DEVELOPMENT OF LEAST-COST BALANCED RATION WITH LOCALLY AVAILABLE FEED INGREDIENTS FOR DAIRY ANIMAL USING FEED MASTER ANDROID SOFTWARE

A THESIS

By

MD. DURUL HUDA (NAYON)
Registration No. 1605162
Session: 2016-2017
Semester: July-December, 2017

MASTER OF SCIENCE (MS)

IN

ANIMAL NUTRITION

DEPARTMENT OF GENERAL ANIMAL SCIENCE AND NUTRITION

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR-5200

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[Submitted to the Department of General Animal Science and Nutrition, Faculty of Veterinary and Animal Science, Hajee Mohammad Danesh Science and Technology University, Dinajpur for partial fulfillment of the requirement of the degree]

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DEPARTMENT OF GENERAL ANIMAL SCIENCE AND NUTRITION
HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR-5200

DECEMBER, 2017

Dedicated

To

My Beloved Parents

Acknowledgements

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The Author

ABSTRACT

A study was conducted at the central dairy farm of Hajee Mohammad Danesh Science and Technology university, Dinajpur during January to April, 2017 on 12 number of dairy cows about their ration formulation by feed master android software developed by some student of CSE of HSTU with locally available feed ingredient .The study was conducted to find out the impact of this software on ration formulation as well as on milk production. The method of this software is very simple than others, just the farmer needs to put the body weight on this software then the whole ration will be calculated automatically according to their body weight. In this study 12 animals were assigned into four groups. Each group contains three cows and T_0 is the control group. Here we made a variation in case of supplying grass and straw but the amount of concentrate was same to all groups according to their body weight. T_0 group were given 100% straw, T_1 were given 75% straw and 25% grass, T_2 were given 50% straw and 50% grass, T_3 were given 75% grass and 25% straw. It is revealed from the study that average total body weight gain and heart girth gain were higher in those heifers received 75% straw, 25% grass and concentrate mixture per head per day. Also, body weight gain was significantly differed ($p<0.05$) from the other groups. On the other hand, average total dry matter intake was found higher in T_3 groups and the highest body length gain was observed in T_0 group. The results suggest that supplying of 75% straw, 25% grass and concentrate mixture would give a better performance of the heifer. The result indicates that Feed Master android software is effective on ration formulation of dairy cow. It also indicates that this software can be easily used by the farmer even by an illiterate farmer. It will help the farmer to formulate a ration by using minimum feed ingredients more accurately and conveniently and will help to improve the health and production and will reduce the economic loss of the farmer.

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CHAPTER I

INTRODUCTION

Bangladesh has made remarkable development in the fight against poverty during the last two decades and the incidence of poverty has come down to 31.5 percent in 2010 with respect to 56.6 percent in 1991-92 (BBS, 2011). Poverty trend shows that according to national standard 31.5% people are living below the national poverty line and according to international standard 43.3% are living with less than 1.25 USD a day (World Bank, 2012). Poverty is intimately associated with under nutrition. Due to the severe poverty, most of the people of this country face an acute deficiency of animal protein sources, like meat, milk, egg, etc. The domestic production of milk, meat and egg in Bangladesh are 3.46, 2.33, and 7,303 million tons in the 2011-2012 fiscal year against the demand of 13.50, 6.48, and 15,392 million tons, respectively (Hossain and Hassan, 2013). Livestock and poultry play the key role to meet up the protein requirement in Bangladesh. But keeping of livestock by rural farmers are becoming tougher due to shortage of concentrate and roughage.

Profitable animal production depends on so many factors and feeding is most important among them as feeding cost responsible for 60% cost of animal production. Feeding of animal economically requires proper feed formulation according to animal requirement considering their age, sex and stage of production. In conventional animal production system, farmers are not conscious enough about their animal requirement, available feed sources and their nutritive values as information regarding these issues are scattered. So, approach has been taken to give a complete package to the farmers as well as stakeholder to feed their animals in proper way. Feed master is an android application that can easily be installed in android device which can formulate ration instantly according to thumb rule. Formulation of ration and feeding to animal is done on the basis of Dry Matter Intake of animal considering their body weight. This software helps the village farmer to increase the milk production. Practitioners who are growing animals will be able to maximize the nutritional content of their feed while keeping costs down. Professionals working in feed-mixing companies will be able to maximize profits by offering products composed of low-cost ingredients that are also of good nutritional value. Students will gain a firm background in nutritional and economic concepts, insight into how to apply them to practical problems, and an understanding of the way good nutrition and good value can be achieved by applying the action. Several studies on feeds and ration formulation for high yielding cows have shown positive relationships between increased ratio of concentrate and feed intake, milk yield and body weight gain. In some of the studies, negative relationships have been found between ratios of concentrate: roughage and milk fat content (Oldham and Sutton, 1979; Sporndly, 1986). These relations have been well documented by Macleod *et al*. (1983) in their studies of forage: concentrates ratios from 80:20 to 35:65. But by this software the farmer will get the chance to maintain the perfect ratio of concentrate and roughage according to body weight. The feeding amount will be increased as the increased body weight. by solving a simple ration-balancing problem, providing step-by-step instructions with the computer program that any user - even one without computer training - can readily follow. It then discusses specific feed formulation techniques in terms of their practical applications and economic implications. Included are such techniques as sensitivity analysis, parametric cost and nutrient ranging, optimum density formulation, multi-blending, and risk analysis, among others. Applying these and other techniques using the special features users can select the proper ingredients, adjust proportions among nutrients, determine which feeds might require scarce ingredients, consider the risks involved in dealing with ingredients with below average compositions, and ultimately determine the costs and nutritional content of various feed formulations. The program can be applied to determining feed formulations for any animal, including sheep, beef and dairy cattle, swine, turkeys, broilers, catfish, and horses. Feed formulation is one of the important aspects of animal feed industry. Balancing the feed stuffs is big challenge faced by the industries when the costumers and requirement increases. Development of animal feed industry depends upon the quality of feed and quality of feed is based upon the raw material used to formulate feed (ration). Ration is the total amount of feed given to the animal on a daily basis while, ration formulation can be defined as the process by which different ingredients are combined in a proportion necessary to provide the animal with proper amount of nutrients needed at a particular stage of production, (Afolayan and Afolayan 2008).

