COMPUTERIZATION OF LEAST COST RATION FORMULATION IN FISH FEED COMPOUNDING BY LINEAR PROGRAMMING.

(A case study of National **Institute of Fresh Water Fisheries Research (NIFFR) New Bussa, Niger State**

BY

OKOYE OKWUDILI VIRGINUS.
PGD/MCS/1093

DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE OF THE FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA NIGER STATE.

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A PROJECT SUBMITTED TO THE DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE OF THE FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA FOR THE AWARD OF POST GRADUATE DIPLOMA IN COMPUTER SCIENCE.

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CERTIFICATION

We agree in every capacity that this project work was produced by the bearer Mr Okoye Okwudili V. in partial fulfilment of the Post Graduate course in computer science

Prof. K. R Adeboyo
Project supervisor

Date

Mr L.N. Eziakor
HOD

Date

External Examiner

Date

DEDICATION

This project work is dedicated to the almighty God and to all my friends and well wishes

ACKNOWLEDGEMENT

I wish to acknowledge the effort of all my lecturers at Federal University of Technology Minna, for their tirelessly effort in seeing that this my project work get the required knowledge in computer science and information technology at its highest level.

I am particularly grateful to my project supervisor Prof. K. R. Adeboye for his guidance.

Finally I wish to thank my friends and course mates for there company and encouragement throughout my stay in the institution.

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ABSTRACT

This project work is concerned with the need to develop a very comprehensive computerization procedures for least cost ration formulation in fish feed compounding using linear programming based on the National Institute for Freshwater Research (NIFFR), new bussa Niger state.

The main emphasis is the computerization of the least cost ration formulation in fish feed compounding which will replace the existing manual system of the fish feed compounding procedures using linear programming and recommended that a suitable system design to be use.

Finally, the mode of the operation of the propose system is to analysed, and its usage of implementation. The implementation is developed in a way to ensure reliability and continuity of fish feed compounding in National Institute for Freshwater Research (NIFFR), new bussa Niger state.

CHAPTER ONE

1.1 STATEMENT OF PROBLEMS

Over the years, there has been a lot of waste of feed in fish farming even a lot has been invested in that aspect too. However, with the introduction of linear programming cost ration formula it will help to suggest ways of curbing the problems encountered in fish farming. However, the problems are summarised as follows:

a. The decision as to which feed materials to be combined in order to attend the compounded feed is the concern of the management.

b. The feed producer obviously wants to produce the compound materials at the least possible cost, and finally

c. He (producer) will also like to look at the chemical composition of the materials and the market price at the same time so as to determine the choice of any feed and formulation for arriving to that. All the problems stated above called for the need of the computerisation of linear programming cost ration so as to actualize that.

1.2 OBJECTIVE OF THE PROJECT

The objective of the project is to illustrate the use of linear programming tools to formulate least cost rations which will meet the specific nutritional requirement of intensive fish enterprises using readily available feed ingredients in the fish farming of National Institute of Fresh Water Fisheries Research (NIFFR) in Bussa, Niger State.

1.3 SIGNIFICANCE OF THE PROJECT

It is only when the result of any study is effectively use that the time and resources invested on it can be justified. However, the significance of the project is as follows:

a. The introduction of the linear programming tool to formulate the least cost ration so as meet the specific nutritional requirement in the fish farming at the appropriate time.

b. The power and flexibility of applying the linear programming cost ration will enhance the productivity of the fish farming because it will save the management time in computing the profit.

c. Finally, instead of computing the profit manually, a database can be created and updated from time to time.

1.4 LIMITATION AND DELIMITATION OF STUDY

Due to time constraints, this study has been narrowed down to the activities of fish farming with the hope of computerising them in order to reduce the problems stated above. In addition, the study was confined only to fish farming at National Institute for Fish Farming Research (NIFFR) Bussa, Niger State.

1.5 FEASIBILITY STUDY

This stage is otherwise referred to as the preliminary investigation because it was embarked upon in determining whether or not the proposed project is desirable. It involved the study of the existing system in details in order to provide the management with detailed information about the proposed computerization system. The feasibility study covers three major areas:

a. Designing the computerized system

b. Testing

c. Implementation of the computerized system

To test the project feasibility, the following are to be considered:

a. **Operational Feasibility:** This relates to the workability of the proposed information system when developed and installed.

b. **Technical Feasibility:** This test seeks to clarify if the proposed project can be done with current equipment, existing software technology and available personnel.

c. **Economic Feasibility:** The test for financial feasibility is undertaken to assess cost of implementing a proposed project i.e. the benefit derived from implementing the project.

1.6 DEFINITION OF TERMS

(i) **Dough:** This means mixing of fish feed ingredients such as maize, groundnut cake, soybeans, blood meal, and fishmeal to give the desired level of the fish.

(ii) **Pelleting:** The dough formed in (i) above is placed in the receiver or funnel of a pelleting machine and then pellets are produced when the machine is put on.

(iii) **Drying and Bagging:** After pelleting, the pellets are dried in the sun or oven. The pellets are later weighed and labelled. All the above processes are manually done and moreover, no effect has been made to formulate least cost rations in compounding fish feed. The introduction of a suitable computerised linear programming to formulate least cost ration so as to reduce the manual workload on the staff minimised waste in feed compounding.

Besides, the quantitative improvement in data generation and managerial decisions based on the systematic flow of information are the major advantages expected from the project.

(iv) **Computerisation:** An act of using electronic devices, which accept, processed data by a finite set of instruction called programme to produce the accurate results or information.

(v) **Linear Programming:** This is one of the few mathematical tools that can be used in the solution of a wide variety of large and complex problems that involves decision-making. Each linear programme has an objective function and a set of constraints. Maximising or minimising constraints are the common object.

(vi) **Least Cost:** The most reasonable course of action from a combination of measures designed to reduce the cost of feed through improvement in feeding practice and the quality of diets such that high level of annual performance and efficiency could be obtained.

(vii) **Ration Formulation or Feed Compounding:** The collection, definiting and mixing together of various raw materials putting the ingredients level into consideration so as to produce a given weight of any ration which meets specific nutritional requirement of a given animal or bond.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

INTRODUCTION

NIFFR also known as National Institute for Freshwater Fisheries Research is one of the establishments inhabiting New-Bussa "paradise of nature" depending on the pride of the nature for nourishment.

The research institute was considered suitable due to the presence of the first man-made Lake in the country. The primary aim of constructing the Lake was for power generation i.e. the sitting of the dam offered great opportunity for a varieties of developmental projects such as fisheries, irrigations and improved navigation from the coast up to the Republic of Benin.

However, numerous problems initially arose from the construction of the lake Kainji which include the displacement of the villagers due to the flooding, that came with it as a result of this the federal government of Nigeria in 1965 requested for an assistance from the United Nations to set up a research project in New-Bussa to undertake a post-impoundment studies. Its long-term purpose is to assist in the comprehensive development of the Kainji Dam through research and surveys. The (NIFFR) was established in 1968 as the Kainji research project with assistance from the United Nations project (UNDP).

The original objective was to research into the behaviour and the characteristics of the Lake Kainji and other man-made lakes and their effects on the fish and other aquatic life. The abundance, distribution and other biological characteristics of species of fish and practical method of the rational exploitation in the said lake and wildlife and their conservation as well as range ecology in New Bussa, the public health problems arising from the construction of dams and the resettlement of people around them. The project was under the management of food and agricultural organisation from 1969 to 1974. During the period, research programmes were set up in the field of fisheries ***, fisheries biology, boat building, fisheries technology, wildlife range ecology, public health, etc.

In 1975, qualified Nigerians took over the mantle of leadership of what to be known as Kainji Lake Research Institute. The research institute is housing a college of technology in New Bussa which is known as the Federal College of Freshwater Fisheries Technology which was established in 1978. The college train middle level manpower in fisheries management at ordinary and higher Diploma levels, and also vocational training in different aspects of fisheries in different categories of fisheries personnel.

In addition, the (NIFFR) has changed the life of Nigerians in so many ways, it has achieved among others, the resettlement of the displaced population in New-Bussa, the studies of wildlife population and other characteristics, yearly production of fingerling from broad stock of mudfish, clarias and tilapia and other culturable fish species and scale to farmers in various parts of the country at subsidised prices.

2.1 FISH FEED FORMULATION AND ANIMAL PERFORMANCE

In his contribution to feed formulation, Bisi (1988) opined that the problem of feed formulation should be considered from two broad perspectives.

(a) The problem of fish formulation as it affects the fish producer. The objective of the two participants are somewhat different; so also are the economic criteria which gives the attainment

(b) The problem of fish formulation as it affects the fish producer. The objective of the participants are somewhat different; so also are the economic criteria which gives the attainment of their objective.

The feed compounder is interested in maximizing returns on the capital invested in plant; equipment and building. His preoccupation is therefore, the plan as optimum production policy for the mill as a unit and his market potentials. Following the above, the fish compounder sets out to minimize the cost of producing a given weight of any ration which meets specific nutritional requirements of a given animal or bird, for it is by so doing that the feed compounders can maximize profit given the cost of the ingredients and the selling prices. However, as far as the fed miller is concerned the compound rations need not necessarily be the ones that can produce the maximum rate of weight gain when fed to animal or bird. The fish farmer also aims to maximize profit with the fixed capital structure of his farm, but one of the way to achieve this objective is to maximize return over feed costs unlike the feed compounder owner, the livestock producer is mainly interested in using the least-cost to achieve the maximum live-weight gain per unit of feed. In order words, the livestock producer is interested not only in diet that meet certain nutritional specification at the lowest cost, but also in the responses of the animal or bird to such feed. To the extent that the benefit of least cost ration can be passed down to the livestock farmer he will gain in terms of better animal performance and reduce feed cost.

2.2 FISH FEED FORMULATION AND LINEAR PROGRAMMING FOR FORMULATION

Fish require a well balanced diet for the supply of energy, sufficient indispensable amino acids, essential fatty acids, specific vitamins and minerals to supply and support life and to promote growth. Fish in their natural habitat meets their nutritional requirements by feeding on the abundant natural food in the water bodies under semi intensive or intensive culture system characterised by high stocking density, artificial feeds must be supplied to supplement the limited natural food in the culture system.

