APPLICATION OF GOAL PROGRAMMING FOR DIET PLANNING IN THE INDIAN CONTEXT

A DISSERTATION

submitted in partial fulfilment of the
requirements for the award of the degree
of
MASTER OF ENGINEERING
in
ELECTRICAL ENGINEERING
(With Specialization in System Engineering & Operations Research)

By

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Dedicated

To

My Parents

CANDIDATE'S DECLARATION

I hereby declare that the work which is being presented in the Dissertation entitled, APPLICATION OF GOAL PROGRAMMING FOR DIET PLANNING IN THE INDIAN CONTEXT in partial fulfilment of the requirements for the award of the degree of MASTER OF ENGINEERING in ELECTRICAL ENGINEERING with specialization in SYSTEM ENGINEERING AND OPERATIONS RESEARCH, submitted in the Department of Electrical Engineering, University of Roorkee, Roorkee (India) is an authentic record of my own work carried out for a period of about five months from August 1988 to January 1989 under the supervision of Dr. A.K. Pant, Professor, Department of Electrical Engineering, University of Roorkee, Roorkee.

The matter embodied in this dissertation has not been submitted by me for the award of any other degree or diploma.

DATED 16/1/89

(DAMODAR AGARWAL)

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

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ABSTRACT

Selection of diets by quantitative techniques is becoming an increasingly common practice. The most popular of these techniques is linear programming. However, although linear programming is satisfactory for selection of least cost mixes of foods to meet specific nutritional requirements, it often results in an over - supply of certain nutrients. This overdose of some nutrients is equally dangerous as undernutrition.

Goal programming, which is a multi objective programming technique and which allows for a simultaneous solution of a system of complex objectives rather than a single objective, can be used to overcome the problem of nutritional imbalance while selecting least cost mix of foods. In the present work, linear goal programming has been used to optimize the nutritional balance, while minimizing the cost also, of a selected 'mix of foods' from 75 food raw materials for different catagery of persons such as man, woman, expecting mothers, nursing mothers, pre-school children, school going children, adolescents etc. in different months of the year. The objectives considered are those related to fulfilment of nutritional requirements, cost minimization, availability of foods and preferences of individuals in Indian context.

CONTENTS

CHAPTER - 1

INTRODUCTION

1.1 Necessity of Diet - Planning :

Nutrition is assuming increasing importance in a country like India where nutritional diseases are not only widely prevalent, but they modify the course of events of almost any clinical disorder. The effects of malnutrition are both direct and indirect[1]. The direct effects are the occurrence of frank nutritional difficiency diseases like Kwasiorkar, beri - beri, Goitre etc. The indirect effects are a lowered vitality of the people, arrested growth, high infant mortality, still - birth rates, high incidence of low birth - weight, high sickness rates and a lower expectation of life. In the recent years, the effect of malnutrition in the area of mental retarda - tion is also being actively investigated. In the more deve- loped countries also, the problem is there, but it is some - what different. Overnutrition is encountered much more frequently than undernutrition there. The health hazards from overnutrition and obesity are an increase in mortality and higher incidence of many diseases such as hypertension, cardiovascular and mental disorder, disorders of liver and gall bladder and diabetes etc.

Thus we see that both undernutrition and overnutrition are equally harmful. Therefore, a balanced diet, which while fulfilling the minimum nutritional requirements minimizes the over-supply of nutrients also, is essential to maintain

health and prevent numerous diseases.

1.2 Balanced Diet

A balanced diet may be defined[2] as one which contains the various groups of foodstuffs such as energy yielding foods, body building foods and protective foods in the correct proportion so that an individual is assumed of obtaining the minimum requirements of all nutrients and at the same time avoiding overnutrition as much as possible. As the nutritional requirements of different catagory of persons are different, so the component of a balanced diet will differ according to age, sex, physical activity, economic status and physiological state viz pregnancy and lactation etc.

A balanced diet at high cost will include liberal amounts of costly foods such as milk, eggs, meat, fish and fruit and moderate quantities of cereals, pulses and nuts etc.

At moderate cost, a balanced diet will include moderate amounts of milk, eggs, meat, fish, fruits and fats and liberal amounts of cereals, pulses, nuts and green leafy vegetables.

At low cost, a balanced diet will contain small amounts of milk, egg, meat, fish and fruits and liberal amounts of cereals, pulses, nuts and green leafy vegetables.

Thus it is seen that with proper knowledge a balanced diet can be formed at low cost also and in the present work, emphasis is given on forming such diets for different catagory of persons.

1.3 Diet Problem and its solutions: A general Review

Linear programming has been frequently applied to the selection of dietary components to meet specific nutritional requirements at least cost.

The first solution of a diet problem using linear programming was by V.E.Smith[3]. This further led to a wide variety of applications, ranging from planning of food - supplies on national and global scales (Hruby[4] and Sukhatme[5] to menu planning for specific groups of people (Unkelsbay and Unkelsbay[6] and Ngarmsak et al[7]). A review of many of these applications is presented by Edwardson et al[8].

In most of these applications, an attempt is made to select the least cost mixes of foods (in a diet) subject to specific nutritional constraints. The nutritional constraints in these applications have specified mainly lower levels of nutritional requirements. In such cases, there is a tendency for the solutions, showing a gross imbalance of some nutrients i.e. the solution often results in an over-supply of certain nutrients.

Some nutrients have been proved to have harmful side effects when taken in excess. The most common type of disease which takes place due to dietary excesses is chronic degenerative diseases, such as coronary heart disease (CHD). Excessive calcium intake have been associated with kidney stone formation (FAO/WHO[9]), while high levels of vitamin A may cause

serious injury to health with symptoms including loss of hair, pain in long bones and dry skin (Mitchell et al[10]). Sufficient concerns about the dangers of excessive intakes of certain nutrients has prompted FAO/WHO expert committees on nutrition to recommend further research in the newly developed research field of nutritional toxiocology (FAO/WHO[11]).

Thus nutritionists are becoming more and more aware of the dangers of overdoses of some nutrients and of the need for a balanced intake of all nutrients. Starting with Sweden in 1968, nearly 15 countries of Europe and North America, Australia and Newzealand have now drawn up dietary guidelines for their populations in which emphasis is given on educating people to avoid dietary excesses which would render them more prone to chronic degenerative diseases specially CHD. The low priority for prescriptions and propogation of dietary guidelines of this nature in India has apparently stemmed from the consideration that our major nutritional concerns are those related to maternal under-nutrition, high infant and child mortality, impaired growth and development of frank undernutrition. These concerns have led our nutritionists to prepare dietary guidelines so as to ensure that at least basic energy needs of the majority of our populations are met and frank nutritional deficiency diseases in them are prevented and controlled, rather than that possible overnutrition and dietary excess in a small minority are concerned.

However, the emerging scenario in many developing countries will show that this may be a somewhat shortsighted and complacent view. It is now becoming increasingly clear that it may in fact be important for India to develop and promote dietary guidelines for its relatively affluent population groups even at the current stage of its development. While large section of our population is, no doubt, poor and undernourished, there is a steadily expanding middle and affluent class and so one cannot neglect our affluent minority and problems of overnutrition associated with such affluence. The affluent and middle class are not only a steadily growing minority, but they are also the pace setters, and they include some of the most important influential and productive elements of society. As far as India is concerned, a minority even just five percent of the total population still means over 40 million people. Therefore, it will be wise and prudent for us to benefit from the experience of developed countries and through timely action avoid repeating their earlier mistakes.

1.4 Brief outline of the present work

In the present work, emphasis is given on this point also. That is, while formulating diets, beside fulfilling the minimum nutritional requirements, attempt is also made to minimize any overdose of nutrients as far as possible.

Again, peoples of different regions have different foods - habits, depending on the availability of foods, social and religious beliefs etc. Moreover, every individual may have his own choice of foods. Thus there cannot be one and only one prescribed diet for a particular category of persons. In the present work, this point is also taken into consideration.

In the 2nd chapter, it is described that how the goal programming technique can be effectively applied to diet planning problem and what advantages it has over the conven - tional single objective linear programming approach. Mathematical model formulation and its solution techniques are also discussed in this chapter.

A problem of such dimension obviously requires the use of computer for its solution. In the third chapter, formulation of the computer model for the problem and preparation of data - base is discussed in details.

It is obviously impossible to include the results for each catagory of persons and for every month in the report. In the fourth chapter, some typical results and their interpretation is discussed.

In the fifth and concluding chapter limitations of the present work is discussed and suggestions are given for further work in this field.

CHAPTER - 2

GOAL PROGRAMMING APPROACH TO DIET PLANNING

2.1 Introduction

In the earlier chapter, it has been discussed that the application of the conventional linear programming technique to diet planning often results in an over - supply of some nutrients. One way to overcome this problem, while using linear programming, is to specify upper as well as lower limits for each nutrient. But then, it will result in an over - constrained problem to which there is often no feasible solution. It is, however, possible to progressively relax the constraints until a feasible solution is obtained. This process is not only tedious, but it is also difficult to define any logical basis for varying (relaxing) constraints.

A technique which provides a more systematic approach to the problem of balancing the supply of nutrients in a selection of foods is goal programming. It is a modification and extension of linear programming which allows for a simultaneous solution of a system of complex objectives rather than a single objective. It can achieve the objective of nutritional balance through replacement of cost minimization function by the minimi - zation of a function signifying the deviation of the nutrients from prespecified levels required for optimum balance. Cost is accounted for in this approach by obtaining solutions at different cost levels and hence

defining a cost - nutrition balance relationship or by defining an aspiration level for the cost.

Before discussing the actual problem, we will first discuss goal programming in general.

2.2 Goal Programming : A multiobjective programming technique

The decision problems that are encountered in actual practice often incorporate multiple, conflicting objectives. In fact, a real - world problem is seldom a single - objective one. A decision maker in the real world, often, has to make a decision so as to achieve a set of multiple objectives to the fullest possible extent in an environment of conflicting interests, limited resources and incomplete information. In such a case, if it is decided to use the conventional approach i.e. single objective linear programming, it is required to introduce other objectives (other than one objective function) as model constraints. The linear programming model, however, requires that the optimum solution must satisfy all the constraints. Furthermore, it is assumed that all constraints have equal importance in solving the problem. However, in reality such assumptions are not always valid. First of all, often all the constraints of a real - world problem do not have equal importance. Next, it is quite possible that all

the constraints of the problem cannot be satisfied fully. In conventional linear programming, such a problem is called infeasible which means insoluble. But then a very important real- world problem cannot be abandoned merely on the ground that it cannot be solved by linear progra - mming. In such cases, goal programming comes as a rescue. This technique allows for simultaneous solution of a system of conflicting objectives rather than a single - objective.

The initial development of the concept of Goal programming was due to Charnes and Cooper in 1961[12]. In essence, they proposed a model and approach for dealing with certain linear programming problems in which conflicting goals of management were included as constraints. In 1965, Ijiri[13] presented a definition of pre-emptive priority levels so as to treat goals according to their percieved importance. For example, an objective or a set of commensurable objectives might be assigned to priority level one i.e. P_1 and the satisfaction of this objective (or these objectives) is then preemptively preferred over the satisfaction of any lower priority (P_2, $P_3 \ldots P_k, \ldots P_K$) objectives. That is, in general, $P_k >> P_{k+1}$ regardless of the multiplier associated with P_{k+1}, (however big the multiplier may be). The introduction of preemptive priori - ties, though it allowed the analyst to form a more valid

model, resulted in a model which could no longer be solved by the standard simplex algorithm. Consequently investigations began to examine ways on which to modify the simplex method, so as to encompass the preemptive priority structure.

In 1972, the 1st text dedicated solely to goal programming was published by S.M.Lee[14,15] who must be given much of the credit for the present popularity of and interest in this field. Lee's text presented in a straight-forward, readable fashion, an introduction to strictly linear goal programming (LGP) including model formulation, a technique for solution and a number of quite interesting applications.

2.3 Essential features of goal programming

As mentioned earlier, goal programming, which is a special extension of linear programming is capable of solving decision problems with a single goal or multiple goals. Goals set by management are often achievable at the expense of other goals. Furthermore, these goals are incommensurable, i.e they cannot be measured on a same unit basis. Thus there is a need to establish a hierarchy of importance among these conflicting goals so that low order goals are considered only after the higher order goals are satisfied or have reached a point beyond which no further improvements are possible or desirable. If an

ordinal ranking of the goals in terms of their importance can be made , the problem can be solved by goal programming.

The characteristic feature of goal programming is that, instead of trying to maximise or minimise the objective function directly, as in linear programming, the deviations among goals and what can be achieved within the given set of constraints are minimised. Thus, whether goals are completely attainable or not, the solution always gives a result which comes as close as possible to the indicated goals.

Professor H.A.Simon, an authority on decision theory states that today's manager is not trying to 'optimize', instead he tries to 'satisfy'. If we accept this theory, Goal programming can be said to be an appropriate technique for modern decision analysis.

2.4 Applications

Since goal programming now encompasses any linear, integer, zero-one or non-linear multi-objective problem (for which preemptive priorities may be established), the field of applications is wide open. The recent increase in interest in this area has already led to a large number and wide variety of actual and proposed applications[16]. Some of these applications are Manpower planning. Hospital Administration, Academic resource allocation, Transportation problems, Facility allocation, Capital Budgeting in production area, Portfolio selection, Maintenance level determination, Water resources developement, Agriculture etc.

All of these applications have one thing in common, they could be forced into a traditional single-objective model if one so wished. However, those investigating these problems believed that they truely involved multiple, conflicting objectives and were thus most naturally modelled as a goal programming problem.

Thus we see that goal programming is a practical, realistic and rather natural representation of a wide variety of real world problems and all traditional single objective models may be viewed simply as a special case of the general goal programming model. This is rather in opposition to some of the early views of goal programming in which it was considered to be simply an interesting extension of linear programming.

2.5 The Goal programming model

Goal programming is a mathematical model in which the optimum attainment of multiple goals is sought within the given decision environment. The decision environment determines the basic components of the model, namely, the decision variables, constraints and the objective function.

Before discussing the model formulation in details, let us first be aquinted with the terms often used in Goal programming.

GOAL

An objective in conjunction with an aspiration level is termed as a goal.

ASPIRATION - LEVEL

It is a specific value associated with a desired or acceptable level of achievement of an objective. It generally serves to 'anchor' the objective to reality.

GOAL - DEVIATION

The difference between what is accomplished and what is aspired to is the deviation from goal. In all but trivial problems (where aspiration levels are unrealistically low), we shall encounter deviations from our goals. A deviation can represent over as well as under - achievement of a goal.

OBJECTIVE OR ACHIEVEMENT FUNCTION

In goal programming, the objective function is composed of either a pair of or a single deviational variable for each goal constraint. If over-achievement is acceptable, the positive deviation can be eliminated from the objective function and if underachievement means a satisfactory solution, the negative deviation may not be included in the objective function. Exact achievement of a goal requires both its negative and positive deviation be included in the objective function.

PRIORITY RANKING

In order to achieve the goals according to their importance, goal programming provides a means by which the negative and positive deviations about the goal may be ranked according to the preemptive priority factors. In this way, the low order goals are considered only after higher order goals are achieved as desired. The preemptive priority factors have the relationship $P_j >>> P_{j+1}$, which implies that multiplication by n, however large it may be cannot make a lower-level goal as important as the higher-level goal.

WEIGHING FACTORS

If there are more than one deviation variables at the same priority level, weights may be assigned to them in order to minimize the 'opportunity cost' or 'regret'. These weights or co-efficient of regrets simply represent the relative amounts of unsatisfactory deviation from the goal. For this, deviation variables on the same priority level must be commensurable.

MODEL FORMULATION

In the formulation of G.P. model, all objectives are converted into goals. This conversion is accomplished by assigning an 'aspiration level' to the right hand side of each objective. One then seeks the solution which minimises the distance or deviation between that solution and the aspired level.

If the objective function is expressed in general terms as $f_i(X)$ ie a function of decission variables

$$X = (x_1, x_2, x_3 \ldots x_n)$$

and b_i = value of the aspiration level associated with objective i, then, three possible forms of goal may result viz.

i. $f_i(X) \geq b_i$

ii. $f_i(X) \leq b_i$

and iii. $f_i(X) = b_i$

Now, regardless of the form, any of these relations can be transformed into the goal format by adding a -ve deviation variable ($d_i^- \geq 0$) and subtracting a +ve deviation variable ($d_i^+ \geq 0$) as shown below

$$f_i(X) + d_i^- - d_i^+ = b_i$$

We then seek to minimise the non-achievement of the goals by minimising specific deviation variables.

The table below summerises the approach taken to accomplish the desire :

TABLE- MODEL FORMULATION

Goal type	Processed goal	Deviation variable to be minimised
$f_i(X) \leq b_i$	$f_1(X)+d_i^- d_i^+ = b_i$	d_i^+
$f_i(X) \geq b_i$	do	d_i^-
$f_i(X) = b_i$	do	$d_i^+ + d_i^-$

Once every objective and constraint has been transformed into the desired (goal) form, we need to develop a relationship that indicates and measures the level of achievement of any solution proposed. Such a relationship is named 'achievement function' which is a vector and in general may be written as

$$\bar{a} = (a_1, a_2, a_3 \ldots a_k \ldots a_K)$$

where,

a = achievement vector

k = Ranking or priority

and $a_K = g_K(d^-, d^+), \quad k = 1,2 \ldots K$

where

$g_k\ (d^- \bar{d}^+)$ = linear function of the deviation variables, associated with goals that are to be minimised at a priority level k.

Normally a_1, the Ist term in $\bar{a}$ is always reserved for the deviation function associated with any rigid constraints or goals.

So, the steps necessary in the formulation of a goal programming model are -

i. Develop the base line model.

ii. Specify aspiration levels for each and every objective.

iii. Include negative and positive deviation variables for each and every goal.

iv. Rank the goals in terms of their importance (priority 1 is always reserved for any rigid constraint)

v. Establish the achievement function.

Once these steps have been accomplished, we have a linear goal programming (LGP) model that takes on the following general form.

$$\text{FIND } X = (x_1, x_2 \ldots\ldots, x_n) \text{ so as to minimise}$$

$$a = \{ g_1 (d^+, d^-), \ldots . g_k (d^+, d^-) \}$$

subject to

$$f_i(X) + d_i^- - d_i^+ = b_i \quad \text{for } i = 1,2,\ldots m.$$

$$X_i \, , \; d_i^-, \; d_i^+ \geq 0$$

For strictly linear models, the form of $f_i(X)$ is given as

$$f_i(X) = \sum_{j=1}^{n} C_{i,j} \, x_i$$

where $C_{i,j}$ is the co-efficient associated with variable j in goal or constraint i.

2.6 Solution of goal-programming model

There are two basic approaches to the solution of the linear goal programming model [16] with an achievement function that has preemptive priority structure. These methods are -

(i) The one which relies upon the solution of a sequence of single objective linear programming models is named as 'sequential linear goal programming or SLGP.

(ii) The 2nd one, which was developed by Lee[14,15] and Ignizio[17] is a modified version of the well-known two-phase simplex method and is known as 'modified simplex method or multiphase simplex method.

The fundamental difference between the approach to a single-objective linear programming and multiobjective linear goal programming is that the conventional approach seeks a point to maximize or minimise a single objective, whereas goal programming seeks a region that provides a compromise to a set of conflicting goals.