The first ever computer used for feed formulation was made in 1951 when F.V. Waugh published a paper titled “The Minimum-Cost Dairy Feed”. Dent & Casey (1967) authored the first published book on computer-based formulation entitled as “Linear Programming and Animal Nutrition.” Computers used by feed industry for practical feed formulation started in the year 1970s when computers were affordable for large industries. Later, use of computers increased for feed formulation in the 1980s when personal computers became commercially available (A. Victor Suresh, 2016). In the present age, feed formulation without the use of computers is very rare.

All feed formulation software must have the following database:

- Ingredient: Database of feed ingredient and cost is very important. Availability of feed and nutrient composition like percentage of dry matter, protein, energy, calcium, phosphorus present in the feed etc., plays vital role in feed formulation.
- Nutrient: Nutrients are the key factor for the feed formulation. Database of nutrient may be simple with corresponding unit. Different category of animal has different requirement of nutrient and restriction on nutrient.
- Nutrient specification: It defines the nutrient level required in the formula and feed ingredient inclusion level. The limits are said to be constraints which have to be satisfied in formulation

Feed Master android software contains the entire database mentioned above.

Some positive sites of the research are

- Farmer can use the local feed ingredient available in the market like Maize, Wheat bran, Rice polish, khesari, Soyabin, DCP and Salt.

The major objectives of the research are:

i) Give an idea to the farmer and extension worker for year round fodder production planning and budgeting

ii) Digitalize livestock sector to fulfill vision 2021

iii) To modernize the departmental research facilities, and generate knowledge and technology through basic and applied research

The specific research objectives are

- To develop a least-cost ration for dairy animal by local feed ingredients using Feed Master android software
- To help the farmer to formulate a ration by using minimum feed ingredients more accurately and conveniently

CHAPTER II

REVIEW OF LITERATURE

Smallholder dairy farmers in sub-Saharan Africa are constrained by inadequate supply of good quality protein sources particularly during the dry season. Commercial protein concentrates are expensive and not readily accessible. Multipurpose forage legumes and other non-conventional protein sources available on-farm have been promoted as alternative cheaper protein sources. The major problem faced by smallholder dairy farmers however is the formulation of diets balanced for the key nutrients and also being cost-efficient. This paper presents a step by step spreadsheet based procedure of diet formulation for smallholder dairy production. The procedure ensures that the diet is balanced for all the key nutrients, is low-cost and the user has significant control over the formulation process. An example using this formulation method incorporating the fodder legumes Leucaena diversifolia, Leucaena pallida, Leucaena esculenta, Acacia angustissima and Calliandra calothyrsus indicate a cost reduction from 10% on C. calothyrsus to 30% on L. diversifolia inclusion when compared to the conventional dairy meal concentrate (US$ 0.34/kg). This ration formulation method is recommended for use by livestock extension advisors and smallholder dairy farmers to quickly formulate low-cost diets using locally available feed sources so as to optimise the feeding of dairy animals at the farm level. (Chakeredza *et al.*, 2008).

The Pearson square has been widely used in ration formulation process (Wagner and Stanton, 2006). However, its major disadvantage is that one can only balance for one nutrient at a time. It therefore has limited application where farmers have to formulate diets balanced for protein, energy, vitamins and minerals and also being low-cost. Simultaneous equations and matrices should be developed for this purpose and this often requires proficient knowledge in advanced mathematics.

Least-cost formulation is a mathematical solution based on linear programming. This practice is widely used within the commercial feed industry using commercially available software programmes. Least-cost formulation of diets optimises the combination of feed ingredients that supplies the required levels of nutrients at least cost (Rossi, 2004). It requires the professional knowledge of animal nutritionists who take into consideration the nutrient requirements of the target animal and its capability to digest and assimilate nutrients from various available ingredients. Commercial feed formulation software is costly for most extension organizations in developing countries and the return on investment when using them on a small scale does not justify their purchase. These software programmes are also not flexible since the feed database cannot be modified easily and one cannot improve on the programme as and when advances in ration formulation systems take place (Chakeredza *et al*., 2008).

The paper highlights the different feed formulation software's for least cost formulation of livestock and animals, where the comparison of techniques is done based on different aspects like data collection, software used, price, scope and limitations. Feed formulation requires large amount of data about the composition of feeds, environment conditions, and availability of feeds. Development of Software's for feed formulations is changing with change in computer. With advancement of technology, the feed formulation can be calculated for 'n' number of feed stuff but still Linear Programming is used as base for mathematical modelling, where uses of nonlinear programming is very less. Maximum number of feed formulation software's is developed to select the feeds for formulation within budget of the farmers or dairy industry (Pati *et al*., 2015).

Feed formulation is one of the important aspects of animal feed industry. Balancing the feed stuffs is big challenge faced by the industries when the costumers and requirement increases. Development of animal feed industry depends upon the quality of feed and quality of feed is based upon the raw material used to formulate feed (ration). Ration is the total amount of feed given to the animal on a daily basis while, ration formulation can be defined as the process by which different ingredients are combined in a proportion necessary to provide the animal with proper amount of nutrients needed at a particular stage of production, (Afolayan and Afolayan 2008).

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There are many conventional and non-conventional methods of feed formulation. Conventional methods are: Simultaneous equation method, trial-and-error method, two by two matrix method and square method. After this, new methods like linear programming, stochastic programming, goal programming, least-cost formulation and non-linear programming came into effect (Pratiksha Saxena 2010).

Feed Formulation (www.kasturi.info/ feed.htm) is simple and practical feed formulation software is developed by K. Chandra Shekhar in the year 2002. It is meant for least cost feed formulation with user friendly interface. A person with basic knowledge can easily use this software. It comes with two functions, Optimize: where it uses liner programming to optimize feed formulation at least cost and Analyse: If we don't want least cost formulation but only want to know the nutrient values, this will calculate the Nutrients Values and the Formula Cost on entering the ingredients quantity and rate. It is suitable for Egg Producers, Broilers, Nutritionist, Hatcheries, Feed Manufacturers, etc.

