Department of Industry

Application of Computers to Formulation of Animal Feeds for Small and Medium Volume Producers.

March, 1968

DEPARTMENT OF INDUSTRY

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Kates, Peat, Marwick and Company

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FOREWORD

The use of computers for least cost formulation of animal feeds has become widespread among larger manufacturers who are able to justify purchase of their own computing equipment.

Small and medium-sized feed manufacturers have not been able to afford such facilities. It was, therefore, considered a part of the function of the Department of Industry to determine the feasibility, costs and resulting economies available to small firms which are able to use a shared computer facility, data centres or other means of least cost formulation.

Toward this end, the consulting firm of Kates, Peat, Marwick and Company was engaged to carry out this study. Their report, presented in March 1968, indicates that it is economically feasible for small feed manufacturers to use data centres to compute economical formulation for the production of animal feeds.

This report should be of assistance and guidance to small feed manufacturers who wish to use computers for least cost feed formulation.

Director
Food Products Branch
Department of Industry

DEPARTMENT OF INDUSTRY

APPLICATION OF COMPUTERS TO FORMULATION OF ANIMAL FEEDS FOR SMALL AND MEDIUM VOLUME PRODUCERS

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I - INTRODUCTION

This study, commissioned by the Department of Industry, was carried out in accordance with the terms of reference set out in the Department's contract of December 6, 1967.

The purpose of the study is to ascertain whether it is practical for small and medium-sized feed mills to use computers for least cost formulation of the animal feeds they produce. The study presupposes some sort of sharing arrangement for the computing facilities. In addition, the study shows the advantages which can be expected from the application of computers, and the conditions required to make their application a success.

Five feed companies participated in the survey upon which this study is based. These companies operate mills located in southern Ontario.

II - BACKGROUND

Larger volume producers of animal feeds have been using computers for feed formulation successfully for at least five years. Specifically, the computer technique used to achieve least cost formulation is called linear programming. To date, comparatively few small and medium scale feed mills have implemented the use of computers for feed formulation in their day-to-day operations. Probably, this is due to the lack of resources available to the smaller producer, such as the specialized skills required to make such a computer application a success.

Recent years have brought significant advances in computing technology, with associated economies to the users of computers. At the same time, computers have become increasingly widespread. We have also observed the rise of numerous computing service bureaux, in which the user with small scale computing needs can purchase relatively small and inexpensive amounts of computer time in accordance with his own particular needs. These developments substantially enhance the ability of the small and medium scale feed producer to utilize computers.

III - SURVEY FINDINGS

In our survey of the feed mills participating in the study, we investigated areas of mill operation having a bearing upon the application of the least cost computing technique.

CURRENT PRACTICES OF THE FEED MILLS

Production Volumes

There are substantial differences in the annual production volumes of the feed companies. The largest company produces a volume well over five times that of the smallest mill. We have found convincing evidence that even the smallest of the companies participating in our study has sufficient volume to make use of the computer method, at least for some of the feeds it produces.

Feeds Produced

Each of the companies produces at least 50 different feeds, with some companies producing significantly more than that number. Each feed company has two or three groups of feeds in which it specializes more than others. Examples of these feed groupings are:

- poultry feeds
- hog feeds
- broiler feeds
- dairy feeds
- turkey feeds.

Several companies produce a line of low volume feeds such as rabbit feeds, horse feeds, sheep feeds, and pigeon feeds. These lower volume feeds might not merit least cost formulation using the computer. However, the lowest volume feed for which it would be profitable to use a computer for formulation is easily established.

Production Practice

Production practice is reasonably uniform among the mills. Normally, production is in made-to-order batches. Several of the mills also maintain limited inventories of certain popular feeds for "off the floor" sales.

Feed mix batches are normally in the range of one to fifteen tons. In scheduling the production of these batches, some of the mills take advantage of any economies which can be gained by scheduling the batches by feed type.

All of the mills make use of pre-mixes. The pre-mixes consist of chemical ingredients designed to supply vitamin requirements, antibiotics, and the trace minerals. Some of the mills produce their own pre-mixes, while others purchase them from suppliers of chemicals in an economical purchasing arrangement.

