Grouping Strategies for Feeding Lactating Dairy Cattle

Victor E. Cabrera

United States Department of Agriculture

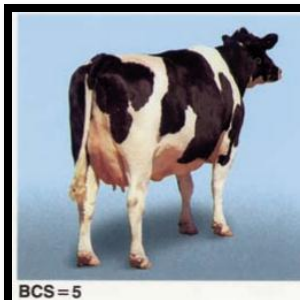
National Institute of Food and Agriculture

"This project is supported by Agriculture and Food Research Initiative Competitive Grant no. 2011-68004-30340 from the USDA National Institute of Food and Agriculture."

2011 ANRE Conference, October 26-28, 2011, Wilderness Resort, Wisconsin Dells

Rationale

- A large proportion of lactating dairy cows might be overfed
  - Ration is the same for all cows in a group
  - Nutritionists and farmers prefer to give the “higher” ration rather than the “lower”
  - Lower producing animals receive more than required nutrients

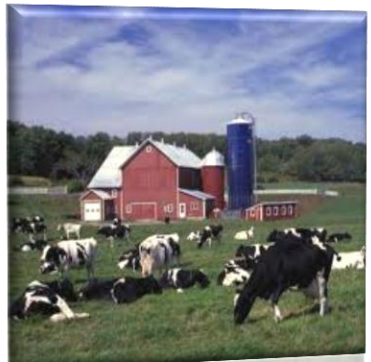


Rationale

- Grouping for feeding purposes and providing different rations make sense
  - Increases the efficiency nutrients use
  - Saves money
  - Increases profitability because improves the income over feed cost
  - Decreases the excretion of nutrients and hence environmental impacts

Why Farmers do not Group More?

- Farm facilities are not appropriated
- Additional equipment is required
- Management constraints
- Labor constraints
- Additional investment required
- …

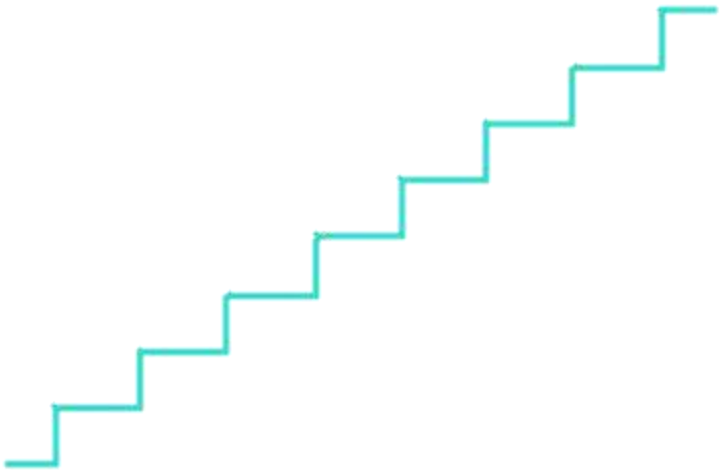


Strategies for Grouping

- Several strategies could exist
- The most accepted strategy in the literature
  - Individual cow nutrient requirement expressed as:
    - Mcal/lb of DM, and
    - % CP of DM
  - Number of animals
  - Farm's capacity to handle and feed different group diets

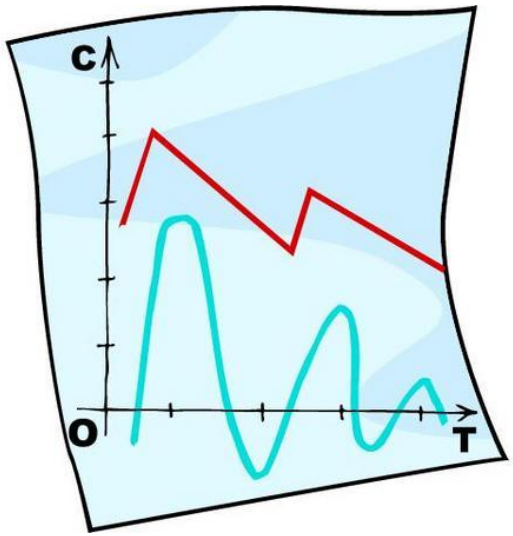
Adapted from McGilliard et al., 1982; St-Pierre and Thraen, 1999

Approach



1. Get the Farm Data

- Time-specific database is needed (DHIA Test Records)
- For every record (cow) :
  - Cow identification (Cow ID)
  - Lactation (parity)
  - Days after calving (DIM)
  - Milk production (lb/d)
  - Milk fat content (%)
  - Body weight (lb; optional)

