COMPUTER UNIVERSITY (MANDALAY)

FINAL YEAR PROJECT REPORT
ON

EVALUATION OF NUTRIENT BLENDING RESULT FOR HEN'S FOOD DIET BY USING DUALITY METHOD

Bachelor of Computer Science

(B.C.Sc.)

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Abstract

This system evaluate the nutritional requirement for hen's food by using duality method. Duality is one of the most operational research (OR) tool.The original form of every mathematical programming problem is called primal and the second form is called dual. In the primal side, accept the necessary input to produce outputs. In the dual side, produce the output result by using the input from the primal side.This system requests the current prices for the food type of the hen. And then system use these inputs as the objective function and formulate the equations with the nutrient percentage. The objective function is the sum of the cost per serving of each food product. The goal of this system is to minimize the total costand maximize the nutrient blending ratio. The system is implemented with java programming language.

CONTENTS

		PAGE
Acknowledgements		**i**
Group Member List		**ii**
Project Schedule		**iii**
Abstract		**iv**
List of Figures		**v**
List of Tables		**vi**
CHAPTER 1	**INTRODUCTION**	
1.1	Introduction	1
1.2	Objectives of the Project	1
1.3	Project Requirements	2
	1.3.1 Hardware Requirements	2
	1.3.2 Software Requirements	2
CHAPTER 2	**THEORY BACKGROUND**	
2.1	Operation Research	3
2.2	Linear Programming	4
	2.2.1 Linear Programming Terminology	5
	2.2.2 Terms of Linear Programming	7

2.2.3 Type of Additional Variables 8

2.2.4 Application Areas of Linear Programming 9

2.2.5 Advantages of Linear Programming 10

2.2.6 Methods of Linear Programming 10

2.2.7 Linear Programming: Duality 11

2.2.8 Definition of Dual LP Model 11

2.3 Duality 12

2.3.1 Relationship between the primal problem and the dual problem 13

2.3.2 Economic Interpretation 15

2.3.3 Rules for Constructing the Dual from Primal 16

2.3.4 The Character of Dual Solutions 17

2.3.5 Advantage of Duality 17

CHAPTER 3	**DESIGN AND IMPLEMENTATION**		
	3.1	System Flow Diagram	19
	3.2	Use Case Diagram	20
	3.3	Database Design	21
	3.4	Data Set Tables	22
	3.5	Implementation of the Project	23
		3.5.1 Main Window of the System	23
		3.5.2 Home Page of the System	24
		3.5.3 Type of Hen Food Form of System	25
		3.5.4 Information Form of System	26
		3.5.5 Calculation Form of System	27
		3.5.6 Error Message of System	28
		3.5.7 Result Form of System	29
		3.5.8 Result Form of System	30
CHAPTER 4	**CONCLUSION**		
	4.1	Conclusion	31
	4.2	Advantages of the Project	31
	4.3	Limitations	31
	4.4	Further Extension	32
References			

List of Figures

Figure		Page
3.1	System Flow Diagram	19
3.2	Use Case Diagram	20
3.3	Database Design of System	21
3.4	The main window of the system	23
3.5	Home Page of the System	24
3.6	Type of Hen Food Form of System	25
3.7	Information Form of System	26
3.8	Calculation Form of System	27
3.9	Error Message of System	28
3.10	Result Form of System	29
3.11	Result Form of System	30

List of Tables

Table		Page
(2.1)	Additional Variables	9
(2.2)	Matrix Definition of Primal and Dual Problems	12
(2.3)	Algebraic Definition of Primal and Dual Problems	12
(3.4)	Ingredients Ratio for each Food Type of Hen	22
(3.5)	Minimum Nutrient Ratio for Hen	22

CHAPTER 1

INTRODUCTION

1.1Introduction

Linear Programming (LP) is in some sense the fundamental tool of Operation Research. The first operation research programs have been modeled by using linear objective function and constraints. Mathematical Programming solves the problem of determining the optimal allocations of limited resource required to meet a given objective.

The goal of the diet problem is to find the cheapest combination of foods that will meet the minimal daily nutritional requirements of an individual. To solve the problem, the complete nutritional information for each food product must be known as the dietary constraints for the serving of each food product and the constraints are the minimal dietary guidelines to be met.

In the real world, computer programs designed to solve LP problems are now widely available. Most large LP problems can be solved with just a few minutes of computer time. So, this system solves objectives to get more convenient result for user by using duality method of Linear Programming.

1.2 Objectives of the System

The objectives of the system are:

- To maximize the nutrient ratio and minimize the total cost
- To avoid human errors and miscalculation.
- To help to decision makers or managers in evaluating nutritional requirements of hen's food.

- To avoid the time consuming

1.3 Project Requirements

1.3.1 Hardware Requirements

The system will be required

- Intel Dual Core 1GHz Processor.

  512 MB of RAM, 40 GBHD
- Other *peripheral devices.(monitor, keyboard, mouse)*

1.3.2 Software Requirements

Software will be required

- Window operation system(xp, 7, 8 or heigher)
- Eclipse(Luna)
- Java (JDK 7)

CHAPTER 2

THEORY BACKGROUND

2.1 Operation Research

Operation research, or operational research in British usage, is discipline that deals with the applications of advanced analytical methods to help make better decisions. It is often considered to be a sub-field of mathematics. The terms management science and decision science are sometimes used as synonyms.