Ingredient
Purchasing Practice

Purchasing practice is reasonably uniform among the feed mills.

In most cases a weekly cycle is followed in which most of the ingredients are priced. Purchases are then made based upon current inventories, expected ingredient requirements, and the current ingredient prices. Some of the mills utilize a method whereby a rough quantitative evaluation can be made of the nutritional value of an ingredient compared to its current price.

Generally, ingredient purchasing is carried out so as to obtain a supply of ingredients required to meet production needs. At the same time, the mix of ingredients which is purchased must be more or less nutritionally sound and as economical as conventional methods will provide.

Some of the mills differ somewhat from the others in that more attention is given to the purchasing exercise. In this case, price trends are examined closely in order to make astute purchases; more attention is given to economical feed formulation, by taking into account expected future movements of the prices of the major feed ingredients.

Brokers are usually used to obtain corn, wheat, oats, barley, and soyabean meal. Most other ingredients, such as meatmeal, fishmeal, and chemical ingredients, are purchased directly from suppliers.

To ensure adequate supply of grains during the winter months, the mills normally take some future positions on these grains.

Most mills claim to have more than enough storage capacity for ingredients. One mill has just enough capacity to get by.

In general, the mills appear to have the full flexibility required in their ingredient purchasing practices to make use of least cost computer feed formulation.

Ingredient Analyses and Prices

The analyses of the nutrient qualities vary somewhat from mill to mill. In some cases the variations are small, while in others they are significant. Notwithstanding, based on the limited contact we have had, it is our opinion that a common analysis for ingredients can be agreed upon for use by all the mills.

The delivered price for ingredients paid by the mills also varies. The difference is significant, and the computer system will have to accept individual prices from each mill.

Nutritional Control in Feed Mixes

In this area of practice a considerable variation among the mills is evident. In all cases the mills appear to be striving to market as excellent a nutritional product as possible. The degree of success achieved appears to be limited by the amount of detailed attention which the nutritionist is able to devote to his nutritional duties.

Several different levels of nutritional control appear to be practiced among the various mills. Making due allowance for the fact that the degree of nutritional detail depends upon the type of feed being produced, the following levels of nutritional control are in use:

1. The minimum level of nutritional control in effect appears to be concerned primarily with meeting the feed specifications as they are set out in the Government Feed Registration. In this case the major nutritional emphasis is upon the percentage protein, fat, fibre, salt, with vitamins and trace minerals being accounted for in a chemical pre-mix which is added into the feed mix at a fixed level.

2. More frequently a higher level of nutritional control is observed in which the percentage of calcium and phosphorous is controlled, together with the metabolizable energy of the feed. In addition, some attention is usually given to the levels of a few of the amino-acids.

3. The highest level of nutritional control in use in any of the mills includes extensive control over a larger number of amino-acids, vitamins, trace minerals, and attention to the balance of metabolizable energy with protein.

It is apparent that in most cases a certain amount of nutritional control is being exercised by the nutritionist through informal methods which are not reflected in the explicitly documented facts available from the feed mills. This means that rule of thumb methods are being used to a greater or lesser extent which are based upon the individual nutritionist's experience. While this informal control is always directed

toward producing a feed mix with nutritional quality, it is clear that nutritional uniformity and accuracy cannot be consistently maintained using these methods.

In all cases, the degree of control over the nutritional qualities achieved in formulating a feed is somewhat restricted by the manual methods of computation which are being used. This limitation is particularly important to the nutritionist who is attempting to maintain the most extensive nutritional control. The computational task involved in formulating a feed where numerous nutritional qualities are being controlled, while attempting to produce an economical feed, is very tedious indeed.

Re-formulation of Feed Mixes

The frequency with which feed mixes are re-formulated is also related to the amount of time available to the nutritionist for his nutritional duties. Here again, the practices of the mills vary considerably.