The importance of fish feed in fish culture is supported by the facts that the highest proportional cost of a fish culture system is expended on fish feed accounting for over 2/3 (two-thirds) of the variable cost of a fish culture operation. The rapid expansion and success for commercial fish culture therefore depends largely upon the availability of good quality feed. Eyo (1995) asserted that, the need to supply a well balanced diet to supplement the natural fish food in the culture system is important for two main reasons.

(a) To enable the fish attain optimal growth within a reasonably short period in order to make fish farming a portable venture.

(b) To ensure good health of the cultured fish. In feed production industry, the producer is given a member of parameters which guide his formulation. Lower and higher limits are set for some of the ingredients and the relevant important nutrients with these limit, an empirical solution to the optimisation problem accompanying their objective become positive.

2.3 BASIC BIOCHEMISTRY OF THE ELEMENTS IN FISH NUTRITION

Eyo (1995) a known research officer and a fish nutrition specialists, shed more lights on fish nutrition that the elements of feed nutrition are:

(a) **Proteins and Amino Acids**

Proteins are complex organic substance occurring naturally and reformed from combinations of amino acids, proteins and the most important constituents of fish tissues and automatically the major component of fish body.

They are made up of carbon, oxygen, hydrogen and nitrogen. Protein varies in shape, size, composition, physical proportions and functions. They act as enzymes, structure elements, receptors, antibodies and hormones. Protein requirement of fish is limited to a few species, carnivorous species appear to require more protein in their diet than her herbivorous ones. The catfish requires more protein than the tilapia (Eyo '95).

(b) **Amino Acids**

They are regarded as the building blocks of protein and about twenty-three amino acids have been isolated. Amino acids are classified into two groups: Dispensable (non-essential) and indispensable (essential). The dispensable ones are those that could be synthesised readily by the fish. The indispensable ones are those that cannot be synthesised at the rate needed by the body i.e. the body does not possess the necessary carbon skeleton to synthesise the indispensable and therefore must be supplied by the food. Fishes are known to require ten amino acids in their diets, they are orginine, instidine, isocencine etc.

(c) **Lipids and Fatty Acids**

They are found in plants and animal tissues and made of fat phospholipid, sphingonyhins waxes. They are made up of chemical elements of carbon, hydrogen and oxygen which are contained in carbohydrates. They provide energy and help for absorption of fat-soluble vitamins; they also serve as precursors for steroids, hormones and other compounds. Most fat is not desirable in fish feed because it can cause an imbalance of protein and energy in the ration. It can cause excess fat in the fish and can affect building of the feed components during pulleting.

(d) **Carbohydrates**

They represent a braod group of compounds which are composed of carbon and oxygen with hydrogen and oxygen present in the ratio of 2:1, sufficient amount of starch in feed allows fish to use dietary protein mainly for growth, reproduction and maintenance, instead of utilising it as energy source. The merit of this spring effect of carbohydrate on protein is that it reduces feed cost since carbohydrate is the cheapest source of energy in fish diet; it also acts as a binder in pelleted feeds by texturising the pellets and thereby reducing their disintegration.

(e) **Vitamins**

They are organic compounds which are required in small amount for normal growth, reproduction, health and maintenance of fish metabolism. They are grouped into eight water soluble B vitamins. The macro vitamins L-ascorbic acid, chlorine and majo-inositol, and the fat soluble vitamins, A,D,E and K. their requirement are effected by the size, age, growth rate of fish and by the environmental factors and nutrients interrelationship.

(f) **Minerals**

The requirement of minerals by fish is similar to those of terrestrial animals. Calcium, phosphorus, potassium, chloride, magnesium, iron etc. of all these only calcium and phosphorus are required in large proportion.

2.4 TYPES OF ARTIFICIAL FEEDS

(a) **Fresh Water Feeds**

These are animal slaughtered by-products which are fed directly tot eh fish. Good feed value have been found from beef, liver, spleen, heart, *** ad poor ovaries.

The fresh water feed has an advantage of making it possible to utilise the waste generated by fishing industry and processing as well as scrap fish unusable for human food animal feed without supplemental processing. The main advantages of most pellet is its susceptibility to microbial spoilage unless in refrigerators.

(b) **Pellets Feeds**

This involves the use of moisture heat and pressure to agglomerate ingredients into larger homogenous particles (NRC 1983). Good quality pellets are resistant to crumbling or disintegration while in water and this is a function of the amount of fat, fibre or starch is the formula.

(c) **Cooked-Extruded**

Feed extrusion involves passing-freely grounded ingredients which have been cooked with stream or hot water through high temperature and pressure to the lever temperature and pressure. During the cooking process, starch is gelatinised which allows strong intermolecular bonding. However the additional lasting *** *** of starch and gives extruded feed better in water stability than pelted feed. The advantages generated from this is as follows:

(i) Extruded feeds floats so that the problem of the feeding being unavailable for the fish to minimise.
(ii) Fish farm could easily access the level of feed intake by the fish, especially in pounds where the stocking rate is known.

2.5 LINEAR PROGRAMMING APPLICATIONS

All decisions including business involve selecting from asset of alternative course of action available to one. Each course of action, if selected will be carried out in some future. 'State of the world' and the course of action will depend on which of the many futures actually occurs. Adeboye (1998) wrote that in most business situation each outcome will give rise to a profit or loss and it is the comparison of these expected gain or loss under the various possible future states that determine which course of action is selected. He classified linear programming into: -

(a) Decision under certainty that is where sufficient data and information are available.

(b) Decision under uncertainty, where no statistical data is available to help in decision making

Linear programming is define as one of the few mathematical tools that can be used in the solution of a wide varieties of large or complex problem that involves decision making, such problems are characterized by the goods and restriction (constraints). Each linear programming has an objective function and sets of constraints maximizing profit or minimizing cost are common objective.

Linear programming problems 0is one where the feasible region is a set of the non-negative portion define by linear equations and inequalities and or the objective function to be minimized or maximized in linear, ie of the form $P(X_1, X_2, \text{------} X_n) = (a_1X_1 + a_2X_2 + \text{-----------} + a_nX_n)$ the general format for the linear programming problems is as follows

Maximized or Minimized X=[PijXj, J=1,2,-----n}

Subject to

{aijXj (<>, =} b   I=1,2, - - - m

the Xj, J=1,2 ---n are called decision variables

pj is the per unit effect of the activity J. on the objective. the total numbers of constraints or restrictions bi, is the upper limit or or lower limit cannot be executed or below which we cannot go. Aij is the per unit consumption of the constraints by the activity J.

ASSUMPTIONS OF LINEAR PROGRAMMING

(a) **OPTIMIZATION:** - it is assumed that an appropriate objective function is either maximized or minimized

(b) **FIXEDNESS:** - at least a non-zero right hand side co-efficient

(c) **FINITENESS:** - a finite number of activities and constraints to be considered so that a solution may be sought

(d) **DETERMINISM:** -The limit of the constraints must be observed.

(e) **HORMOGENITY**: - All units of the same resources or activities are identical

(f) **ADDITIVITY:** - The activities are assumed to be additive that is total product is the same of the individual products

(g) **PROPORTIONALITY**:- The gross margin and resources requirement per unit of the activities are assumed to be constant regardless of the level of the activity.

Adeboye (1998) concluded that additively and proportionality together define linearity as the activities thereby giving rise to linear programming.

TYPES OF LINEAR PROGRAMMING

Adeboye (1998) Classified linear programming problems into three

(a) **RESOURCE ALLOCATION PROBLEMS: -** This is determine on how to used limited assets to maximized gain or minimized loss

(b) **TRANSPORTATION PROBLEMS:** -finding the cheapest means of transportation of goods

(c) **DIET PROBLEMS: -** Finding the best food mix that would result in the maximization of profit or net gain in value and or minimized cost of services

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 ANALYSIS

The fish feed formulation activities of the National Institute of Freshwater Fisheries Research (NIFER) are recorded by a manual process using a fairly adequate set of document which could be modified to form the base for a computerized information system. From my personal investigation and study, the present problems of diet formulation computerization centre around inadequate follow up rather than the absence of proper procedures.

The analysis is concerned with the study and gathering of data about the existing manual system used for fish feed formulation. The identification of problems and difficulties encountered by the feed compounder and the factor that influence the management of introducing computer into diet formulation. The system analysis is therefore, concerned with the NIFFR management objective in converting information and data from manual processing to the method of computerization.

Full and detailed analysis was carried out of the current manual system of diet formulation to establish the following

(a) procedures
(b) information flow
(c) method of work, organization and control.

The procedure is concerned with the procurement and formulation of ingredients and nutrients and their restrictions as well as the cost involves in fish feed compounding. The information flow is triggered by management action plan for a particular period of time, the information flow circle runs from the action plan through procurement, distribution, formulation and feedback, Since the fish nutritional activities are recorded by a manual processing using a fairly adequate set of documents which could be modified, the addition of few new formats to form the base for a computerization information system becomes necessary.

3.2 THE EXISTING SYSTEM

Beside the varieties of artificial feeds such as fresh wet feeds, pellet feeds and cooked-Extruded feeds as highlighted in Chapter two, and the manual compounding of fish feeds like dough, pelleting and drying and bagging which is also discussed in Chapter two, fish feed are manually prepared as below:

3.2.1 PREPARATION OF FISH FEEDS

(a) **Materials** – Plastic bowls, Grinding machine, pelleting machine, or hand pelleter, oven weighing balance, Nylon bags, pan and pot.

(b) Ingredients maize, groundnut cake, soyabean, blood meal, fish meal, vitamin and mineral premix and bone meal.

(c) Preparation of Ingredients

(i) **Maize** The maize is ground to a fine powder. The chaff after extracting the starch can also be used.

(ii) **Groundnut cake** This can either be bought from companies or can be prepared locally as we do when preparing "kulikuli" The groundnut cake is ground to a fine powder

(iii) **Blood meal** Cow blood meal is collected with a plastic bowl from the sun or oven (electric or gas) and then ground into powder.

(iv) **Soyabean meal** Soyabean meal is toasted by roasting on a hot pan or pot for a short while usually ten to fifteen minutes. If it is in the oven where temperature is under control, then toasting can be done for 30 minutes at 1000 C. The toasting improve the quality of the soyabean as well as making it easier for the hull or outer coat to be removed. The soyabean is ground in a grinder and the hull is winnowed away before final grinding into a fine powder.