Employing techniques from other mathematical sciences, such as mathematical modeling, statistical analysis and mathematical optimization, operations research arrives at optimal or near-optimal solutions to complex decision-making problems. Because of its emphasis on human-technology interaction and because of its focus on practical applications, operation research has overlap with other disciplines, notably industrial engineering and operations management, and draws on psychology and organization science. Operations research is often concerned with determining the maximum (of profit, performance, or yield) or minimum (of loss, risk, or cost) of some real world objective. Originating in military efforts before World War II, its techniques have grown to concern problems in a variety of industries.Operational research (OR) encompasses a wide range of problem-solving techniques and methods applied in the pursuit of improved decision-making and efficiency, such as simulation, mathematical optimization, queuing theory and other stochastic-process models, Markov decision processes, econometric methods, data envelopment analysis, neural networks, expert systems, decision analysis, and the analytic hierarchy process. Nearly all of these techniques involve the construction of mathematical models that attempt to describe the system. Because of the systems, decision analysis, and the analytic hierarchy process. Nearly all of these techniques involve the construction of mathematical models that attempt to describe the system. Because of the computational and statistical nature of most of these fields, OR also has strong ties to computer science and analytics. Operational researchers faced with a new problem must determine which of these techniques are most appropriate given the nature of the system, the goals for improvement, and constraints on time and computing powerThe major sub-disciplines in modern operational research are:

- Linear Programming
- Computing and information technologies
- Financial engineering
- Manufacturing, service sciences, and supply chain management
- Marketing Engineering
- Policy modeling and public sector work
- Revenue management
- Simulation
- Stochastic models
- Transportation

2.2 Linear Programming

Linear programming (LP; also called linear optimization) is one of the most successful disciplines within the field of operation research. Linear programming is a method to achieve the best outcome (such as maximum profit or lowest cost) in a mathematical model whose requirements are represented by linear relationships. Linear programming is a special case of mathematical programming (mathematical optimization).More formally, linear programming is a technique for the optimization of a linear objective function, subject to linear equality and linear inequality constraints. *Linear programming is the considerable* field of optimization for several problems. Many practical problems in operation research can be express as linear programming problems.

Historically, ideas from linear programming have inspired many of the central concepts of optimization theory, such as duality, decomposition, and the importance of convexity and its generalizations. Likewise, linear programming is heavily used in microeconomics and company management, such as planning, production, transportation, technology and other issues. Although the modern management issues are ever-changing, most companies would like to maximize profits or minimize costs with limited resources. Therefore, many issues can be characterized as linear programming problems.

2.2.1Linear Programming Terminology

Decision variable: Decision variables describe the quantities that the decision makers would like to determine. They are the unknowns of a mathematical programming model. Typically we will determine their optimum values with an optimization method. In a general model, decision variables are given algebraic designations such as $x_1, x_2, x_3, \ldots, x_n$. The number of decision variables is n, and x_j is the name of the j^{th} variable. In a specific situation, it is often convenient to use other names such as x_{ij} or y_k or $z(i, j)$. In computer models we use names such as FLOW1 or AB_5 to represent specific problem-related quantities. An assignment of values to all variables in a problem is called a solution.

Objective function: The objective function evaluates some quantitative criterion of immediate importance such as cost, profit, utility, or yield. The general linear objective function can be written as

$$z = c_1x_1 + c_2x_2 + \ldots + c_nx_n = \sum_{j=1}^{n} c_jx_j$$

Here c_j is the coefficient of the j^{th} decision variable. The criterion selected can be either maximized or minimized

Constraints: A constraint is an inequality or equality defining limitations on decisions. Constraints arise from a variety of sources such as limited resources, contractual obligations, or physical laws. In general, an LP is said to have m linear constraints that can be stated as

$$\sum_{j=1}^{n} a_{ij}x_j \begin{Bmatrix} \leq \\ = \\ \geq \end{Bmatrix} b_i \text{ for } i = 1\ldots m$$

One of the three relations shown in the large brackets must be chosen for each constraint. The number a_{ij} is called a "technological coefficient," and the number b_i is called the "right-side" value of the i^{th} constraint. Strict inequalities (<, >, and) are not permitted. When formulating a model, it is good practice to give a name to each constraint that reflects its purpose.

Simple upper bound: Associated with each variable, x_j, may be a specified quantity, u_j, that limits its value from above;

$$x_j \leq u_j \text{ for } j = 1\ldots n$$

When a simple upper is not specified for a variable, the variable is said to be unbounded from above.

Non-negativity restrictions: In most practical problems the variables are required to be nonnegative;

$$x_j \geq 0 \text{ for } j = 1\ldots n$$

- **Objective**: the system state or performance level intended to be attained.
- **Objective function**: an algebraic equation that stated the end one seeks to achieve.
- **Optimal**: the best possible alternative that satisfies a set of constraints.
- **Optimal solution**: a solution that yields the best possible value (either maximum or minimum) for a given objective function and set of constraints.
- **Parameter**: a numerical constant defining some system attribute
- **Sensitivity analysis**: a procedure that determines the effect on the model solution and the value of the objective function for small changes in model parameters; a technique that throws light on the degree of stability of a given solution when the model is slightly altered.
- **Shadow price**: the opportunity cost (economic value forgone) of not having one additional unit of a particular resource; the maximum premium one would be willing to pay for an additional unit of some resource.
- **Solution**: a set of values for the decision variables that is feasible (complies with all constraints).
- **Uncontrollable variable**: a non-constant quantity that defines some system attribute.
- **Value**: the numerical quantity generated by the objective function for a given solution.

2.2.3 Types of Additional Variables

Three types of additional variables in linear programming, namely

- Slack variables (s)
- Surplus variables (-s)
- Artificial variables (A) are added in given LP problem to convert it into standard form.

Table (2.1) Additional Variables

Type of constraints	Extra variables to be added	Coefficient of extra variables in the objective function		Presence of variables in the initial solution mix
		Max Z	Min Z	
Less than or equal to (<=)	Add only slack variable	0	0	Yes
Greater than or equal to (>=)	• Subtract surplus variables	0	0	No
	and • Add artificial variable	-M	+M	Yes
Equal to (=)	Add only artificial variables	-M	+M	Yes

2.2.4 Application Areas of Linear Programming

Some of the major application areas to which Linear Programming(LP) can be applied are:

- Blending

- Production planning
- Oil refinery management
- Distribution
- Financial and economic planning
- Manpower planning
- Blast furnace burdening
- Farm planning

And, also linear programming is used to solve problems in many aspects of business administration including:

- Product mix planning
- Truck routing
- Staff scheduling
- Financial portfolio
- Corporate restructuring

2.2.5 Advantages of Linear Programming

- Provide the best allocation of available resources
- Provide clarity of thought and better appreciation of problem
- Put across view points more technique helps to make the best possible use of available productive resources (such as time, labour, machines etc.)
- The quality of decision making is improved by this technique because the decisions are made objectively and not subjectively
- By using the technique, wastage of resources like time and money may be avoided

2.2.6 Methods of Linear Programming

- Graphical Solution Method
- Simplex Method
- Two Phase Method
- Big-M Method or Method of Penalties
- Duality and
- Analytical Method

2.2.7Linear Programming: Duality

Associated with every linear programming problem, there is another linear program called its dual, involving a different set of variables, but sharing the same data. When referring to the dual problem of an LP, the original LP is called the primal or the primal problem. Together, the two problems are referred to as a primal, dual pair of linear programs. When a solution is obtained for a linear program with the revised simplex method, the solution to a second model is called the dual problem. Duality in linear programming is essentially a unifying theory that develops the relationships between a given linear program and another related linear program. Every mathematical programming problem has a dual form. There are several benefits to be gained from studying the dual problem, not the least of which is that it often has a practical interpretation that enhances the understanding of the original (called the primal) model.