For major large volume feeds, re-formulation frequency varies from roughly once a year to once every five weeks. Re-formulation of the lower volume feeds takes place considerably less frequently than for the larger volume feeds.

Nutritionist Duties

In all the mills, nutritionists have duties in addition to their nutritional responsibilities. These extra duties

consist of a variety of functions such as sales management, quality control, research and feed development, veterinary troubleshooting, purchasing, and participation in general management. Such an arrangement appears to be necessary when the volume of business cannot support the staff level required to provide specialization in the nutritional function alone.

Accordingly, all of the nutritionists interviewed would like to have more time to devote to their nutritional responsibilities.

Experience with the Application of Computer to Feed Formulation

Experience with computers varies from no experience, to one mill which has developed and implemented its own linear programming system for feed mix formulation. Several of the mills have had some limited experience with a feed formulation system made available as a service by a vendor. Generally, this service was found to be of limited use.

FEATURES OF A COMPUTER FORMULATION SYSTEM REQUIRED BY FEED MILLS

The requirements set out in the following paragraphs highlight practices within feed companies which an effective computer system must be able to accommodate.

Feed Mix Specifications

Although most of the mills produce similar feeds, the specifications of similar feeds differ from mill to mill. These differences are as follows:

1. The mills exercise a different extent of control over nutritional qualities. Although the application of computers will generally result in extended control for all the mills, nevertheless, it appears that some mills will want to exercise control over more nutritional qualities than others. Also, different nutritional specifications are required for individual nutritional qualities. For example, the percentage of calcium in similar feeds can be set to different values by each mill.

2. Controls over individual ingredients will vary.

3. In some cases, possibly a few entirely different ingredients will be utilized by several of the mills.

Ingredient Prices

Provision must be made for different prices for the same ingredients among the various mills.

Speed of Service

The feed mills cite a maximum time for performing the computational service varying from two days to two weeks. Most of the mills, however, do not have direct experience with using a computer service on a day-to-day basis in their operations. Once this experience is gained, the method of using the service will probably be somewhat different than that which

is envisaged by the mills at this point in time. As a result, ideas regarding the timeliness of a service will probably change.

Confidentiality of Data

The mills will require that confidentiality of data be maintained. This will apply particularly to the price of ingredients, and the specifications of the feeds produced.

IV - BENEFITS AND COSTS USING A COMPUTER

The application of computers to feed formulation will provide substantial benefits to the feed mill operators. These benefits, which are described below, make the computer methods very attractive, especially considering the low costs involved in their use.

BENEFITS

Savings in Cost of Ingredients

Our experience in implementing linear programming methods in a number of industries indicates that savings from 2% to 5% of operating costs can be achieved. This is the extent of savings obtainable in operations which are already under reasonably good control. The degree of savings to be expected when linear programming is applied to operations which are not under careful control will, of course, be substantially larger.

In the context of the feed mix application, we could say that the major feeds which are being watched carefully, and are being re-formulated at least several times a year could be defined as processes under reasonably good control. Correspondingly, the lower volume feeds to which the nutritionist cannot devote the same amount of attention, and which are re-formulated once a year or perhaps much less frequently could be defined as processes which are not under careful control.

To estimate the prospective savings more accurately, we have constructed a linear programming model which has been used to make approximate formulations of a laying feed a pig starter feed. These two feeds are typical of the higher volume feeds which are under reasonable close control by the mills.

Cost savings achieved for the laying feed averaged 3.0% over a period of one year. Savings for the present pig starter feed are 4.9%. Appendix A shows a series of measures of the savings in ingredient costs achieved over a period of time in which the laying feed was re-formulated using the computer.

The savings cited in the previous paragraph are those which could be obtained under ideal conditions. In practice, the full amount of ingredient cost savings will probably not be obtained since existing inventories of ingredients preclude the use of optimum feed formulations at all times. As a result, we have decreased these precentage savings in our estimate of the savings which can actually be achieved.

