-	-	19.5	12.95	-
327	Soybean meal.	-	-	-	-	19.4	13.37	-

Code	Description of feedingstuff	Nitrogen	Ether Extract	Crude Fibre	Ash	E	TME	TME_n
566	Sunflower seed meal.	7.82	1.49	12.81	8.76	19.3	10.37	9.23
516	Sunflower seed meal.	7.27	2.37	15.29	8.10	19.4	10.53	9.68
Ms	Sunflower seed meal.	7.48	1.60	10.79	7.91	19.7	10.79	-
505	Sunflower seed meal.	6.64	2.40	18.91	7.88	19.4	9.38	8.94
588	Triticale. whole, ground, (cv. Welsh).	2.64	1.11	3.90	1.97	18.4	14.94	14.27
583	Triticale. whole, ground.	2.68	1.55	3.81	1.78	18.2	14.58	14.14
515	Triticale. whole, ground.	2.49	.96	3.11	1.64	18.4	15.65	15.01
514	Triticale. whole, ground.	2.72	1.70	4.12	1.99	18.6	15.21	14.59
513	Triticale. whole, ground.	2.71	1.99	3.71	2.08	18.6	15.20	14.39
427	Triticale. whole, ground, (cv. Palouse).	-	-	-	-	18.2	14.71	-
472	Wheat. whole, ground.	2.49	1.58	1.74	2.49	18.7	16.25	15.24
471	Wheat. whole, ground.	2.71	1.90	2.59	1.80	18.7	16.53	15.61
428	Wheat. whole, ground, purple.	-	-	-	-	18.5	15.26	-
419	Wheat. whole, ground, Australian, (cv. Gunnedah).	-	-	-	-	18.4	15.26	-
418	Wheat. whole, ground, Australian, (cv. Cootamundra).	-	-	-	-	18.5	15.85	-
417	Wheat. whole, ground, Australian, (cv. Dubba).	-	-	-	-	18.6	15.70	-
416	Wheat. whole, ground, Australian, (cv. Wagga).	-	-	-	-	18.4	15.48	-
400	Wheat. whole, ground.	2.58	-	-	-	18.6	15.01	14.55
391	Wheat. whole, ground, (cv. Glenlea).	2.62	1.50	2.51	1.79	18.6	16.39	-
381	Wheat. whole, ground.	2.57	1.75	2.96	1.99	18.0	15.77	-
366	Wheat. whole, ground, (cv. Glenlea).	2.84	1.60	2.65	2.05	18.4	15.80	-
361	Wheat. whole, ground.	2.35	2.77	3.86	2.30	18.5	15.56	-
542	Wheat bran. (Ontario Wheat).	2.52	2.77	13.07	6.59	18.9	8.07	7.49
438	Wheat bran.	2.72	3.77	12.22	6.34	19.0	9.01	8.70
539	Wheat middlings. (Ontario wheat).	2.57	4.24	3.70	2.60	18.9	14.96	14.25
520	Wheat middlings.	2.67	3.93	9.50	2.67	19.1	13.99	13.49

Code	Description of feedingstuff	Nitrogen	Ether Extract	Crude Fibre	Ash	E	TME	TME_n
538	Wheat shorts. (Ontario wheat).	2.78	6.32	7.14	4.00	19.6	12.39	11.92
511	Wheat shorts.	3.06	4.41	11.21	5.12	19.3	10.60	8.96
509	Wheat shorts.	3.06	4.14	5.65	3.52	18.9	10.84	9.44
439	Wheat shorts.	2.49	3.21	8.65	5.17	19.0	11.69	11.22
535	Whey. powder.	2.03	.25	.33	9.35	15.5	5.90	3.11
508	Whey. powder.	1.96	.22	.45	8.88	15.4	5.78	2.70
602	Yeast. dried.	8.20	.15	7.99	7.83	21.2	13.47	13.39
574	Yeast. dried, brewer's.	6.32	3.03	6.50	8.39	19.4	12.78	11.58
541	Yeast. dried, brewer's.	6.42	.69	5.69	8.16	18.9	12.82	12.05
503	Yeast. dried, brewer's.	7.20	.40	5.51	10.41	19.5	11.19	10.42
572	Yuca. dried.	.60	.12	17.46	4.78	16.9	10.91	10.51

1. To convert the TME and TME_n data to kcal/g divide by 4.184.

2. By microscopic analysis found to contain: empty seed pods, stems, chaff 32%; wild oats 27%; rapeseed 25%; wheat and barley 9%; lambsquarter, red root pig weeds with trace of stickseed and seeds of compositae family 4%; wild buckwheat 1%; injurious weed seeds 1%; rodent excreta 1%.

3. By microscopic analysis found to contain: lambsquarter and red root pig weeds 53%; brassica sp. 37%; stink weed 8%; miscellaneous 2%.

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