This software can easily be downloaded from the internet free of cost and without a validity period. It comes with a user manual by which the two functions can be performed without any confusion. Once it is opened, the main menu appears which contains

- Animal Types - (Layers, Broilers, Sheep, Pigs, Fish, etc.)
- Feed Types – Mentioning the feed types (Chick, Grower, Layer 1, Layer 2, Layer 3 for Layers)
- Ingredients–Mentioning name of the ingredients and the price
- Nutrients – Mentioning the Nutrient Names and their Units. (Energy, Protein, Fat, Fiber, Lysine, etc.)
- Nutritional Composition - Mentioning the Nutrient Values for each Ingredient
- Ingredients Selector - Select Ingredients which are used for a particular animal type
- Nutrients Selector - Select Nutrients which are to be calculated for a particular animal type
- Formula Analysis - New Feed Formulation is followed as

Step 1: Select the Animal Type

Step 2: Select the Feed Type.

Step 3: Select the Date on which you are formulating.

Step 4: Select Task Optimize or Analyse

Step 5: Select the weight of the feed formula.

Step 6: Next, if you want mention any comments you can do so in the Remarks field.

In this software, provision is given to set minimum/maximum quantity of ingredient, and fixing the rate of ingredient. One can add new ingredient by clicking on add button. And in case the solution is not found then user can change the bounds and optimize it again. In this software, there is an option for saving as well as taking print of least cost formulation.

Kasturi feed formulation is compatible with Windows XP with SP2 / Windows 2000 with SP4 / Windows Server 2003 with SP1 / Windows Vista. Software developed is based on Microsoft.NET Platform and its only requirement is that Microsoft's.net 2.0 should be present in the system on which this is going to be used.

Winfeed (www.winfeed.com) is the cheapest least cost feed formulation software developed in the year 2012. It is equally useful for ruminants and non-ruminants such as poultry, cattle, sheep, horses, dogs, cats, fish and aqua culture etc. WinFeed works in two modes, Linear Mode: suitable for conventional feed formulation and Stochastic Mode: specifically for probability based least cost feed formulation.

By providing minimum personal information, the user can download and install the demo version of the software with the installation key. The user can also download feed store files and nutrient requirement files. It allows saving the animal’s nutrient requirement in one file and the feed store (Ingredient Composition Database) in another file. Once the user selects the feed store, a main window appears where ingredients are selected. Nutrient requirements, their price and nutrient composition are entered manually in the main window. Winfeed is connected with MS Excel where data can be Imported or Exported between Excel and Winfeed. The method of formulation can be selected as Linear or Stochastic. After fixing the minimum and maximum limits for nutrients, the ingredient formula is saved and its nutrient analysis is saved in a text file. This text file can be opened in Microsoft Word or Microsoft Excel for further processing. Formula reports can be prepared in graphical form using pie chart and bar chart. It also allows the user to print out the feed formula.

Winfeed is compatible with Windows NT, 98, Me, 2000, XP and Windows 2003. Unix/Linux compatible versions are also available on request. It is the first feed formulation software in the world that is capable of doing Stochastic Formulation and it gives up to 99.99% assurance of meeting nutrient requirements in the feed. However, it doesn't display the unit cost of each ingredient. The formulate button is also not easy to find. The user has to click the Formulate button on top of the menu or press Ctrl+F to get the result (Wan Nurhayati *et al*., 2015).

AFSO (Animal Feed Optimization Software) AFOS (www.animalfeedsoftware.com) is built using hybrid-cloud technology which allows system installation on cloud or on the user's PC as a standalone application and from mobile devices using just a browser. The standalone application is focused on users who want a traditional application with database saved locally. It is mainly developed for Nutritionist Professional, Feed Production Professionals; Farming Professionals which helps the user develop, manage, store, analyse, collaborate and exchange animal feed formulas. It is available in English, French, Italian, etc.

AFOS supports multi-plant and multi-animal group data with no limitations on number of nutritional instances including plants, animal groups, nutrients, ingredients, products and recipes. The user can freely add, edit, remove and customize all data, including adding new currencies, editing nutrient units, weight units, prices and additional costs. For a complex process, AFOS allows creation of templates to reduce time for repetitive actions (Pati *et al*., 2015).

Feed Assist (An Expert System on Balanced Feeding for Dairy Animals) "Feed Assist" is a farmer friendly expert system for balancing the feed formulation of dairy animals. It has been developed using linear programming. "Feed Assist" does not require much expertise to operate and enables the farmers to formulate least cost rations for different categories of livestock using locally available feed resources. It has huge data according to (ICAR, 2013a) standards (Pati *et al*., 2015).

Eco-Mix is (www.logicsoftsolutions.com) user friendly windows-based software which prepares any kind of balanced feed with least cost. It is developed by LOGIC SOFT SOLUTIONS, established in the year 1998. This software can be used for poultry, cattle, horse, fish, pets, ruminants and non-ruminants etc.

Requirements for standard rations are available as default and formulas can be compared with standard feed types. Modifications like add, delete, rename Ingredients and Nutrients, and change minimum and maximum values of Ingredients and Nutrients, Change specifications for standard rations, nutrient values of feed ingredients can be performed very easily. While preparing the formulation after providing all the inputs required if it shows 'solution is not found' then it will indicate which nutrient is out of range and advise, how to modify the formula. The user can take the print. This software is already provided to Hatcheries, Poultry Farms and Feed Manufacturers (Poultry, Cattle & Live Stock), Consultants, Doctors (Pati *et al*., 2015).

All feed formulation software must have the following database (Pati *et al*., 2015):

- Ingredient: Database of feed ingredient and cost is very important. Availability of feed and nutrient composition like percentage of dry matter, protein, energy, calcium, phosphorus present in the feed etc., plays vital role in feed formulation.
- Nutrient: Nutrients are the key factor for the feed formulation. Database of nutrient may be simple with corresponding unit. Different category of animal has different requirement of nutrient and restriction on nutrient.
- Nutrient specification: It defines the nutrient level required in the formula and feed ingredient inclusion level. The limits are said to be constraints which have to be satisfied in formulation.
- All the software which is mentioned above aimed to provide balanced nutrients or ration for livestock or animals at least cost, either by linear programming or stochastic method.
- Overview of formulation process is given in the following chart.

CHAPTER III

METHODS AND MATERIALS

The experiment was conducted using local feed ingredients on milking performance of dairy animals. The materials and methods followed in the experiment are discussed in below:

3.1 Experimental site and duration

The experiment was conducted at Hajee Mohammad Danesh Science and Technology University (HSTU) dairy farm, Dinajpur-5200, Bangladesh. Total duration of this study was 11 weeks on the basis of their age, body size and body condition.