Our best estimate of the savings which will actually be achieved by using a computer is 2% to 3% of ingredient costs. These are the savings which would apply to feed mixes already under close control using manual methods. The savings which would apply to feed mixes which are not currently under close control would be significantly greater, perhaps 5% of ingredient costs or more. The impact of the savings on overall

mill profits of these less carefully controlled feeds, however, would depend entirely on the volume involved, which normally is much less than that of more closely controlled feeds.

We believe that savings of the degree mentioned above will improve profits significantly. At the present time ingredients constitute an average of 75% of the sale price of feed mixes. The remaining 25% is made up of miscellaneous costs such as ingredient shrinkage, bags, tags, labour, sales commissions, administrative overheads, and net profit. The total of the miscellaneous costs varies considerably from mill to mill, depending upon efficiencies and financial and accounting practices. The latter situation makes it difficult to provide an accurate estimate of net profits. Notwithstanding, net profits of the mills we visited averaged less than 5% of total feed mix sales revenue. As a result, a saving of only 2% on ingredient costs would substantially improve the profits of the feed mills.

Nutritional Quality and Uniformity

The use of a computer will permit the feed mills to exercise more extensive control over the nutrient qualities of their feed mixes. We anticipate that most of the mills will want to control more nutrients than they are presently controlling. In addition, when feed mixes are re-formulated from time to time, the resulting nutritional quality of the feeds should be more uniform.

We point out, however, that as more controls over nutritional qualities are added, the cost of a feed tends to increase. Hence, it is possible that a mill which decides to improve extensively its nutritional control, might not obtain very large ingredient cost savings. One of the advantages of using linear programming, though, is that it allows an intelligent evaluation of the ingredient cost versus nutritional control.

In any case, the net result will be higher nutritional quality in every way. This will apply to individual feed mills, where nutritional quality will be more uniform over a period of time, and to the feed industry as a whole, where nutritional quality among the mills will become more uniform.

Assistance to the Nutritionist

The use of the computer method will provide considerable assistance to the nutritionist, who will be relieved of the tedious and time-consuming task of formulating the feed mixes by manual methods. In general, the nutritionist will be able to do a much better nutritional job using less time and effort. The amount of time to be saved will depend upon the amount of time which the nutritionist is currently devoting to his nutritional duties. However, it is quite possible that this saving could be several days per month.

The use of a computer will also facilitate experimental work in which the nutritionist can experiment with new feed formulations. Also, the value of new ingredients which become available in the market can be readily evaluated.

Another task which could be carried out using the same computer system is feed formulation costing. In this case, a formulation could be entered in which all ingredients are specified at given levels. The feed mix would not be altered or optimized in any way. The result would be the specified formulation, but showing a total cost reflecting current ingredient prices. Hence, the nutritionist can use this method to cost out feeds which he feels are not yet due for re-formulation, although ingredient prices have changed. This operation is fairly trivial, involving only the multiplication of a series of ingredient levels by ingredient costs and summing the results.

Additional Information Supplied by the Computer

The linear programming method supplies, as a by-product to finding the least cost formulation, a wealth of other useful information.

Cost ranging enables the nutritionist to know the amount by which the price of an ingredient may change without affecting the amount of that ingredient which will be included in the least cost formulation. This information can be used in deciding when a feed should be reformulated.

Also, for each ingredient which is not in the least cost formulation, the amount is shown by which the cost of that ingredient would have to be reduced in order for it to be included in the formulation. This amount is often called the shadow cost.

The so-called dual solution shows the nutritionist the extent to which individual constraints make the feed mix more expensive. For example, the dual solution will indicate exactly how much it would cost to increase methionine in a feed by a specified amount.

COST OF COMPUTING LEAST COST FORMULATION

To give an approximate evaluation of the cost of the computing service, it is assumed that the nutritionist will want to submit a series of feeds for re-formulation about once each month. In this monthly computation we assume the nutritionist would want to re-formulate approximately ten different feeds. Computing costs for this monthly service, based on current information from the IBM Data Centre and the feed mix companies, are estimated as follows:

- keypunching and verifying of data	$ 7.00
- computer; ten L.P. cases at $5.00 per case	50.00
- printing of results	13.00
- data processing analyst setup and co-ordination; two hours at $10.00 per hour	20.00
TOTAL	$90.00

For the feed companies which we contacted, the computing costs estimated above are quite small when compared to the savings which will be achieved. The exact ratio of computational cost to savings depends in large part upon the volume of the feeds to be formulated by computer, and the previous attention given to manual formulation.