SEQUENTIAL LINEAR GOAL PROGRAMMING (SLGP)

This is perhaps the earliest approach to solve a multiobjective linear goal programming problem. The underlying basis for this method is the sequential solution to a series of conventional linear programming models. This is accomplished by partitioning the model according to priority levels, and then solving each part sequentially until all the priority levels have been considered.

One of the appealing facets of SLGP is that one always deals with the more familiar single - objective model and consequently one may use any readily available commercial simplex code to implement the procedure. However, the need for the construction of new constraints at each sequence, makes this method very lengthy.

MULTI - PHASE METHOD

The 2nd method of solution presented by Lee is simply a refinement of the well- known two-phase method and involves a slight modification of the standard simplex algorithm.

After formulation of the model, the following steps are involved in this method.

Step 1 Set up the initial table from the model

Here it is assumed that the initial solution is at the origin, so all the negative deviational variables in the model goals enter the solution base initially. The R.H.S. value of the different goals are stored in a column vector while the co-efficients of different variables are stored in a matrix. The preemptive priority factor and the differential weights to the appropriate variables in the objective function are listed in a separate matrix called objective function input matrix. The simplex criteria $Z_j - C_j$ which is a KXJ matrix (where K = no. of priorities and J = No. of variables) is calculated by finding the net contribution of each variable in obtaining the optimum solution.

Step 2 Determine the new entering variable

This step is identical to the identification of the key column. First, we find the highest priority level that has not been completely attained by examining the elements

of $Z_j - C_j$ matrix. Once the priority level is determined, we proceed to identify the variable column that has the largest +ve $Z_j - C_j$ value. The variable in that column will enter the solution base in the next iteration. If there is a tie between the largest positive values in $Z_j - C_j$ at the highest unattained priority level, check the next lower priority levels and select the column that has a greater value at the next lower priority level. However, even if the tie is broken arbitrarily, it does not matter, as the other column would be choosen in the subsequent iteration.

Step 3 Determine the leaving variable from the solution base

This step is identical to finding the key row. Calculate the value of the R.H.S. devided by the coefficient of the key column. Select the row that has the minimum nonnegative value. The variable in that row will be replaced by the variable with the higher priority factor. However, if a tie is broken arbitrarily the answer will be same, the no. of iterations required might the more however.

Step 4 Determine the new solution

First, find the new R.H.S. and co-efficients of elements of the key row by dividing old values by the pivot element, i.e. the element at the intersection of the key row and the key column. Then, find the new values for all other rows by using the calculation procedure of ordinary simplex method (new value = old value - intersectional element of

that row x new value in the key row in the same column). Now, complete the table by finding new $Z_j - C_j$ values for all the priority rows.

Step 5 Determine whether the solution is optimal

Examine $Z_j - C_j$ co-efficients for all the priority rows. If there are positive $Z_j - C_j$ values in any row, find whether there are negative $Z_j - C_j$ values at a higher priority level in the same column. If yes, the solution is optimal. But, if there exists a positive $Z_j - C_j$ value at a certain priority level and there is no negative $Z_j - C_j$ value at a higher priority level in the same column, the solution is not optimum. Then return to step 2, and continue until optimum solution is reached.

Thus we see that the multiphase method of solution of goal- programming is similar to the well-known two-phase method. However, there is an important difference. In the two-phase simplex method all artificial variables are driven to zero in the first phase and if it is not accomplished i.e. if at the end of phase 1, any artificial variable is in the basis at a positive value, the problem is said to be infeasible and we stop the process. But in goal-programming, the deviational variables at the higher level are minimised to the best possible extent and then one can move to the next priority level, even if all the deviational variables at this priority level have not become zero, which implies that

within the given framework, all the deviational variables at the said priority level cannot be made zero, and the solution at this stage is the best within the given framework of the problem.

In the present work, this 2nd method i.e. the multiphase method is used as the solution technique for the goal programming model of the diet-planning problem.

2.7 Solution of the diet planning problem by Goal programming

The first solution of a diet planning problem using goal- programming approach was by A.M. Anderson and M.D. Earle[18]. In A.E's paper, the diet planning problem is approached as the minimization of the total deviation of the nutrient levels from their pre-specified levels in order to minimise the nutritional imbalance. Thus, the approach deviates from the conventional cost minimization basis of diet selection using linear programming. The methodology is explained using a simple example of two foods and three nutritional requirements and then applying this framework to human diet planning in Thailand, involving 150 foods and 26 nutrients.

Even though, A.E.'s model produces satisfactory results, it has some weak points also. It, in fact, creates the impression that Goal programming is redundant rather than offering any improvement over the conventional linear

programming. This is because of the fact that in A.E.'s paper deviational variables have been introduced to convert the objective of 'minimization of total nutritional imbalance' into goal, whereas this total imbalance of nutrients can be expressed as a straightforward linear function of decision variables. Therefore there is no need to introduce deviational variables in the model to reduce it to a G.P.model (which then can be solved by ordinary L.P.), because the same structure is obtained deducing the deviational variables of A.E's G.P. model (in terms of decision variables) and then substituting their values into the objective function.Hence A.E's model is really an L.P.problem rather than a G.P.one.

However, the attempt to resolve the problem of nutritional imbalance by using G.P. technique is worthwhile. For example, if in A.E's problem, aspiration levels for the total percentage nutritional imbalance and for the cost are set, then the minimization of these two can be introduced as goals into the model, by adding negative and positive deviational variables. We can then minimise the appropriate deviational variables subject to the nutritional constraints by introducing preemptive weights to minimize the non-achievement of the goals.

However, even without setting aspiration levels for the cost or the total nutritional imbalance, the problem can be formulated as a G.P.model. This is accomplished by

1. adding both -ve and +ve deviational variables in the nutritional constraints.
2. treating the objectives of minimising the cost and the total nutritional imbalance as goals with right-hand side set equal to zero and adding both +ve and -ve deviational variables to these.
3 then minimising the proper deviational variables at different priority levels according to their percieved importance.

Advantages of Using goal-programming for diet planning problem

The main advantage of solving the diet planning problem by goal programming is that both the objectives of cost minimisation and nutritional imbalance minimization can be incorporated in the same model and in addition, any extra constraint (or goal) can be incorporated and the different objectives or goals can be assigned different priorities according to their percieved importance. The optimum solution of such a model will thus, result in a more practical diet which, beside taking care of cost and nutrition also considers its practicability and individual's preferences.

2.8 Mathematical model of the present work

The objectives or goals considered in the present work are -

1. Fulfillment of minimum nutritional requirements (for all the twelve nutrients).
2. Avoiding any excess over the specified maximum limits of the two nutrients, viz. calories and fats.
3. Satisfaction of the constraints imposed on some foods to make the diet practically implementable.
4. Satisfaction of the constraints added by the user (i.e. satisfaction of individual's preferences).
5. Minimization of the total cost of the diet.
6. Minimization of the total nutritional imbalance (%) which is defined as the sum of individual percentage imbalance (% excess or shortage) of all the twelve nutrients over their pre-specified values.

Different goals are put under six different priority levels. These are

Priority level 1

This is assigned to the fulfillment of minimum nutritional requirements and for this constraints of greater than equal to type are introduced with R.H.S. equal to the minimum specified level for each nutrient. The negative slacks associated with these nutritional constraints are minimised at this priority level.

Priority level 2

Under this priority level, fulfillment of maximum nutritional requirements for the two nutrients viz. calories and fats have been considered and therefore

positive slack associated with these constraints are minimised to their best possible extent at this priority level.

Priority level 3

It is assigned to some special constraints which are introduced in order to make the resultant diet practically implementable. These include maximum limits on the total cereals consumption, pulses and on each vegitable and fruit. The +ve deviation variables associated with these constraints are minimised to their best possible extent at this priority level.

Priority level 4

This priority level is reserved for any special choice (extra constraints) of the user. All such extra constraints are considered and their appropriate deviation variables are minimised at this priority level. However, weights may be assigned to the deviational variables of different extra constraints according to their importance (in user's view or according to what the user prefers).

Priority level 5

This priority is assigned to the minimization of cost constraint and accordingly +ve slack associated with cost constraint is minimised at this priority level.

Priority level 6

It is given to the minimization of total nutritional imbalance (%), which, in fact, represents excess of nutrients and so +ve slacks associated with the constraint is minimized at this priority level.

The mathematical model for the present work is as follows -

$$\text{Minimize } Z = \{ P_1(d_1^- + d_2^- + \ldots d_m^-) + P_2(d_{m+1}^+ + \ldots d_{m1}^+) + P_3(d_{m1+1}^+ + \ldots d_{m2}^+) + P_4(d_{m2+1}^+ + \ldots d_{m3}^+) + P_5(d_{N-1}^+) + P_6(d_N^+) \}$$

Subject to

$$\sum_{j=1}^{n} a_{ij}x_i + d_i^- - d_i^+ = b_i \qquad i=1,m$$

$$\sum_{j=1}^{n} a_{kj}x_k \; d_k^- - d_k^+ = b_k \qquad k=(m+1),m1$$

$$\sum_{i=n_1}^{n_2} x_{i\ell} + d_\ell^- - d_\ell^+ = b_\ell \qquad \ell=m1+1,\ m2$$

$$\sum_{i=n_3}^{n_4} x_{ip} + d_p^- + d_p^+ = b_p \qquad p = m2+1, m3$$

$$\sum_{i=1}^{n} C_i x_i + d_{N-1}^- - d_{N+1}^+ = 0$$

and $$\sum_{j=1}^{n}\sum_{i=1}^{m} \frac{a_{ij} \times 100}{b_i} + d_N^- - d_N^+ = m \times 100$$

where,

a_{ij} = No. of units of nutrient i (i=1, m1) in one unit of food raw material j.

b_i (i=1, m3) = aspiration levels for different goals.

n = no. of food raw materials considered.

m = no. of nutrients considered.

N = Total No. of constraints or goals.

C_i = cost per unit of foodstaff i.

$n_1 \ldots n_2$ = indexes of foods upon which maximum limit is imposed.

λ (λ = m1+1, m2) = indexes for such constraints which represents maximum limit on some foods.

$n_3 \ldots n_4$ = indexes of foods which are considered under special choice.

P(p= m2+1, m3) = indexes for constraints representing special choices.

$d_1^+ \ldots d_N^+$ = Deviational variables associated with different goals.

$P_1 \ldots P_6$ = Priorities assigned to different deviation variables in the objective function.

The solution of this model, obviously will require the use of computer. So the preparation of the computer model and data used to solve the problem on a DEC-2050 system is discussed in details in the following chapter.

CHAPTER - 3

PREPARATION OF DATABASE AND COMPUTER MODEL

3.1 Preparation of the Data

In the present work, altogether 75 Indian foods have been considered for preparing the diet with, each with specified compositional data on twelve nutrients including protein, calories, fats, fibre, two minerals viz. calcium and iron and six vitamins viz. vitamin A, Thiamine, Riboflavin, Niacin, vitamin C and folic acid. This information on the nutritive values of different foods has been taken from the book 'nutritive value of Indian Foods, by C.Gopalan et al[19], which again is based on the analysis of foods made at national institute of nutrition, Hyderabad and several other such institutions throughout the country. This information is given in Table 1. The data given relate only to the edible portion of the foodstuffs.

To specify aspiration levels for the nutritional constraints, the weighted average requirement for different catagory of persons which have been calculated over the Indian population by the Nutrition Advisory Committee of the Indian council of Medical Research and updated in 1981[20] have been used. This information is given in table 2. Based on this, minimum levels of requirements for all the nutrients and maximum allowable limits for two nutrients viz. calories and

fats have been specified. Altogether ten categories of persons viz. Adult man (moderate working), Adult woman (moderate working), expecting mothers, nursing mothers, Hard-working man, pre-school children, school-going children, adolescents (boys) and adolescents (girls) and persons on diet have been considered. Each of these ten categories of persons is again divided into three groups viz. vegetarian, Non-vegetarian and Egg-eater, so that different diets are formulated for these different groups (Nutritional requirements for these groups are obviously the same).

As all the food materials may not be available throughout the year and again the prices of all the foods are not same throughout the year, so prices of foods have been considered month-wise according to their availability. This information is given in table 3. The prices taken here are roughly based on that prevaling in the year 1988 in Roorkee. In the table N.A. against a particular food in a particular month indicates the non-availability of that food in that particular month. However, while formulating diet for a particular month, the foods not available in that month are not considered. Prices of foodstuffs change with time also. However, as the results (the recommended diets) depend on the relative prices of foodstuffs, so any change in prices of foodstuffs will not affect the recommended diets too much (unless the change is too much uneven). Only the total cost of the diet will change.

3.2 Development of Computer Program

To solve the problem on a computer (DEC-2050 system), the mathematical model of the problem described in the last chapter has been used. Separate programmes have been developed for 'Diet planning' and 'Menu Planning'.

Diet - Planning

All of the above mentioned data, that is, composition of foods, nutritional requirements of different categories of persons and prices of different foods in different months are stored permanently in a data file.

Program has been developed to solve the problem in three phases.

In the first phase, different goals are assigned priorities as given below.

1. First priority is given to the fulfillment of minimum nutritional requirements for the twelve nutrients and hence negative slacks associated with such constraints are minimised to their best possible extent. All the 12 negative slacks are given equal weightages.
2. Next priority is given to the fulfillment of the constraints which put an upper limit on two nutrients viz. calories and fats. So the positive slacks associated with these two constraints are minimised to their best possible extent at this stage.

3. Third priority is given to the fulfillment of the constraints which specify upper limits on some foods viz. total cereal consumption, total pulse consumption, each vegetable and each fruit. These limits have been imposed, after examining the results, at the initial stage of the development of the program, to make the recommended diet practically implementable. To achieve this goal, positive slacks associated with all such constraints are minimised to their best at this stage.

4. The fourth priority level is reserved for any special choice of the user.

5. Fifth priority is given to the minimization of the total cost of the diet and so positive slack associated with the cost constraint is minimised to its best possible extent at this stage. As the Right hand side of the cost constraint (aspiration level) is taken to be zero, which cannot be attained ever, so the result at the end of this stage, positive slack of the cost constraint to be more specific, represents the least possible total cost of the diet, after fulfilling all the constraints at priority levels prior to this, to their best possible extents.

6. The sixth priority is given to the minimization of the total nutritional imbalance (%), which, in fact, represents excess of nutrients over pre-specified minimum requirements and which is calculated by adding the % imbalance of each of the twelve nutrients. Therefore,

the positive slack associated with this nutritional imbalance constraint is minimised at this priority level.

As in this phase, cost minimization is given higher priority than nutritional imbalance iminimization, so, the results at the end of this phase, gives a diet which has minimum cost after satisfying the different 'nutritional requirements' constraints, the special constraints on some particular foods and the constraints added by the user (if any) to their best.

In the 2nd phase, the priorities given to 'cost minimization' and 'nutritional imbalance minimization' are interchanged. The resultant diet, at the end of this phase, will therefore have minimum % nutritional imbalance after satisfying the nutritional requirement constraints, the special constraints on some foods and the constraints added by the user (if any) to their best possible extent. As the 'cost minimization' is given a lower priority in this phase, the cost of the diet will obviously be more than what has been attained in the first phase.

In the third phase, a price celling equal to what has been obtained in the 2nd phase is imposed on the cost constraint and this constraint is again given higher priority than nutrition imbalance minimization constraint. In the subsequent iterations in this phase, the celling on the cost is reduced in steps and the result thus obtained

will give a relationship between cost and nutritional imbalance. The user can then select a diet of his/her own choice depending on how much relative importances he/she gives to cost and nutrition.

To take user's preferences into consideration, the program asks for any extra constraint on foods at the beginning of the first phase, and if there is any, the deviational variables (positive or negative as the case may be) associated with such constraints are also added to the objective function. Thus the results satisfy user's choices also. However, in the presence of any such extra constraint, the total cost of the diet will obviously be more than that when no such constraint is there.

3.3 Execution of the Programs

To execute the program on a DECK-2050 system, after logging in the directory in which the file is stored, the user has to follow the following steps.

A. To Execute the program for Diet Planning

GIVE the execute Command as 'Execute $ Diet. FOR

As soon as this command is given, execution will start and the program will ask for insertion of category of persons, whether vegetarian, non-vegetarian or egg-eater and the month for which result is sought by displaying the message:

INSERT THE VALUES OF ICAT, IPRD, IVEG AS IG, IP, IV'

A menu containing the indexes of all these variables is displayed after the above message and the user has to insert the indexes of the three variables.

After the user feeds this information (by storing it in a file or directly from the console), the program will ask if the user has any special choice by displaying the message.

'ANY SPECIAL CHOICE (TYPE YES OR NO)'

In case the user has any special choice, he has to type 'YES', otherwise 'NO'. If he types 'NO' the program will give recommended diets, first by giving cost the higher priority and nutritional balance a lower and then interchanging these priorities. Further in this case, results are also obtained reducing the cost of the diet in steps.

In case, the user types 'YES', the program will ask to insert the details of these special constraints. These details include the number of such constraints consisting of single food and more than one foods, the indexes of the foods on which the constraints are imposed (in case of constraints consisting of more than one food, the no. of foods in the constraint has also to be specified), minimum or maximum requirements, and the relative weightages given to all such constraints. A complete menu showing when, how and in what sequence all this information is to be fed is displayed

on the screen of the computer. The user can feed all this information either by storing it in a file or directly from the console. The data has to be fed in free format only, so the user would not have any difficulty in feeding this information.

After taking this information, the program will formulate the extra constraints imposed by the user and it will give diets at different cost levels as in the previous case (when there had been no extra constraint), but this time, taking the constraints which the user adds to the original model into consideration. It is to be noted that, the user's choice is given higher priority than cost and nutritional balance but lower than minimum and maximum requirements for individual nutrients and the special constraints which are imposed on some foods to make the diet practically implementable. The user can then select a diet of his/her own choice.

The result, gives weekly inputs. Some typical results and their analysis are given in the following chapter. Alongwith the results, the messages and menu displayed at the time when the program asks for some data from the user, are also printed, so that one can know exactly when and how data are to be fed.

B. Menu -Planning

A separate program has also been developed for planning menus from some specified foodstuffs, taking both cost and nutritional balance and also user's choice into consideration. This program is similar to that for diet planning. Only some minor defferences are there. Here, the prices and the avai - lability of foods are not permenently stored. Instead, the user has to supply this. The other informations to be supplied by the user are category of persons and number of persons in each category (if there are more than one category) for which the menu is being prepared, indexes of foods to be included in the menu, their minimum specified levels and their prices per unit. Beside this, if there is any special constraint on any food or foods, the details of that has to be given. The program then prepares the menu at different cost levels (the range of cost being from what is obtained by giving nutritional balance higher priority to that obtained by giving cost the higher priority). The user can then select one which he/she likes best.

Execution of the Program

For the execution of this program, the same procedure is to be followed as in case of diet planning.