3.2 Collection and preparation of feed ingredients

Rice polish, wheat bran, mustard oil cake, di-calcium phosphate, vitamin and salt were purchased from Dinajpur town at Dinajpur. We put individual body weight on the software and got the amount of feed ingredients individually. All ingredients were then mixed uniformly and kept in gunny bag for future uses. Feed ration calculated by the Feed Master Android software. Grass and straw were also collected locally every day. Grass and straw given to the animal in chopped form.

Figure 1: Feeds used in the experiment

 

Figure 2: cows of experiment

3.3 Design, layout and others activities

Dairy animals of four treatment groups were denoted as T_0 (control), T_1, T_2, and T_3. Each group contain three animal. The entire animal was marked by tag number before starting the experiment. T_0 contain tag number 21, 14 and 29, T_1 contain 17,22 and R_1 (red one),T_2 contain tag number 18,20 and 26,T_3 contain tag number W_1 (white one),15 and 23. Adjustment period of 15 days were carried out to habituate the animals with experimental feed. Concentrate mixture were supplied to the experimental animals twice daily i.e. at 6.00 am and 12.45 pm according to their body weight by using feed master android software. Animal's body weights were measured by calculating hirgth girth (HG) and length of the body. Body weight was taken in every week and the feeding amount was also changed in every week. Here we made a variation in case of supplying grass and straw. T_0 group were given 100% straw, T_1 were given 75% straw and 25% grass, T_2 were given 50% straw and 50% grass, T_3 were given 75% grass and 25% straw. All the animals had free access to the clean cold fresh drinking water for 24 hours. All the animal was taken to the nearest pasture land for free moving once daily. Feed intake was calculated after subtracting left over from the feed supplied. The animals were weighed throughout the experimental period every 7 days interval. The total milk production was recorded and maintained daily. During this time, all types of necessary data were maintained and calculate accordingly. Respective samples of feed and feces were subjected to chemical analysis for crude protein (CP), crude fiber (CF), ether extract (EE), ash and nitrogen free extract (NFE) accordingly the methods of AOAC (2004). The data were analyzed using the "SPSS" statistical programme to compute analysis of variance (ANOVA) for a Completely Randomized.

3.4 The steps of activity of the Feed Master software from left to right

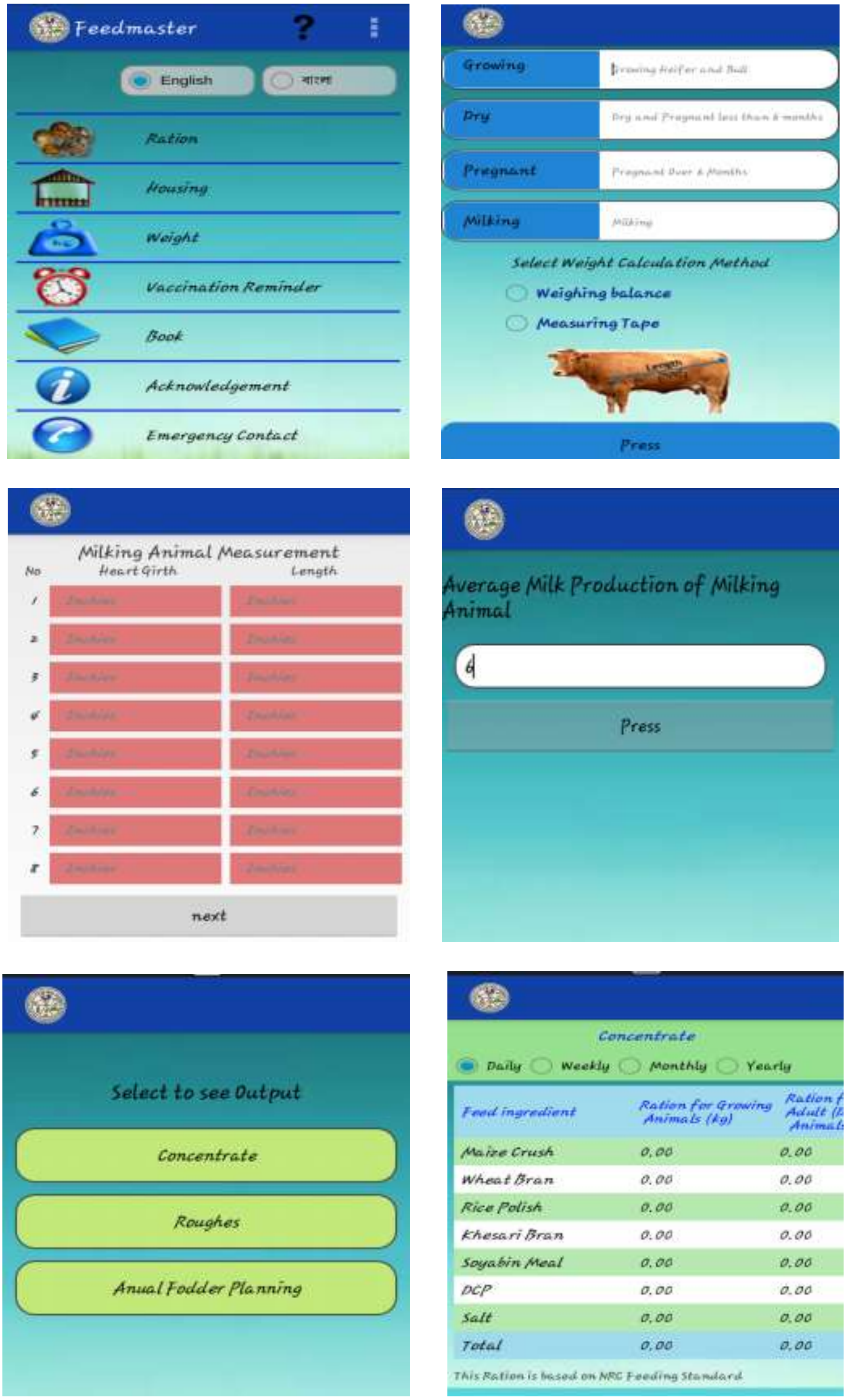

Figure 3: Health condition of heifer

3.5 Statistical analysis

Repeated Measures Analysis of Variance (RMANOVA) in Completely Randomized Design (CRD) was performed to investigate the effect of different treatment on dry matter intake, body weight gain, body length gain and heart-girth gain of crossbred heifer (Zar, 2002). Also, Tukey's HSD test was done to compare the treatment means. Design (CRD). Duncan's Multiple Range Test (DMRT) was also done for different parameter to compare the treatment means.