Some effort will be required on the part of the nutritionist and/or an assistant in setting up the computation. This effort is estimated at less than half a day to set up the monthly run previously described, once a highly efficient set of forms is developed.

V - PROPOSED FEED FORMULATION SYSTEM

This section outlines a computerized system utilizing linear programming which would meet the requirements of the feed mills.

GENERAL DESCRIPTION

To gain simplicity in the computing operation, we recommend that a common linear programming matrix be used and shared by all the mills. This matrix would consist of all available ingredients, giving the nutritional analysis of each ingredient.

This matrix would have to be set up with the co-operation of all the participating feed mills. The mills would have to agree upon an analysis for each ingredient. Should agreement not be obtainable, it would still be possible to construct an individual matrix for each feed mill. In this case, the operation of the system would be somewhat more costly than the system we are recommending.

In the proposed system, provision will be made for each mill to set up its individual prices for all of the ingredients. In addition, provision will be made for each mill to maintain a set of feed specifications for each feed to be formulated using the computer.

To facilitate the operation of the system, a set of forms for input data should be designed. These forms would be drafted for easy interpretation by the nutritionist, and to ensure that the data be recorded in the format required by the computer.

During the periodic reformulation of the feeds the nutritionist would fill in the forms and mail them to the computing centre where the results would be generated and mailed back to the mill.

SPECIFIC CONSTRAINTS AND CONTROLS

We suggest the following list of constraints for nutritional qualities be utilized in the feed formulation system:

- total weight
- protein
- metabolizable energy
- total digestible nutrients
- fat
- fibre
- calcium
- salt
- phosphorous (two controls)
- methionine
- cystine

- methionine plus cystine
- lysine
- tryptophene

- riboflavin
- niacin
- pantothenic acid
- folic acid
- choline
- vitamin A
- vitamin B12
- vitamin D3
- vitamin K
- manganese
- zinc
- iron
- iodine
- copper
- cobalt.

We believe the above list is sufficiently comprehensive to cover all of the nutritional controls being practised by the mills at the present time. However, additional control can be included if the mills feel there is a very good reason for doing so.

In most cases, it would appear that the mills will not want to make use of all of the constraints listed above. In the proposed system, it would be a simple matter for any

mill to activate only those nutritional constraints which it feels necessary to formulate its feeds. The remainder of the constraints would then be inactive for that mill.

The system would also contain a simple method of rejecting and/or bounding individual ingredients. This means that each mill would have the capability of rejecting any ingredient, setting a lower limit for an ingredient, setting an upper limit for an ingredient, or setting both lower and upper limits for an ingredient for each feed to be formulated.

NUMBER OF FEEDS

The number of feeds for which the computer would be used would depend upon the amount of effort the nutritionist can devote to setting up the data.

Computational costs for the formulation of each feed will average under $10.00. At the same time ingredient cost savings of at least several dollars per ton can readily be expected. A common method of deciding to use a computer for formulation is that the expected cost saving will be at least double the computational expenses. On this basis it would appear economical to use the computer for the formulation of virtually all of the feeds produced.

Accordingly, the factor governing the number of feeds for which the computer is to be used is the time required for the nutritionist to set up the initial data and instruct-

ions for each new feed. Given sufficient time for the latter work to be carried out, we expect that a minimum of the 30 highest volume feeds of each mill should be formulated on an ongoing basis using the computer.

FREQUENCY OF REFORMULATION

The very first time a feed is formulated by computer, the saving achieved over the previous formulation is usually much greater than that of subsequent optimizations by computer of that feed. This circumstance occurs because only the first computer formulation represents a difference between manual formulation and computer optimization. Later computer formulations represent differences between previous formulations due to changing conditions such as ingredient costs, but do not have the additional savings of a first-time optimization. Consequently, a feed is reformulated only when there has been a significant enough change in conditions to achieve worthwhile savings.