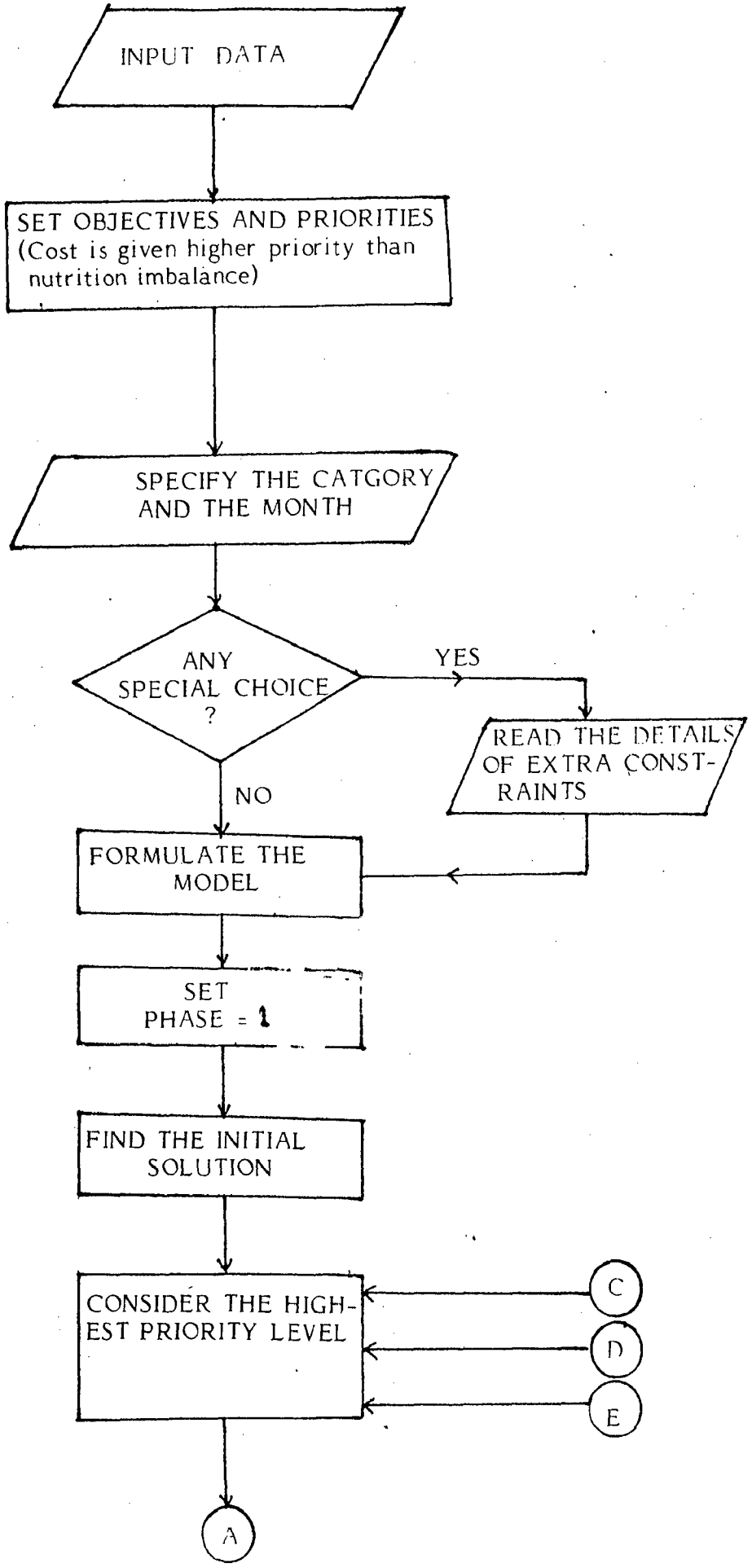
First, the user has to give the execute command as

'Execute $ MENU.FOR

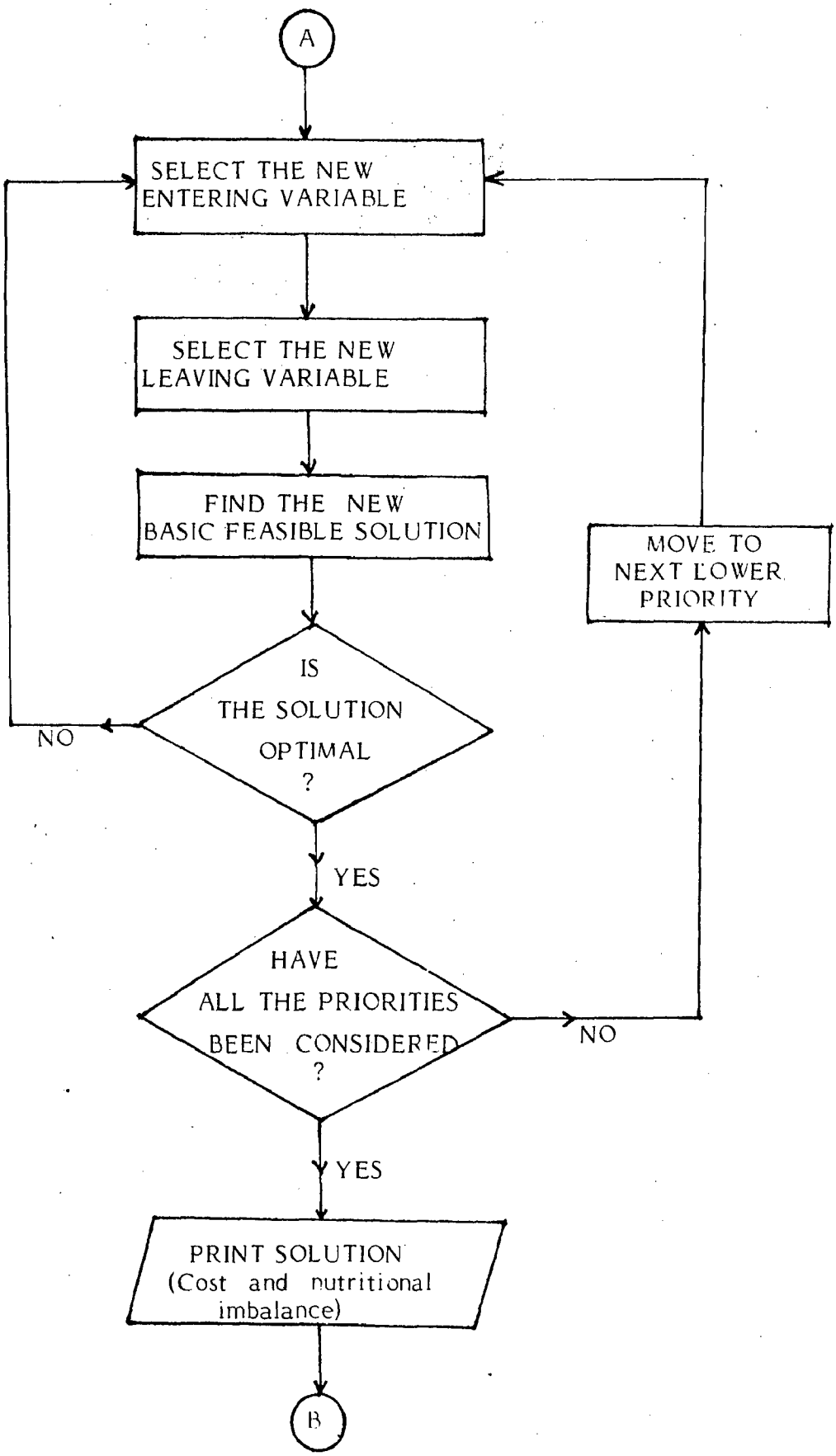
Then, the program will ask for insertion of different data by displaying messages. The details of the data to be

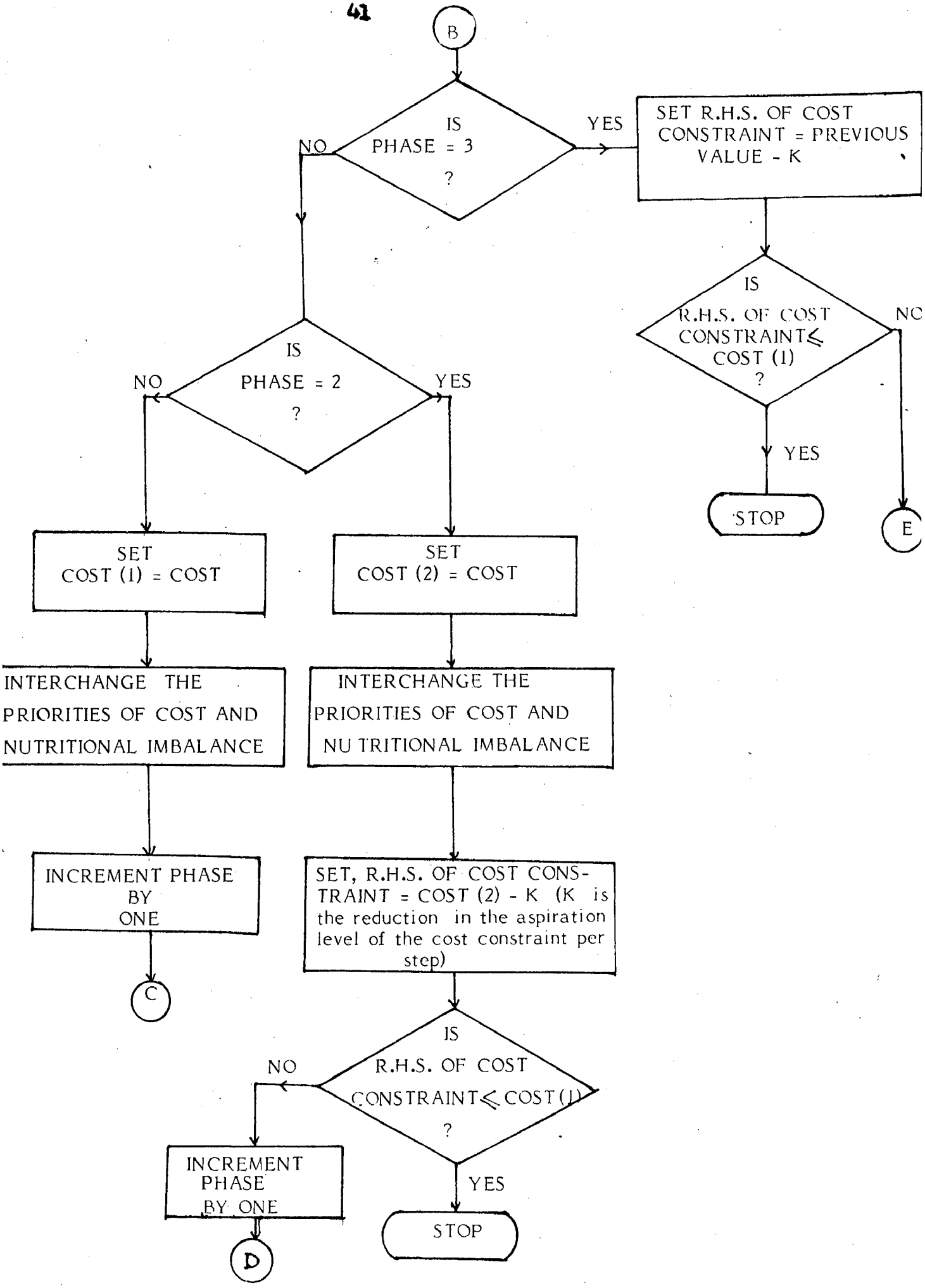
inserted is contained in the messages displayed each time the program asks for data. So the user has no difficulty in inserting these data. After the user supplies the last data, the program will give recomm - ended menus by first giving higher priority to cost, then to nutritional balance and lastly reducing the cost in steps. Thus the user has more than one menu at different cost levels to select from.

Some sample results of menu planning are also given in the following chapter.



FLOW-CHART FOR DIET PLANNING PROBLEM BY GOAL PROGRAMMING


A
SELECT THE NEW ENTERING VARIABLE
SELECT THE NEW LEAVING VARIABLE
FIND THE NEW BASIC FEASIBLE SOLUTION
IS THE SOLUTION OPTIMAL ?
NO
YES
HAVE ALL THE PRIORITIES BEEN CONSIDERED ?
NO
MOVE TO NEXT LOWER PRIORITY
YES
PRINT SOLUTION (Cost and nutritional imbalance)
B


B
IS PHASE = 3 ?
YES
NO
SET R.H.S. OF COST CONSTRAINT = PREVIOUS VALUE - K
IS R.H.S. OF COST CONSTRAINT ≤ COST (1) ?
YES
NO
STOP
E
IS PHASE = 2 ?
NO
YES
SET COST (1) = COST
SET COST (2) = COST
INTERCHANGE THE PRIORITIES OF COST AND NUTRITIONAL IMBALANCE
INTERCHANGE THE PRIORITIES OF COST AND NUTRITIONAL IMBALANCE
INCREMENT PHASE BY ONE
SET, R.H.S. OF COST CONSTRAINT = COST (2) - K (K is the reduction in the aspiration level of the cost constraint per step)
C
IS R.H.S. OF COST CONSTRAINT ≤ COST (1) ?
NO
YES
INCREMENT PHASE BY ONE
STOP
D

- TABLES -

-: TABLE:1 :-

FOOD VALUES OF DIFFERENT FOODSTUFFS(NUTRIENT PER100 GMS. OF FOODSTUFFS)

SL.NO. FOODS	PRTIN (GM)	FATS (GM)	FIBRE (GM)	CALRY KCAL	CALCM (MG)	IRON (MG)	VIT A (MG)	THMIN (MG)	RBFVN (MG)	NIACN (MG)	VIT C (MG)	FOLIC (MG)
1. BAJRA	11.60	5.00	1.20	361.00	42.00	5.00	132.00	0.33	0.25	2.30	0.00	14.70
2. BARLEY	11.50	1.30	3.90	336.00	26.00	3.00	10.00	0.47	0.20	5.40	0.00	0.00
3. JOWAR	10.40	1.90	1.60	349.00	25.00	5.80	47.00	0.37	0.13	3.10	0.00	14.00
4. MAIZE	11.10	3.60	2.70	342.00	10.00	2.00	90.00	0.42	0.10	1.80	0.00	14.00
5. RAGI	7.30	1.30	3.60	328.00	344.00	6.40	42.00	0.42	0.19	1.10	0.00	5.20
6. RICE (ब्राउन)	6.80	0.50	0.20	345.00	10.00	3.10	0.00	0.06	0.06	1.90	0.00	4.10
7. RICE	6.40	0.40	0.20	346.00	9.00	4.00	0.00	0.21	0.05	3.80	0.00	8.90
8. WHEAT(ATA)	12.10	1.70	1.90	341.00	48.00	11.50	29.00	0.49	0.17	4.30	0.00	12.10
9. MAIDA	11.00	0.90	0.30	348.00	23.00	2.50	25.00	0.12	0.07	2.40	0.00	11.00
10. CHANA DAL	20.80	5.60	1.20	372.00	56.00	9.10	129.00	0.48	0.18	2.40	1.00	32.00
11. MUNG DAL	24.50	1.20	0.80	348.00	75.00	8.50	49.00	0.47	0.21	2.40	0.00	24.50
12. URD DAL	24.00	1.40	0.90	347.00	154.00	9.10	38.00	0.42	0.20	2.00	0.00	24.00
13. LOBIA	24.10	1.00	3.80	323.00	77.00	5.90	12.00	0.51	0.20	2.00	0.00	69.00

14. MASUR DAL	25.10	0.70	0.70	343.00	69.00	4.80	270.00	0.45	0.20	2.60	0.00	14.50
15. ARHAR DAL	22.30	1.70	1.50	335.00	73.00	5.80	132.00	0.45	0.19	2.90	0.00	19.00
16. RAJMAH	22.90	1.30	0.00	346.00	260.00	5.80	0.00	0.00	0.00	0.00	0.00	0.00
17. CABBAGE	1.80	0.10	1.00	27.00	39.00	0.80	120.00	0.06	0.09	0.04	124.00	13.30
18. METHI-SAG	4.40	0.90	1.10	49.00	395.00	16.50	2340.00	0.04	0.31	0.80	52.00	0.00
19. SARNSO-SAG	4.00	0.60	0.80	34.00	155.00	16.30	2622.00	0.03	0.00	0.00	33.00	0.00
20. MOOLI-SAG	3.80	0.40	1.00	28.00	265.00	3.60	5295.00	0.18	0.47	0.80	81.00	0.00
21. PALAK	2.00	0.70	0.60	26.00	73.00	10.90	5580.00	0.03	0.26	0.50	28.00	51.00
22. CARROT	0.90	0.20	1.20	48.00	80.00	2.20	1890.00	0.04	0.02	0.60	3.00	5.00
23. ARWI	3.00	0.10	1.00	97.00	40.00	1.70	24.00	0.09	0.03	0.40	0.00	16.00
24. ONION	1.20	0.10	0.60	50.00	46.90	0.70	0.00	0.08	0.01	0.40	11.00	1.50
25. POTATO	1.60	0.10	0.40	97.00	10.00	0.70	24.00	0.10	1.01	1.20	17.00	3.00
26. MOOLI	0.70	0.10	0.80	17.00	35.00	0.40	3.00	0.06	0.02	0.50	15.00	0.00
27. SEM	3.80	0.70	1.80	48.00	210.00	1.70	34.00	0.10	0.06	0.70	9.00	0.00
28. LAUKI	0.20	0.10	0.60	12.00	20.00	0.70	0.00	0.03	0.01	0.20	0.00	0.00
29. KARELA	1.60	0.20	0.80	26.00	20.00	1.80	126.00	0.07	0.09	0.50	88.00	0.00
30. BRINJAL	1.40	0.30	1.30	24.00	18.00	0.90	74.00	0.04	0.11	0.90	12.00	5.00
31. PHUL-GOBEE	2.60	0.40	1.20	30.00	33.00	1.50	30.00	0.04	0.10	1.00	56.00	0.00

32. CUCUMBER	0.40	0.10	0.40	13.00	10.00	1.50	0.00	0.03	0.00	0.20	7.00	12.60
33. BHINDI	1.90	0.20	1.20	35.00	66.00	1.50	52.00	0.07	0.10	0.60	13.00	25.30
34. PARWAL	2.00	0.30	3.00	20.00	30.00	1.70	153.00	0.05	0.06	0.50	29.00	0.00
35. HARE-MATAR	7.20	0.10	4.00	93.00	20.00	1.50	83.00	0.25	0.01	0.80	9.00	0.00
36. KACHA-KELA	0.50	0.10	0.80	42.00	10.00	1.10	0.00	0.02	0.01	0.20	7.00	1.60
37. KADDU	1.40	0.10	0.70	25.00	10.00	0.70	50.00	0.06	0.04	0.50	2.00	3.00
38. TORI	0.50	0.10	0.50	17.00	18.00	0.50	33.00	0.00	0.01	0.20	5.00	0.00
39. AMLA	0.50	0.10	3.40	58.00	50.00	1.20	9.00	0.03	0.01	0.20	600.00	0.00
40. APPLE	0.20	0.50	1.00	59.00	10.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00
41. BANANA	1.20	0.30	0.40	116.00	17.00	0.90	78.00	0.05	0.08	0.50	7.00	0.00
42. GUAVA	0.90	0.30	5.20	51.00	10.00	1.40	0.00	0.03	0.03	0.40	212.00	0.00
43. JACK-FRUIT	1.90	0.10	1.10	88.00	20.00	0.50	175.00	0.03	0.13	0.40	7.00	0.00
44. GRAPES	0.50	0.30	2.90	71.00	20.00	0.50	0.00	0.00	0.00	0.00	0.00	1.00
45. JAMUN	0.70	0.30	0.90	62.00	15.00	1.20	48.00	0.03	0.01	0.20	18.00	0.00
46. NIMBU	1.00	0.90	1.70	57.00	70.00	2.30	0.00	0.02	0.01	0.10	39.00	0.00
47. MANGO	0.60	0.40	0.70	74.00	14.00	1.30	2743.00	0.08	0.04	0.90	16.00	0.00
48. LICHI	1.10	0.20	0.50	61.00	10.00	0.70	0.00	0.02	0.06	0.40	31.00	0.00
49. MELON	0.30	0.20	0.40	17.00	32.00	1.40	169.00	0.11	0.08	0.30	26.00	0.00