FEED COMPOSITION

NAME	DM %	CP %	By Pass %	EE %	CF %	ADF %	NDF %	Ash %	Ca %	TDN %	DE Mcal/lb	NEg Mcal/lb
Maize	90.60	12.75	18.73	6.25		8.48	25.99	2.99		79.71	3.11	
Rice Polish	91	14	72	15	13	18	24	11	0.07	82	74	46
Wheat Bran	89	18	-	4.8	11	14	47	7	0.1	70	1.40	0.44
Mustard cake	91.53	37.25	8.49	7.91		24.64	22.69	6.99		76.63	2.98	
Soybean meal	89.6	54	35	1.5	36	46	-	7	0.30	75	2.94	1.25
1Straw	91	4	-	1.4	38	47	72	13	0.23	40	42	0
Grass	18.40	6.25		2.26	45	45.50	68.14	22	0.11			
DCP	96	0	-	0.0	0	0	0	94	22	0	0.00	0.00

CHAPTER IV

RESULTS AND DISCUSSION

It is revealed from the study that average total body weight gain and heart girth gain were higher in those heifers received 75% straw, 25% grass and concentrate mixture per head per day. Also, body weight gain was significantly differed ($p<0.05$) from the other groups. On the other hand, average total dry matter intake was found higher in T_3 groups and the highest body length gain was observed in T_0 group. The results suggest that supplying of 75% straw, 25% grass and concentrate mixture would give a better performance of the heifer.

Table 1: The mean value with its standard error of DMI, BWG, BLG and HGG at different treatment over the period of experiment

Parameters	**T_0**	**T_1**	**T_2**	**T_3**	**Level of sig.**
DMI (Kg/d)	2.425±0.34	2.825±0.34	2.853±0.34	3.118±0.34	NS
BWG (Kg/15day)	5.75±0.84	9.30^{a}±0.84	6.28±0.84	4.58^{b}±0.84	*
BLG (inch/15day)	1.23±0.30	0.58±0.30	1.13±0.30	0.46±0.30	NS
HGG (inch/15day)	0.76±0.91	2.98±0.91	-0.15±0.91	1.33±0.91	NS

DMI, dry matter intake; BWG, body weight gain; BLG, body length gain; HGG, heart girth gain. Mean values within a row having different superscripts differ significantly. *indicates significant at $p<0.05$.

Quang *et al.* (2015) from an earlier experiment concluded that, improved live weight gain (LWG) is likely due to the increased dry matter intake (DMI), organic matter intake (OMI) and organic matter (OM) digestibility resulting from increased intake of concentrate. Treated rice straw improved feed intake, digestibility, rumen fermentation and efficiency of microbial N synthesis in crossbred dairy cow, obtained in an experiment conducted by Gunun, *et al.* (2013). Supplementation with legume doubled ($P < 0.01$) rice straw and total N intake, and increased total DM intake by 32%. It did not affect the DM, organic matter, neutral detergent fibre and acid detergent fibre digestibility ($P > 0.05$) but did increase ($P < 0.05$) N digestibility. This is the findings of research conducted by Pen Miranda *et al.,* (2013).

Judson & Edwards (2008).in a survey of 49 kale paddocks grazed by dairy cows in Canterbury, found the high dry matter intake giving high amount of grass and less straw. The result was also consistent with the study of Greenwood *et al.* (2011).

Gazzola *et al*. (2008) and Keogh *et al*. (2007), which reported a lower gain in BCS of cows fed on perennial ryegrass pastures over the winter period compared to those offered kale straw. However, another Irish study, Keogh *et al.* (2009b) showed that grass silage-fed cows had a greater gain in BCS during winter than cows offered kale.

The high DMI of napier grass in supplemented diets might have been due to several reasons. Lab lab hay might have provided essential nutrients particularly CP which might have been lacking in the napier grass for the animals to maintain optimal rumen activity. Lab lab hay might also have been degraded more rapidly in the rumen. This is because of the positive effects of Nitrogen (N) in increasing microbial population and efficiency thus enabling them to increase the rate of breakdown of the digesta. As the rate of breakdown and passage of the digesta increases, feed intake is accordingly increased (Muinga et al. (1992).

The low DM intake recorded in cows supplemented with grass pea bran, which had relatively higher crude protein content, than those supplemented with wheat bran might be attributed to the higher NDF content of the former. Neutral detergent fibre content is negatively correlated with intake (Arelovich *et al.,* 2008).

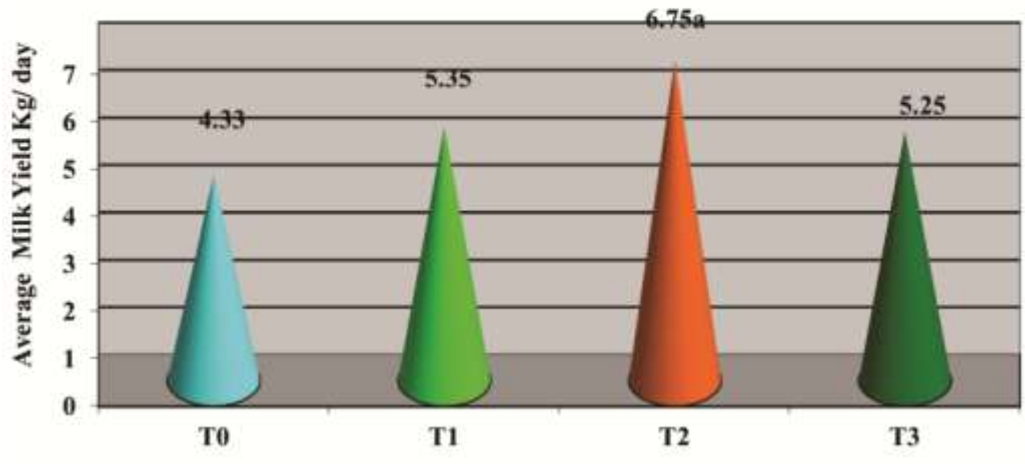

Figure 4: Graphical representation of milk production

According to the graphical representation of milk production, it is revealed that milk production was maximum in case of T_2 group. So in this trial the cows those were given 50% straw and 50% green grass produced highest average milk.