Appendix B shows the variations in prices of some major feed mix ingredients over the past few years. Applying the above principle to the price changes shown would probably result in the reformulation of the higher volume feeds about once every two months. Intermediate volume feeds might be reformulated three times a year, while the very low volume feeds might be reformulated once each year.

VI - SELECTION OF A COMPUTING FACILITY

COMPUTING FACILITY REQUIREMENTS

The following features, listed in approximate order of importance, are those which we have identified as being the most critical from a point of view of the mills' requirements:

1. A proven linear programming system should be available containing sufficient technical capability and providing as much ease of user operation as possible.
2. The computing service should be economical.
3. The service provided should be as fast as possible.

RECOMMENDED COMPUTING FACILITY

The computing method which best meets the requirements of the mills as set out above is the Mathematical Programming System (MPS), available through the IBM Data Centres.

The MPS appears to be a fully tried and proven system. An advanced and efficient LP code, the MPS incorporates all the desired features, including the dual solution, shadow costs, optimality and feasibility ranging. The MPS can easily accommodate the largest matrix conceivable for any feed mix application.

The MPS system is available at a reasonable cost. The estimated costs given in Section IV are based upon our actual experience with running trial feed mix evaluations using the MPS. Further, we have discussed our cost estimates with the management of an IBM Data Centre, and have obtained their concurrence.

IBM personnel have quoted to us that the speed of service using the IBM MPS system is three or four working days. This estimate allows for one day for data in transit from the mills to the Data Centre, one or two days at the Data Centre, and one day for results in transit to the feed mills. While the speed of this service is slightly slower than the most demanding requirement specified in our survey of mills, we feel that it will be sufficient.

Further details of available alternative computing facilities are given in Appendix C.

VII - IMPLEMENTATION AND OPERATION OF THE FEED FORMULATION SYSTEM

The ultimate success of any computer based system depends in large part upon the interest, effort, and degree of experience and expertise brought to bear by system designers and system users in the launching and running of the system. This situation must be recognized by the mill operators if a decision is taken in favour of implementing the computer system.

IMPLEMENTATION

The first step in implementation would be the detailed design of the feed formulation system described in Section V.

Following this, basic orientation and education of the system users should be carried out. In this phase, agreement on the details of the matrix of ingredients should be obtained. Perhaps this phase could best be effected through a meeting of the mill operators with the system designers, and might also serve to introduce the system operator (IBM Data Centre).

The next step would be for each mill to set up and run several trial feed formulations. This is the step requiring the greatest patience, understanding, and detailed attention

to data inputs and outputs. Typically, the first few trials produce invalid results. Successive refinements are then made until the system is producing feeds which meet all the requirements of the nutritionist.

Once the errors and inconsistencies have been removed from the trial cases, the nutritionist can proceed to set up a number of feeds for ongoing formulation. Probably, these will be the highest volume feeds. Subsequently the intermediate and lower volume feeds can be set up for computer formulation.

SYSTEM OPERATION

We expect that each mill will determine the best method of using the system after a period of experience. At first, the operation will be largely a matter of watching changes in prices of the major ingredients, and deciding when a reformulation is due.

A modification of this operation which some mills might find worthwhile would involve the focusing of more attention on the major ingredient price trends and resulting future prices. In this mode of operation, the nutritionist would work a period of several weeks or possibly much more in the future, determining what the most economical formulations would be, and planning his purchasing accordingly.

A number of smaller practical problems will also probably have to be solved. For example, an efficient method

of making feed formulation changeovers in the mill operation might be desirable. The latter is based upon the assumption that use of the computer system would probably imply a more frequent change in formulation. Another problem which the use of the computer raises is the use of small or possibly non-standard quantities of ingredients. In this case the least cost formulation may include a much smaller quantity of some ingredient than is normally used in making up a formulation. The ultimate solution could be either a manual adjustment to the feed formulation or a change in mill operating practice.