(v) **Vitamin and Mineral Premix** These are added to the fish to supply vitamins and minerals which the feed ingredients could not supply. The premixes used for poultry rations can be used since those for fish are not easily available. These can be bought in the agricultural product shops.

(vi) **Bone meal** the bone meal supply additional minerals to the fish and can be prepared either by steaming or burning cow bone.

When all the above ingredients are manually prepared or supplied, the compounding is done by mixing them together in different proportions so as to give the desired diet level required by the fish.

3.2.2. BALANCING OF FOOD LEVEL

PEARSON'S SQUARE METHOD is the most popular method in NIFFR used in determining the proper dietary proportions of feedstuffs provided the ingredient requirement of the fish is known Eyo (1995) on pearson's square method gave an example of a fish farmer who intends to deed his fish with yellow maize with crude protein (C.P.) of 10.8% and groundnut cake c.p 40.6% to give a 30% crude protein in the diet. A square is constructed and the desired percentage of crude protein in the final mixture is placed protein of yellow maize (10.8%) is placed on the upper left corner and that of groundnut cake 40.6% on the lower left corner. Then the percentage crude protein in yellow maize (10.8%) is subtracted from the percentage of crude protein desired in the mix (30.0) and the difference (19.2) is placed on the corner of the square diagonally opposite from the maize. Similarly, the percentage crude protein desired in the mix (30.0) is subtracted from the percentage crude protein in the supplement (4).6%) and the difference (10.6%) is placed on the corner of the square diagonally opposite from the supplement. The positive and negative signs are ignored.

The above remainders represent the proportions of these two feeds which will provide a mix containing the desired percentage crude protein. The amounts are thus converted to percentage.

10.8		10.6
30
40.6		19.2
	29.8

$$\frac{10.6 \times 100}{29.8} = 35.6\% \text{ Yellow maize}$$

$$\frac{19.2 \times 100}{29.8} = 64.4\% \text{ Groundnut cake}$$

3.3 SYSTEM DESIGN

This is the stage where the proposed system is designed for both clerical and computer procedure, data capture and management information system.

The method selected for the new system is the selection of same of the present set of documents been used, which are fairly adequate to be modified with the design of few new formats to form the base for computerized information system. The files and programs are kept as simple as possible to be users friendly in relation to computerization of least-cost ration in fish-feed formulation.

3.3.1. THE DESIGN OF THE PROPOSED SYSTEM

After the system analysis which produces detailed description of the existing manual systems and highlights the areas where improvement is needed, then the next stage of the proposed system is the system design. The initial step toward system design is the identification of system requirements, and the formulation of design alternative.

The requirements are those factors or details that have to be incorporated to the propose system to produce the desired result. In designing the system, the following strategies are adopted

(i) Identifying areas that require improvements and/or modifications for computerization by the organization (NIFFR0

(ii) Develop an underlying system to achieve the computerization requirements of the leas-cost diet formulation.

(iii) Ensure that the proposed system is easy to operate understood by all the staff of fish nutrition, and which requires minimum changes in the existing systems.

(iv) **Flexibility** – The propose system should be possible to modify in future to enhance efficiency.

(v) **Maintainability:-** The system should be subject to changes and to be sustained in the long run.

(vi) The staff members must be adequately trained to carry out the new system

(vii) The system must be able to minimize human error associated with a manual system.

(viii) It must be efficient, portable and user-friendly.

3.3.2 CONSTRUCTION OF BASIC MATRIX FOR LEAST COST RATION

The stages in the construction of least cost linear programming model are as follows:

(i) Listing the available ingredients which represent the activities to be considered in the model.

(ii) Specifying the levels, in percentage terms, of the nutrients which are crucial to growth and good performance of the different categories of fish. These are often referred to as nutrient constraints.

(iii) Listing the prices per tone of component ingredients (price coefficient).

(iv) Specifying the nutrient composition (technical coefficient), also in percentage terms of individual ingredients.

(v) Specifying the limit, in percentage terms, of inclusion of certain feed ingredients in the ration (ingredient constraints).

These steps are explained with reference to the basic matrix in Table 1 in respect of the formulation of least cost in fish feed compounding.

3.3.3 INGREDIENTS OR ACTIVITIES IN THE MODEL.

Table 1 shows the various feed ingredients that could be used in a typical fish feed ration including their nutrient composition and prices per tone. The list of ingredients is not exhaustive and can vary from locality to locality, depending on their availability. Any set of the combination of ingredients can meet the nutritional specification of fish. However, the set of ingredients selected in the optimum solution should not only meet the ingredient and nutrition constraint s but must do so at minimum cost.

Fourteen 914) ingredients are considered in this model. They include grains, mostly maize, which usually form a significant proportion of the energy-yielding nutrients in fish feeds and contribute reasonable quantities of amino-acids, particularly the sulphur amino-acids, methionine plus cystine. These ingredients are available from local source. Although their supply is subject to seasonal variations. The qualityalso varies, depending on the variety and efficiency of storage and processing.

Blood meals, fish meal and soya beans supply bulk of the fish protein in the diet. They are also readily available from local sources and are subject to wide variation in quality, depending on the processing techniques used. Both vegetable and cod-liver oil provides bulk of the required energy.

Calcium and phosphorus are to be supplied largely by Oyster shell, Bone, meal and Duckweed, Water fern, Rice bran and Duckweed supply bulk of fibre.

The vitamins and other minerals are to be supplied through the inclusion of vitamin mineral premix, which are usually imported.

(i) The price co-efficient

The price coefficient represents the cost of purchasing a tone of each ingredient.

(ii) The Technical Co-efficient

The nutrient compositions are equivalent to the technical co-efficient in the basic matrix of the optimization model. For example, yellow maize was estimated to contain 10.0% crude protein, 2.3% fibre 0.25% Lysine, 0.7% phosphorus. Other ingredients in the basic matrix have been similarly estimated fro their nutrient composition.

3.3.4 RESTRICTION IN THE BASIC MODEL

Three distinct groups of restrictions are specified in this model – These are:

(i) The nutrient requirement specifications
(ii) The ingredient level specifications
(iii) The quantity of the total mix of ingredients, generally refereed to as weight constraint.

The formulation of these constraints requires a very good understanding of animal nutrition and Biochemistry. Least cost ration formulation, therefore, requires an inter-disciplinary approach involving Agricultural Economist and Animal nutritionist. (Ogungfowora 1988).

The performance of intensive fish enterprise is largely determined by nutrient content and balance, as well as the intake of the rations. The level of intake is, in turn, a function of palatability and particle size or texture of the feed.

The intake of nutrients affect the growth rate and carcass conformation. Also, the energy supplied to fish greatly influences the rate of live weight gain. When fish are fed with unbalanced rations, growth rate and efficiency of liveweight gain are reduced, resulting in low levels of profit. It is important therefore, when formulating rations, to ensure that all the important nutritional factors are provided in adequate quantities and ratios.

(ii) Ingredient constraints

Certain restrictions on the level of inclusion of available ingredients are imposed to conform with proper nutritional requirements and take account of their availability and costs. The forms in which same nutrients exist in the ration influence the efficiency of utilization, for example, allowance is made in the model for the nonavailability of phosphorus from grains and vegetable sources by ensuring that the ration contains reasonable percentages of Oyster shell or bone meal.

(iii) The weight constraint

The weight constrain fixes the quantity of the mix within which the nutrient requirements and the ingredients specifications must be met. The model is constrained to produce exactly 1.0 tone of ration

3.4 COST – BENEFIT ANALYSIS

This is a technique for choosing from among alternatives to identify a preferred choice when objectives are far less specific than those expressed by such clear quantities as sales, costs or profits. The system is an improvement over the traditional marginal analysis. It is a technique of weighing alternatives where the optimum solution cannot be conveniently reduced to some other specific measure.

The major features of cost effectiveness are concentration on output from a program or system, weighing the contributing of each alternative against its effectiveness is serving desired objectives, and comparison of costs of each in terms of its effectiveness.

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Although cost benefit analysis involves the same steps as any planning decision, the major features that distinguish cost effectiveness are:

(i) Objectives are normally output or end-result and usually imprecise

(ii) Alternatives ordinarily represent total systems, programs, or strategies for meeting objectives.

(iii) The measures of effectiveness must be relevant to objectives and set in as precise terms as possible, although some may not be subject to quantification.

(iv) Cost estimates are usually traditional and normal, but may include no non-monetary as well as monetary costs, even though the former may be eliminated by expressing them as negative factors of effectiveness.

(v) Decision criteria, while definite but not usually as specific as highest profits, may include achieving a given objectives at least cost, attaining it with resources available, or providing for a trade-off of cost for effectiveness, particularly in the light of the claims of other objectives. Cost effectiveness can be made most systematic through the use of models such as: the Net cash Revenue, Cost of Investment, Terminal or Salvage value of investment, and The interest of Discount rate to use.

Among the cost concepts that are used in decision making, such as marginal cost, sunk cost, and differential cost, the differential cost is found most appropriate to the introduction of the system in the Institute.

In differential cost, there are times when the business person must make a decision on whether to modify methods and equipment even though there may be no significant changes in revenue. Often new machinery is introduced into the production process because it provides better control over quantity or quality of output, or because it reduces cost of production. Before the decisions to change is made, the differences in cost between the existing situation and the proposal should be examined.

There is no doubt that the system may r4esult in the elimination of involving routine, monotonous and sometimes hazardous tasks. However, the loss of these jobs has been offset by the creation of more challenging ones carrying greater responsibilities and offering more opportunities.

Finally it should be noted that the cheapest alternative is not always the most effective, particularly when effectiveness is measured by various factors and although the change may not bring in additional revenue, if there are any cost savings such as time or energy as a result of the change, they represent the eventual net effect on revenue.

3.5 FEATURES OF BASIC PROGRAMMING

The proposed system is recommended to be Basic programming

Basic stands for Beginner's All-purpose symbolic instruction code. The language was developed in 1964 at Dartmonth College, U.S.A. by Professors, J. Kenny and Thomas Kurtz(1). It is a high-level programming language whose method of coding and syntax is oversimplified for whatever class of user, literate children inclusive, and hence from the name it is meant for beginners.