50. MELON	0.40	0.40	N.A	N.A	N.A	0.40	0.40	N.A	N.A	N.A	N.A	N.A
51. ORANGE	1.00	1.00	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	1.00	1.00
52. PAPAYA	0.50	0.50	0.50	N.A	N.A	0.50	N.A	N.A	N.A	N.A	N.A	0.50
53. PINEAPPLE	N.A	N.A	0.50	0.50	N.A	N.A	0.50	0.50	N.A	N.A	N.A	N.A
54. PLUM	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
55. SAPOTA	N.A	N.A	0.40	0.40	N.A	N.A	N.A	0.40	0.40	N.A	N.A	N.A
56. SEETAPHAL	N.A	N.A	0.40	0.40	N.A	N.A	N.A	N.A	0.40	0.40	0.40	N.A
57. TOMAIC	0.50	0.40	0.50	0.50	0.40	0.40	0.80	0.80	0.80	0.80	0.80	0.40
58. MILK	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
59. CURD	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
60. LASSI	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
61. CHEESE	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
62. MILK-POWDR	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
63. GHEE	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
64. BUTTER	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50
65. VANASPATI	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
66. COOKINGOIL	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
67. SUGAR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75

68. JAGGERY	0.40	0.10	0.00	348.00	1638.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
69. HONEY	0.30	0.00	0.00	319.00	5.00	0.90	0.00	0.00	0.04	0.20	4.00	0.00
70. BREAD	7.80	0.70	0.20	245.00	11.00	1.10	0.00	0.07	0.00	0.70	0.00	0.00
71. EGG	13.30	13.30	0.00	173.00	60.00	2.10	2040.00	0.10	0.40	0.10	0.00	70.30
72. MUTTON	21.40	3.60	0.00	118.00	12.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73. MUTTON	18.50	13.30	0.00	194.00	150.00	2.50	0.00	0.18	0.14	6.80	0.00	0.00
74. CHICKEN	25.90	0.60	0.00	109.00	25.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00
75. FISH	16.60	1.40	0.00	97.00	650.00	1.00	0.00	0.05	0.07	0.70	22.00	0.00

NOTE:- (1):-THESE DATA ARE TAKEN FROM THE BOOK 'NUTRIIVE VALUES OF INDIAN FOODS' BY C.GOPALAN ET AL

(2):-THESE DATA RELATE ONLY TO THE EDIBLE PORTION OF THE FOODSTUFFS

-: TABLE:2 :-

NUTRITIONAL REQUIREMENTS OF DIFFERENT CATAGORIES OF PERSONS(PER DAY)

SL.NO.	CATAGORY	PRTIN (GM)	FATS (GM)	FIBRE (GM)	CALRY KCAL	CALCM (MG)	IRON (MG)	VIT A (MG)	THMIN (MG)	RBFVN (MG)	NIACN (MG)	VIT C (MG)	FOLIC (MG)
1.	ADULT-MAN	55.00	46.00	6.00	2400.00	400.00	24.00	3000.00	1.40	1.70	19.00	40.00	100.00
2.	ADULT-WOMAN	45.00	36.00	5.00	1900.00	400.00	32.00	3000.00	1.10	1.30	15.00	40.00	100.00
3.	EXPECING-MOTHERS	59.00	43.00	6.00	2200.00	1000.00	40.00	3000.00	1.30	1.50	17.00	40.00	200.00
4.	NURSHING-MOTHERS	70.00	45.00	6.00	2600.00	1000.00	32.00	4600.00	1.40	1.60	18.00	80.00	150.00
5.	MAN (HEAVY WORKING)	55.00	62.00	6.00	3700.00	450.00	24.00	3000.00	2.00	2.20	24.00	40.00	100.00
6.	PRE-SCHOOL CHILDREN	26.00	32.00	0.00	1400.00	400.00	25.00	1100.00	0.75	0.85	10.00	40.00	100.00
7.	SCHOOL-CHILDREN	39.00	48.00	2.00	2050.00	400.00	25.00	2000.00	1.10	1.30	15.00	40.00	100.00
8.	ADOLSCENTS(BOYS)	52.00	60.00	5.00	2660.00	450.00	25.00	3000.00	1.30	1.70	19.00	40.00	100.00
9.	ADOLSCENTS(GIRLS)	44.00	51.00	4.00	2200.00	450.00	35.00	3000.00	1.20	1.40	15.00	40.00	100.00
10.	PERSONS ON DIET	80.00	25.00	6.00	1500.00	400.00	24.00	3000.00	1.40	1.70	19.00	40.00	100.00

NOTE:THESE DATA ARE TAKEN FROM THE BOOK 'RECOMMENDED DIETARY INTAKES FOR INDIANS' PUBLISHED BY ICMR,NEW DELHI

-: TABLE:3 :-

PRICES OF DIFFERENT FOODS IN DIFFERENT MONTHS(PER 100 GMS.)

SL.NO.	FOODS	JAN (RS.)	FEB (RS.)	MAR (RS.)	APR (RS.)	MAY (RS.)	JUN (RS.)	JUL (RS.)	AUG (RS.)	SEP (RS.)	OCT (RS.)	NOV (RS.)	DEC (RS.)
1.	BAJRA	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
2.	BARLEY	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
3.	JOWAR	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
4.	MAIZE	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
5.	RAGI	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
6.	RICE	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
7.	RICE (Parb)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
8.	WHEAT(ATA)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
9.	MAIDA	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
10.	CHANA DAL	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
11.	MUNG DAL	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
12.	URD DAL	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
13.	LOBIA	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

14. MASUR DAL	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
15. ARHAR DAL	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
16. RAJMAH	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
17. CABBAGE	0.20	0.10	0.15	0.15	N.A	N.A	N.A	N.A	N.A	0.50	0.30	0.30
18. METHI-SAG	0.15	0.10	0.10	N.A	N.A	N.A	N.A	N.A	N.A	N.A	0.20	0.15
19. SARNSO-SAG	0.15	0.10	0.10	N.A	N.A	N.A	N.A	N.A	N.A	N.A	0.20	0.15
20. MOOLI-SAG	0.10	0.10	0.10	0.10	N.A	N.A	N.A	N.A	N.A	0.15	0.10	0.10
21. PALAK	0.10	0.10	0.10	0.15	0.15	0.15	0.20	0.20	0.20	0.20	0.10	0.10
22. CARROT	0.15	0.15	0.15	N.A	N.A	N.A	N.A	N.A	N.A	0.15	0.15	0.15
23. ARWI	N.A	N.A	N.A	N.A	N.A	0.15	0.20	0.30	0.30	N.A	N.A	N.A
24. ONION	0.25	0.30	0.35	0.30	0.20	0.20	0.25	0.25	0.25	0.30	0.30	0.35
25. POTATO	0.15	0.15	0.15	0.15	0.30	0.30	0.30	0.30	0.30	0.30	0.15	0.15
26. MOOLI	0.15	0.15	0.15	0.15	N.A	N.A	N.A	N.A	N.A	0.20	0.15	0.15
27. SEM	0.25	0.20	0.25	0.25	N.A	N.A	N.A	N.A	N.A	N.A	N.A	0.25
28. LAUKI	0.20	0.20	0.25	0.25	0.20	0.20	0.20	0.20	0.30	0.30	0.20	0.20
29. KARELA	N.A	N.A	N.A	N.A	0.15	0.15	0.25	0.25	0.30	N.A	N.A	N.A
30. BRINJAL	N.A	N.A	N.A	0.20	0.20	0.15	0.20	0.30	0.30	0.30	0.30	0.30
31. PHUL-GOBEE	0.20	0.15	0.15	0.30	N.A	N.A	N.A	N.A	N.A	1.00	0.30	0.20

32. CUCUMBER	N.A	N.A	N.A	0.30	0.30	0.20	0.20	0.20	0.20	N.A	N.A	N.A
33. BHINDI	N.A	N.A	N.A	0.50	0.50	0.20	0.20	0.30	0.50	N.A	N.A	N.A
34. PARWAL	N.A	N.A	N.A	N.A	N.A	0.50	0.50	0.50	0.60	N.A	N.A	N.A
35. HARE-MATAR	0.50	0.40	0.30	0.40	N.A	N.A	N.A	N.A	N.A	0.30	0.50	0.40
36. KACHA-KELA	N.A	N.A	N.A	N.A	N.A	N.A	N.A	0.40	0.40	0.30	0.40	N.A
37. KADDU	0.20	0.20	0.30	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.20	0.20
38. TORI	N.A	N.A	N.A	N.A	N.A	N.A	0.30	0.30	0.30	N.A	N.A	N.A
39. AMLA	0.30	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	0.30	0.30	0.30
40. APPLE	1.50	N.A	N.A	N.A	N.A	N.A	N.A	N.A	0.80	0.80	0.80	1.00
41. BANANA	0.30	0.30	0.30	0.30	0.35	0.35	0.35	0.30	0.30	0.30	0.30	0.30
42. GUAVA	N.A	N.A	N.A	N.A	N.A	N.A	N.A	0.25	0.25	0.30	0.30	N.A
43. JACK-FRUIT	N.A	N.A	N.A	0.40	0.40	0.40	0.40	N.A	N.A	N.A	N.A	N.A
44. GRAPES	N.A	N.A	N.A	1.50	1.50	1.50	N.A	N.A	N.A	N.A	N.A	N.A
45. JAMUN	N.A	N.A	N.A	N.A	N.A	0.30	0.30	N.A	N.A	N.A	N.A	N.A
46. NIMBU	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
47. MANGO	N.A	N.A	N.A	N.A	0.80	0.60	0.60	0.70	N.A	N.A	N.A	N.A
48. LICHI	N.A	N.A	N.A	N.A	N.A	0.30	0.30	N.A	N.A	N.A	N.A	N.A
49. MELON	0.40	0.40	N.A	N.A	N.A	0.40	0.40	N.A	N.A	N.A	N.A	N.A

50. MELON	0.20	0.20	0.20	16.00	11.00	7.90	0.00	0.02	0.04	0.10	1.00	0.00
51. ORANGE	0.70	0.20	0.30	48.00	26.00	0.32	1104.00	0.00	0.00	0.00	30.00	0.00
52. PAPAYA	0.60	0.10	0.80	32.00	17.00	0.50	666.00	0.04	0.25	0.25	57.00	0.00
53. PINEAPPLE	0.40	0.10	0.50	46.00	20.00	1.20	18.00	0.20	0.12	0.12	39.00	0.00
54. PLUM	0.70	0.50	0.40	52.00	10.00	0.60	166.00	0.04	0.10	0.10	5.00	0.00
55. SAPOTA	0.70	1.10	2.60	98.00	28.00	2.00	97.00	0.02	0.03	0.03	6.00	0.00
56. SEETAPHAL	1.60	0.40	3.10	104.00	17.00	1.50	0.00	0.07	0.17	0.17	37.00	0.00
57. TOMATO	0.90	0.20	0.80	20.00	48.00	0.40	351.00	0.12	0.06	0.06	27.00	14.00
58. MILK	3.20	4.10	0.00	67.00	120.00	0.20	215.00	0.05	0.19	0.10	2.00	5.60
59. CURD	3.10	4.00	0.00	60.00	149.00	0.20	122.50	0.05	0.16	0.10	1.00	3.30
60. LASSI	0.80	1.10	0.00	15.00	30.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00
61. CHEESE	24.10	25.10	0.00	348.00	790.00	2.10	328.00	0.00	0.00	0.00	0.00	0.00
62. MILK-POWDR	38.00	0.10	0.00	357.00	1370.00	1.40	0.00	0.45	1.64	1.00	5.00	0.00
63. GHEE	0.00	100.00	0.00	900.00	0.00	0.00	2400.00	0.00	0.00	0.00	0.00	0.00
64. BUTTER	0.00	81.00	0.00	729.00	0.00	0.00	3800.00	0.00	0.00	0.00	0.00	0.00
65. VANASPATI	0.00	100.00	0.00	900.00	0.00	0.00	3000.00	0.00	0.00	0.00	0.00	0.00
66. COOKINGOIL	0.00	100.00	0.00	900.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67. SUGAR	0.10	0.00	0.00	398.00	12.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

68. JAGGERY	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
69. HONEY	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
70. BREAD	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
71. EGG	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
72. GOAT'S MEAT	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
73. MUTTON	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
74. CHICKEN	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
75. FISH	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00

NOTE:THESE PRICES ARE BASED ON THOSE PREVAILING IN ROORKEE IN THE YEAR 1988

CHAPTER - 4

RESULTS AND THEIR INTERPRETATIONS

4.1 Results of Diet Planning

Some typical results are given on the following pages. Let us analyse them by taking one of these results given on page 61.

This particular set of results is for adult vegetarian man for the month of December. First, we will consider the case when the user has no special choice about foods. In the first phase, cost minimization is given higher priority. As can be seen from table A, the recommended diet contains a very few items. These food items are mainly cereals, vegetables and a small amount of jaggery and edible oils. Similar results are obtained in most of the cases (see other results). This is because of the fact that cereals and vegetables contain almost all the nutrients in whatever small amount it may be. Now, as the satisfaction of minimum nutritional requirements is given highest priority and cost is given higher priority than nutritional balance, therefore, to satisfy these goals, the diet formulated at this stage consists of considerable amounts of cereals and vegetables which are less costly and the costly foods like milk fruits, pulses etc. are not included in the diet. In this process, the amount of some of the nutrients e.g. colories, fibre and vitamin A which are abundant in these

foods, however, exceeds their pre-specified values consi - derably. Hence this phase results in a diet which has mini - mum cost (Rs. 21.72 for this case), within the given frame- work, but has a considerable total nutritional imbalance (1218.72 %. for this case). The point to be noted here is that, as the minimum nutritional requirements are fulfilled at the highest priority level, so the nutritional imbalance here signifies the total percentage excess of the nutrients over their pre-specified values ie it is the sum of indivi- dual %. excess of all the nutrients.

Although such a diet is not impossible to implement, yet in most cases, users may not find it an ideal diet, as it consists of only some selected foods. However, such a diet will result in a considerable overdose of some nutrients, which may be equally harmful to health as undernutrition. Such diets are mainly meant for low-income group of people.

In the 2nd phase, the priorities given to cost and nutritional balance in the 1st phase are interchanged, that is, this time nutritional balance is given higher priority than cost. As can be seen from Table B, the resultant diet consists of a larger variety of foodstuffs than in the 1st phase. The nutritional imbalance is also seen to have decrea- sed considerably (from 1218.72 %. to 187.94 %. - a decrease of more than 1000 %.). In various cases, the decrease in total nutritional imbalance, due to this change of priorities, is found to vary from 400 %. to 1000 %. nearly. Much of this improvement

is due to a reduction in the levels of fibre, calories and vitamin A. However, the cost of the diet increases in this process (from 21.70 to 40.71 - an increase of about 87 %.). In various cases, the increase in price is found to vary from 40 to 100 %. . But as the diet at this stage consists of a large variety of foodstuffs, most users will find it preferable to the previous one. As the nutritional balance is given higher priority than cost, so this phase results in a diet which has minimum total nutritional imbalance (percentage) within the given framework (that is, which satisfies all other higher priority goals to their best possible extent).

It is seen however, that even this time, more costly foods like some costly fruits, milk etc. are not included in the diet. This happens in most of the cases, except where the nutritional requirements are extraordinary (as in case of expecting mothers). This is because of the presence of the cost constraint, although it is at the lowest priority level. However, if one wants to include these foods in the diet, one has to either give them as extra constraints, in which case, the minimum requirements of such foods has to be specified, or the celling on the cost constraint has to be increased.

In the third phase, the cost is again given higher priority than nutritional balance. But this time, instead

of keeping the R.H.S. of the cost constraint equal to zero, an aspiration level equal to the cost that has been obtained in the 2nd phase is imposed on it. This aspiration level is then decreased in steps and modified diets are formed at different cost levels, the range of cost being from that obtained in the 2nd phase to the one obtained in the Ist phase. Here, the aspiration level is decreased by five rupees in each step. It is observed (table c) that as the cost of the diet decreases, the nutritional imbalance is increased. This increase in total nutritional imbalance is found to be gradual in the first few iterations. Towards the end, however, the increase is very sharp. Thus one has a relationship between cost and nutritional imbalance. Such a relationship could lead to a decision on the most acceptable combination of the two factors, and the user has a large no. of choices to select the diet from. In the present case, the most acceptable diet could be the one which is obtained in iteration number 2 (or 3) as it keeps both the cost and the nutritional imbalance at a reasonably low level.

Now let us analyse the results when the user has some special choice. As has been mentioned earlier, all such constraints (as has been imposed by the user) are considered at priority level 4. In the present example,

altogether three extra constraints - two consisting of single food (Rice and milk) and one consisting of the five pulses are added by the user. The minimum requirements have been specified as 700 gm, 1400 gm and 280 gm per week for Rice, Milk and the pulses.

Here, the result at the Ist phase (table D) shows that a similar combination of foods except those which are included because of the extra constraints. The foods for which minimum limit has been specified in extra constraints are at their minimum specified level. The cost of the diet (Rs. 31.71) is obviously more than what has been obtained when there was no extra constraint. However, the nutritional imbalance (538.22 %) decreases considerably. This may not be true for all cases, because whether nutritional imbalance will increase or decrease because of the extra constraints, depends upon the foods which are included in the extra constraints.

The 2nd phase results (Table E) are also similar to those when no extra constraint was there except for the inclusion of the foods specified in the extra constraints. However, in this case, the nutritional imbalance is more than that in the previous case (when no extra constraint was there) and the cost is less. This again varies depending upon the foods included in the extra constraints.

Similar results are obtained in the third phase also (table F). The most acceptable diet, in this case, seems to be that obtained at iteration number 1 of this phase in which both cost and nutritional balance are at a reasonably low level.

Now, let us examine how far the goals at different priority levels are satisfied.

It is seen that in all cases, the highest level priority goals, that is, the goal of fulfilling the minimum nutritional requirements for various nutrients, is fully satisfied. This is because of the fact that there is always at least some combination of foods which satisfies all the minimum nutritional requirements. At low cost, however, such diet is seen to be consisting of a very few foods mostly cereals and vegetables. At the initial stages of development of the program, when no special constraints were imposed on total cereal consumption, total pulse consumption and on each vegetable, the diet at low cost was found to be consisting of unreasonably large amounts of cereals and vegetables. So to make the diet practically implementable, these constraints were introduced as special constraints.

The 2nd priority goals which impose maximum limits on the two nutrients viz calories and fats are also found to be satisfied in all cases. That is, in no case, the

amount of these two nutrient exceeds the maximum allowable specified limit. The negative slacks vary however, with cost.

All the third priority level goals, which impose special constraints on some foods to make the diet practical, are also found to be satisfied in all cases. At low cost, however, less costly foods like cereals and green leafy vegetables are found to be equal to their maximum specified limits and it is very obvious.