VIII - CONCLUSIONS AND RECOMMENDATIONS

After making a careful review of the facts and analyses contained in the foregoing sections of this report, we are satisfied that the application of computers to formulation of animal feeds for small and medium volume producers is indeed feasible and practical. Accordingly, we advise that implementation be undertaken as soon as arrangements can be made.

CONCLUSIONS

1. Current operating practices of the mills are suitable to and/or easily accommodated by the proposed computer formulation system.

2. Time requirements of the mills can nearly always be met.

3. Major benefits can be obtained in ingredient cost savings, nutritional quality and uniformity of feeds, and general assistance to the nutritionists.

4. The operating cost of the system will be comparatively small.

5. A system to be shared by participating mills can be designed and appears to be feasible.

6. A suitable computing facility is available through the IBM Data Centres.

RECOMMENDATIONS

1. The Department of Industry should apprise the participating feed companies of the findings of this study.

2. The group of companies wishing to join in the use of the system should be determined. The companies should be aware of the active participation required of them.

3. Following the latter, detailed system implementation work should be commissioned and initiated.

Given active and enthusiastic participation on the part of the feed mills, a successful system operation will be assured.

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APPENDICES

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APPLICATION OF COMPUTERS TO FORMULATION OF ANIMAL FEEDS FOR SMALL AND MEDIUM VOLUME PRODUCERS

APPENDIX A

SAVINGS IN INGREDIENT COSTS USING COMPUTER FORMULATION FOR A LAYING FEED

APPENDIX A

SAVINGS IN INGREDIENT COSTS USING COMPUTER FORMULATION FOR A LAYING FEED

Date of Reformulation	Per Cent Saving
January, 1967	4.5
April, 1967	2.6
June, 1967	3.7
August, 1967	2.1
October, 1967	1.9

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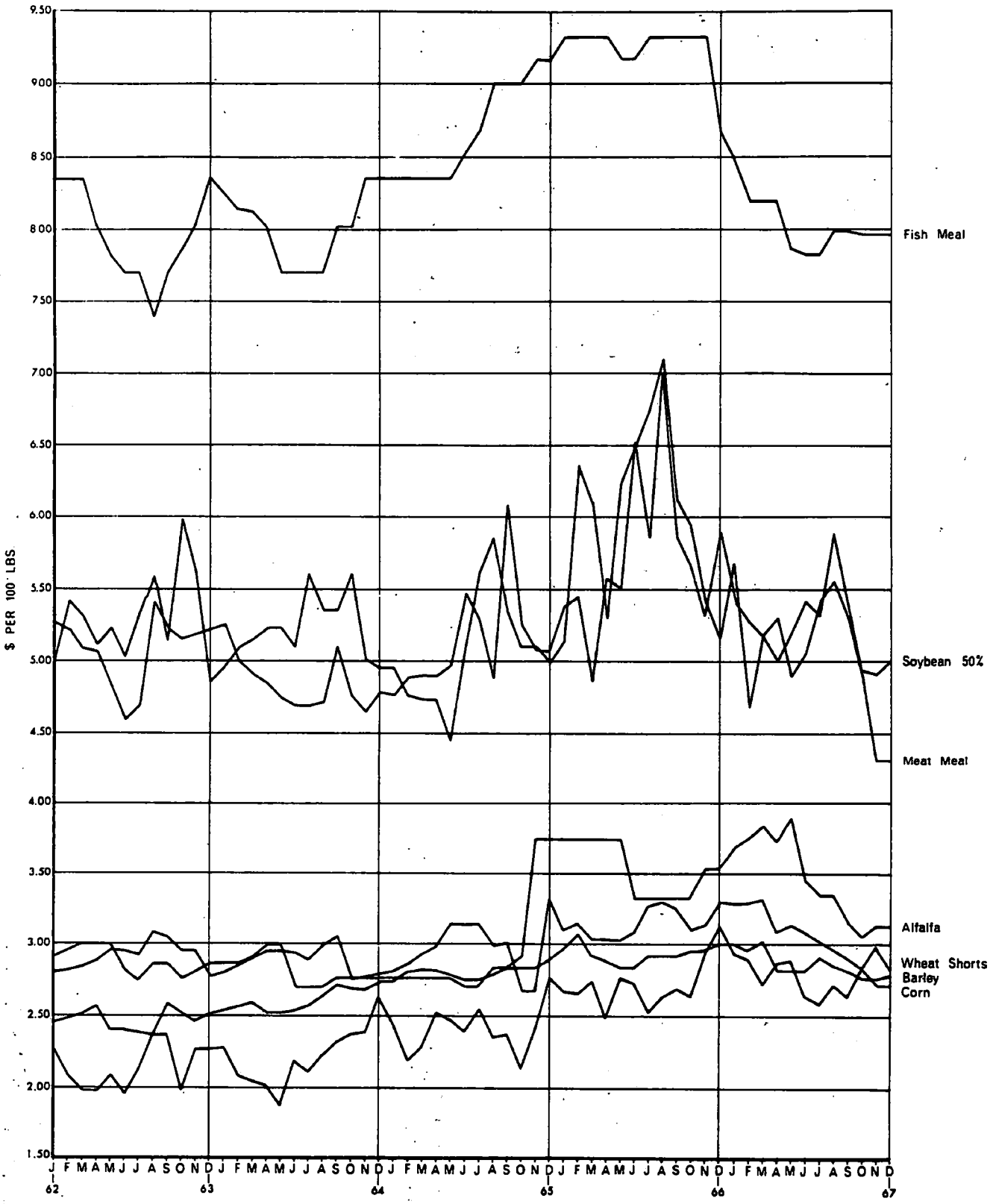
APPENDIX B