2.2.8 Definition of Dual LP Model

The dual model is derived by construction from the standard inequality form of linear programming model as shown in Tables 2.2 and 2.3. All constraints of the primal model are written as less than or equal to, and right-hand-side constants may be either positive or negative. In

A, has m rows and n columns. The dual model used the same arrays of coefficients but arranged in a symmetric fashion.

The dual vectorπ has m components.

Table (2.2) Matrix Definition of Primal and Dual Problems

(P) Maximize $Z_{p=cx}$	(D) Minimize $Z_{d=\pi b}$
Subject to $Ax <= b$	Subject to $\pi A >= c$
$X >= 0$	$\pi >=0$

Table (2.3) Algebraic Definition of Primal and Dual Problems

(P) Maximize $Z_p=c_1x_1+c_2x_2+\ldots+c_nx_n$	(D) Minimize $Z_d=b_1\pi_1+b_2\pi_2+\ldots+b_m\pi_m$
Subject to constraints:	Subject to constraints:
$a_{11}x_1+a_{12}x_2+\ldots+a_{1n}x_n<= b_1$	$a_{11}\pi_1+a_{21}\pi_2+\ldots-a_{m1}\pi_m>=c_1$
$a_{21}x_1+a_{22}x_2+\ldots+a_{2n}x_n<= b_2$	$a_{12}\pi_1+a_{22}\pi_2+\ldots-a_{m2}\pi 2 >=c_2$
⁝⁝	⁝⁝
$a_{m1}x_1+a_{m2}x_2+\ldots+a_{mn}x_n<=b_m$	$a_{1n}\pi_1+a_{1n}\pi_2+\ldots-a_{mn}\pi_m>= c_n$
$x_1>= 0,x_2>= 0, \ldots, x_n>= 0$	$\pi_1>= 0, \pi_2>= 0,\ldots,\pi_3>= 0$

2.3 Duality

In mathematical optimization theory, duality means that optimization problems may be viewed from either of two perspectives, the primal problem or the dual problem (the duality principle). The solution to the dual problem provides a lower bound to the solution of the primal (minimization) problem. However in general the optimal values of the primal and dual problems need not be equal. Their difference is called the duality gap. For convex optimization problems, the duality gap is zero under a constraint qualification condition. Thus, a solution to the dual problem provides a bound on the value of the solution to the primal problem; when the problem is convex and satisfies a constraint qualification, then the value of an optimal solution of the primal problem is given by the dual problem.

In the context of linear programming duality implies that each linear programming problem can be analyzed in two different ways but having equivalent solutions. Each LP problem (both Maximization and minimization) stated in its original form ha associated with another linear programming problem (called dual linear programming problem or in short dual), which is unique, based on the same data. In general, it is immaterial which of the two problems is called primal or dual, since the dual of the dual is primal.

The format of the simplex method is such that solving one type of problem is equivalent to solving the other simultaneously. Thus, if the optimal solution to one is known, then the optimal solution of the other can also be read from the final simplex table. In some cases, considerable computing time can be saved by solving the dual.

2.3.1 Relationship between the primal problem and the dual problem

In the linear case, in the primal problem, from each sub-optimal point that satisfies all the constraints, there is a direction or subspace of directions to move that increases the objective function. Moving in any such direction is said to remove slack between the candidate solution and one or more constraints. An infeasible value of the candidate solution is one that exceeds one or more of the constraints.In the dual problem, the dual vector multiplies the constants that determine the positions of the constraints in the primal. Varying the dual vector in the dual problem is equivalent to revising the upper bounds in the primal problem. The lowest upper bound is sought. That is, the dual vector is minimized in order to remove slack between the candidate positions of the constraints and the actual optimum. An infeasible value of the dual vector is one that is too low. It sets the candidate positions of one or more of the constraints in a position that excludes the actual optimum.This intuition is made formal by the equations in Linear programming: Duality.An interesting example is the shortest path problem. The shortest path problem in a positively weighted graph can be formulated as a special minimum cost flow problem, which is in primal form. And the well-known Dijkstra's algorithm is the primal-dual algorithm that solves the dual form and starts from zeros. Ye et al. pointed out that the popular A* algorithm is also the primal-dual algorithm that solves the dual form. But it starts from -h, where h > 0 is the consistent heuristic. Hence one explanation that the A* algorithm is more efficient than the Dijkstra's algorithm is that as initial solution, h is better than 0.

Primal

Maximize $Z=\sum_{j=1}^{n} c_j x_j$

Subject to: $\sum_{j=1}^{n} a_{ij}x_j <= b_i$ (i=1,2, …,m),

$x_j >= 0$ (j=1,2,…,n)

Dual

Minimize $v=\sum_{i=1}^{m} b_i y_i$

Subject to: $\sum_{i=1}^{m} a_{ij}y_i >= c_j$ (j=1,2, …,n)

$y_i >= o$ (i=1,2, …,m)

Form an algorithmic point of view, solving the primal problem with the dual simplex method is equivalent to solving the dual problem with the

$y_i >= o$ (i=1,2, …,m)

Form an algorithmic point of view, solving the primal problem with the dual simplex method is equivalent to solving the dual problem with the primal method is equivalent to solving the dual problem with the primal simplex method. When written in inequality form, the primal and dual models are related in the following ways:

- When the primal has *n* variables and *m* constraints, the dual has *m* variables and *n* constraints.
- The constraints for the primal are all *less than equal to*, while the constraints for the dual are all *greater than or equal to.*
- The objective of the primal is to *maximize*, while the objective for the dual is to *minimize*.
- All variables for either problem are restricted to be nonnegative.
- For every primal constraint, there is a dual variable. Associated with the i^{th} primal constraints is dual variable π_i. The dual objective function coefficient for π_i is the right-hand-side of the i^{th} primal constraint, b_i.
- For every primal variable, there is a dual constraint. Associated with primal variable x_j is the i^{th} dual constraint whose right-hand-side is the primal objective function coefficient c_j.
- The number a_{ij} is, in the primal, the coefficient of x_j in the i^{th} constraint, while in the dual, a_{ij} is the coefficifent of π_i in the j^{th} constraint.