Table 2: Effect of the ration balancing programme (RBP) on milk production efficiency

Parameters	T_0	T_1	T_2	T_3	Level of sig.
FCM yield (kg/day)	4.1^a±0.16	6.5^c±0.16	5.2^b±0.16	5.1^b±0.16	*
Average DMI (kg/day)	2.425±0.34	2.825±0.34	2.853±0.34	3.118±0.34	NS
FCM yield (kg)/kg DMI	1.69±0.47	2.30^a ±0.47	1.82±0.47	1.63±0.47	*

FCM, fat corrected milk

ab Values with different superscript in a row differ significantly ($P < 0.05$)

According to the above table it is revealed that milk production efficiency was highest in case of group T_1.

Similar types of findings were also obtained by Grimaud *et al.* (2007). They stated that, feeding is well-known as a very influential factor for milk yield. Faruque and Hossain (2007) found that, dietary supplementation might not be required for improving the quantity and quality of milk yield of when plenty of natural grass is available. Such effect of feed on milk production has been reported by Dubey *et al.* (1997) and Sharma *et al.* (1980).

Another similar type study was conducted by Domecq.*et al.*(1997);Roche *et al.* (2009) where milk solid composition over the first 60 days of lactation was higher (32.5kg/cow) along with high milk production.

In our country at pabna district Mr. Khan and Khatun (1998) used the same feeding formula on some cross breed cows. The average milk yield of some crossbred cows was significantly (P<0.01). The daily milk yield was 8.1, 9.7 liters and 7.4 liters for SL × Pabna, F × Pabna and Pabna × Pabna genetic groups, respectively. Sarker (1995) found significant (P<0.01) effect of feeding on the milk yield of local and crossbred cows in Shahjadpur area.

According to A.O.A.C. (1980), the cows used in is experiment, based on body weight and milk production required about 11.2 Mcal day for their maintenance. The amount provided by the supplemented diets was approx1mate y I 7.8 Meal. day' which implies a difference of about 6.6 Mcal/day· over its maintenance requirements . Therefore, this ME in excess of maintenance was insufficient and generated only 5.8 kg FCM day-1 .The cows, therefore, received suboptimal amounts of ME.

The difference in milk yield between treatment groups could be attributed, among other factors, to the differences in crude protein and energy contents in the feeds (Steinshamn, 2010) which are positively correlated with the variable (Table 5). The results of the present study are in agreement with that reported by Adebabay *et al.* (2009) who indicated that supplemented cows produced significantly more milk than those grazed on natural pasture alone. Similar results were also reported by Getu (2008) who indicated that crossbred cows fed urea treated wheat straw supplemented diet has significantly higher milk yield than for non-supplemented animals of cross bred cows.

This result was similar to the report by Phipps *et al.* (1995) who found that diets based on maize silage (MS) increased the milk yield and milk protein content. Wanapat *et al.*

(2009) reported that feeding only rice straw to dairy cows could decrease the milk yield but combination of straw and grass gives better milk production.

But in Some papers we have seen urea treated rice straw to increase milk production along with grass and concentrate feed like Bhaskar *et al*. (1992) observed that milk production profile was higher in treated straw as compare to untreated straw, indicating that feeding treated straw to cows over their entire period of lactation beneficial in terms of reduction in feed cost with sustained higher milk yield.

Similar results were reported by Radotra (2003) and Ahmed *et al*. (1983). With respect to average 4% FCM, it significantly increased from 7.92 to 10.17 liters and from 8.01 to 10.39 liters as a result of urea treatment to paddy straw and local grass, respectively.

Perdok *et al.* (1982) reported increase in 0.15 to 1.5 kg of milk by feeding urea treated straw to lactating cow. Similar results were also reported by Datta *et al*, (1992) and Radotra (2003).Similarly, the average fat percentage was also significantly increased from 3.47 to 4.48 percent and from 3.6 to 4.63 per cent in paddy straw and local grass, respectively as a result of urea treatment.

CHAPTER V

CONCLUSION AND SUMMARY

How to make a least cost ration for dairy animal easily by Feed master android software was studied in this experiment. It has been shown that by this software if we give 75% straw and 25% grass with concentrate to the animal the average total body weight gain and heart girth gain will be higher. It also increases the total dry mater intake. It also indicates that if we give 50% straw and 50% grass to the cow along with concentrate feed we will get maximum average milk production. So it will be effective for the farmers to use this software in their farm to increase production. A variety of software applications for formulating dairy rations are available, selection of an appropriate program can be frustrating and time consuming. As with any type of software search, the user should begin assessing software needs by listing the important program functions and capabilities desired. This software has been tested in this study, so it can be suggested for the farmers. . The program can be applied to determining feed formulations for any animal, including sheep, beef and dairy cattle, swine, turkeys, broilers, catfish, and horses. Feed formulation is one of the important aspects of animal feed industry. Balancing the feed stuffs is big challenge faced by the industries when the costumers and requirement increases. This software can formulate ration more accurately with perfect balance.

Sintayehu Yigrem *et al*. (2008)4 studied about two hundred forty dairy producers. Both rural and urban producers in the four major towns representing the Shashemene–Dilla area in southern Ethiopia, were selected using a multi-stage sampling techniques, with the objective of characterizing dairy production, processing/handling, marketing systems as well as to prioritize constraints and opportunities for dairy development in the area. He also mentioned about the farmers inability to formulate ration due to lack of knowledge. That's why using a mobile software will be easy for the farmers to make it easy.

Smallholder dairy farmers in sub-Saharan Africa are constrained by inadequate supply of good quality protein sources particularly during the dry season. Commercial protein concentrates are expensive and not readily accessible. Multipurpose forage legumes and other non-conventional protein sources available on-farm have been promoted as alternative cheaper protein sources. We used the same feeding source in our study, the feed available locally.