One very vital characteristic of BASIC is its availability of on all Disk Operating System (DOS). It is sufficient therefore to say that if a system runs on DOS then it have the BASIC interpreter.

A computer is often called a sequential machine and this structure is incorporated in the design of the language. BASIC Programs have line numbers, each number per statement and that reflects the order of processing of the instructions. In effect, it helps beginners to be able to design their program in a chronological order.

The BASIC interpreter like a language translates the program, statement by statement and executes it before going to the next statement that contains no error while the interpreter signifies the line thereafter that contains the error. Therefore you keep debugging the statement at the direction of the interpreter giving the statement number.

There are various versions of BASIC interpreter depending on the version of DOS available

To mention a few, the versions are:

1. GWBASIK available on DOS 3.3
2. BASIC and BASICA available on DOS 4.01
3. QBASIC available on DOS 5.0, DOS 6.0, DOS 6.1 and DOS 6.2

It is on the latter (QBASIC) that this programming language is baked.

3.5.1 FEATURES OF QBASIC PROGRAMMING

It is worth mentioning here that each version of BASIC depending on the version of DOS, shows certain superiority, that is enhancement over the lesser versions.

(i) Line numbering is optional in QBASIC and very necessary for those in lower versions of DOS, say GWBASK and BASICA.

(ii) QBASIC support blocked operations particularly structured programming than those before it. For example, Blocks of IF – THEN – ELSE-ENDIF, DO WHILE – UNTIL, LOOP. WHILE – UNTIL and many others.

(iii) QBASIC supports instant syntax checking as instructions are entered and gives instant help on errors.

3.5.2 ADVANTAGES OF BASIC PROGAMMING

Basic programming possesses the following advantages:

(i) As the name implies, it is meant for beginners' because of the flexibility and simplicity and writing

(ii) Basic is available on all disc operating system (DOS) hence making it to be less machine dependent.

(iii) It gives instant error checking since it translates the program statement by statement and executes them before going to the next statement.

Beside al the above merits, Basic programming also possesses the general characteristics of computer which add to it's usefulness.

(i) **Accuracy** The computer produces highly accurate results once the input is correct. Machine errors rarely occur because of in-built error detecting schemes within the computer. In most cases, errors in computing are due to errors in input from the users.

(ii) **Reliability** A computer is consistent and diligent in it's mode of operation, which means it is reliable. Being a machine, it does not suffer from the human traits of tiredness and lack of concentration. It will perform the last task with the same speed and accuracy as the first task given to it, no matter the number of tasks involved.

(iii) **Storability** The computer can store and process large volumes of data without accuracy being affected. Data is stored in the memory sections of the computer. Memory is built up in K (kilo) modules where K equals 1024 memory locations. This ability makes it possible to increase the level of useful data and information supplied to management control and decision making.

(iv) **Speed** A computer has a very high speed of operation. Electrical pulses travel at incredible speeds and because the computer is electronic, its internal speed is virtually instantaneous. Complex calculations are performed within fractions of a second and results obtained first. The speed of operation is usually measured in milliseconds (thousandths of a second), microseconds (millionths of a second), nano-second (thousand-millionths of a second) and pico-second (million-millionths of a second.

(v) **Flexibility** Modern general purpose computers are flexible in that they can be used for a variety of purposes e.g concurrent batch and on-line processing, multi-programming, real time processing and so on.

(vi) **Task ability** Due to the programmable ability of a computer, it can perform almost any task provided the task can be reduced to a cerise of logical steps.

(vii) **Automatic** Once a program is in the computer's memory, the individual instructions are executed without the need of any human intervention.

3.6 Form Design

The existing formats, especially that of the person's square method have been for manual operations. For the new program, the formats need modifications for computerization as well as for preparation of least cost Ration formulation. The changes also take care of improvements in their functional efficiency and effectiveness.

The following forms have been designed for inputs data into the computer.

(i) Ingredient constraint form
(ii) Nutrient constraint form
(iii) Price co-efficient form

From design describes all data inputs of the proposed system in order of flow of documents.

The following strategies were adopted in the form design.

(i) Codification of locations and products
(ii) Required minimum modification and changes in the existing system.

CHAPTER FOUR
PROGRAMME IMPLEMENTATION

INTRODUCTION

Implementation is the process of applying the developed system for the purpose it is meant for system implementation involves the development of quality assurance procedures, including data security, back-up, recovery and system control system implementation objective is to complete the orderly and unobsstructive installation of the new system. During the system implementation, now system. During the system implementation, now system installed, in a test directory, where users received the opportunity to operate the new system "in parallel" with the existing system.

The system implementation comprises the following task:

(i) Application system installation: The installation of the developed software

(ii) Documentation: To provide used manuals

(iii) Users Training: training of users personnel on all aspects of the operation of the system

(iv) Parallel system Testing: The program developed in the new system run parallel against the existing system

(v) Data conversion:- Upon the conclusion of the parallel testing task, the system analyst assist the users personnel in the conversion and transfer of all required data from existing system into new system.

(vi) Acceptance of Testing: The system analyst assisted by the user's personnel in conducting the testing of the developed new system to ensure that the system meet all users need and requirements.

4.1 MODEL SPECIFICATION

The Linear programming model in this study is assumed to have the objective subject to the restrictions imposed by the dietary inclusion levels of the raw attainment of this objective is given by equation

(1) That is, the objective function, through equation (9)

Equation 1: Minimize 2 = [icj xj

Subject to:

Equation 2: Cpi = Ebijxj – crude protein

Equation 3: MEi =3aijxj – Estimated Metabolizable energy

Equation 4: EEi = 3eijxj – Ether Extract (lipid)

Equation 5: CFi = 3eijxj – Crude Fibre

Equation 6: Lyi = 3eijxj – Lysine

Equation 7: METi = 3gijxj – Methionine

Equation 8: Cai = 3Lijxj – Calcium

Equation 9: PHi =3kijxj – Phosphorus

Equation 10: MCi = 3Lijxj – Methioninetlystine

Where Z = Sum of the total cost of the various feedstuffs used in the diet formulation programme such as Fishmeal, Soyabean, Yellow maize, Azolla and others.

C = Per Unit Cost of the different feedstuffs aijbij ----Lij = the coefficients (technical) of the component of the particular nutrient found in the given feedstuffs as obtained from proximate analysis.

Based on the features of the ration described above, the cost minimization model for fish can be implicitly expressed as follows:

Minimize Zo = 3Cjxj

j=i

Where:

Zo = the cost of one tone of the ration to be minimized;

Cj=the net price per unit of the jth ingredient, n=1--- -14 in this Model.

Xj=is the quantiy (percentage) of the jth ingredient in the optimum ration.

The objective function, Zo, is to be minimized subject to the following constraints

(i) Crude protein <or> 3aijxj

j=i

(ii) Energy = 3bijxj

j=i

(iii) Ether Extract (ligid < 3Rijxj

i=1

(iv) Crude Fibre> 3Eijxj

j=i

(v) Lysine> 3Eijxj

j=i

(vi) Methionine> 3Fijxj

j=i

(vii) Calcium < 3Gijxj

j=i

(viii) Phosphorous > or < 3Kijxj

j=i

(ix) Methionine + Cystine > 3Kijxj

$j = i$

(x) $Xj > 0$

Where: aij, --- Kij, represent the percentage provisions of crude protein, energy fibre and others o the jth feed ingredient, while xj is the percentage contribution by weight of the jth ingredient in the ration.

The constraints take the form of linear inequalities and mean that the total nutrients provided by all the ingredients used for compounding the ration must be equal to, less than, greater than, less than or greater than a specified nutrient level which has been found to be needed for optimum fish growth and performance.

Thus, applying the Linear programming model to the data on fish feed formulation, we have:

Minimize:

$C + 20xi =+ 35x_2 + 120x_3 + 104 + 5x_5\ 6x_6 + 5x_7 + 5x_8 + 10x_9 + 25x10 + 300x_{11} + 250x_{12}\ H5x_{13} + 20x14$

Subject to:

(i) Crude protein:

$10x_1 + 42z_2 + 65x_3 + 89.2x_4 + 12.8x_5 + 28.6 + 25x_7 + 0.2x14 > 32 < 40$

(ii) Energy ME:

$3432X_1 + 2700X_2 + 2860X_3 + 3080X_4 + 2860X_5 + 3491X_6 + 34950X_7 + 1716X_9 + 8170X_{10} + 8200X11 + 3400x14 > 2618$

(iii) Ether Extract (Lipid):

$3.6X_1 + 3.5x_2 + 9.6X_3 + 1.3X_4 + 13.7X_5 + 14.1 X_6 + 10.5X_7 < 5$

(iv) Crude Fibre:

$2.3X_1 + 6.5X_2 + 0.7X_3 + 1.0X_4 + 11.1X_5 + 14.07 X_6 + 10.52X_7 + 0.08X_{14} < 16$

(v) Lysine:

$0.25X_1 + 2.8X_2 + 4.72X_3 + 6.33 X_4 + 0.52 X_5 + 0.72X_6 + 0.72 X_7 + 0.08X14 < 6$

(vi) Methionine:

$0.17X_1 + 0.59X_2 + 1.75X_3 + 0.88X_4 + 0.5X_5 + 0.73X_6 + 0.44X_7 + 0.58X_9 > 0.03$

(vii) Calcium:

$0.03X_{14} + 0.2X_2 + 5.19X_3 + 0.29X_4 + 0.03X_5 + 0.52X_6 + 9.06X_7 + 0.58X_9 > 0.03$

(viii) Phosphorous:

$028X_1 + 0.6X_2 + 2.88X_3 + 0.24X_4 + 0.27X_5 + 0.7X_6 + 0.28X_1. + 0.5X_7 + 0.07X_8 + 15X_9 > 0.5\ 0.7.$

(ix) Methionine + Cystine:

$0.39X_1 + 1.21X_2 + 0.31X_3 + 2.12X_4 + 0.33X_5 + 0.8X_6 + 0.68X_7 + 0.73X_9 > 0.74.$

4.4.1 DISCUSSION OF RESULT

Simplex method is one of the linear programming tools for solving problems involving the optimization of a linear function subject to a system of solving linear programming problems. It is based on the property that the optimum solution to a linear programming linear constraints. The simplex method is the most general and powerful method of all available method for solving linear programming problem. If it exists can also be found in one of the Basic feasible solutions.