2.3.2 Economic Interpretation

- Z = return
- x_j= units of variable j
- b_i= units of resource i

- c_j = return per unit of variable x_j
- a_{ij} =requirement of resource I by per unit of variable j

Primal

Maximize (return) Z = $\sum_{j=1}^{n}$ {return / units of variables x_j}(units of variable x_j)

Subject to constraints:

$\sum_{j=1}^{n}$ {units of resource i / units of variable x_j}(units of variable x_j) <= units of resource i;

(i=1,2, …, n) and x_j>= 0

Dual

Minimize (return) Z=$\sum_{i=1}^{m}$ (units of resource i) y_i

Subject to constraints:

$\sum_{i=1}^{m}$ {units of resource i / units of variable x_j} y_i>= {return / units of variable x_j};

(j=1,2, …,m) and y_i>= 0

2.3.3 Rules for Constructing the Dual from Primal

The rules for constructing the dual from the primal or primal from the dual when using the symmetrical form are:

- If the objective function of the primal is to be maximized, then the objective function of the dual becomes minimization and vice versa.
- For a maximization primal with all <= type constraints there exists a minimization dual problem with all >= type constraints and vice

versa. Thus the inequality sing is reversed in all the constraints except the non-negativity conditions.

- Each constraint in the primal corresponds to a dual variable in the dual and vice versa. Thus given a primal problem with m constraints and n variables there exists in a dual problem with m variables and n constraints.
- The right hand side constraints $b_1, b_2, \ldots, b_m$ of the primal become the coefficient of the dual variables $y_1, y_2, \ldots, y_m$in the dual objective function Z_y. also the coefficients $c_1, c_2, \ldots, c_n$ of the primal variables $x_1, x_2, \ldots, x_n$ in the objective function become the right hand side constraints in the dual.
- The matrix of the coefficients of variables in dual is the transpose of the matrix of coefficients of variables in primal and vice versa.

2.3.4 The Character of Dual Solutions

If the primal problem possesses a unique non-degenerate, optimal solution, then the optimal solution to the dual is unique. However, dual solutions arise under a number of other conditions. Several of the cases which can arise are:

- When the primal problem has a degenerate optimal solution, then the dual has multiple optimal solutions.
- When the primal problem has multiple optimal solution, then the optimal dual solution is degenerate.
- When the primal problem is unbounded, then the dual is infeasible.
- When the primal problem is infeasible, then the dual is unbounded.

2.3.5Advantage of Duality

- It is advantages to solve the dual of a primal having fewer constraints, because the number of constraints usually equals the number of iterations required to solve the problem.
- It avoids the necessity for adding surplus or artificial variables and solves the problem quickly (i.e. primal-dual algorithm). In economics, duality is useful in the formulation of the input and output systems. It is also useful in
- physics, engineering, mathematics, etc.
- The dual variables provide and important economic interpretation of the final solution of an LP problem.
- It is quite useful when investigation changes in the coefficients or formulation of an LP problem (i.e. in sensitivity analysis).
- Duality is used to solve an LP problem by the simplex method in which the initial solution is infeasible (i.e. the dual simplex method).