The goals at the fourth priority level, under which user's choices are considered, are also found to be satisfied fully in almost all the cases. The fifth and sixth priority level goals are cost and nutritional imbalance minimization in the first and second phase interchangeably. The level of satisfaction of these two goals are found to vary with the priorities given to them, that is, the goal given higher priority being satisfied to a greater extent than the other. Thus any of these two goals can be said to be attainable at the expense of the other.

From the results, it may be concluded that the idea that a diet fulfilling the minimum nutritional requirements must always be costly, is totally wrong. Nutritional requirements can well be fulfilled with less costly diet by proper planning. Even when the nutritional balance is given higher priority, the diet is not too costly and a good number of items are there to prepare the food with.

Thus the application of a multiobjective programming technique to diet planning is found to be fruitful as it gives a diet which fulfills more than one objective viz. minimum cost, optimum nutritional balance, user's preferences etc.

4.2 Results of Menu Planning

Some results of menu planning are also shown on the following pages.

These results show that some costly foods are always at their minimum specified levels in the recommended menu. This is because that beside being costly such foods do not have good nutrious values also.

Here also the priorities are assigned to different goals in the same order as in the case of diet planning and the levels of satisfaction of different goals are also found to be same.

It should be noted here that the total cost of the diet refers to the cost of raw foodstuffs only and is does not include cooking expenses, cost of tea, coffee or snacks and sweets (if any) etc.

RESULTS OF DIET PLANNING

INSERT THE VALUE OF ICAT,IPRD & IVEG AS IC,IP,IV

ICAT=1 FOR ADULT-MAN,2 FOR ADULT-WOMAN,3 FOR EXPECTING MOTHERS
4 FOR NURSING MOTHERS,5 FOR MAN(HEAVY WORKING),6 FOPRE-SCHCOL CHILDREN
7. FOR SCHOOL GOING CHILDREN,8 FOR ADOLSCES(BOYS),9 FOR ADOLSCENTS(GIRLS)
,& 10 FOR PERSONS ON DIET

IPRD SIGNIFIES THE MONTTH NUMBER

IVEG=1 FOR VEG,2 FOR EGG-EATERS & 3 FOR NON-VEG

1, 12, 1,

ANY SPECIAL CHOICE ? (PRINT YES OR NO)

NO

THE FINAL RESULTS

TABLE-A

PHASE-1 :WHEN COST IS GIVEN HIGHER PRIORITY:-

CATAGORY:-ADULT-MAN :VEGETARIAN MONTH:-DECEMBER

SLACK ANALYSIS

ROW	NUTRIENT	MIN.REQD	+SLK	-SLK	%DEVIATION
1.	PROTINS	385.00	91.80	0.00	23.84 %
2.	FATS	322.00	0.00	0.00	0.00 %
3.	FIBRES	42.00	36.72	0.00	87.43 %
4.	CALORIES	16800.00	0.00	0.00	0.00 %
5.	CALCIUM	2800.00	8800.64	0.00	314.31 %
6.	IRON	168.00	339.87	0.00	202.30 %
7.	VITAMIN A	21000.00	62566.22	0.00	297.93 %
8.	THIAMIN	9.80	9.09	0.00	92.76 %
9.	RIBOFLVN	11.90	6.53	0.00	54.88 %
10.	NIACIN	133.00	34.65	0.00	26.05 %
11.	VITAMIN C	280.00	290.72	0.00	103.83 %
12.	FOLATES	700.00	101.56	0.00	14.51 %

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	VANASPATI	2.50	1.71
2	JAGGERY	0.60	4.56
3	WHEAT(ATA)	0.35	35.00
4	POTATO	0.15	7.00
5	MOULI-SAG	0.10	7.00
6	PALAK	0.10	7.00

TOTAL WEEKLY COST OF THE DIET = RS. 21.72

% NUTRITIONAL IMBALANCE(TOTAL) = 1218.72 %

TABLE-B

PHASE-2 :WHEN NUTRITION IS GIVEN HIGHER PRIORITY:-

CATAGORY:-ADULT-MAN :VEGETARIAN MONTH:-DECEMBER

SLACK ANALYSIS

ROW	NUTRIENT	MIN.REQD	+SLK	-SLK	%DEVIATION
1.	PROTINS	385.00	152.93	0.00	39.72 %
2.	FATS	322.00	0.00	0.00	0.00 %
3.	FIBRES	42.00	12.54	0.00	29.86 %
4.	CALORIES	16800.00	2133.33	0.00	12.70 %
5.	CALCIUM	2800.00	0.00	0.00	0.00 %
6.	IRON	168.00	139.90	0.00	83.27 %
7.	VITAMIN A	21000.00	0.00	0.00	0.00 %
8.	THIAMIN	9.80	2.22	0.00	22.61 %
9.	RIBOFLVN	11.90	0.00	0.00	0.00 %
10.	NIACIN	133.00	0.00	0.00	0.00 %
11.	VITAMIN C	280.00	0.00	0.00	0.00 %
12.	FOLATES	700.00	0.00	0.00	0.00 %

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	ARHAR DAL	1.20	5.96
2	COOKINGOIL	2.50	2.55
3	JAGGERY	0.60	0.59
4	RICE	0.55	25.74
5	WHEAT(ATA)	0.35	9.25
6	POTATO	0.15	4.96
7	BRINJAL	0.30	7.00
8	CHANA DAL	1.20	4.00
9	TOMATO	0.40	0.16
10	KADDU	0.20	7.00
11	PALAK	0.10	3.32

TOTAL WEEKLY COST OF THE DIET = RS. 40.71

% NUTRITIONAL IMBALANCE(TOTAL) = 187.94 %

TABLE-C

PHASE-3 :EFFECT OF COST DECREAMENT ON NUTRITION:-

ITERATION NUMBER:- 1

CATAGORY:-ADULT-MAN :VEGETARIAN MONTH:-DECEMBER

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	COOKINGOIL	2.50	2.46
2	JAGGERY	0.60	0.64
3	RICE	0.55	21.49
4	PALAK	0.10	3.40
5	WHEAT(ATA)	0.35	13.50
6	POTATO	0.15	5.16
7	ARHAR DAL	1.20	1.87
8	BRINJAL	0.30	7.00
9	PHUL-GOBEE	0.20	0.30
10	CHANA DAL	1.20	5.92

TOTAL WEEKLY COST OF THE DIET = RS. 35.69

% NUTRITIONAL IMBALANCE(TOTAL) = 190.72 %

ITERATION NUMBER:- 2

CATAGORY:-ADULT-MAN :VEGETARIAN MONTH:-DECEMBER

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	COOKINGOIL	2.50	2.48
2	JAGGERY	0.60	0.59
3	RICE	0.55	15.35
4	PALAK	0.10	3.31
5	WHEAT(ATA)	0.35	19.08
6	POTATO	0.15	5.64
7	CHANA DAL	1.20	5.49
8	TOMATO	0.40	3.19

TOTAL WEEKLY COST OF THE DIET = RS. 30.71

% NUTRITIONAL IMBALANCE(TOTAL) = 203.77 %

ITERATION NUMBER:- 3

CATAGORY:-ADULT-MAN :VEGETARIAN MONTH:-DECEMBER

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	COUKINGOIL	2.50	2.45
2	SUGAR	0.75	3.76
3	JAGGERY	0.60	0.43
4	RICE	0.55	11.32
5	PALAK	0.10	6.77
6	WHEAT(ATA)	0.35	23.68
7	POTATO	0.15	5.23
8	AMLA	0.30	0.07
9	CABBAGE	0.30	0.47

TOTAL WEEKLY COST OF THE DIET = RS. 25.35

% NUTRITIONAL IMBALANCE(TOTAL) = 274.57 %

ITERATION NUMBER:- 4

CATAGORY:-ADULT-MAN :VEGETARIAN MONTH:-DECEMBER

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	VANASPATI	2.50	1.71
2	JAGGERY	0.60	4.56
3	PALAK	0.10	7.00
4	WHEAT(ATA)	0.35	35.00
5	POTATO	0.15	7.00
6	MOOLI-SAG	0.10	7.00

TOTAL WEEKLY COST OF THE DIET = RS. 21.72

% NUTRITIONAL IMBALANCE(TOTAL) = 1218.72 %

```
INSERT THE VALUE OF ICAT,IPRD & IVEG AS IC,IP,IV

ICAT=1 FOR ADULT-MAN,2 FOR ADULT-WOMAN,3 FOR EXPECTING MOTHERS
4 FOR NURSING MOTHERS,5 FOR MAN(HEAVY WORKING),6 FOPRE-SCHOOL CHILDREN
7 FOR SCHOOL GOING CHILDREN,8 FOR ADOLSCES(BOYS),9 FOR ADOLSCENTS(GIRLS)
,& 10 FOR PERSONS ON DIET

IPRD SIGNIFIES THE MONTTH NUMBER

IVEG=1 FOR VEG,2 FOR EGG-EATERS & 3 FOR NON-VEG

1, 12, 1,

ANY SPECIAL CHOICE ? (PRINT YES OR NO )

YES

NO. OF FOODS AVAILABLE= 36

SELECT FROM THE FOLLOWINGS----

  6      RICE
  8      WHEAT(ATA)
 10      CHANA DAL
 11      MUNG DAL
 12      URD DAL
 14      MASUR DAL
 15      ARHAR DAL
 17      CABBAGE
 18      METHI-SAG
 19      SARNSO-SAG
 20      MOOLI-SAG
 21      PALAK
 22      CARROT
 24      ONION
 25      POTATO
 27      SEM
 28      LAUKI
 30      BRINJAL
 31      PHUL-GOBEE
 35      HARE-MATAR
 37      KADDU
 39      AMLA
 40      APPLE
 41      BANANA
 46      NIMBU
 51      ORANGE
 52      PAPAYA
 57      TOMATO
 58      MILK
 59      CURD
 63      GHEE
 65      VANASPATI
 66      COOKINGOIL
 67      SUGAR
 68      JAGGERY
 70      BREAD

ENTER THE NO. OF CONSTRAINTS(CONSISTING ONE FOOD)

2,

ENTER THE INDEXES OF FOODS CHOOSEN

6, 58,

ENTER  NO. OF CONSTRANTS CONS. MORE THAN ONE FOOD

1,

ENTER THE NO. OF FOODS & THEIR INDEXES

5,
10, 11, 12, 14, 15,    ----

ENTER THE MIN OR MAX REQUIREMENTS

  7.000000    ,   14.00000    ,   2.800000    ,

ENTER  SIGNS OF EXTRA CONSTRAINTS(G OR B)

G IF MIN & B IF MAX

GGG

ENTER THE WEIGHTAGES

  1 , 1 , 1
```

THE FINAL RESULTS

TABLE-D

PHASE-1 :WHEN COST IS GIVEN HIGHER PRIORITY:-

CATAGORY:-ADULT-MAN :VEGETARIAN MONTH:-DECEMBER

SLACK ANALYSIS

ROW	NUTRIENT	MIN.REQD	+SLK	-SLK	%DEVIATION
1.	PROTINS	385.00	136.27	0.00	35.39
2.	FATS	322.00	0.00	0.00	0.00
3.	FIBRES	42.00	20.73	0.00	49.35
4.	CALORIES	16800.00	0.00	0.00	0.00
5.	CALCIUM	2800.00	2858.32	0.00	102.08
6.	IRON	168.00	248.82	0.00	148.11
7.	VITAMIN A	21000.00	15176.49	0.00	72.27
8.	THIAMIN	9.80	7.14	0.00	72.88
9.	RIBOFLVN	11.90	5.09	0.00	42.80
10.	NIACIN	133.00	18.79	0.00	14.13
11.	VITAMIN C	280.00	0.00	0.00	0.00
12.	FOLATES	700.00	0.00	0.00	0.00

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	VANASPATI	2.50	2.27
2	MILK	0.50	14.00
3	WHEAT(ATA)	0.35	28.00
4	POTATO	0.15	7.00
5	RICE	0.55	7.00
6	JAGGERY	0.60	0.95
7	URD DAL	1.00	2.77
8	MOOLI-SAG	0.10	1.35
9	PALAK	0.10	3.26

TOTAL WEEKLY COST OF THE DIET = RS. 31.17

% NUTRITIONAL IMBALANCE(TOTAL) = 538.22 %

TABLE-E

PHASE-2 :WHEN NUTRITION IS GIVEN HIGHER PRIORITY:-

CATAGORY:-ADULT-MAN :VEGETARIAN MONTH:-DECEMBER

SLACK ANALYSIS

ROW	NUTRIENT	MIN.REQD	+SLK	-SLK	%DEVIATION
1.	PROTINS	385.00	104.26	0.00	27.08 %
2.	FATS	322.00	0.00	0.00	0.00 %
3.	FIBRES	42.00	15.80	0.00	37.61 %
4.	CALORIES	16800.00	176.90	0.00	1.05 %
5.	CALCIUM	2800.00	547.18	0.00	19.54 %
6.	IRON	168.00	166.98	0.00	99.39 %
7.	VITAMIN A	21000.00	0.00	0.00	0.00 %
8.	THIAMIN	9.80	3.27	0.00	33.39 %
9.	RIBOFLVN	11.90	0.00	0.00	0.00 %
10.	NIACIN	133.00	0.00	0.00	0.00 %
11.	VITAMIN C	280.00	0.00	0.00	0.00 %
12.	FOLATES	700.00	0.00	0.00	0.00 %

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	COOKINGOIL	2.50	1.99
2	MILK	0.50	14.00
3	WHEAT(ATA)	0.35	16.74
4	PHUL-GOBEE	0.20	0.45
5	POTATO	0.15	2.68
6	RICE	0.55	18.26
7	KADDU	0.20	7.00
8	BRINJAL	0.30	7.00
9	CHANA DAL	1.20	4.18
10	PALAK	0.10	2.87

TOTAL WEEKLY COST OF THE DIET = RS. 37.16

% NUTRITIONAL IMBALANCE(TOTAL) = 218.09 %

TABLE-F

PHASE-3 :EFFECT OF COST DECREAMENT ON NUTRITION:-

ITERATION NUMBER:- 1

CATAGORY:-ADULT-MAN :VEGETARIAN MONTH:-DECEMBER

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	COOKINGOIL	2.50	2.08
2	MILK	0.50	14.00
3	SUGAR	0.75	1.56
4	PALAK	0.10	3.86
5	WHEAT(ATA)	0.35	22.58
6	POTATO	0.15	3.09
7	RICE	0.55	12.42
8	AMLA	0.30	0.19
9	CHANA DAL	1.20	2.79

TOTAL WEEKLY COST OF THE DIET = RS. 32.36

% NUTRITIONAL IMBALANCE(TOTAL) = 259.47 %

ITERATION NUMBER:- 2

CATAGORY:-ADULT-MAN :VEGETARIAN MONTH:-DECEMBER

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	VANASPATI	2.50	2.27
2	MILK	0.50	14.00
3	PALAK	0.10	3.26
4	WHEAT(ATA)	0.35	28.00
5	POTATO	0.15	7.00
6	RICE	0.55	7.00
7	JAGGERY	0.60	0.95
8	URD DAL	1.00	2.77
9	MOOLI-SAG	0.10	1.35

TOTAL WEEKLY COST OF THE DIET = RS. 31.17

% NUTRITIONAL IMBALANCE(TOTAL) = 538.22 %

INSERT THE VALUE OF ICAT,IPRD & IVEG AS IC,IP,IV

ICAT=1 FOR ADULT-MAN,2 FOR ADULT-WOMAN,3 FOR EXPECTING MOTHERS
4 FOR NURSING MOTHERS,5 FOR MAN(HEAVY WORKING),6 FOPRE-SCHCOL CHILDREN
7 FOR SCHOOL GOING CHILDREN,8 FOR ADOLSCES(BOYS),9 FOR ADOLSCENTS(GIRLS)
,& 10 FOR PERSONS ON DIET

IPRD SIGNIFIES THE MONTTH NUMBER

IVEG=1 FOR VEG,2 FOR EGG-EATERS & 3 FOR NON-VEG

3, 2, 3,

ANY SPECIAL CHOICE ? (PRINT YES OR NO)

NO

THE FINAL RESULTS

TABLE-A

PHASE-1 :WHEN COST IS GIVEN HIGHER PRIORITY:-

CATAGORY:-EXPECTING-MOTHERS :NON-VEGETARIAN MONTH:-FEBRUARY

SLACK ANALYSIS

ROW	NUTRIENT	MIN.REQD	+SLK	-SLK	%DEVIATION
1.	PROTINS	413.00	171.57	0.00	41.54
2.	FATS	301.00	0.00	0.00	0.00
3.	FIBRES	42.00	43.20	0.00	102.87
4.	CALORIES	15400.00	0.00	0.00	0.00
5.	CALCIUM	7000.00	0.00	0.00	0.00
6.	IRON	280.00	326.23	0.00	116.51
7.	VITAMIN A	21000.00	50265.97	0.00	239.36
8.	THIAMIN	9.10	10.66	0.00	117.11
9.	RIBOFLVN	10.50	2.77	0.00	26.41
10.	NIACIN	119.00	41.47	0.00	34.85
11.	VITAMIN C	280.00	1185.35	0.00	423.34
12.	FOLATES	1400.00	0.00	0.00	0.00

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	EGG	1.00	7.42
2	COOKINGOIL	2.50	1.60
3	CABBAGE	0.10	7.00
4	METHI-SAG	0.10	6.49
5	JAGGERY	0.60	2.05
6	PALAK	0.10	7.00
7	WHEAT(ATA)	0.35	35.00

TOTAL WEEKLY COST OF THE DIET = RS. 26.96

% NUTRITIONAL IMBALANCE(TOTAL) = 1093.17 %

NOTE:IN ADDITION TO THIS 10 MG OF FOLIC ACID IS TO BE TAKEN AS SUPPLIMENT(IN THE FORM OF TABLETS)

TABLE-B

PHASE-2 :WHEN NUTRITION IS GIVEN HIGHER PRIORITY:-

CATAGORY:-EXPECTING-MOTHERS :NON-VEGETARIAN MONTH:-FEBRUARY

SLACK ANALYSIS

ROW	NUTRIENT	MIN.REQD	+SLK	-SLK	%DEVIATION
1.	PROTINS	413.00	150.73	0.00	36.50 %
2.	FATS	301.00	0.00	0.00	0.00 %
3.	FIBRES	42.00	3.46	0.00	8.23 %
4.	CALORIES	15400.00	926.82	0.00	6.02 %
5.	CALCIUM	7000.00	0.00	0.00	0.00 %
6.	IRON	280.00	29.28	0.00	10.46 %
7.	VITAMIN A	21000.00	11727.32	0.00	55.84 %
8.	THIAMIN	9.10	3.21	0.00	35.31 %
9.	RIBOFLVN	10.50	0.48	0.00	4.62 %
10.	NIACIN	119.00	0.00	0.00	0.00 %
11.	VITAMIN C	280.00	0.00	0.00	0.00 %
12.	FOLATES	1400.00	0.00	0.00	0.00 %

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	EGG	1.00	15.70
2	COOKINGOIL	2.50	0.47
3	JAGGERY	0.60	3.20
4	RICE	0.55	15.88
5	WHEAT(ATA)	0.35	19.12
6	PHUL-GOBEE	0.15	4.98

TOTAL WEEKLY COST OF THE DIET = RS. 34.97

% NUTRITIONAL IMBALANCE(TOTAL) = 154.56 %

NOTE:IN ADDITION TO THIS 10 MG OF FOLIC ACID IS TO BE TAKEN AS SUPPLIMENT(IN THE FORM OF TABLETS)