In minimization case of the simplex method, it is required to covert the inequalities into equalities by subtracting rather than addition of Planck variables. In most cases we observe that the non-negativity constraints for the variables does not make any sense in terms of physical interpretation of the slack variables. This situation could be avoided by the introduction of artificial slack variables into the original inequalities with infinitely large c-efficient. Hence, if artificial slack variable are introduced, then the problem can be formulated by minimization.

Degeneracy in Linear Programming Problem.

When applying the simplex algorithm, one needs to identify the pivot column and the pivot row in order to proceed from solution to the next. However, two problems could be faced while attempting to select the pivot row.

i) The initial simplex tableau may be such that one or more of the variables currently in the basis has or have value zero. It will then appear that the replacement process cannot be continued for the variable to be replaced is already zero

ii) The Minimum non-negative replacement ratio for two or more variables currently in the basis may be the same. In this case, there is a tie in terms of selection of the they row. Removal of one of the tied variables will also reduce the other tied variables to zero. The two conditions above give rise to a phenomenon known as degeneracy. Attempts to solve degenerate Linear Programming problem will show that either:-

a) After a finite number of interactions the 1 optimal solution can be obtained.

b) The problem begins to circle, thereby preventing the attainment of the optimal solution stage, we keep returning to the same basis.

Solving a Degenerate Problem

When a degenerate problem arises, the following steps should be taken to resolve it

i) Identify the tied variables or rows

ii) For each of the column in the identity (Starting with the extreme left hand column of the identity and proceeding one at a time to the right) computer a ratio by dividing the entry in each tied row by the key column number in that row.

iii) Compare ratio, column by column proceeding to the right. The first time the ratios are unequal, the tie is broken.

iv) Of the field rows, the one in which the smaller algebraic ratio falls is the key row.

v) If the ratio in the identify do not break the tie from similar ratios for the column of the main body and select the they row as described in three to four.

The Result

The first page of the output shows the total input in rows comprising the fourteen variables from x 1 to x 14. – Z represents the cost while the RHS depicts the right hand side. The G and L stands for Greater than and less than respectively. The tableau shows the constraints at the RHS. For instance, x 15 shows the minimum constraint for protein while x 16 shows the maximum constraint for the same ingredient. The pivot at this stage is 8200.

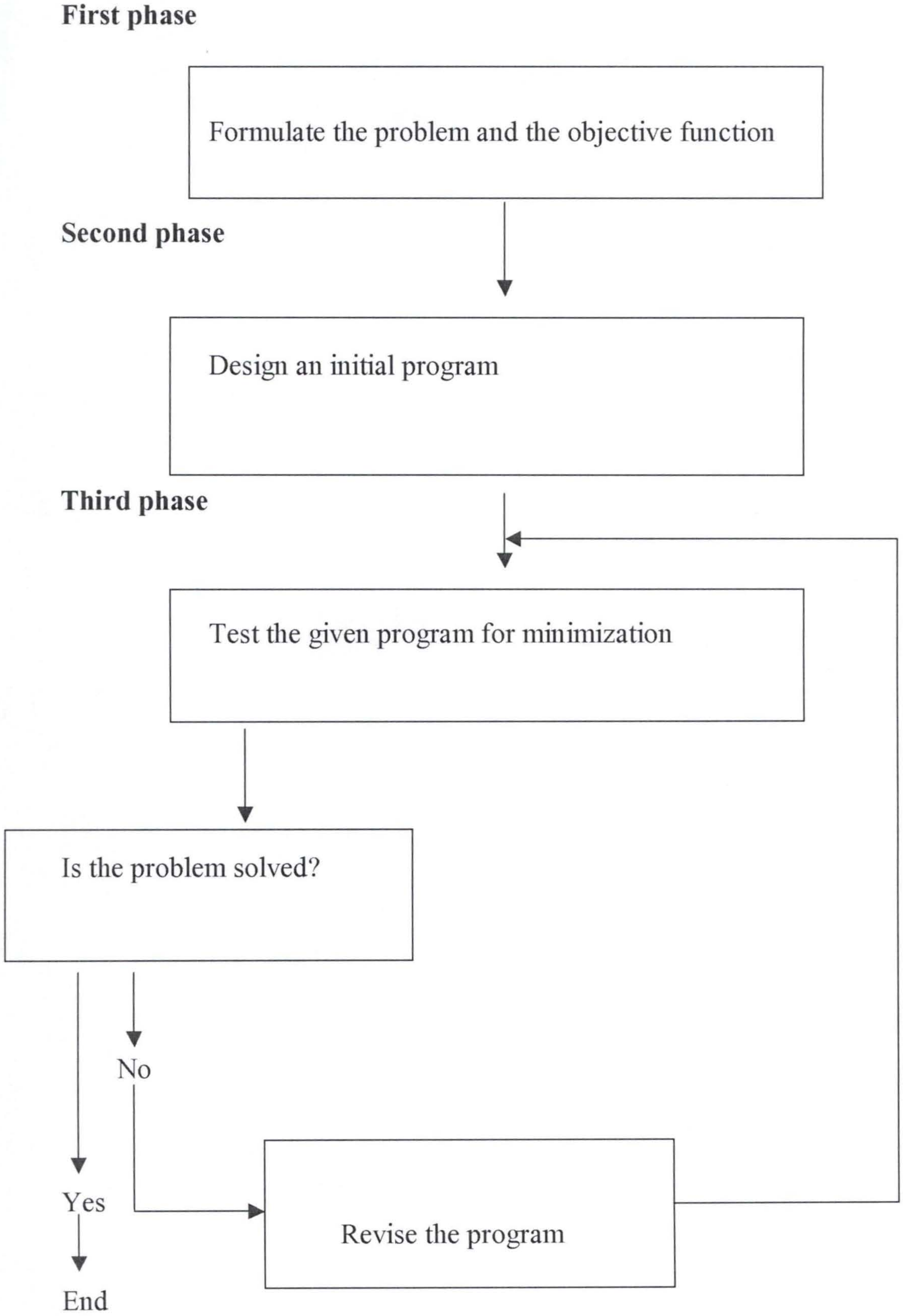
The output was iteracted six times before a final result was given which appear on the final page of the output.
The following steps are necessary for computing simplex methods in minimization case. The first step is to check whether the constraints on the right hand side of the variable s are already non-negative. If no, re-arrange the original system of equation so that all the constraints terms are positive or zero either by changing where necessary the signs of both sides of any of the equation.

The second step is to ascertain that the constraints are not only in standard form but also in canonical form by additing artificial variables.

The next step is to design the feasibility form by putting the variables in complete array. This array can be written in canonical form with basic variables, since this canonical system could provide an initial basic feasible solution before starting the phases of simplex method.
Step four involves the checking the basic feasible solution and ensure that it does not contain any of the article variables and the last values is equal to zero. If this condition is met, then, phase one is completed.

The last step consists of starting phase two computation by dropping the "zero value" row from further consideration. The result of phase two are again shown in table form. When all the ration are non-negative, phase two of the simplex is completed.

The above discussion are the steps involved in solving linear programming method by manually. For mechanical approach, the following diagram is a schematic representation of the simplex method algorithm.



4.2 SYSTEM TESTING

After the installation of the new system, if the system must undergo a test; once all the programs have been written and the training of the departmental personnel is completed. The system testing is to ensure that all the programs have been efficiently and correctly written. The system testing entails the execution of the program with text data so as to enable the system developer and the management to know the operational efficiency of the system.

The system testing will also enable the designer to correct errors and delete programs that are not efficient by dobugging process with text data input into the programs so as to produce the desired output deports.

During this task, the programmers or the System Designers assists the project staff in conducing the testing of the developed system so as to ensure that the system meets all the users needs and requirements. System testing entails the testing and certification for he system developed. Testing is conducted in order to determine if the physical data model implemented, properly represents the conceptual model. This phase ensured that all required features, functions, and capabilities are present in the system developed, and that all other requirements are met. Any necessary revision are made during the system testing.

4.3 HARDWARE REQUIREMENT

Major options for system design include mainframe computers, minicomputers, and microcomputers. The choice depends on the task to be done and the financial capability of the Institute. Factors in selection of the Hardware requirements depend on the software package developed for the system

The system design should be able to establish the volume and capacity of the software package before determining the hardware requirement.

In this system, the hardware requirements are:-

(a) Microcomputer with RAM 640KB, CPU model 80586, Hard disk (MB) 30, Floppy 3 [], Basic Interpreter of DOS 5.0.