CHAPTER 3

DESIGN AND IMPLEMENTATION

3.1System Flow Diagram

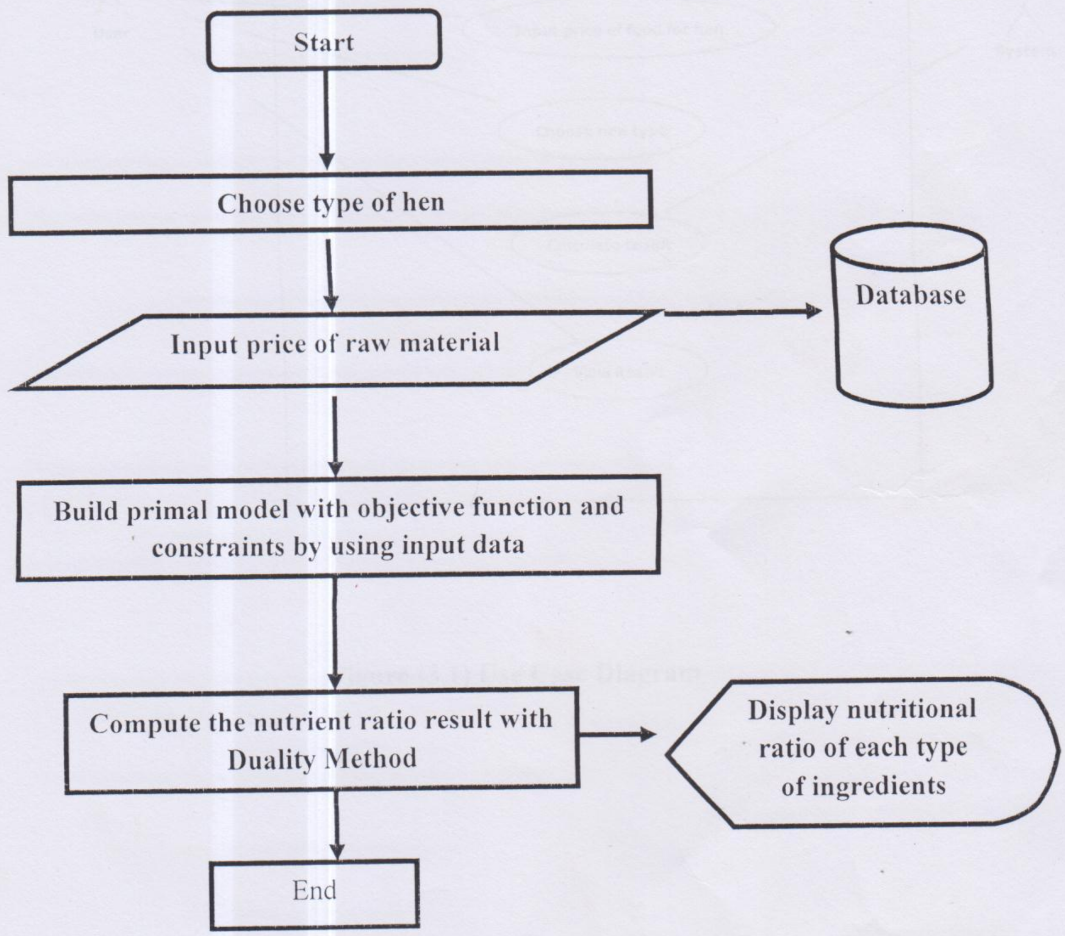

Figure (3.1) System Flow Diagram

3.2 Use Case Diagram

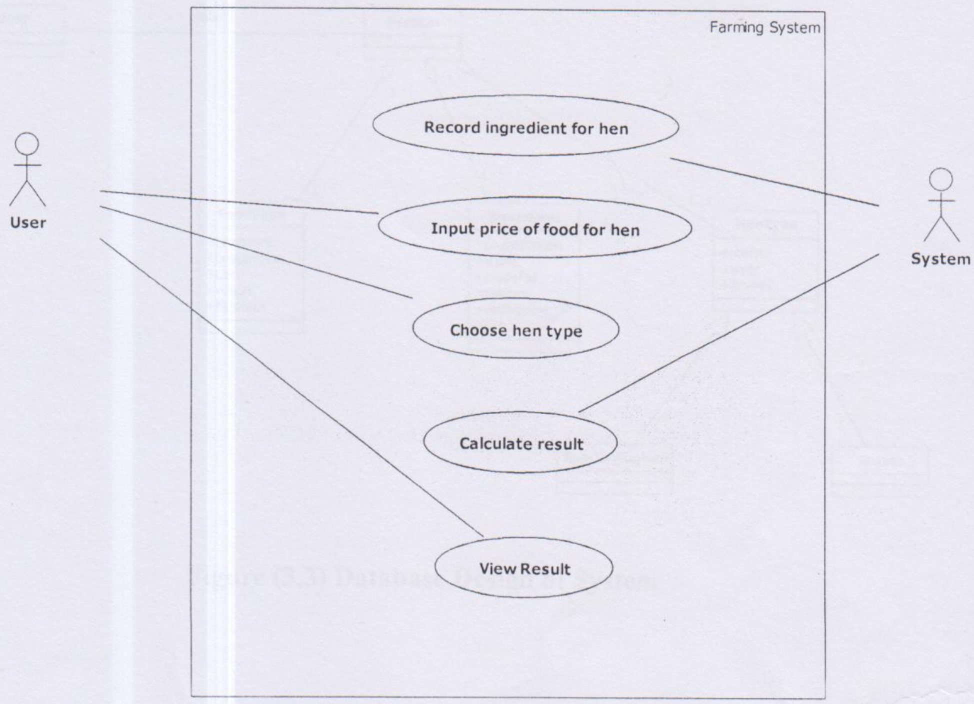

Figure (3.1) Use Case Diagram

3.3 Database Design of System

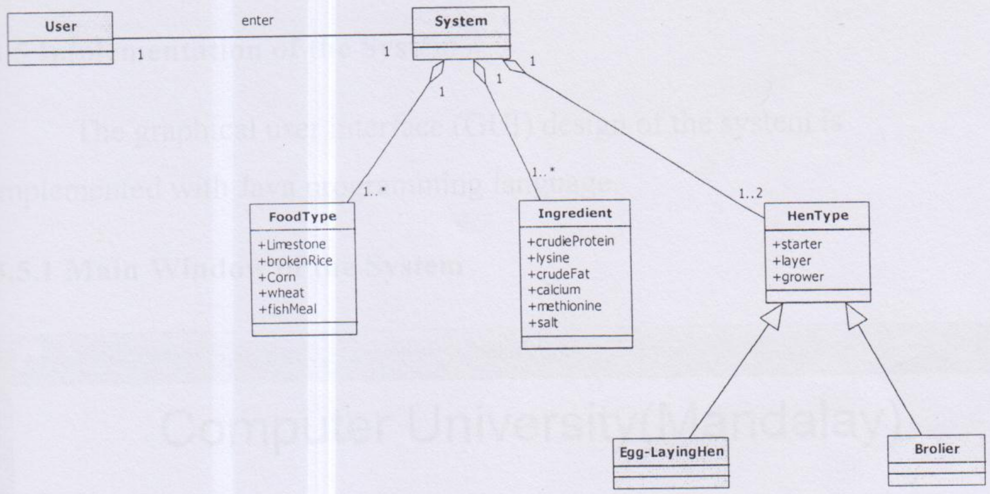

Figure (3.3) Database Design of System

Methionine 6.98%

Salt 4.32%

3.5 Implementation of the System

The graphical user interface (GUI) design of the system is implemented with Java programming language.