TABLE-C

PHASE-3 :EFFECT OF COST DECREAMENT ON NUTRITION:-

ITERATION NUMBER:- 1

CATAGORY:-EXPECTING-MOTHERS :NON-VEGETARIAN MONTH:-FEBRUARY

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	EGG	1.00	14.13
2	COOKINGOIL	2.50	0.65
3	CABBAGE	0.10	2.17
4	JAGGERY	0.60	3.01
5	RICE	0.55	3.35
6	WHEAT(ATA)	0.35	29.99

TOTAL WEEKLY COST OF THE DIET = RS. 30.11

% NUTRITIONAL IMBALANCE(TOTAL) = 265.79 %

NOTE:IN ADDITION TO THIS 10 MG OF FOLIC ACID IS TO BE TAKEN AS SUPPLIMENT(IN THE FORM OF TABLETS)

ITERATION NUMBER:- 2

CATAGORY:-EXPECTING-MOTHERS :NON-VEGETARIAN MONTH:-FEBRUARY

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	EGG	1.00	7.42
2	COOKINGOIL	2.50	1.60
3	CABBAGE	0.10	7.00
4	METHI-SAG	0.10	6.49
5	JAGGERY	0.60	2.05
6	PALAK	0.10	7.00
7	WHEAT(ATA)	0.35	35.00

TOTAL WEEKLY COST OF THE DIET = RS. 26.96

% NUTRITIONAL IMBALANCE(TOTAL) = 1093.17 %

NOTE:IN ADDITION TO THIS 10 MG OF FOLIC ACID IS TO BE TAKEN AS SUPPLIMENT(IN THE FORM OF TABLETS)

THE FINAL RESULTS

TABLE-D

PHASE-1 :WHEN COST IS GIVEN HIGHER PRIORITY:-

CATAGORY:-EXPECTING-MOTHERS :NON-VEGETARIAN MONTH:-FEBRUARY

SLACK ANALYSIS

ROW	NUTRIENT	MIN.REQD	+SLK	-SLK	%DEVIATION
1.	PROTINS	413.00	246.00	0.00	59.56
2.	FATS	301.00	0.00	0.00	0.00
3.	FIBRES	42.00	39.24	0.00	93.43
4.	CALORIES	15400.00	0.00	0.00	0.00
5.	CALCIUM	7000.00	0.00	0.00	0.00
6.	IRON	280.00	302.63	0.00	108.08
7.	VITAMIN A	21000.00	94697.94	0.00	450.94
8.	THIAMIN	9.10	9.68	0.00	106.41
9.	RIBOFLVN	10.50	5.78	0.00	55.08
10.	NIACIN	119.00	28.63	0.00	24.06
11.	VITAMIN C	280.00	1772.00	0.00	632.86
12.	FOLATES	1400.00	0.00	0.00	0.00

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	EGG	1.00	7.75
2	VANASPATI	2.50	1.90
3	WHEAT(ATA)	0.35	25.75
4	JAGGERY	0.60	0.19
5	CABBAGE	0.10	7.00
6	METHI-SAG	0.10	7.00
7	MOOLI-SAG	0.10	7.00
8	PALAK	0.10	7.00
9	RICE	0.55	7.00
10	FISH	2.00	2.50
11	URD DAL	1.00	2.80

TOTAL WEEKLY COST OF THE DIET = RS. 36.07

% NUTRITIONAL IMBALANCE(TOTAL) = 1517.80 %

NOTE:IN ADDITION TO THIS 10 MG OF FOLIC ACID IS TO BE TAKEN AS SUPPLIMENT(IN THE FORM OF TABLETS)

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INSERT THE VALUE OF ICAT,IPRD & IVEG AS IC,IP,IV

ICAT=1 FOR ADULT-MAN,2 FOR ADULT-WOMAN,3 FOR EXPECTING MOTHERS
4 FOR NURSING MOTHERS,5 FOR MAN(HEAVY WORKING),6 FOPRE-SCHCOL CHILDREN
7 FOR SCHOOL GOING CHILDREN,8 FOR ADOLSCES(BOYS),9 FOR ADOLSCENTS(GIRLS)
,& 10 FOR PERSONS ON DIET

IPRD SIGNIFIES THE MONTTH NUMBER

IVEG=1 FOR VEG,2 FOR EGG-EATERS & 3 FOR NON-VEG

3, 2, 3,

ANY SPECIAL CHOICE ? (PRINT YES OR NO )

YES

NO. OF FOODS AVAILABLE= 37

SELECT FROM THE FOLLOWINGS----

  6      RICE
  8      WHEAT(ATA)
 10      CHANA DAL
 11      MUNG DAL
 12      URD DAL
 14      MASUR DAL
 15      ARHAR DAL
 17      CABBAGE
 18      METHI-SAG
 19      SARNSO-SAG
 20      MOOLI-SAG
 21      PALAK
 22      CARROT
 24      ONION
 25      POTATO
 27      SEM
 28      LAUKI
 31      PHUL-GOBEE
 35      HARE-MATAR
 37      KADDU
 41      BANANA
 46      NIMBU
 50      MELON
 52      PAPAYA
 57      TOMATO
 58      MILK
 59      CURD
 63      GHEE
 65      VANASPATI
 66      COOKINGOIL
 67      SUGAR
 68      JAGGERY
 70      BREAD
 71      EGG
 72      MUTTON
 74      CHICKEN
 75      FISH

ENTER THE NO. OF CONSTRAINTS(CONSISTING ONE FOOD)

1,

ENTER THE INDEXES OF FOODS CHOOSEN

6,

ENTER  NO. OF CONSTRANTS CONS. MORE THAN ONE FOOD

2,

ENTER THE NO. OF FOODS & THEIR INDEXES

3, 5,
72, 74, 75,
10, 11, 12, 14, 15,

ENTER THE MIN OR MAX REQUIREMENTS

  7.000000    ,    2.500000    ,    2.800000    ,

ENTER  SIGNS OF EXTRA CONSTRAINTS(G OR B)

G IF MIN & B IF MAX

GGG


ENTER THE WEIGHTAGES
1. 1. 1.
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TABLE-E

PHASE-2 :WHEN NUTRITION IS GIVEN HIGHER PRIORITY:-

CATAGORY:-EXPECTING-MOTHERS :NON-VEGETARIAN MONTH:-FEBRUARY

SLACK ANALYSIS

ROW	NUTRIENT	MIN.REQD	+SLK	-SLK	%DEVIATION
1.	PROTINS	413.00	218.02	0.00	52.79 %
2.	FATS	301.00	0.00	0.00	0.00 %
3.	FIBRES	42.00	0.68	0.00	1.61 %
4.	CALORIES	15400.00	1686.41	0.00	10.95 %
5.	CALCIUM	7000.00	0.00	0.00	0.00 %
6.	IRON	280.00	28.11	0.00	10.04 %
7.	VITAMIN A	21000.00	10084.32	0.00	48.02 %
8.	THIAMIN	9.10	3.17	0.00	34.83 %
9.	RIBOFLVN	10.50	0.35	0.00	3.33 %
10.	NIACIN	119.00	0.00	0.00	0.00 %
11.	VITAMIN C	280.00	0.00	0.00	0.00 %
12.	FOLATES	1400.00	0.00	0.00	0.00 %

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	EGG	1.00	14.77
2	COOKINGOIL	2.50	0.53
3	WHEAT(ATA)	0.35	16.05
4	JAGGERY	0.60	2.14
5	PHUL-GOBEE	0.15	3.96
6	RICE	0.55	18.95
7	FISH	2.00	2.50
8	CHANA DAL	1.20	2.80

TOTAL WEEKLY COST OF THE DIET = RS. 42.38

% NUTRITIONAL IMBALANCE(TOTAL) = 159.99 %

NOTE:IN ADDITION TO THIS 10 MG OF FOLIC ACID IS TO BE TAKEN AS SUPPLIMENT(IN THE FORM OF TABLETS)

TABLE-F

PHASE-3 :EFFECT OF COST DECREAMENT ON NUTRITION:-

ITERATION NUMBER:- 1

CATAGORY:-EXPECTING-MOTHERS :NON-VEGETARIAN MONTH:-FEBRUARY

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	EGG	1.00	14.36
2	COOKINGOIL	2.50	0.67
3	WHEAT(ATA)	0.35	21.67
4	JAGGERY	0.60	1.91
5	CABBAGE	0.10	1.81
6	RICE	0.55	8.98
7	FISH	2.00	2.50
8	URD DAL	1.00	2.80

TOTAL WEEKLY COST OF THE DIET = RS. 37.68

% NUTRITIONAL IMBALANCE(TOTAL) = 187.04 %

NOTE:IN ADDITION TO THIS 10 MG OF FOLIC ACID IS TO BE TAKEN AS SUPPLIMENT(IN THE FORM OF TABLETS)

ITERATION NUMBER:- 2

CATAGORY:-EXPECTING-MOTHERS :NON-VEGETARIAN MONTH:-FEBRUARY

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	EGG	1.00	7.75
2	VANASPATI	2.50	1.90
3	WHEAT(ATA)	0.35	25.75
4	JAGGERY	0.60	0.19
5	CABBAGE	0.10	7.00
6	METHI-SAG	0.10	7.00
7	MOOLI-SAG	0.10	7.00
8	PALAK	0.10	7.00
9	RICE	0.55	7.00
10	FISH	2.00	2.50
11	URD DAL	1.00	2.80

TOTAL WEEKLY COST OF THE DIET = RS. 36.07

% NUTRITIONAL IMBALANCE(TOTAL) = 1517.80 %

NOTE:IN ADDITION TO THIS 10 MG OF FOLIC ACID IS TO BE TAKEN AS SUPPLIMENT(IN THE FORM OF TABLETS)

```
INSERT THE VALUE OF ICAT,IPRD & IVEG AS IC,IP,IV

ICAT=1 FOR ADULT-MAN,2 FOR ADULT-WOMAN,3 FOR EXPECTING MOTHERS
4 FOR NURSING MOTHERS,5 FOR MAN(HEAVY WORKING),6 FOPRE-SCHOOL CHILDREN
7 FOR SCHOOL GOING CHILDREN,8 FOR ADOLSCES(BOYS),9 FOR ADOLSCENTS(GIRLS)
,& 10 FOR PERSONS ON DIET

IPRD SIGNIFIES THE MONTTH NUMBER

IVEG=1 FOR VEG,2 FOR EGG-EATERS & 3 FOR NON-VEG

6, 5, 1,

ANY SPECIAL CHOICE ? (PRINT YES OR NO )

YES

NO. OF FOODS AVAILABLE= 30

SELECT FROM THE FOLLOWINGS----

  6      RICE
  8      WHEAT(ATA)
 10      CHANA DAL
 11      MUNG DAL
 12      URD DAL
 14      MASUR DAL
 15      ARHAR DAL
 21      PALAK
 24      ONION
 25      POTATO
 28      LAUKI
 29      KARELA
 30      BRINJAL
 32      CUCUMBER
 33      BHINDI
 37      KADDU
 41      BANANA
 43      JACK-FRUIT
 44      GRAPES
 46      NIMBU
 47      MANGO
 57      TOMATO
 58      MILK
 59      CURD
 63      GHEE
 65      VANASPATI
 66      COOKINGOIL
 67      SUGAR
 68      JAGGERY
 70      BREAD

ENTER THE NO. OF CONSTRAINTS(CONSISTING ONE FOOD)

1,

ENTER THE INDEXES OF FOODS CHOOSEN

58,

ENTER  NO. OF CONSTRANTS CONS. MORE THAN ONE FOOD

1,

ENTER THE NO. OF FOODS & THEIR INDEXES

2,
6, 8,

ENTER THE MIN OR MAX REQUIREMENTS

  17.50000     ,   14.00000     ,

ENTER  SIGNS OF EXTRA CONSTRAINTS(G OR B)

G IF MIN & B IF MAX

GB

ENTER THE WEIGHTAGES

1, 1,
```

THE FINAL RESULTS

TABLE-D

PHASE-1 :WHEN COST IS GIVEN HIGHER PRIORITY:-

CATAGORY:-PRE-SCHOCL CHILDREN :VEGETARIAN MONTH:-MAY

SLACK ANALYSIS

ROW	NUTRIENT	MIN.REQD	+SLK	-SLK	%DEVIATION
1.	PROTINS	182.00	109.20	0.00	60.00 %
2.	FATS	224.00	0.00	0.00	0.00 %
3.	FIBRES	0.00	33.90	0.00	0.00 %
4.	CALORIES	9800.00	0.00	0.00	0.00 %
5.	CALCIUM	2800.00	8486.23	0.00	303.08 %
6.	IRON	175.00	88.51	0.00	50.58 %
7.	VITAMIN A	7700.00	36223.95	0.00	470.44 %
8.	THIAMIN	5.25	4.22	0.00	80.41 %
9.	RIBOFLVN	5.95	2.41	0.00	40.43 %
10.	NIACIN	70.00	1.33	0.00	1.89 %
11.	VITAMIN C	280.00	0.00	0.00	0.00 %
12.	FOLATES	700.00	0.00	0.00	0.00 %

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	KARELA	0.15	0.50
2	WHEAT(ATA)	0.35	14.00
3	MILK	0.50	17.50
4	JAGGERY	0.60	5.05
5	PALAK	0.15	7.00
6	COOKINGOIL	2.50	1.09
7	CHANA DAL	1.20	2.50

TOTAL WEEKLY COST OF THE DIET = RS. 23.52

% NUTRITIONAL IMBALANCE(TOTAL) = 894.39 %

TABLE-E

PHASE-2 :WHEN NUTRITION IS GIVEN HIGHER PRIORITY:-

CATAGORY:-PRE-SCHOCL CHILDREN :VEGETARIAN MONTH:-MAY

SLACK ANALYSIS

ROW	NUTRIENT	MIN.REQD	+SLK	-SLK	%DEVIATION
1.	PROTINS	182.00	141.16	0.00	77.56 %
2.	FATS	224.00	0.00	0.00	0.00 %
3.	FIBRES	0.00	43.75	0.00	0.00 %
4.	CALORIES	9800.00	0.00	0.00	0.00 %
5.	CALCIUM	2800.00	703.94	0.00	25.14 %
6.	IRON	175.00	4.04	0.00	2.31 %
7.	VITAMIN A	7700.00	0.00	0.00	0.00 %
8.	THIAMIN	5.25	2.87	0.00	54.73 %
9.	RIBOFLVN	5.95	1.56	0.00	26.16 %
10.	NIACIN	70.00	0.00	0.00	0.00 %
11.	VITAMIN C	280.00	0.00	0.00	0.00 %
12.	FOLATES	700.00	0.00	0.00	0.00 %

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	SUGAR	0.75	0.86
2	KADDU	0.20	7.00
3	BHINDI	0.50	7.00
4	CUCUMBER	0.30	7.00
5	WHEAT(ATA)	0.35	6.09
6	MILK	0.60	17.50
7	RICE	0.55	7.91
8	BRINJAL	0.20	6.37
9	PALAK	0.15	0.35
10	COOKINGOIL	2.50	1.04
11	CHANA DAL	1.20	5.01

TOTAL WEEKLY COST OF THE DIET = RS. 32.82

% NUTRITIONAL IMBALANCE(TOTAL) = 85.87 %

TABLE-F

PHASE-3 :EFFECT OF COST DECREAMENT ON NUTRITION:-

ITERATION NUMBER:- 1

CATAGORY:-PRE-SCHOOL CHILDREN :VEGETARIAN MONTH:-MAY

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	SUGAR	0.75	5.42
2	KARELA	0.15	0.06
3	BHINDI	0.50	7.00
4	WHEAT(ATA)	0.35	14.00
5	MILK	0.50	17.50
6	TOMATO	0.40	0.73
7	CUCUMBER	0.30	7.00
8	PALAK	0.15	2.80
9	COOKINGOIL	2.50	1.25
10	CHANA DAL	1.20	0.48

TOTAL WEEKLY COST OF THE DIET = RS. 27.73

% NUTRITIONAL IMBALANCE(TOTAL) = 251.74 %

ITERATION NUMBER:- 2

CATAGORY:-PRE-SCHOOL CHILDREN :VEGETARIAN MONTH:-MAY

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	KARELA	0.15	0.50
2	WHEAT(ATA)	0.35	14.00
3	MILK	0.50	17.50
4	JAGGERY	0.60	5.05
5	PALAK	0.15	7.00
6	COOKINGOIL	2.50	1.09
7	CHANA DAL	1.20	2.50

TOTAL WEEKLY COST OF THE DIET = RS. 23.52

% NUTRITIONAL IMBALANCE(TOTAL) = 893.92 %

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INSERT THE VALUE OF ICAT,IPRD & IVEG AS IC,IP,IV

ICAT=1 FOR ADULT-MAN,2 FOR ADULT-WOMAN,3 FOR EXPECTING MOTHERS
4 FOR NURSING MOTHERS,5 FOR MAN(HEAVY WORKING),6 FOPRE-SCHCOL CHILDREN
7 FOR SCHOOL GOING CHILDREN,8 FOR ADOLSCES(BOYS),9 FOR ADOLSCENTS(GIRLS)
,& 10 FOR PERSONS ON DIET

IPRD SIGNIFIES THE MONTTH NUMBER

IVEG=1 FOR VEG,2 FOR EGG-EATERS & 3 FOR NON-VEG

5, 1, 1,

ANY SPECIAL CHOICE ? (PRINT YES CR NO )

YES

NO. OF FOODS AVAILABLE= 35

SELECT FROM THE FOLLOWINGS----

  6      RICE
  8      WHEAT(ATA)
 10      CHANA DAL
 11      MUNG DAL
 12      URD DAL
 14      MASUR DAL
 15      ARHAR DAL
 17      CABBAGE
 18      METHI-SAG
 19      SARNSO-SAG
 20      MOOLI-SAG
 21      PALAK
 22      CARROT
 24      ONION
 25      POTATO
 27      SEM
 28      LAUKI
 31      PHUL-GOBEE
 35      HARE-MATAR
 37      KADDU
 40      APPLE
 41      BANANA
 46      NIMBU
 50      MELON
 51      ORANGE
 52      PAPAYA
 57      TOMATO
 58      MILK
 59      CURD
 63      GHEE
 65      VANASPATI
 66      COOKINGOIL
 67      SUGAR
 68      JAGGERY
 70      BREAD

ENTER THE NO. OF CONSTRAINTS(CONSISTING ONE FOOD)

0,

ENTER  NO. OF CONSTRANTS CONS. MORE THAN ONE FOOD

1,

ENTER THE NO. OF FOODS & THEIR INDEXES

5,
10, 11, 12, 14, 15,

ENTER THE MIN OR MAX REQUIREMENTS

  2.800000    ,

ENTER  SIGNS OF EXTRA CONSTRAINTS(G OR B)