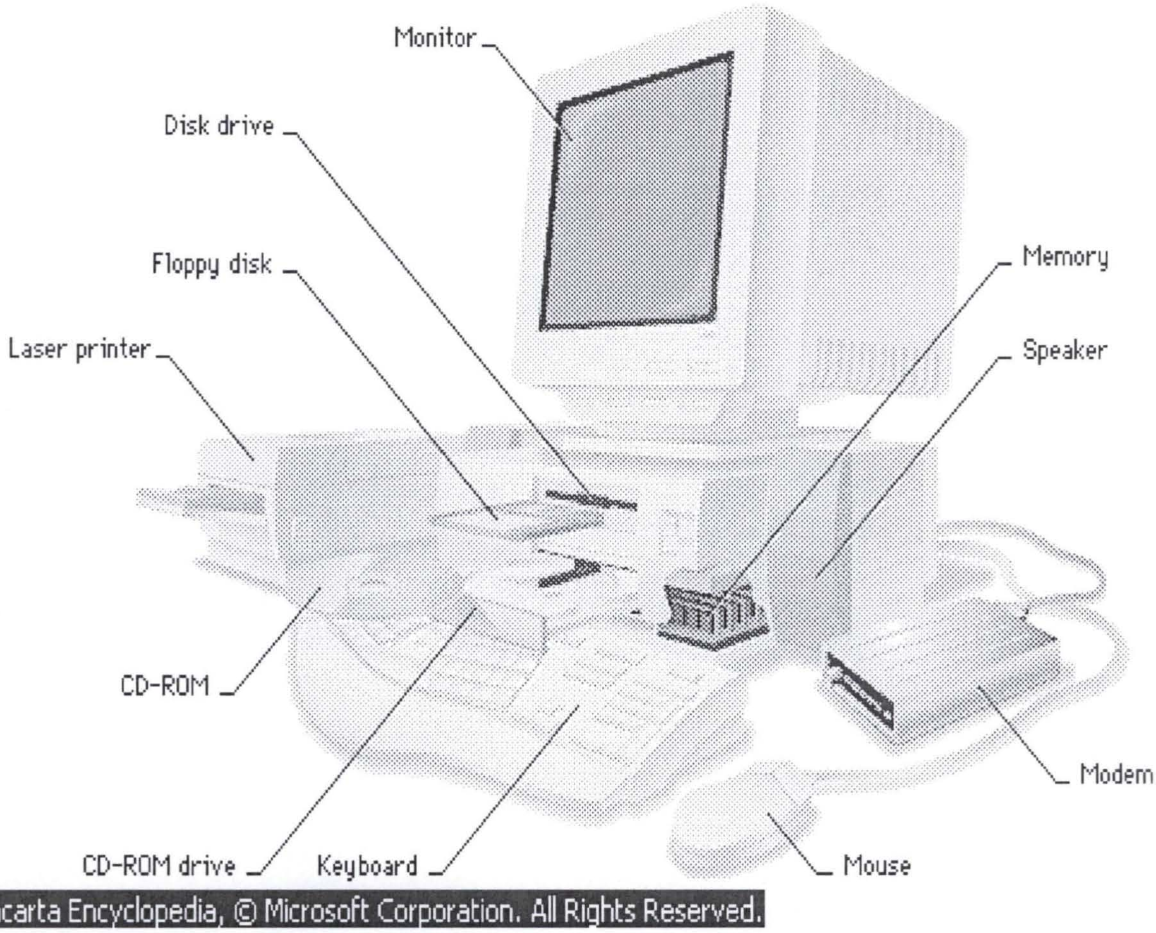
(b) Peripherals; Dax matrix print, Laser Jet printer, Tape Drive for Back up.

Microcomputers represent the small-scale and of the continuum, Since the entire central processing Unit (CPU) is on a single microprocessor clip, it is possible to house the entire microcomputer system in a desk-top or even a portable unit. While it is possible to configure microcomputers as multi-user machine, they are usually stand-alone, single user machine.

Since microcomputers require less support personal than either mainframe or minicomputer, recurrent cost are substantially lower.

The computer should have a speed of at least 40 MHZ to aid fast processing of records and a UPS which can store power for a period of time – about forth five (45) minutes to safeguard against power failure.

DIAGRAME OF A FULL MULTIMEDIA COMPUTER



4.4 CHANGE OVER

The change over from old to the new system may take place when the system has been proved to the satisfaction of the new system analyst and the other implementation activities have been completed. The users managers (NIFFR) must have been satisfied with the result of the system tests, the training of the staff and the reference manuals.

The method and approach used for the change over is the parallel running system. The parallel results. The main advantage is that the old system is kept alive and operational until the new system has been proved for at least one system circle.

Using full live data in the red operational environment of the equipments, people and data. The results of the new system will be compared with the old system to ensure the efficiency, capability and durability before acceptance by the user.

The changeover task is designed to ensure that the software developed replicate the functionality of the system to be replaced. Once the changeover ends, the user staff complete their training and the parallel system testing is successful, the change over system will move to an on-line director, and users may commence the operation.

CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

Computerization involves issues of people and management as well as hardware and software information, is a resource requiring effective management as much than any other organization. It is evident that he advantage of computer system facilitates handling of large amount of data, a high degree of accuracy, suitability for professing edges that reflect themselves over and over, suitability for performing must complex calculations, speed and using common data for served different procedures.

Although computerization of fish feed may result in documentation of information access and use, the overall information management function should not be equally decentralized in this content the role of the information manager becomes especially critical. These role has these major elements.

(a) Understanding the new computerization and the impact it will have on the roles of organization staff;

(b) Developing and implementing services and support that match end-users (management) need.

(c) Providing direction for the organizations overall information management strategy;

(d) Managing the process of information sharing among location points of data processing in the system.

For any computerization project to be successful, it is essential that, before taking the lunge on appropriate strategy is developed such strategy should take into account the organizational factors, such as critically o the application area being considered, monetary budget, manpower and above all the organizations ability to sustain the new system.

Since fish feed production is one of the problems of aquacultural development in Nigeria, more attention should be given to the development of this aspect of fish husbandry.

This could be done by funding of Research. Institutes to conduct appropriate research, training of fish farmers in the liaison services. Useful information for the development of appropriate formula for the local species will only come after painstaking research over a period. It may not take Nigeria so long to get a suitable formula for the fast growing local species if the research efforts are properly coordinated and funded. Feed back from the farmers to Researchers through the appropriate authority will enable researchers determine where to channel their research efforts in fish feed formulation and diet development for the locally culturable fish species.

The linear programming techniques for least cost ration formulation offer a much wider scope for considering a wide range of alternatives than the conventional methods. The use of Linear programming, based on the use of micro-computers, has been found to result in significant savings in feed costs while ensuring flexibility and adaptability to changing economic and technological circumstances as well as supply of feed ingredients.

The use of Linear programming is subject to certain guidelines and pre-requisites.

- The nutritional composition of all ingredients must be readily ascertainable. Research must be intensified to develop and up0dte, on a continuing basis, the nutrient requirement of different fish enterprises.

- The nutritional standard requirements of different classes of fish must be developed and subjected to periodic review through experimentation.
- Efforts must be made to develop improved and standardized processing storage technology for all ingredients in order to minimize loss of nutrients.
- Intensive research must be carried out to breed crop varieties with high nutrient content and balance.
- Micro-computers and programmers must be available. Animal scientists must graduate from the old fashion and tedious desk-calculator approach to ration formulation to the use of faster and more accurate method based on computerization.

The Linear programming matrix is usually constructed using single value estimates of technical coefficients of the various ingredients. But, it is well known that the variation in quality and composition of different batches o the same ingredients may be considerable. Consequently, there is a need to establish a range of composition values obtained through extensive analysis of different batches of several commonly used feed ingredients. Rapid test that would screen ingredients and discard those that are severely defective would al go a long way to make the use of this technique more effective.

It is important to note that this model ignores other costs of feed production. However, such costs as labour, machine and building depreciation, insurance, marketing costs, bags and so on, are essential common costs, which usually vary between mills depending on their scales of operation capacity utilization and management efficiency and organization. Consequently, it is not considered necessary to include these costs in order to formulate least-cost rations, although models could be constructed to maximize returns while taking account of capacity utilization, market demands and operating costs.

While cost reduction may be achieved through Linear programming, this must, in all cases, be related to fish performance, as it is clearly known that the cheapest rations are not necessarily the most efficient. In order to relate least cost ration fish performance, a feed growth production formait must be quantities in such a way that an iso-growth curve could be derived for the given rate of liveweight gain.

Finally, the analysis of compounded ration must be carried out to ensure that specified nutrient requirements are adequately provided. In this regard on Farm feeding trials, are the surest way to confirm the quality of compounded rations.

5.1 SUGGESTED SOLUTIONS TO FISH FEED INDUSTRIAL PROBLEMS

Presently, there seems to be an unresolved controversy over the capability of Nigeria to meet its fish feed raw materials. This is partly borne out of the long standing tradition of importation of most of the raw materials by the existing feed producers. A rapid expansion of our fish farms in a bid to bridge the demand and supply gap of fish should not be allowed to face the feed raw materials problem which almost crippled the poultry. Other problem militating against fish feed industries are: Inadequate machinery and spare parts for the fish feed Industry; Inadequate capital; Non-availability of skilled manpower among others.

In the consideration of the author's strategies for solving the major problems of fish feed industry to meet the future requirements of fish feeds in Nigeria, the following solutions are preferred and outlined briefly below:

- Stimulate the awareness of the feed produces towards the large scale production of seeds. This could be achieved through establishment of own farms a/or making contract with outgrowers for the production of basic raw materials.
- Recognition by government of the close similarity between the requirements of fish feed industry and poultry feed industry such that adequately high loam facilities can be extended to the industry as to poultry
- Training of skilled manpower for proper maintenance to handling of the essential plants and equipment. There is al need for locally developed technologies and know-how. This is however, dependent on the availability offlat sheets for the fabrication of equipment.
- Promotion of fish feed industry by government through ms media to create public awareness and deliberate program of education to include finance houses on the profitability of the venture, hence instilling confidence for loan advancement.
- Restructuring Research Institutes: Information emanating from our research Institutes that would engender to the rapid development fish feed industry in Nigeria must disseminated without delay means of well coordinated extension research liaison services.
- Cost reducing measures

(i) The potential investors can either buy up or team up with existing feed millers and purchase extrudes and pelleting units to augment the existing machines as to produce pelleted fish feed.

(ii) Small medium size fish farms should have feed processing units of a capacity of about 1-2 tones capacity per hour, capable of satisfying their fish feed needs.

(iii) Through the inclusion of low-cost, high quality plant protein like soyabean to replace very expensive fish protein sources like blood-meal, fish meal and others.

5.3 RECOMMENDATIONS

(i) The high cost of pelleted fish feed is the major factor militating again the use of pelleted fish feeds in fish culture. This could be reduced if fish farmers could also engage in farming the major feed ingredients such as soyabean, groundnut, maize, guinea corn depending their locality.

(ii) Fish farmers old be should be properly trained on fish need formulation using the available agro-products. The assistance of the State and Federal Fisheries Departments as well as Agricultural Development Project (ADP) is needed in this regard.

(iii) Establishment of feed mills by private agencies and government would help to ease the availability of pelleted feeds but such pelleted fish feeds should be sold at a rate affordable by the local fish species.

(iv) Information on the nutrient requirement of the local fish species are still vary scanty. Fisheries Institutes and Fisheries Departments in University's should be properly funded to tackle this problem which is a prerequisite to formulating nutritionally balanced dists for our local fish species.

(v) Government should encourage the production of low cost feed ingredients by subsidizing agricultural inputs. This will help fish farmers to produce nutritionally adequate fish feed at minimum cost.