3.5.1 Main Window of the System

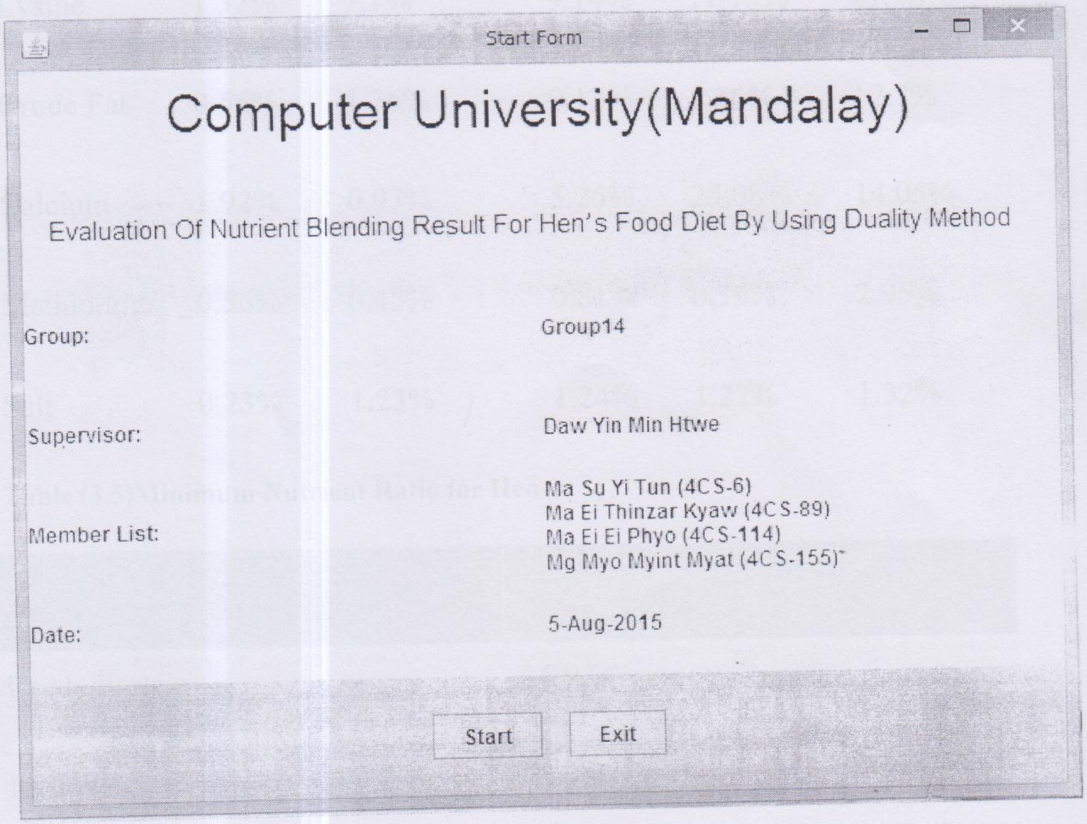

Figure (3.4) The main window of the system

In Figure (3.3), if user click the "Start" button, we can access the system. If user click the "Exit" button, we exist from the main window.

3.4 Data Set Tables

Tale (3.4) Ingredients Ratio for each Food Type of Hen

Nutrient	Broken Rice	Limestone	Corn	Wheat	Fish Meal
Crude Protein	32.95%	2.96%	18.23%	40.23%	50.12%
Lysine	1.32%	2.1%	9.14%	11.75%	21.46%
Crude Fat	0.56%	1.36%	0.17%	1.36%	12.7%
Calcium	1.92%	0.97%	5.26%	25.08%	14.05%
Methionine	0.56%	0.45%	0.81%	0.39%	2.95%
Salt	0.23%	1.23%	1.24%	1.22%	1.32%

Table (3.5)Minimum Nutrient Ratio for Hen

Nutrient	Levels
Crude Protein	36.97%
Lysine	23.15%
Crude Fat	13.02%
Calcium	9.99%

3.5.2 Home Page of the System

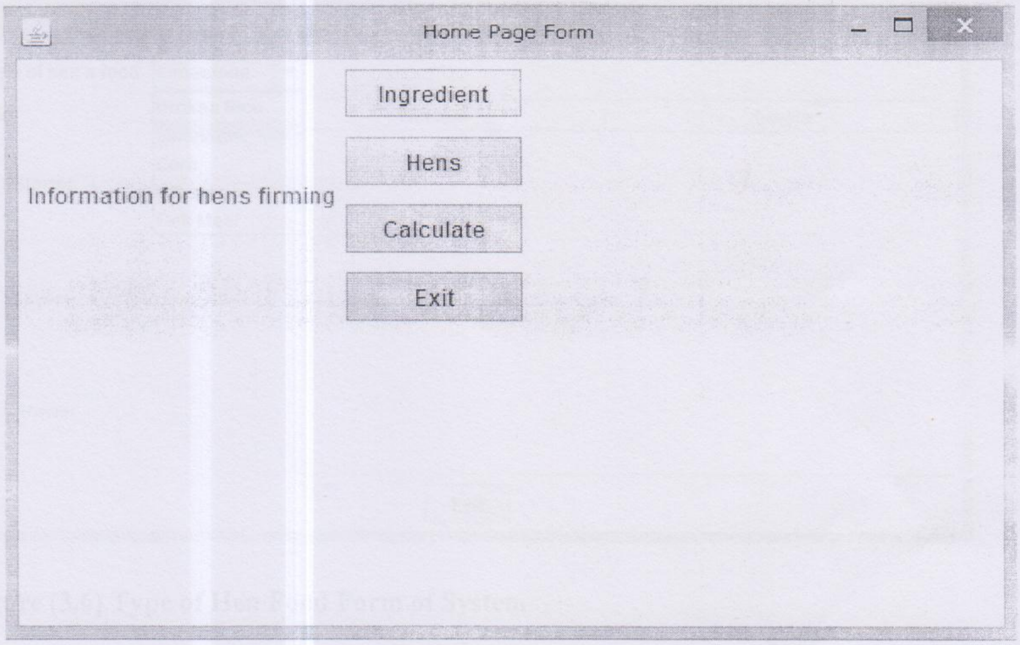

Figure (3.5) Home Page of the System

In Figure (3.5), user can choose the various tasks by clicking the button such as Ingredient, Hens, Calculate and Exit button. If user click the "Ingredient" button, user can view the ingredient information for hens, show in Figure (3.6). If user click the "Hens" button, user can view the type of hens show in Figure (3.7). If user click the "Calculate" button, user can view the result of the system show in Figure (3.10). If user click the "Exit" button, exist from the system.