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APPENDICES

Appendix-I: Descriptive Statistics of DMI

	Treatment	Mean	Std. Deviation	N
1st 15	1	2.4533	.63501	3
	2	2.6633	.70501	3
	3	2.6600	.59000	3
	4	2.8433	.15503	3
	Total	2.6550	.50213	12
2nd 15	1	2.0833	.28501	3
	2	2.6833	.62501	3
	3	2.3400	1.15000	3
	4	3.1833	.47501	3
	Total	2.5725	.74323	12
3rd 15	1	2.4800	.70000	3
	2	2.7233	.78501	3
	3	2.9033	.72501	3
	4	3.0633	.03512	3
	Total	2.7925	.59010	12
4th 15	1	2.4933	.71002	3
	2	2.8033	.82501	3
	3	3.0600	.59228	3
	4	3.1667	.05774	3
	Total	2.8808	.59450	12
5th 15	1	2.6167	.74218	3
	2	3.2500	.66144	3
	3	3.3000	.45826	3
	4	3.3333	.15275	3
	Total	3.1250	.56307	12

Appendix-II: Tests of Within-Subjects Effects of DMI

Source		Type III Sum of Squares	Df	Mean Square	F	Sig.
TIME	Sphericity Assumed	2.218	4	.555	12.110	.000
	Greenhouse-Geisser	2.218	1.340	1.655	12.110	.003
	Huynh-Feldt	2.218	2.114	1.049	12.110	.000
	Lower-bound	2.218	1.000	2.218	12.110	.008
TIME * V2	Sphericity Assumed	1.012	12	.084	1.841	.083
	Greenhouse-Geisser	1.012	4.020	.252	1.841	.193
	Huynh-Feldt	1.012	6.343	.159	1.841	.148
	Lower-bound	1.012	3.000	.337	1.841	.218
Error(TIME)	Sphericity Assumed	1.465	32	.046		
	Greenhouse-Geisser	1.465	10.720	.137		
	Huynh-Feldt	1.465	16.914	.087		
	Lower-bound	1.465	8.000	.183		

Appendix-III: Tests of Within-Subjects Contrasts of DMI

Source	TIME	Type III Sum of Squares	Df	Mean Square	F	Sig.
TIME	Linear	1.870	1	1.870	30.219	.001
	Quadratic	.233	1	.233	6.575	.033
	Cubic	.026	1	.026	.445	.524
	Order 4	.089	1	.089	3.212	.111
TIME * V2	Linear	.273	3	.091	1.471	.294
	Quadratic	.128	3	.043	1.203	.369
	Cubic	.414	3	.138	2.377	.146
	Order 4	.197	3	.066	2.359	.148
Error(TIME)	Linear	.495	8	.062		
	Quadratic	.284	8	.035		
	Cubic	.464	8	.058		
	Order 4	.222	8	.028		

Appendix-IV: Tests of Between-Subjects Effects of DMI

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Intercept	472.138	1	472.138	271.603	.000
V2	3.672	3	1.224	.704	.576
Error	13.907	8	1.738		

Appendix-V: Descriptive Statistics of BWG

	Treatment	Mean	Std. Deviation	N
Body weight gain	1	-9.3000	7.55447	3
	2	3.8333	1.75594	3
	3	7.0000	6.00000	3
	4	19.4167	2.26844	3
	Total	5.2375	11.50097	12
BWG	1	6.7167	.70059	3
	2	10.9167	.52042	3
	3	5.2500	7.75000	3
	4	-6.5000	4.00000	3
	Total	4.0958	7.71443	12
BWG	1	28.5000	9.00000	3
	2	5.0000	3.50000	3
	3	24.0000	5.50000	3
	4	8.5000	3.00000	3
	Total	16.5000	11.49901	12
BWG	1	4.8333	3.31976	3
	2	10.5833	1.28290	3
	3	-2.0000	15.50000	3
	4	9.8333	.28868	3
	Total	5.8125	8.57462	12
BWG	1	-2.0000	4.00000	3
	2	16.1667	9.00463	3
	3	-2.8333	13.84136	3
	4	-8.3300	4.51406	3
	Total	.7508	12.20899	12

Appendix-VI: Tests of Within-Subjects Effects of BWG

Source		Type III Sum of Squares	Df	Mean Square	F	Sig.
TIME	Sphericity Assumed	1690.768	4	422.692	8.150	.000
	Greenhouse-Geisser	1690.768	2.249	751.637	8.150	.002
	Huynh-Feldt	1690.768	4.000	422.692	8.150	.000
	Lower-bound	1690.768	1.000	1690.768	8.150	.021
TIME * V5	Sphericity Assumed	4085.438	12	340.453	6.564	.000
	Greenhouse-Geisser	4085.438	6.748	605.399	6.564	.001
	Huynh-Feldt	4085.438	12.000	340.453	6.564	.000
	Lower-bound	4085.438	3.000	1361.813	6.564	.015
Error (TIME)	Sphericity Assumed	1659.713	32	51.866		
	Greenhouse-Geisser	1659.713	17.996	92.229		
	Huynh-Feldt	1659.713	32.000	51.866		
	Lower-bound	1659.713	8.000	207.464		

Appendix-VII: Tests of Within-Subjects Contrasts of BWG

Source	TIME	Type III Sum of Squares	Df	Mean Square	F	Sig.
TIME	Linear	63.191	1	63.191	.676	.435
	Quadratic	820.087	1	820.087	14.462	.005
	Cubic	75.272	1	75.272	2.055	.190
	Order 4	732.219	1	732.219	35.412	.000
TIME * V5	Linear	840.360	3	280.120	2.997	.095
	Quadratic	1371.156	3	457.052	8.060	.008
	Cubic	1113.634	3	371.211	10.135	.004
	Order 4	760.288	3	253.429	12.256	.002
Error (TIME)	Linear	747.619	8	93.452		
	Quadratic	453.658	8	56.707		
	Cubic	293.017	8	36.627		
	Order 4	165.419	8	20.677		

Appendix-VIII: Tests of Between-Subjects Effects of BWG

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Intercept	2518.906	1	2518.906	235.357	.000
V5	181.782	3	60.594	5.662	.022
Error	85.620	8	10.703		

Appendix-IX: Multiple Comparisons of BWG

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-3.5500	1.19457	.069	-7.3754	.2754
	3	-.5333	1.19457	.968	-4.3588	3.2921
	4	1.1660	1.19457	.766	-2.6594	4.9914
2	1	3.5500	1.19457	.069	-.2754	7.3754
	3	3.0167	1.19457	.130	-.8088	6.8421
	4	4.7160*	1.19457	.018	.8906	8.5414
3	1	.5333	1.19457	.968	-3.2921	4.3588
	2	-3.0167	1.19457	.130	-6.8421	.8088
	4	1.6993	1.19457	.521	-2.1261	5.5248
4	1	-1.1660	1.19457	.766	-4.9914	2.6594
	2	-4.7160*	1.19457	.018	-8.5414	-.8906
	3	-1.6993	1.19457	.521	-5.5248	2.1261