G IF MIN & B IF MAX

G

ENTER THE WEIGHTAGES

1.
```

THE FINAL RESULTS

TABLE-D

PHASE-1 :WHEN COST IS GIVEN HIGHER PRIORITY:-

CATAGORY:-MAN (HEAVY WORKING) :VEGETARIAN MONTH:-JANUARY

SLACK ANALYSIS

ROW	NUTRIENT	MIN.REQD	+SLK	-SLK	%DEVIATION
1.	PROTINS	385.00	211.56	0.00	54.95 %
2.	FATS	434.00	0.00	0.00	0.00 %
3.	FIBRES	42.00	45.62	0.00	108.63 %
4.	CALORIES	25900.00	0.00	0.00	0.00 %
5.	CALCIUM	3150.00	31754.59	0.00	1008.08 %
6.	IRON	168.00	370.78	0.00	220.70 %
7.	VITAMIN A	21000.00	0.00	0.00	0.00 %
8.	THIAMIN	14.00	8.75	0.00	62.49 %
9.	RIBOFLVN	15.40	0.50	0.00	3.26 %
10.	NIACIN	168.00	27.57	0.00	16.41 %
11.	VITAMIN C	280.00	0.00	0.00	0.00 %
12.	FOLATES	700.00	0.00	0.00	0.00 %

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	COOKINGOIL	2.50	3.10
2	JAGGERY	0.60	19.48
3	URD DAL	1.00	2.80
4	MOONI-SAG	0.10	1.29
5	WHEAT(ATA)	0.35	41.55
6	POTATO	0.15	7.00
7	PALAK	0.10	2.03
8	VANASPATI	2.50	0.46

TOTAL WEEKLY COST OF THE DIET = RS. 39.31

% NUTRITIONAL IMBALANCE(TOTAL) = 1471.66 %

TABLE-E

PHASE-2 :WHEN NUTRITION IS GIVEN HIGHER PRIORITY:-

CATAGORY:-MAN (HEAVY WORKING) :VEGETARIAN MONTH:-JANUARY

SLACK ANADYSIS

ROW	NUTRIENT	MIN.REQD	+SLK	-SLK	%DEVIATION
1.	PROTINS	385.00	257.54	0.00	66.89 %
2.	FATS	434.00	0.00	0.00	0.00 %
3.	FIBRES	42.00	23.63	0.00	56.27 %
4.	CALORIES	25900.00	0.00	0.00	0.00 %
5.	CALCIUM	3150.00	0.00	0.00	0.00 %
6.	IRON	168.00	214.82	0.00	127.87 %
7.	VITAMIN A	21000.00	0.00	0.00	0.00 %
8.	THIAMIN	14.00	2.14	0.00	15.25 %
9.	RIBOFLVN	15.40	0.00	0.00	0.00 %
10.	NIACIN	168.00	0.00	0.00	0.00 %
11.	VITAMIN C	280.00	0.00	0.00	0.00 %
12.	FOLATES	700.00	0.00	0.00	0.00 %

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	BANANA	0.30	8.81
2	SUGAR	0.75	6.75
3	JAGGERY	0.60	0.36
4	RICE	0.55	24.80
5	PALAK	0.10	2.95
6	ARHAR DAL	1.20	10.00
7	WHEAT(ATA)	0.35	17.20
8	POTATO	0.15	7.00
9	GHEE	6.00	0.51
10	KADDU	0.20	7.00
11	COOKINGOIL	2.50	3.12
12	MILK	0.50	1.40

TOTAL WEEKLY COST OF THE DIET = RS. 53.90

% NUTRITIONAL IMBALANCE(TOTAL) = 266.29 %

TABLE-F

PHASE-3 :EFFECT OF COST DECREAMENT ON NUTRITION:-

ITERATION NUMBER:- 1

CATAGORY:-MAN (HEAVY WORKING) :VEGETARIAN MONTH:-JANUAI

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	CHANA DAL	1.20	2.12
2	JAGGERY	0.60	0.43
3	RICE	0.55	22.42
4	MILK	0.50	0.51
5	PALAK	0.10	3.08
6	MASUR DAL	1.00	6.10
7	WHEAT(ATA)	0.35	19.58
8	POTATO	0.15	7.00
9	ARHAR DAL	1.20	1.78
10	BANANA	0.30	10.22
11	COOKINGOIL	2.50	3.62
12	SUGAR	0.75	6.59

TOTAL WEEKLY COST OF THE DIET = RS. 48.90

% NUTRITIONAL IMBALANCE(TOTAL) = 272.75 %

ITERATION NUMBER:- 2

CATAGORY:-MAN (HEAVY WORKING) :VEGETARIAN MONTH:-JANUAI

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	COOKINGOIL	2.50	3.51
2	JAGGERY	0.60	0.01
3	RICE	0.55	10.45
4	MILK	0.50	4.25
5	MOOLI-SAG	0.10	0.28
6	WHEAT(ATA)	0.35	31.55
7	POTATO	0.15	7.00
8	CABBAGE	0.20	0.34
9	PALAK	0.10	3.11
10	URD DAL	1.00	2.80
11	SUGAR	0.75	15.94

TOTAL WEEKLY COST OF THE DIET = RS. 43.90

% NUTRITIONAL IMBALANCE(TOTAL) = 318.27 %

ITERATION NUMBER:- 3

CATAGORY:-MAN (HEAVY WORKING) :VEGETARIAN MONTH:-JANUARY

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	COOKINGOIL	2.50	3.10
2	URD DAL	1.00	2.80
3	VANASPATI	2.50	0.46
4	MOOLI-SAG	0.10	1.29
5	WHEAT(ATA)	0.35	41.55
6	POTATO	0.15	7.00
7	PALAK	0.10	2.03
8	JAGGERY	0.60	19.48

TOTAL WEEKLY COST OF THE DIET = RS. 39.31

% NUTRITIONAL IMBALANCE(TOTAL) = 1471.66 %

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INSERT THE VALUE OF ICAT,IPRD & IVEG AS IC,IP,IV

ICAT=1 FOR ADULT-MAN,2 FOR ADULT-WOMAN,3 FOR EXPECTING MOTHERS
4 FOR NURSING MOTHERS,5 FOR MAN(HEAVY WORKING),6 FOPRE-SCHOOL CHILDREN
7 FOR SCHOOL GOING CHILDREN,8 FOR ADOLSCES(BOYS),9 FOR ADOLSCENTS(GIRLS)
,& 10 FOR PERSONS ON DIET

IPRD SIGNIFIES THE MONTTH NUMBER

IVEG=1 FOR VEG,2 FOR EGG-EATERS & 3 FOR NON-VEG

2, 6, 3,

ANY SPECIAL CHOICE ? (PRINT YES OR NO )

YES

NO. OF FOODS AVAILABLE= 40

SELECT FROM THE FOLLOWINGS----

  6     RICE
  8     WHEAT(ATA)
 10     CHANA DAL
 11     MUNG DAL
 12     URD DAL
 14     MASUR DAL
 15     ARHAR DAL
 21     PALAK
 23     ARWI
 24     ONION
 25     POTATO
 28     LAUKI
 29     KARELA
 30     BRINJAL
 32     CUCUMBER
 33     BHINDI
 34     PARWAL
 37     KADDU
 41     BANANA
 43     JACK-FRUIT
 44     GRAPES
 45     JAMUN
 46     NIMBU
 47     MANGO
 48     LICHI
 50     MELON
 52     PAPAYA
 57     TOMATO
 58     MILK
 59     CURD
 63     GHEE
 65     VANASPATI
 66     COOKINGOIL
 67     SUGAR
 68     JAGGERY
 70     BREAD
 71     EGG
 72     MUTTON
 74     CHICKEN
 75     FISH

ENTER THE NO. OF CONSTRAINTS(CONSISTING ONE FOOD)

2,

ENTER THE INDEXES OF FOODS CHOOSEN

6, 41,

ENTER  NO. OF CONSTRANTS CONS. MORE THAN ONE FOOD

2,

ENTER THE NO. OF FOODS & THEIR INDEXES

5, 3,
10, 11, 12, 14, 15,
72, 74, 75,

ENTER THE MIN OR MAX REQUIREMENTS

  7.000000    ,   14.00000    ,   2.800000    ,   2.500000    ,

ENTER  SIGNS OF EXTRA CONSTRAINTS(G OR B)
G IF MIN & B IF MAX

GGGG

ENTER THE WEIGHTAGES

1, 1, 1, 1,
```

THE FINAL RESULTS

TABLE-D

PHASE-1 :WHEN COST IS GIVEN HIGHER PRIORITY:-

CATAGORY:-ADULT-WOMAN :NON-VEGETARIAN MONTH:-JUNE

SLACK ANALYSIS

ROW	NUTRIENT	MIN.REQD	+SLK	-SLK	%DEVIATION
1.	PROTINS	315.00	78.34	0.00	24.87 %
2.	FATS	252.00	0.00	0.00	0.00 %
3.	FIBRES	35.00	12.67	0.00	36.21 %
4.	CALORIES	13300.00	0.00	0.00	0.00 %
5.	CALCIUM	2800.00	1442.07	0.00	51.50 %
6.	IRON	224.00	106.93	0.00	47.74 %
7.	VITAMIN A	21000.00	20022.60	0.00	95.35 %
8.	THIAMIN	7.70	3.10	0.00	40.29 %
9.	RIBOFLVN	9.10	0.00	0.00	0.00 %
10.	NIACIN	105.00	0.00	0.00	0.00 %
11.	VITAMIN C	280.00	111.34	0.00	39.76 %
12.	FOLATES	700.00	0.00	0.00	0.00 %

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	POTATO	0.30	2.43
2	COOKINGOIL	2.50	2.34
3	FISH	2.00	2.50
4	WHEAT(ATA)	0.35	16.39
5	RICE	0.55	7.00
6	BANANA	0.35	14.00
7	ARVI	0.15	0.95
8	URD DAL	1.00	2.80
9	BHINDI	0.20	0.97
10	PALAK	0.15	7.00

TOTAL WEEKLY COST OF THE DIET = RS. 30.25

% NUTRITIONAL IMBALANCE(TOTAL) = 340.44 %

TABLE-E

PHASE-2 :WHEN NUTRITION IS GIVEN HIGHER PRIORITY:-

CATAGORY:-ADULT-WOMAN :NON-VEGETARIAN MONTH:-JUNE

SLACK ANALYSIS

ROW	NUTRIENT	MIN.REQD	+SLK	-SLK	%DEVTATION
1.	PROTINS	315.00	150.35	0.00	47.73 %
2.	FATS	252.00	0.00	0.00	0.00 %
3.	FIBRES	35.00	0.00	0.00	0.00 %
4.	CALORIES	13300.00	4074.92	0.00	30.64 %
5.	CALCIUM	2800.00	0.00	0.00	0.00 %
6.	IRON	224.00	0.00	0.00	0.00 %
7.	VITAMIN A	21000.00	0.00	0.00	0.00 %
8.	THIAMIN	7.70	0.00	0.00	0.00 %
9.	RIBOFLVN	9.10	0.00	0.00	0.00 %
10.	NIACIN	105.00	0.00	0.00	0.00 %
11.	VITAMIN C	280.00	0.00	0.00	0.00 %
12.	FOLATES	700.00	0.00	0.00	0.00 %

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS
1	BHINDI	0.20	0.42
2	POTATO	0.30	1.96
3	PALAK	0.15	1.37
4	FISH	2.00	1.85
5	EGG	1.00	4.46
6	WHEAT(ATA)	0.35	6.05
7	RICE	0.55	28.95
8	BANANA	0.35	14.00
9	VANASPATI	2.50	0.75
10	ARHAR DAL	1.20	2.80
11	BRINJAL	0.15	3.58
12	CUCUMBER	0.20	2.99
13	MUTTON	2.50	0.65
14	COOKINGOIL	2.50	0.76

TOTAL WEEKLY COST OF THE DIET = RS. 41.88

% NUTRITIONAL IMBALANCE(TOTAL) = 78.42 %

TABLE-F

PHASE-3 :EFFECT OF COST DECREAMENT ON NUTRITION:-

ITERATION NUMBER:- 1

CATAGORY:-ADULT-WOMAN :NON-VEGETARIAN MONTH:-JUNE

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	POTATO	0.30	2.03
2	PALAK	0.15	2.14
3	FISH	2.00	1.48
4	EGG	1.00	3.24
5	WHEAT(ATA)	0.35	10.71
6	RICE	0.55	19.61
7	BANANA	0.35	14.00
8	MASUR DAL	1.00	2.80
9	BHINDI	0.20	4.22
10	COOKINGOIL	2.50	1.67
11	MUTTON	2.50	1.02

TOTAL WEEKLY COST OF THE DIET = RS. 36.92

% NUTRITIONAL IMBALANCE(TOTAL) = 106.64 %

ITERATION NUMBER:- 2

CATAGORY:-ADULT-WOMAN :NON-VEGETARIAN MONTH:-JUNE

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	MASUR DAL	1.00	2.80
2	COOKINGOIL	2.50	1.68
3	POTATO	0.30	1.95
4	FISH	2.00	1.33
5	EGG	1.00	2.89
6	WHEAT(ATA)	0.35	16.12
7	BHINDI	0.20	4.37
8	RICE	0.55	7.42
9	PALAK	0.15	2.24
10	MUTTON	2.50	1.17
11	BANANA	0.35	14.00

TOTAL WEEKLY COST OF THE DIET = RS. 31.88

% NUTRITIONAL IMBALANCE(TOTAL) = 140.57 %

ITERATION NUMBER:- 3

CATAGORY:-ADULT-WOMAN :NON-VEGETARIAN MONTH:-JUNE

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	POTATO	0.30	2.43
2	FISH	2.00	2.50
3	WHEAT(ATA)	0.35	16.39
4	RICE	0.55	7.00
5	BANANA	0.35	14.00
6	ARVI	0.15	0.95
7	URD DAL	1.00	2.80
8	BHINDI	0.20	0.97
9	PALAK	0.15	7.00
10	COOKINGOIL	2.50	2.34

TOTAL WEEKLY COST OF THE DIET = RS. 30.25

% NUTRITIONAL IMBALANCE(TOTAL) = 340.44 %

INSERT THE VALUE OF ICAT,IPRD & IVEG AS IC,IP,IV

ICAT=1 FOR ADULT-MAN,2 FOR ADULT-WOMAN,3 FOR EXPECTING MOTHERS
4 FOR NURSING MOTHERS,5 FOR MAN(HEAVY WORKING),6 FOPRE-SCHOOL CHILDREN
7 FOR SCHOOL GOING CHILDREN,8 FOR ADOLSCES(BOYS),9 FOR ADOLSCENTS(GIRLS)
,& 10 FOR PERSONS ON DIET

IPRD SIGNIFIES THE MONTIH NUMBER

IVEG=1 FOR VEG,2 FOR EGG-EATERS & 3 FOR NON-VEG

10, 3, 2,

ANY SPECIAL CHOICE ? (PRINT YES OR NO)

NO

THE FINAL RESULTS

TABLE-A

PHASE-1 :WHEN COST IS GIVEN HIGHER PRIORITY:-

CATAGORY:-PERSONS ON DIET :EGG-EATER MONTH:-MARCH

SLACK ANALYSIS

ROW	NUTRIENT	MIN.REQD	+SLK	-SLK	%DEVIATION
1.	PROTINS	560.00	0.00	0.00	0.00 %
2.	FATS	175.00	0.00	0.00	0.00 %
3.	FIBRES	42.00	36.95	0.00	87.98 %
4.	CALORIES	10500.00	1400.00	0.00	13.33 %
5.	CALCIUM	2800.00	5133.78	0.00	183.35 %
6.	IRON	168.00	484.17	0.00	288.19 %
7.	VITAMIN A	21000.00	107371.21	0.00	511.29 %
8.	THIAMIN	9.80	6.67	0.00	68.11 %
9.	RIBOFLVN	11.90	2.27	0.00	19.11 %
10.	NIACIN	133.00	0.00	0.00	0.00 %
11.	VITAMIN C	280.00	1133.74	0.00	404.91 %
12.	FOLATES	700.00	453.91	0.00	64.84 %

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	EGG	1.00	5.03
2	MOOLI-SAG	0.10	7.00
3	MASUR DAL	1.00	2.76
4	METHI-SAG	0.10	7.00
5	WHEAT(ATA)	0.35	25.57
6	SARNSO-SAG	0.10	7.00
7	VANASPATI	2.50	0.63
8	PALAK	0.10	7.00

TOTAL WEEKLY COST OF THE DIET = RS. 21.11

% NUTRITIONAL IMBALANCE(TOTAL) = 1647.12 %

TABLE-B

PHASE-2 :WHEN NUTRITION IS GIVEN HIGHER PRIORITY:-

CATAGORY:-PERSONS ON DIET :EGG-EATER MONTH:-MARCH

SLACK ANALYSIS

ROW	NUTRIENT	MIN.REQD	+SLK	-SLK	%DEVIATION
1.	PROTINS	560.00	0.00	0.00	0.00
2.	FATS	175.00	0.00	0.00	0.00
3.	FIBRES	42.00	37.25	0.00	88.69
4.	CALORIES	10500.00	1400.00	0.00	13.33
5.	CALCIUM	2800.00	1314.22	0.00	46.94
6.	IRON	168.00	180.88	0.00	107.66
7.	VITAMIN A	21000.00	6757.83	0.00	32.18
8.	THIAMIN	9.80	6.36	0.00	64.95
9.	RIBOFLVN	11.90	0.00	0.00	0.00
10.	NIACIN	133.00	0.00	0.00	0.00
11.	VITAMIN C	280.00	325.47	0.00	116.24
12.	FOLATES	700.00	327.76	0.00	46.82

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	PHUL-GOBEE	0.15	7.00
2	KADDU	0.30	7.00
3	MOOLI-SAG	0.10	1.35
4	ARHAR DAL	1.20	4.02
5	POTATO	0.15	1.45
6	WHEAT(ATA)	0.35	23.76
7	SEM	0.25	7.00
8	EGG	1.00	8.99

TOTAL WEEKLY COST OF THE DIET = RS. 27.37

% NUTRITIONAL IMBALANCE(TOTAL) = 517.09 %

TABLE-C

PHASE-3 :EFFECT OF COST DECREAMENT ON NUTRITION:-

ITERATION NUMBER:- 1

CATAGORY:-PERSONS ON DIET :EGG-EATER MONTH:-MARCH

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	PHUL-GOBEE	0.15	2.63
2	MOOLI-SAG	0.10	4.76
3	MASUR DAL	1.00	1.95
4	METHI-SAG	0.10	7.00
5	EGG	1.00	9.50
6	WHEAT(ATA)	0.35	26.66

TOTAL WEEKLY COST OF THE DIET = RS. 22.36

% NUTRITIONAL IMBALANCE(TOTAL) = 941.92 %

ITERATION NUMBER:- 2

CATAGORY:-PERSONS ON DIET :EGG-EATER MONTH:-MARCH

RECOMMENDED WEEKLY DIET

SL NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	EGG	1.00	5.03
2	MOOLI-SAG	0.10	7.00
3	MASUR DAL	1.00	2.76
4	METHI-SAG	0.10	7.00
5	WHEAT(ATA)	0.35	25.57
6	SARNSO-SAG	0.10	7.00
7	VANASPATI	2.50	0.63
8	PALAK	0.10	7.00