3.5.3 Type of Hen Food Form of System

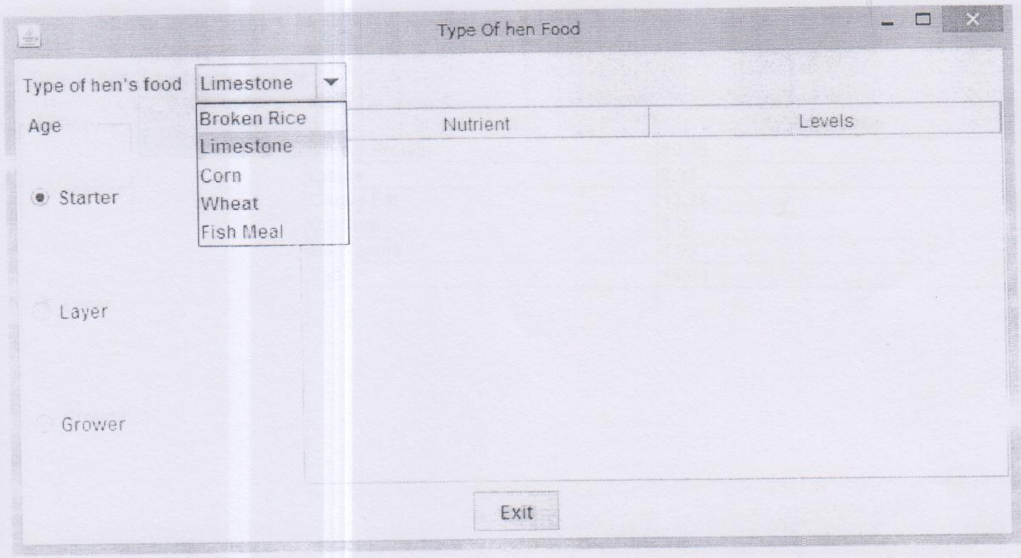

Figure (3.6) Type of Hen Food Form of System

In Figure (3.6), when user click the "Ingredient" button, user perform the following tasks. Choose type of hen's food from hen's food list and select the age of hen then system show type of hen's ingredient such as Broken Rice, Limestone, Corn, etc; with their corresponding nutrient percentage.

3.5.4 Information Form of System

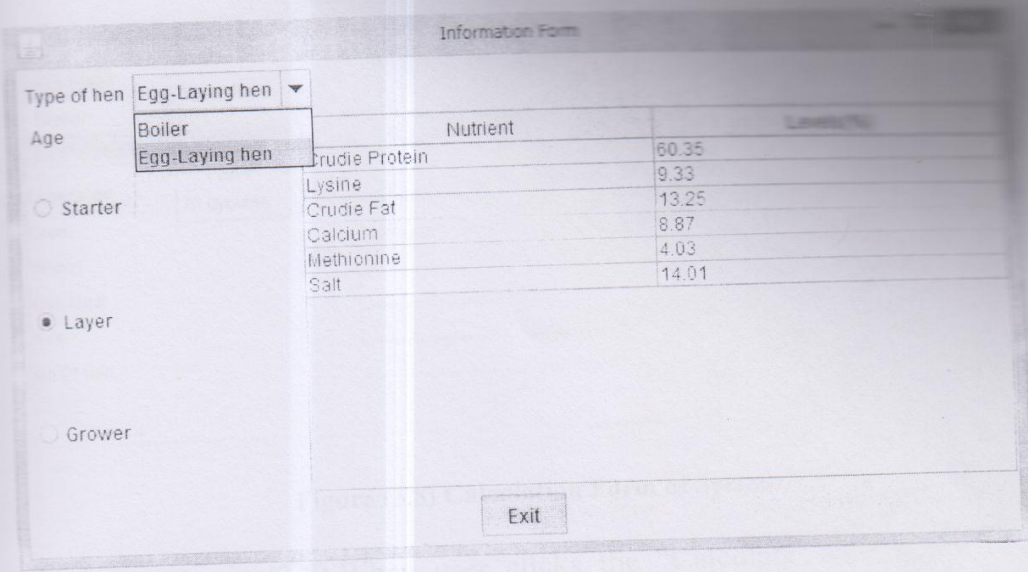

Figure (3.7) Information Form of System

In Figure (3.7), if user chooses "Hen" button, user perform the following tasks. Choose type of hen from hen's type list and select the age of hen then system show type of hen's ingredient with their corresponding nutrient percentage.

3.5.5 Calculation Form of System

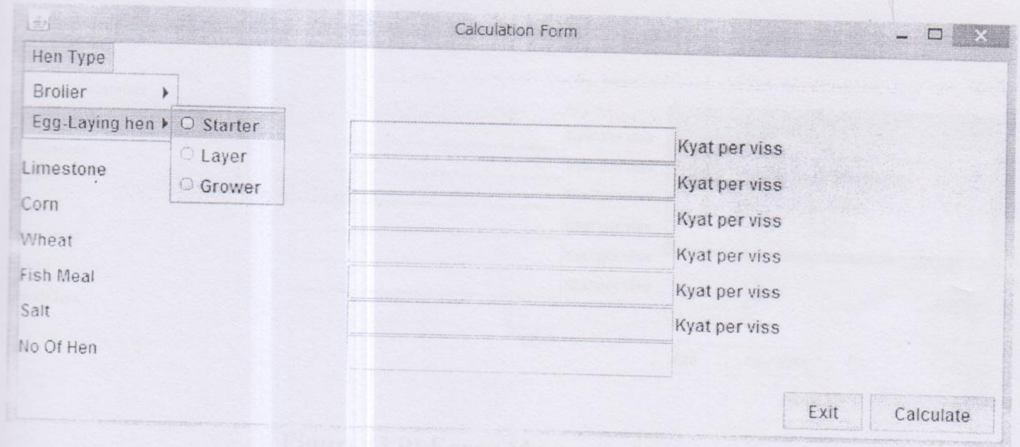

Figure (3.8) Calculation Form of System

In Figure (3.8),When user clicks the "Calculate" button, user can perform the following tasks. Chooser type of hen from hen type menu and fill the prices for each ingredient type and click the "Calculate" button, system show result in Figure (3.10).

3.5.6 Error Message of System

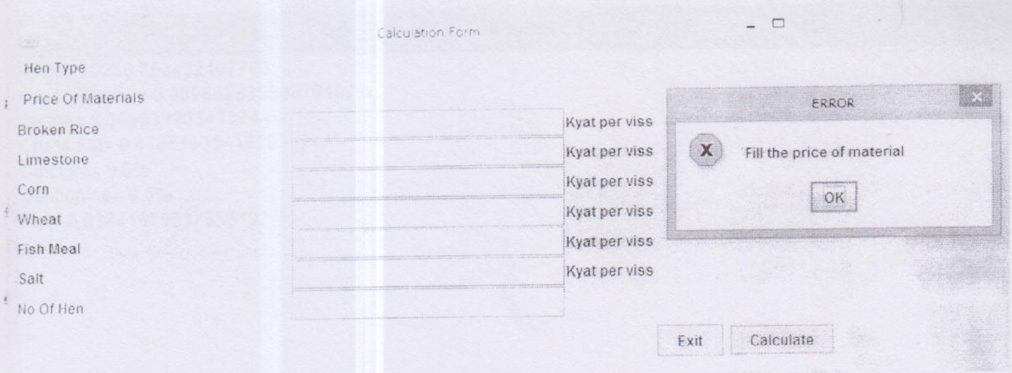

Figure (3.9) Error Message of System

In Figure (3.9), when user click the "Calculate" button without choosing "Hen Type" and without filling "Price of Materials", the system shows the error message box.