(vi) Fish farmers should always seek for guidance form fish nutritionists on fish fed formulation to avoid the use of substandard fish feeds.

From the feasibility study on the computerization of least-cost feed formulation, an appropriate environment needs to be created to optimize the benefit of computerization or automation.

For the proper functioning of the new system, the recommendation for sustenance are:

(i) Control should be exercised over timeliness and reliability of data.

(ii) Management should periodically review the status of the system. The authority, role willing the organization and scope of authority of the senior officer in charge of the system, need to be defined and made clear to system users.

(iii) Mechanisms should be established to ensure that all equipments and software are in good operating conditions at all times with a minimum of down time.

(iv) The effect of any computer application will be determined in part, by its effect on the place of individual in the organization.

A move towards automation, often, infact, creates new information related to jobs. The need to re-channel human resources should be seized as an opportunity and interpreted as such by management to the organization should train the staff on computer training that directly related to their needs and operator skills.

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```
DECLARE SUB rationalize (col!)
DECLARE SUB swaprows (ri)
' Standard Linear Programming Problem

` ns=number of slack variables
` nv=number of original variables
` ne=number of original equations i.e rows
` nr=number of rows of tableau
` ne=number of columns of tableau

CLS
INPUT "enter number of variables: "; nv
INPUT "enter number of equations: "; ne
DIM SHARED nr, nc AS INTEGER
nr = ne + 1
ns = ne
nc = ns + nv + 2

DIM SHARED table (nr, nc)
DIM SHARED X (nv)
DIMconsts (nr – 1) 'array of constants in the rightmost column

FOR i = 1 TO nr
FOR + = 1 TO nc
table (i, j) = 0
NEXT j: NEXT I

` input of values of table

` first the variables
FOR i = 1 TO ne
FOR j = 1 TO nv
PRINT "Enter variable x("; j; ") = ";
INPUT table (i, ...j)
NEXT j
INPUT "<= "; table (i, nc)
NEXT i
```

Then the objective function

```
INPUT "Input coefficients of variables in the objective function:"
FOR j – 1 TO nv
PRINT Coefficient of X(" ; i; " ) = ";
INPUT table (nr, i)
table (nr, i) = - table (nr, i)
NEXT i

Then the P column
table (nr, nc – 1) = 1
`

FOR i = 1 TO nr - 1
FOR j = nv + 1 TO nc - 1
table (i, j) = 0
NEXT j
NEXT i

CLS

this is the initial tableau
PRINT "This is the initial tableau"
PRINT
FOR I = TO nr
For j = 1 TO nc
PRINT USING "#####"; table (i, j);
NEXT j
PRINT
NEXT I

s• = INPUT$ (1)
` step seven (check)
opt 0
FOR j = 1 TO nc
OF ( (table (nr, i) <> ABS (table (nr, i))) AND (table (nr, i) <> 0)) THEN opt =
1
NEXT i

DO WHILE (ott <> 0)
step 2
D-row largent negative value i.e. row nr
largestDcol = 1
FOR j = 1 TO nc – 1
```

```
IF (table (m, i) <> Ans(table (m, i))) THEN          must be negative
IF (ABS (table (nr, i)) > ABS (table (nr, largestDcol)) AND (ABS (table (nr, i))
<> THE
END IF
NEXT I
PRINT largestDcol

Step three (all according to note)
FOR i = 1 TO nr – 1
consts (i) = table (i, nc)
NEXT i

FOR i = 1 TC nr – 1
consts (i) = consts (i) / ABS (table (i, largestDcol

step three (all according to note)
FOR i = 1 TO nr – 1
consts (i) = table (I, nc)
NEXT i

PRINT i = 1 TO nr – 1
consts (i) = consts / ABS (table (I, largestDcol))
NEXT i
FOR i = 1 TO nr - 1
consts (i) = consts / ABS (table (I, largestDcol))
NEXT i

PRINT leastConstrow
Enteringrow = leastConstrow
Enteringrow = leastDcol

` step five
j = table (enteringrow, enteringCol)
FOR i = 1 TO nc
table (enteringrow, i) / j
NEXT i
swaprows (enteringrow)

PRINT
FOR i = 1 TO nr
FOR j = 1 TO nc
```

```
PRINT USING "# # # # . # #"; table (i, j);
NEXT j
PRINT
NEXT i

s• = INPUT$ (1)
` step six
rationalize (enteringCol)

PRINT "rationalized"
FOR i = 1 TO nr
FOR j = 1 TO nc
PRINT USING "# # # # . # #"; table (i, j);
NEXT j
PRINT
NEXT i

s• = INPUT$ (1)
opt = 0
FOR i = 1 TO nc
IF ( (table (nr, i) <> ABS (table (nr, i))) AND (table (nr, i) <> 0)) THEN opt =
1
NEXT i

Loop
Else the optimum value has been reached, evaluate and print
FOR i = 1 TO nv
FOR j = 1 TO nr – 1
IF table (j, I) = 1 THEN X (i) = TABLE (J, nc)
NEXT i
NEXT j

FOR I = 1 TO nv
PRINT x (i)
NEXT i

SUB rationalize 9col)
FOR i - 2 TO nr
k = table (i, j) – (k * table (i, j))
NEXT j
NEXT i
```

```
END SUB

SUB swaprows ®
DIM  temp (nc)

FOR i = 1 TO nc
temp (i) = table (r,  I)
NEXT i

FOR i  = r – 1 TO 1 STEP – 1
FOR j = 1 TO nc
table (I + 1, j) = table (i,  j)
NEXT j
NEXT i

FOR i = 1 TO nc
table (1, i)  = temp (i)
NEXT i
END SUB

DECLEARE SUB procphase ()
DECLEARE SUB procpivot ()
DECLEARE SUB procpivotrow ()
DECLEARE SUB prociterate ()
DECLEARE SUB procoqualities ()
DECLEARE SUB proctransform ()
DECLEARE SUB procartificial ()
DECLEARE SUB procslacks  ()
DECLEARE SUB procmatrix ()
DECLEARE SUB procprint ()
DECLEARE SUB procinput ()
OPTION BASE 0

DIM SHARE a (11,21), b(21), c(11), status (21), type•   (11)
` DIM SHARE a (30,30), b(30), c(30), status (30), types•   (30)
DIM SHARED iteration, 1, e.g, phase, al, cmax, i0

DIM SHARED n, m, i, j, i1, j1, type1•  , z•  , edit, p
DIM SHARED coeff, test, ratio, col, best

iteration = 0
```

```
l = 0
e = 0
g = 0
phase = 0
al = 0
cmax – 0
i.0 = 0
CLS
PRINT "This Software solves a linear programming Problem"
PRINT
PRINT

PRINT "Involving >=,  =, and <= constraints for any system of equations"
PRINT
PRINT

PRINT "Press any key to input variables and constraints"
PRINT
PRINT

r•  = INPUT•  (1)

procinput
procprint
edit = 0
procmatrix
procprint
prociterate
END

SUB procartifical
a (i0, n + i0) = -1
a (i0, 0 = nnr+m+1
a ( i0, n + m+ 1) = 1
status (n + m + 1) = 1
FOR  j = 1 TO n + m
a(m + 1, j) = a(m + 1, j) + a(io, j)
NEXT j
c(m + 1) = c(m + 1) + c(i0)

END SUB
```

```
SUB procequalities
FOR I = m – e + 1 TO m
FOR j = 1 TO n
a(m + j) = a(m + 1, j) + a(i, j)
NEXT j
c(m + 1) = c(m + 1) + c(i)
a(i, n + e) = i
status (n + 1) = 1
NEXT i

END SUB

SUB procinput
INPUT "Number of main variables: ", n
INPUT "Number of constraints: ", m
PRINT
FOR i = 1 TO m
PRINT
PRINT "Input type of constaint 1="; STR•  (i)
PRINT "i.e. input L, E, G for <=, =, >=: ";
INPUT tpe1•
IF type1•  = "L" THEN l = l: type•  (i – e) = "L"
IF type1•  = "G" THEN g = l: type•  (i – e) = "G"
IF type1•  = "E" THEN e = l: type•  (m – e + 1) = "E"
PRINT "input a(i,j) & c(i) for constraint I="; STR•  (i)
FOR j = 1 TO n
PRINT "a("; STR•  (i); ", "; STR•  (j); ") =";
IF type1•  = "E" THEN INPUT c(m – e + 1)
IF type1•  <> "E" THEN INPUT c(i – e)
IF type1•  = "G" AND c(i – e) >= cmax THEN cmax = c(i  - e): i0 = i - e

NEXT i

INPUT "type of objective function (enter MAX or MIN): ", z•
PRINT "Now input the objective function coeffs b(j)"

FOR j = 1 TO n
PRINT "b("; DTR•  (j); ") = ";
Input b(j)
```

```
IF z•  = "MIN" THEN a(0, j) = b(j)
IF z•  = "MAX" THEN a(0, j) = b(j)
NEXT j

FOR j = 1 TO n
a(i1, j) = a(il, j) / p
NEXT j
c(il) = c(il) / p
FOR i = 0 TO m 1 phase
col = a(i, jl)
FOR j = 1 TO n
IF i < > il THEN a(i, j) = a(i, j) -  col * a(il, j)
NEXT i
IF i < > il THEN c(i) = c(i) -  col * c(il)
NEXT i
iteration = iteration + 1

END SUB

SUB procpivotcolumn
best = 0
coef = 0
ji = 0
FOR j = 1 TO n
IF phase = 0 AND  a(0,j) < -1E-08 THEN coeff = a(m + 1, j)
IF phase = 1 AND a(m + 1, j) > 1E-08 THEN coeff = a(m + 1, j)
IF coeff > best THEN best = coeff: ji =j
NEXT j
status (ji)  = 1

END SUB

SUB procpivotrow
ratio  = 1 E +11
best = 1 E +11
i1 = 0
FOR i = 1 TO m
IF a(i,ji)  > 1E-08 THEN test = c(i) / a(i, jl)
IF test > ratio THEN ratio = test: il = i
NEXT i
status (a(ij.  0)) = 0
```