TOTAL WEEKLY COST OF THE DIET = RS. 21.11

% NUTRITIONAL IMBALANCE(TOTAL) = 1647.12 %

RESULTS OF MENU PLANNING

```
INSERT THE NO. OF CATAGORY OF PERSONS
1,
INSERT INDEXES FOR CATAGORY & NO. OF PERSONS IN EACH CATAGORY
1, 100,
ENTER THE NO. OF FOODS
20,
ENTER THE INDEXES FOR FOODS
   6   8  10  11  12  14  15  20  21  24
  25  31  41  46  58  59  65  66  67  70
ENTER THE PER UNIT PRICES OF FOODS
  0.55  0.35  1.15  1.20  1.00  1.00  1.20  0.15  0.20  0.30
  0.30  1.00  0.30  0.50  0.50  0.80  2.50  2.50  0.80  0.50
ENTER MINIMUM REQUIREMENTS
  7.00  7.00  0.40  0.40  0.40  0.40  0.40  0.50  0.50  0.50
  0.50  0.50  2.00  0.50  2.50  2.00  1.00  1.00  1.00  1.00
ENTER THE NO. OF CONSTRAINTS (CONS. ONE FOOD)
0,
2,
ENTER THE NO. OF FOODS & THEIR INDEXES
2, 5,
6, 8,
10, 11, 12, 14, 15,
ENTER THE MIN OR MAX REQUIREMENTS
  35.00   2.80
ENTER SIGNS OF EXTRA CONSTRAINTS(G OR B)
G IF MIN & B IF MAX
BG
ENTER THE WEIGHTAGES
1, 1,
```

THE FINAL RESULTS

WHEN COST IS GIVEN HIGHER PRIORITY:-

RECOMMENDED WEEKLY MENU

SL.NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS
1	WHEAT(ATA)	0.35	2844.14
2	PHUL-GOBEE	1.00	50.00
3	RICE	0.55	700.00
4	CHANA DAL	1.15	40.00
5	MUNG DAL	1.20	40.00
6	URD DAL	1.00	88.28
7	MASUR DAL	1.00	40.00
8	ARHAR DAL	1.20	40.00
9	CURD	0.80	200.00
10	ONION	0.30	50.00
11	POTATO	0.30	50.00
12	BANANA	0.30	200.00
13	NIMBU	0.50	50.00
14	MILK	0.50	250.00
15	VANASPATI	2.50	164.67
16	COCKINGOIL	2.50	100.00
17	SUGAR	0.80	100.00
18	BREAD	0.50	100.00
19	PALAK	0.20	472.78
20	MOOLI-SAG	0.15	930.52

TOTAL WEEKLY COST OF THE MENU=RS. 3126.53

NUTRITIONAL IMBALANCE(TOTAL)= 981.93 %

WHEN NUTRITION IS GIVEN HIGHER PRIORITY:-

RECOMMENDED WEEKLY MENU

SL.NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS
1	WHEAT(ATA)	0.35	871.11
2	PHUL-GOBEE	1.00	50.00
3	RICE	0.55	3201.82
4	CHANA DAL	1.15	827.75
5	MUNG DAL	1.20	40.00
6	URD DAL	1.00	40.00
7	MASUR DAL	1.00	40.00
8	ARHAR DAL	1.20	40.00
9	CURD	0.80	200.00
10	ONION	0.30	228.52
11	POTATO	0.30	429.45
12	BANANA	0.30	200.00
13	NIMBU	0.50	50.00
14	MILK	0.50	495.44
15	VANASPATI	2.50	100.00
16	COCKINGOIL	2.50	106.07
17	SUGAR	0.80	100.00
18	BREAD	0.50	100.00
19	MOOLI-SAG	0.15	50.00
20	PALAK	0.20	223.39

TOTAL WEEKLY COST OF THE MENU=RS. 4631.28

NUTRITIONAL IMBALANCE(TOTAL)= 198.02 %

EFFECT OF COST DECREAMENT ON NUTRITION:-

ITERATION NUMBER:- 1

RECOMMENDED WEEKLY MENU

SL.NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	WHEAT(ATA)	0.35	1406.21
2	RICE	0.55	2070.41
3	CHANA DAL	1.15	792.17
4	MUNG DAL	1.20	40.00
5	URD DAL	1.00	40.00
6	MASUR DAL	1.00	40.00
7	ARHAR DAL	1.20	40.00
8	CURD	0.80	200.00
9	PALAK	0.20	220.94
10	ONION	0.30	50.00
11	POTATO	0.30	420.89
12	BANANA	0.30	200.00
13	NIMBU	0.50	50.00
14	MILK	0.50	454.94
15	VANASPATI	2.50	100.00
16	COCKINGOIL	2.50	108.34
17	SUGAR	0.80	100.00
18	BREAD	0.50	100.00
19	PHUL-GOBEE	1.00	88.44
20	MOOLI-SAG	0.15	50.00

TOTAL WEEKLY COST OF THE MENU=RS. 4122.61

NUTRITIONAL IMBALANCE(TOTAL)= 223.31 %

ITERATION NUMBER:- 2

RECOMMENDED WEEKLY MENU

SL.NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS
1	WHEAT(ATA)	0.35	1907.27
2	PHUL-GOBEE	1.00	88.44
3	RICE	0.55	988.89
4	CHANA DAL	1.15	758.76
5	MUNG DAL	1.20	40.00
6	URD DAL	1.00	40.00
7	MASUR DAL	1.00	40.00
8	ARHAR DAL	1.20	40.00
9	CURD	0.80	200.00
10	PALAK	0.20	220.94
11	ONION	0.30	50.00
12	POTATO	0.30	426.07
13	BANANA	0.30	200.00
14	NIMBU	0.50	50.00
15	MILK	0.50	360.96
16	VANASPATI	2.50	100.00
17	COCKINGOIL	2.50	112.84
18	SUGAR	0.80	100.00
19	BREAD	0.50	100.00
20	MOOLI-SAG	0.15	50.00

TOTAL WEEKLY COST OF THE MENU=RS. 3630.53

NUTRITIONAL IMBALANCE(TOTAL)= 248.87 %

ITERATION NUMBER:- 3

RECOMMENDED WEEKLY MENU

SL.NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	WHEAT(ATA)	0.35	2393.41
2	PHUL-GOBEE	1.00	50.00
3	RICE	0.55	1065.85
4	CHANA DAL	1.15	46.34
5	MUNG DAL	1.20	40.00
6	URD DAL	1.00	105.45
7	MASUR DAL	1.00	40.00
8	ARHAR DAL	1.20	40.00
9	CURD	0.80	200.00
10	PALAK	0.20	524.84
11	ONION	0.30	50.00
12	POTATO	0.30	425.14
13	BANANA	0.30	200.00
14	NIMBU	0.50	50.00
15	MILK	0.50	250.00
16	VANASPATI	2.50	100.00
17	COCKINGOIL	2.50	152.85
18	SUGAR	0.80	100.00
19	BREAD	0.50	100.00
20	MOOLI-SAG	0.15	50.00

TOTAL WEEKLY COST OF THE MENU=RS. 3155.78

NUTRITIONAL IMBALANCE(TOTAL)= 343.77 %

ITERATION NUMBER:- 4

RECOMMENDED WEEKLY MENU

SL.NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	WHEAT(ATA)	0.35	2844.14
2	PHUL-GOBEE	1.00	50.00
3	RICE	0.55	700.00
4	CHANA DAL	1.15	40.00
5	MUNG DAL	1.20	40.00
6	URD DAL	1.00	88.28
7	MASUR DAL	1.00	40.00
8	ARHAR DAL	1.20	40.00
9	CURD	0.80	200.00
10	PALAK	0.20	472.78
11	ONION	0.30	50.00
12	POTATO	0.30	50.00
13	BANANA	0.30	200.00
14	NIMBU	0.50	50.00
15	MILK	0.50	250.00
16	VANASPATI	2.50	164.67
17	COCKINGOIL	2.50	100.00
18	SUGAR	0.80	100.00
19	BREAD	0.50	100.00
20	MOOLI-SAG	0.15	930.52

TOTAL WEEKLY COST OF THE MENU=RS. 3126.53

NUTRITIONAL IMBALANCE(TOTAL)= 981.93 %

```
INSERT THE NO. OF CATAGORY OF PERSONS
3,
INSERT INDEXES FOR CATAGORY & NO. OF PERSONS IN EACH CATAGORY
1, 1,
2, 1,
6, 2,
ENTER THE NO. OF FOODS
23,
ENTER THE INDEXES FOR FOODS
   6    8   10   11   12   14   15   21   22   24
  25   26   31   35   41   58   59   65   66   67
  68   70   71
ENTER THE PER UNIT PRICES OF FOODS
  0.55   0.35   1.20   1.15   1.00   1.00   1.20   0.15   0.20   0.30
  0.20   0.15   0.30   0.50   0.30   0.50   0.80   2.50   2.50   0.80
  0.60   0.50   1.00
ENTER MINIMUM REQUIREMENTS
  7.00   7.00   0.20   0.20   0.20   0.20   0.20   0.70   0.70   0.70
  3.50   1.00   1.50   1.50  14.00  14.00   3.00   1.40   1.40   1.40
  0.10   3.50   3.00
ENTER THE NO. OF CONSTRAINTS (CONS. ONE FUOD)
2,
ENTER THE INDEXES OF SUCH FOODS
6, 8,
ENTER NO. OF CONSTAINTS CONS. MORE THAN ONE FOOD
2,
ENTER THE NO. OF FOUDS & THEIR INDEXES
2, 5,
6, 8,
10, 11, 12, 14, 15,
ENTER THE MIN OR MAX REQUIREMENTS
  14.00  14.00  25.00   2.80
ENTER SIGNS OF EXTRA CONSTRAINTS(G OR B)

G IF MIN & B IF MAX
BBBG
ENTER THE WEIGHTAGES
1, 1, 1, 1,
```

THE FINAL RESULTS

WHEN COST IS GIVEN HIGHER PRIORITY:-

RECOMMENDED WEEKLY MENU

SL.NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	PALAK	0.15	75.72
2	PHUL-GOBEE	0.30	6.00
3	VANASPATI	2.50	5.60
4	EGG	1.00	12.00
5	RICE	0.55	28.00
6	CHANA DAL	1.20	0.80
7	MUNG DAL	1.15	0.80
8	URD DAL	1.00	0.80
9	MASUR DAL	1.00	8.00
10	ARHAR DAL	1.20	0.80
11	CARROT	0.20	2.80
12	ONION	0.30	2.80
13	POTATO	0.20	14.00
14	MOCLI	0.15	4.00
15	CURD	0.80	12.00
16	HARE-MATAR	0.50	6.00
17	COCKINGOIL	2.50	5.60
18	BANANA	0.30	56.00
19	JAGGERY	0.60	0.40
20	BREAD	0.50	14.00
21	WHEAT(ATA)	0.35	38.93
22	SUGAR	0.80	5.60
23	MILK	0.50	56.00

TOTAL WEEKLY COST OF THE MENU=RS. 167.74

NUTRITIONAL IMBALANCE(TOTAL)= 1634.16 %

WHEN NUTRITION IS GIVEN HIGHER PRIORITY:-

RECOMMENDED WEEKLY MENU

SL.NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS)
1	PALAK	0.15	7.18
2	PHUL-GOBEE	0.30	6.00
3	VANASPATI	2.50	5.60
4	EGG	1.00	16.24
5	RICE	0.55	76.53
6	CHANA DAL	1.20	0.80
7	MUNG DAL	1.15	8.00
8	URD DAL	1.00	0.80
9	MASUR DAL	1.00	0.80
10	ARHAR DAL	1.20	0.80
11	CARROT	0.20	2.80
12	ONION	0.30	2.80
13	POTATO	0.20	14.00
14	MOCLI	0.15	4.00
15	CURD	0.80	12.00
16	HARE-MATAR	0.50	6.00
17	COCKINGOIL	2.50	5.60
18	BANANA	0.30	56.00
19	JAGGERY	0.60	0.40
20	BREAD	0.50	14.00
21	WHEAT(ATA)	0.35	28.00
22	SUGAR	0.80	5.60
23	MILK	0.50	56.00

TOTAL WEEKLY COST OF THE MENU=RS. 185.65

NUTRITIONAL IMBALANCE(TOTAL)= 557.81 %

EFFECT OF COST DECREAMENT ON NUTRITION:-

ITERATION NUMBER:- 1

RECOMMENDED WEEKLY MENU

SL.NO.	FOODS	P.U.COST(RS.)	AMOUNTS(100GMS
1	PALAK	0.15	7.30
2	PHUL-GOBEE	0.30	6.00
3	VANASPATI	2.50	5.60
4	EGG	1.00	15.36
5	RICE	0.55	32.78
6	CHANA DAL	1.20	0.80
7	MUNG DAL	1.15	8.00
8	URD DAL	1.00	0.80
9	MASUR DAL	1.00	0.80
10	ARHAR DAL	1.20	0.80
11	MILK	0.50	56.00
12	CARROT	0.20	2.80
13	ONION	0.30	2.80
14	POTATO	0.20	14.00
15	MOOLI	0.15	4.00
16	CURD	0.80	12.00
17	HARE-MATAR	0.50	6.00
18	COCKINGOIL	2.50	5.60
19	BANANA	0.30	56.00
20	JAGGERY	0.60	0.40
21	WHEAT(ATA)	0.35	47.46
22	SUGAR	0.80	5.60
23	BREAD	0.50	14.00

TOTAL WEEKLY COST OF THE MENU=RS. 167.53

NUTRITIONAL IMBALANCE(TOTAL)= 609.20 %

CHAPTER 5

CONCLUSIONS AND SUGGESTIONS

5.1 Conclusions

The present work advocates an interesting and quite useful application of goal programming - a recently developed approach to multi-objective problems. The results are found to be quite interesting.

An important conclusion which can be made by examining the results of this work is that a balanced diet must not always be a costly one. Even in the absence of milk, fruits or such other costly items, minimum nutritional requirements are fulfilled and thus a balanced diet can be formed at reasonably low cost. However, such a diet is found to consist of very few food items and as such diets include some foods like cereals and vegetables in sufficiently large amounts, an individual may not prefer it.But then, the user may always specify an upper limit on all such foods. In that case, the cost of the diet will obviously increase, but it will be still reasonable.

One important point to be noted about the formulation of the problem is that while formulating the nutritional imbalance goal, equal weightages have been given to all the nutrients i.e. it has been assumed that the percentage imbalance of all the individual nutrients have equal importance to the nutritional quality of the diet. But, this may not be the case,some nutrients may be more important than

others from imbalance point of view. However, this may be easily incorporated in the present formulation after consulting a nutritionist. All one has to do is to multiply all the nutritional constraints (which specify minimum requirements) by the relative weightages. For instance, if the imbalances in vitamin A and calcium are considered to be respectively three and four times more important than the imbalance in other nutrients (which, for instance, are considered to have equal importance), then the constraints for the above two nutrients are to be multiplied by 3 and 4 respectively and then the nutritional imbalance goal is to be reformulated.

Another point to be noted is about the cost minimization goal. This goal is considered after the satisfaction of the user's choices and in some cases, the cost of the resultant diet may be well above an individual's budget. To get rid of this, a celling which is nothing but the aspiration level, may be put on the cost constraint (or goal) and this goal is to be given higher priority than the goal which considers user's choices. In that case, however, all the user's choices may not be fully satisfied which implies that in the specified cost, a diet which satisfies all the choices of the user cannot be formulated and the resultant diet is the one which satisfies the choices to the best possible extent.

Depending upon the availability of foods and social and religious believes, the food habits of people of different regions are different. Therefore, there cannot be one and only one prescribed diet for a particular catagory of persons of every region. Although, the program developed gives a good number of diets to select from, still these may be quite impracticable for a particular region. This is because while considering the availability of foods in different months of the year, the foods which are most commonly available in most parts of the country are only considered. Thus if some more foods are available or some of the foods considered here are not available in a particular region, then changes have to be made accordingly in the data file. Likewise, the prices also very from region to region and month to month. In the present work, the prices have been taken as those prevailing in Roorkee. To formulate diet for any other region, changes have to be made in the data file accordingly.

Again, prices of foodstuffs also change with time. The prices taken here are roughly based on those prevailing in the year 1988. However, as the results depend on the relative prices of different foodstuffs, so any increase or decrease in prices of food-stuffs will not change the results too much (unless the change in price is too much uneven).

Thus it can be concluded that goal programming technique can be very successfully applied to diet - planning.

5.2 Suggestions and Scope for further work

The work presented in this dissertation provides a very powerful tool for diet and menu planning. However, the various objective functions used should be considered illustrative. There is need to develop objective functions which could more closely reflect the effects of under and over nourishment and nutritional imbalances. In particular, the nutritional imbalance objective function needs to be recast and this would need collaboration between nutrition experts and system analysits. Further, it is very likely that a linear formulation may not suffice and in that case, non-linear techniques will have to be incprporated in the present program.

References

1. J.E.Park, K.Park (1977), 'Text book of preventive and Social medicine', Sixth edition, Jabalpur.
2. Swaminathan, M. (1974), 'Essentials of food and nutrition', Ganesh and Co., Madras -17.
3. V.E.Smith (1959), 'Linear programming methods for the determination of palatable human diets', J.Farm.Econ., 41, pp.272-283.
4. J.Hruby (1970), 'Versuch ZUR Bestimmung der optimal emphorhlenen lebensmittlemengen out der basis der linearer programmie-rung' Z.Ernahr Wiss 17.17.
5. P.V.Sukhatme (1961), 'The world's hunger and future needs of food supplies', J.R.Statist.Soc., 124A, 463.
6. N.Unkelsbay and K.Unkelsbay (1978), 'An automated system for planning menus for the elderly in title VII nutrition programs', Food Technol.32, 80-83.
7. T.NGARMASK, A.M.Anderson and M.D.Earle (1980), 'Menu planning for Northeast Thailand paper presented at the Symposium on Food Product and Process Development in Pacific Countries, Newzealand.
8. W.Edwardson, A.M. Anderson, P.Chitterporn, T.Ngurmask and M.D.Earle (1980), 'Linear programming in food formulation design', Paper presented at the Symposium on food product and process development in pacific countries. Newzealand.

9. FAO/WHO joint Expert group (1965), 'Requirements of ascorbic acid, vitamin D, vitamin B_{12}, folate and iron, FAO Nutrition meetings Report series No. 47, FAO, Rome.

10. H.S.Mitchell, H.I.Ryloprn, L.Anderson and M.J.Diblele (1968), 'Nutrition in Health and Disease' Lippin coH Philadelphia.

11. FAO/WHO joint Expert committee report on Nutrition (1966), 7th Report, FAO, Rome.

12. A Charnes and N.W.Cooper (1961), Management models and the Industrial applications of linear programming' Vol.1 John Willey Sons, Inc. New York London

13. Y.Ijiri (1965), 'Management Goals and acconnting for control,' North-Holland publishing company, Amsterdam.

14. S.M.Lee (1972), 'Goal programming for Decision analysis', Anerbach, Philadelphia.

15. S.M.Lee (1977), 'Linear optimization for management'.

16. J.P.Ignizio (1978), 'A review of goal programming: A tool for mutriobjective analysis', J.Opl.Res.Soc.Vol.29.11 pp. 1109 to 1119.

17. J.P.Ignizio (1982),'Linear programming in single and multi-objective systems', Prentice Hall, London.

18. A.M.Anderson and M.D.Earle (1983), 'Diet planning in the third world by linear and Goal programming', J.opl. Res. Soc. Vol. 34, pp. 9-16.

19. C.Gopan, B.V.Ramasastri, S.C.Balasubramaniam (1987) 'Nutritive value of Indian foods' National Institute of Nutrition, ICMR, Hyderabad, India.

20. Indian Council of Medical Research (1984), 'Recommended Dietary intakes for Indians', ICMR, New Delhi-16.