3.5.7 Result Form of System

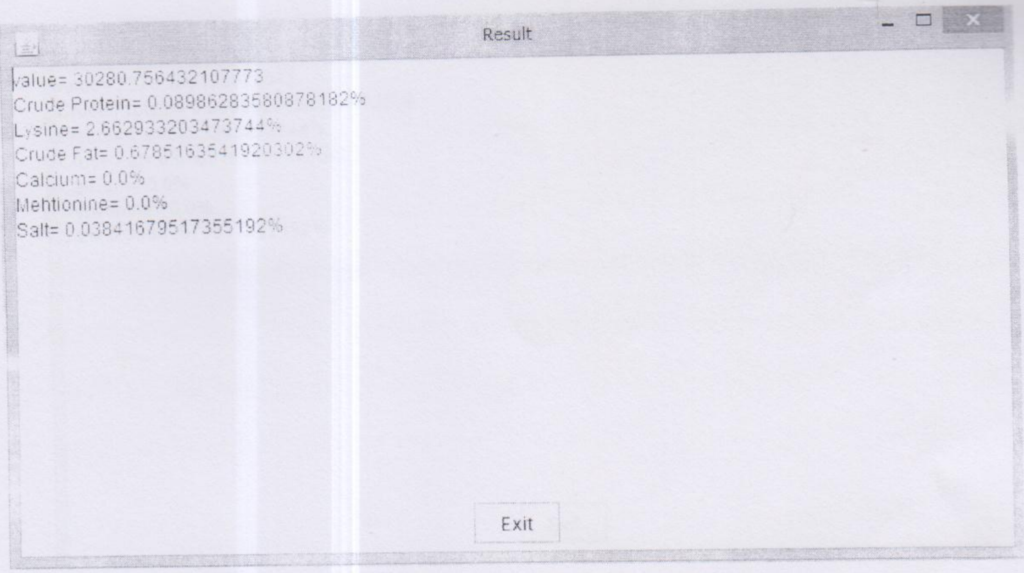

Figure (3.10) Result Form of System

In Figure(3.10), when user click the "Calculate" button, system show total cost for two hundred number of hens and ingredients with their corresponding nutrient percentage.

3.5.8 Result Form of System

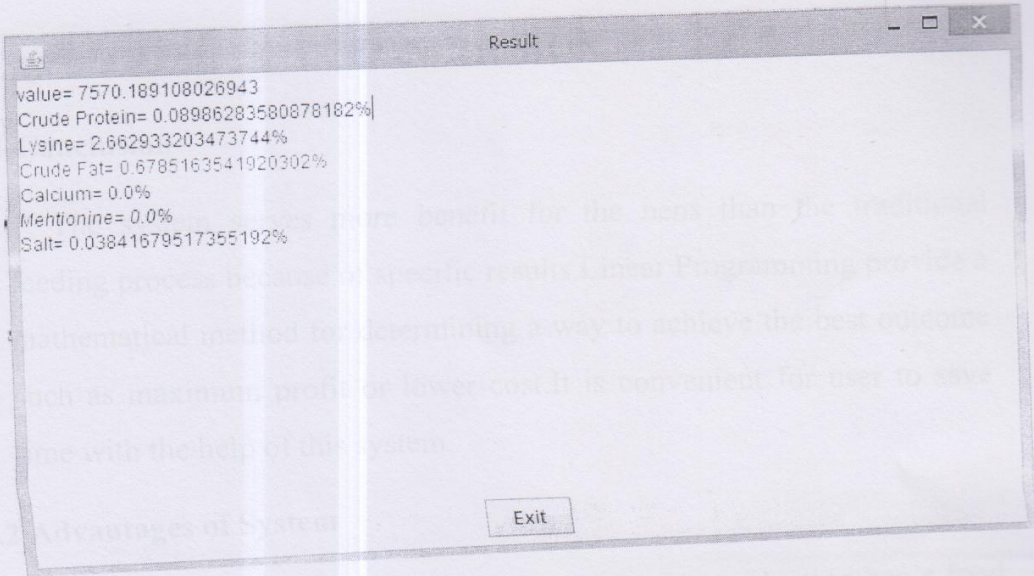

Figure (3.11) Result Form of System

In Figure(3.11), when user click the "Calculate" button, system show total cost for fifty number of hens and ingredients with their corresponding nutrient percentage.

CHAPTER 4

CONCLUSION

4.1 Conclusion

The system serves more benefit for the hens than the traditional feeding process because of specific results.Linear Programming provide a mathematical method for determining a way to achieve the best outcome such as maximum profit or lower cost.It is convenient for user to save time with the help of this system.

4.2 Advantages of System

- The system is easy to use and help the user in evaluating hen's food diet according to different case.
- Although changing the price of ingredients, the system can produce the output

4.3 Limitations

. This system uses the important nutrients and popular ingredients. In the real world, some ingredients are popular and system variables are calculated on those ingredients. And, the system also uses essential nutrients over numerous nutrients. The system does not include other ingredients. There may not be the integer as the solution, e.g., the require number of men may be a fraction and the nearest integer may not be the optimal solution. Linear programming technique may give practical valued answer which is not desirable. If user blend the food which does not include in this system, he or she can't get the result.

4.4 Further Extension

This system is one of the most popular application areas of Linear Programming (LP). The future plans of the system is to develop new computer programs for solving other areas such as production planning, oil refinery management, distribution, financial and economic planning, manpower planning, and blast of furnace burdening etc.

The hen food diet blending system can be extended in real world economic and technical problem. Now, in this system, duality method is used. The dual simplex method and Two-Phase Method can be further developed.

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