```
END SUB
SUB procprint
PRINT
IF edit = q THEN PRINT "BASIC"; ELSE PRINT "TYPE";
FOR j = 1 TO n
PRINT TAB (10 * j); "X"; STR•  (j);
NEXT j
PRINT TAB (10 *  (n + 1)); "R.H.S"
PRINT
FOR i = 0 TO nm + phase
FOR j = 0 TO n
IF z•   = "MAX" AND I = 0 AND j = 0 THEN  PRINT "z";
 IF z•   = "MIN" AND I = 0 AND j = 0 THEN  PRINT "z";
IF edit = 0  AND I >  0 AND j = 0 THEN  PRINT "X" STR•   (a(i, 0));
IF edit = 1  AND I >  0 AND j = 0 THEN  PRINT type•   (i);
IF j > 0 THEN PRINT TAB (10 +j) a(i,j);
NEXT j
PRINT TAB (n + 1) * 10); c(i)
edit = 1
PRINT
PRINT "Rows as Input"

END SUB
SUB prociterate
DO
Procpivotrow
IF j1 = 0 THEN PRINT "UNBOUNDED SOLUTION"; END
p = a(i), ji)
PRINT "IVOT ="; p; "NEW BASIC VAR. X"; STRS (j1);
PRIN "11 PLACE OF X"; STR•   (a(i1, 0))
Procprint

LOOP

END SUB
SUB procmatrix
IF g > 0 THEN procartificial
FOR i = 1 TO m – e
IF type•   (i) = "L" THEN procslacks
```

```
IF type•   (i) = "G" AND i < > 10 THEN proctransform
NEXT i
IF e > 0 THEN procequalities
IF e + g > 0 THEN phase = 1
IF g > 0 THEN al = 1
Al = al + e
PRINT
IF  al > 0 THEN PRINT "ARTIFICAIAL VARIABLES REQUIRED"
IF al > 0 THEN FOR i m – e + 1 TO m; PRINT "X", STR•   (n + 1); NEXT I
IF g > 0 THEN PRINT "X"; STR•   (N + M + 1)
IF g > 0 THEN n = n + m 1 ELSE n = n + m
PRINT
PRINT "PRIMAL FEASIBLE TABLEAU"
END SUB
SUB provphase
Phase = 0
FOR i  = 0 – al + 1 TO n
IF status (i) = 1 THEN n = n – al

END SUB

SUB procpivot
a(il; 0) = ji
FOR j = TO n
PRIN "b("; STR•   (j); ") =";
INPUT b(j)
IF z•   = "MIN" THEN a(0,  j)  = b(j)
IF z•   = "MAX" THEN a(0,  j)  = b(j)
NEXT j

edit = 1
PRINT
PRINT "Rows as Input"

END SUB

SUB prociterate
DO
procpivotcolumn
IF j1 = 0 AND phase = 1 THEN PRINT "NO FEASIBLE BASIS"; END
IF j1 = 0 AND phase = 0 THEN EXIT SUB
```

```
procpivotrow
IF il = 0 THEN PRINT "UNBOUNDED SOLUTION": END
p = a(il, ji)
PRINT "PIVOT ="; p; " NEW BASIC VAR. X"; STR•  (ji);
PRINT "IN PLACE OF X"; STR•  (a(il, 0))
procpivot
IF phase = 1 THEN procphase
PRINT
PRINT "PREATION No "; STR•  (iteration)
procprint

LOOP

END SUB
SUB procmatric
IF g > 0 THEN procartificial
FOR i = 1 TO m – e
IF type•  (i) = "L" THEN procslacks
IF type•  (i) = "G" AND i < > 10 THEN proctransform
NEXT i
IF e > 0 THEN procequalities
IF e + g > 0 THEN phase = 1
IF g > 0 THEN al = 1
al = al + e
PRINT
IF al > 0 THEN PRINT "ARTIFICAIAL VARIABLES REQUIRED"
IF al > 0 THEN FOR i m – e + 1 TO m; PRINT "X", STR•  (n + 1); NEXT I
IF g > 0 THEN PRINT "X"; STR•  (N + M + 1)
IF g > 0 THEN n = n + m 1 ELSE n = n + m
PRINT
PRINT "PRIMAL FEASIBLE TABLEAU"

END SUB
```

ARTIFICIAL VARIABLES REQUIRED
X 26

PRIMAL FEASIBLE TABLEAU

BASIC	X 1	X 2	X 3	X 4	X 5	X 6	X 7	X 8	X 9	X 10	X 11	X 12	X 13	X 14	X 15	X 16	X 17	X 18	X 19	X 20	X 21	X 22	X 23	X 24	X 25	X 26	R.H.S
-Z	20.0000	35.0000	120.0000	10.0000	5.0000	5.0000	5.0000	5.0000	10.0000	25.0000	300.0000	250.0000	15.0000	20.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
X 15	3422.0000	2658.0000	2795.0000	2990.8000	2847.2000	3462.2000	3425.0000	0.0000	1716.0000	8170.0000	8200.0000	0.0000	0.0000	3399.8000	1.0000	0.0000	-1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	2586.0000
X 16	10.0000	42.0000	65.0000	89.2000	12.8000	28.8000	25.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	40.0000
X 26	3432.0000	2700.0000	2860.0000	3080.0000	2860.0000	3491.0000	3450.0000	0.0000	1716.0000	8170.0000	8200.0000	0.0000	0.0000	3400.0000	0.0000	0.0000	-1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	2618.0000
X 18	3.6000	3.5000	9.6000	1.3000	13.7000	14.1000	10.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	5.0000
X 19	2.3000	6.5000	0.7000	1.0000	11.1000	14.0700	10.5200	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0800	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	6.0000
X 20	3431.7500	2697.2000	2855.2800	3073.6699	2859.4800	3490.2800	3448.2200	0.0000	1713.8000	8170.0000	8200.0000	0.0000	0.0000	3400.0000	0.0000	0.0000	-1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	2616.3701
X 21	3431.8301	2699.4099	2858.2500	3079.1201	2859.8000	3490.2700	3449.5601	0.0000	1715.4200	8170.0000	8200.0000	0.0000	0.0000	3400.0000	0.0000	0.0000	-1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	2617.7000
X 22	3431.6101	2698.7900	2859.6899	3077.8799	2859.6699	3490.2000	3449.3201	0.0000	1715.2700	8170.0000	8200.0000	0.0000	0.0000	3400.0000	0.0000	0.0000	-1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	2617.2600
X 23	0.0300	0.2000	5.1900	0.2900	0.0300	0.5200	9.0600	37.6200	37.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	1.5000
X 24	3431.7200	2699.3999	2857.1201	3079.7600	2859.7300	3490.3000	3449.5000	-0.0700	1701.0000	8170.0000	8200.0000	0.0000	0.0000	3400.0000	0.0000	0.0000	-1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	2617.5000
X 25	0.2800	0.6000	2.8800	0.2400	0.2700	0.7000	0.5000	0.0700	15.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.7000
X 0	3432.0000	2700.0000	2860.0000	3080.0000	2860.0000	3491.0000	3450.0000	0.0000	1716.0000	8170.0000	8200.0000	0.0000	0.0000	3400.0000	0.0000	0.0000	-1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	2618.0000

PIVOT = 8200   NEW BASIC VAR. X 11 IN PLACE OF X 15

ITERATION No 1

BASIC	X 1	X 2	X 3	X 4	X 5	X 6	X 7	X 8	X 9	X 10	X 11	X 12	X 13
-Z	-105.1951	-62.2439	17.7439	-99.4195	-99.1658	-121.6659	-120.3049	5.0000	-52.7805	-273.9024	0.0000	250.0000	15.0000
X 11	0.4173	0.3241	0.3409	0.3647	0.3472	0.4222	0.4177	0.0000	0.2093	0.9963	1.0000	0.0000	0.0000
X 16	10.0000	42.0000	65.0000	89.2000	12.8000	28.8000	25.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
X 26	10.0001	42.0001	65.0000	89.2001	12.8001	28.8000	25.0001	0.0000	0.0000	-0.0000	0.0000	0.0000	0.0000
X 18	3.6000	3.5000	9.6000	1.3000	13.7000	14.1000	10.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
X 19	2.3000	6.5000	0.7000	1.0000	11.1000	14.0700	10.5200	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
X 20	9.7501	39.2000	60.2800	82.8700	12.2801	28.0800	23.2201	0.0000	-2.1999	-0.0000	0.0000	0.0000	0.0000
X 21	9.8302	41.4100	63.2500	88.3202	12.6002	28.0700	24.5601	0.0000	-0.5799	-0.0000	0.0000	0.0000	0.0000
X 22	9.6102	40.7901	64.6899	87.0799	12.4700	27.9999	24.3202	0.0000	-0.7299	-0.0000	0.0000	0.0000	0.0000
X 23	0.0300	0.2000	5.1900	0.2900	0.0300	0.5200	9.0600	37.6200	37.0000	0.0000	0.0000	0.0000	0.0000
X 24	9.7201	41.4000	62.1201	88.9601	12.5301	28.1000	24.5001	-0.0700	-15.0000	-0.0000	0.0000	0.0000	0.0000
X 25	0.2800	0.6000	2.8800	0.2400	0.2700	0.7000	0.5000	0.0700	15.0000	0.0000	0.0000	0.0000	0.0000
X 0	10.0001	42.0001	65.0000	89.2001	12.8001	28.8000	25.0001	0.0000	0.0000	-0.0000	0.0000	0.0000	0.0000

BASIC	X 14	X 15	X 16	X 17	X 18	X 19	X 20	X 21	X 22	X 23	X 24	X 25	X 26	R.H.S
-Z	-104.3829	-0.0366	0.0000	0.0366	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-94.6098
X 11	0.4146	0.0001	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3154
X 16	0.2000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	40.0000
X 26	0.2000	-1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	32.0000
X 18	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	5.0000
X 19	0.0800	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	6.0000
X 20	0.2000	-1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	30.3701
X 21	0.2000	-1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	31.7000
X 22	0.2000	-1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	31.2600
X 23	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	1.5000
X 24	0.2000	-1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	31.5000
X 25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.7000
X 0	0.2000	-1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	32.0000

PIVOT = 88.96008 NEW BASIC VAR. X 4 IN PLACE OF X 24