Appendix-X: Descriptive Statistics of BLG

	Treatment	Mean	Std. Deviation	N
Body length gain	1	-.7500	.75000	3
	2	-3.5833	2.80995	3
	3	.3333	2.75379	3
	4	-3.7500	2.88314	3
	Total	-1.9375	2.80244	12
BLG	1	3.7500	1.25000	3
	2	1.7500	.66144	3
	3	.7500	.75000	3
	4	2.7500	1.25000	3
	Total	2.2500	1.45384	12
BLG	1	2.0000	.00000	3
	2	3.7500	2.25000	3
	3	3.7500	.25000	3
	4	1.5000	1.00000	3
	Total	2.7500	1.49621	12
BLG	1	1.4167	.62915	3
	2	.0000	.00000	3
	3	2.0000	.00000	3
	4	1.0833	1.18145	3
	Total	1.1250	.95048	12
BLG	1	-.2500	.25000	3
	2	1.0000	4.00000	3
	3	-1.1667	4.31084	3
	4	.7500	.75000	3
	Total	.0833	2.68483	12

Appendix-XI: Tests of Within-Subjects Effects of BLG

Source		Type III Sum of Squares	Df	Mean Square	F	Sig.
Time	Sphericity Assumed	168.042	4	42.010	10.169	.000
	Greenhouse-Geisser	168.042	1.611	104.281	10.169	.003
	Huynh-Feldt	168.042	2.714	61.921	10.169	.000
	Lower-bound	168.042	1.000	168.042	10.169	.013
Time * V5	Sphericity Assumed	73.608	12	6.134	1.485	.181
	Greenhouse-Geisser	73.608	4.834	15.226	1.485	.262
	Huynh-Feldt	73.608	8.141	9.041	1.485	.219
	Lower-bound	73.608	3.000	24.536	1.485	.291
Error(Time)	Sphericity Assumed	132.200	32	4.131		
	Greenhouse-Geisser	132.200	12.891	10.255		
	Huynh-Feldt	132.200	21.710	6.089		
	Lower-bound	132.200	8.000	16.525		

Appendix-XII: Tests of Within-Subjects Contrasts of BLG

Source	Time	Type III Sum of Squares	df	Mean Square	F	Sig.
Time	Linear	10.208	1	10.208	1.080	.329
	Quadratic	135.720	1	135.720	60.280	.000
	Cubic	21.888	1	21.888	7.015	.029
	Order 4	.225	1	.225	.132	.726
Time * V5	Linear	23.879	3	7.960	.842	.508
	Quadratic	1.259	3	.420	.186	.903
	Cubic	28.931	3	9.644	3.091	.090
	Order 4	19.540	3	6.513	3.824	.057
Error(Time)	Linear	75.600	8	9.450		
	Quadratic	18.012	8	2.251		
	Cubic	24.963	8	3.120		
	Order 4	13.626	8	1.703		

Appendix-XIII: Tests of Between-Subjects Effects of BLG

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Intercept	43.776	1	43.776	31.813	.000
V5	6.678	3	2.226	1.618	.260
Error	11.008	8	1.376		

Appendix-XIV: Descriptive Statistics of HGG

	Treatment	Mean	Std. Deviation	N
Heart girth gain	1	2.0000	3.90512	3
	2	3.1667	10.26320	3
	3	.2500	.75000	3
	4	.7500	.25000	3
	Total	1.5417	4.84162	12
HGG	1	-2.0833	1.80854	3
	2	6.9167	3.18525	3
	3	1.7500	.75000	3
	4	2.5000	1.73205	3
	Total	2.2708	3.77260	12
HGG	1	2.9167	.62915	3
	2	1.0833	2.67317	3
	3	-1.0000	2.50000	3
	4	2.0000	1.00000	3
	Total	1.2500	2.23353	12
HGG	1	.5000	.00000	3
	2	2.7500	.25000	3
	3	-1.0000	2.50000	3
	4	2.0000	1.00000	3
	Total	1.0625	1.89534	12
HGG	1	.5000	.00000	3
	2	1.0000	.00000	3
	3	-.7500	3.75000	3
	4	-.5833	2.37610	3
	Total	.0417	2.04171	12

Appendix-XV: Tests of Within-Subjects Effects of HGG

Source		Type III Sum of Squares	Df	Mean Square	F	Sig.
Time	Sphericity Assumed	31.452	4	7.863	.970	.437
	Greenhouse-Geisser	31.452	1.792	17.555	.970	.393
	Huynh-Feldt	31.452	3.141	10.014	.970	.425
	Lower-bound	31.452	1.000	31.452	.970	.353
Time * V5	Sphericity Assumed	116.598	12	9.716	1.199	.326
	Greenhouse-Geisser	116.598	5.375	21.693	1.199	.360
	Huynh-Feldt	116.598	9.423	12.374	1.199	.338
	Lower-bound	116.598	3.000	38.866	1.199	.370
Error(Time)	Sphericity Assumed	259.350	32	8.105		
	Greenhouse-Geisser	259.350	14.333	18.095		
	Huynh-Feldt	259.350	25.127	10.322		
	Lower-bound	259.350	8.000	32.419		

Appendix-XVI: Tests of Within-Subjects Contrasts of HGG

Source	Time	Type III Sum of Squares	Df	Mean Square	F	Sig.
Time	Linear	21.252	1	21.252	1.333	.282
	Quadratic	6.095	1	6.095	.833	.388
	Cubic	1.008	1	1.008	.211	.658
	Order 4	3.096	1	3.096	.708	.424
Time * V5	Linear	10.252	3	3.417	.214	.884
	Quadratic	10.955	3	3.652	.499	.693
	Cubic	29.842	3	9.947	2.080	.181
	Order 4	65.549	3	21.850	4.999	.031
Error (Time)	Linear	127.583	8	15.948		
	Quadratic	58.548	8	7.318		
	Cubic	38.250	8	4.781		
	Order 4	34.969	8	4.371		

Appendix-XVII: Tests of Between-Subjects Effects of HGG

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Intercept	91.267	1	91.267	7.254	.027
V5	78.058	3	26.019	2.068	.183
Error	100.650	8	12.581		