PRICE VARIATIONS OF SEVEN MAJOR FEED INGREDIENTS

APPENDIX B

PRICE VARIATIONS OF SEVEN MAJOR FEED INGREDIENTS



APPLICATION OF COMPUTERS TO FORMULATION OF
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APPENDIX C

DETAILS OF ALTERNATIVE COMPUTING FACILITIES

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APPENDIX C

DETAILS OF ALTERNATIVE COMPUTING FACILITIES

Our report recommends the use of the IBM Data Centre computing service. This Appendix describes alternative computing arrangements which were considered.

Computer Operated by One of the Mills

The smallest machine which can practically perform linear programming calculations would be a computer approximately the size of an IBM System 360 Model 30. This computer, configurated with at least one disc and a 64K core which would be required would rent for about $11,000 per month. This high cost, coupled with the obvious loss of confidentiality of data, makes this alternative impractical.

General Electric Time-Sharing System

Linear programming is available on this system. However, matrix size is severely restricted, even for a feed-mix application. The full range of linear programming features is not available with this system. The basic rental of over $300 per month for the time-sharing terminal alone makes this alternative unattractive.

IBM Quiktran Time-Sharing System

The linear programming facility available with this

system is also rather restrictive in matrix size, but it does supply most of the desired linear programming features. However, monthly rental of over $350 for the time-sharing terminal alone makes this alternative unattractive.

Univac 1108 -
Large Scale Computer

The Univac 1108 system is reported to contain a good LP code. The machine is available to outside users at a rental of $950 per hour. While we believe the recommended feed formulation system could easily be handled by this computer, mistakes in set-up and operation of this system could prove highly costly.

Control Data Corporation
3600 Computer

The CDC 3600 provides an LP facility at a rental of $425 per hour. Due to the fact that the CDC Service Bureau is not in full operation in several Canadian centres, this alternative is not recommended.

Burroughs B5500 Computer

The B5500 makes use of a LP code called ALPS, which is available at a rental of $325 per hour. This service could be provided by the Computing Services Company, a Service Bureau, but will not be available until the installation of additional disc equipment.

Other Services

Both Honeywell and NCR reported some capability in providing LP computing services. However, neither of these

services appear to be in the state of development where they would be consistently available to a user with on-going needs.