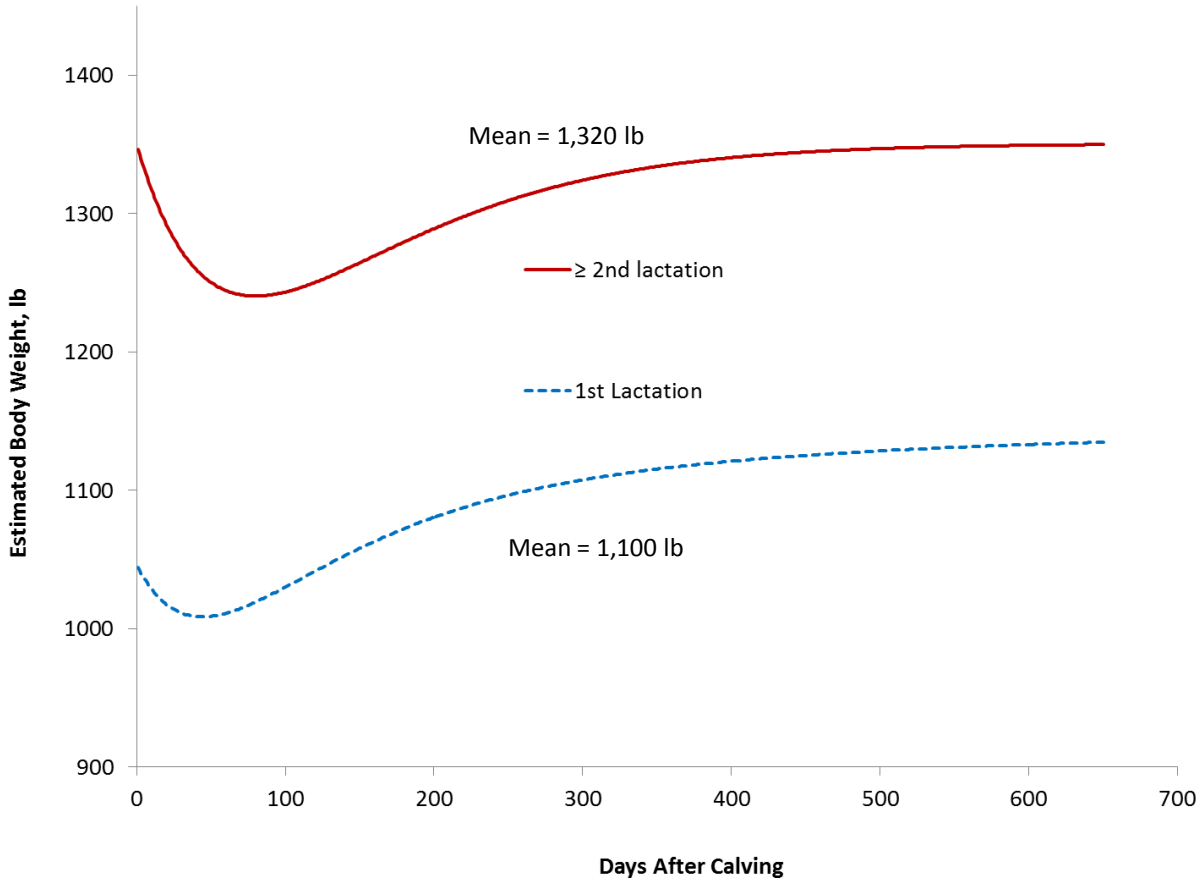


2. Estimate Individual Requirements

- Net Energy (NE)
  - Total NE = NE(maintenance) + NE(milk)
    - NE(maintenance) = 0.079 x $BW^{0.75}$ (NRC, 2001)
    - NE(milk) = Milk x (0.36 + 0.0969 x FAT%) (NRC, 2001)
    - NE (Mcal/lb DM) = Total NE/DMI

- Crude Protein (CP)
  - Total CP = CP(maintenance) + CP(milk)
    - CP(maintenance) = 104.78 + 0.73 x BW – 0.000015432 x BW^2
    - CP(milk) = Milk x (4586+1036 x FAT%) (McGilliard et al., 1983)
    - % CP = Total CP/DMI

2. Cow's Body Weight



Korver Function described by Van Arendonk (1985) and parameterized by Kalantari et al. (2010)

2. Dry Matter Intake (DMI)

- DMI = function of DIM, BW, and fat corrected milk (FCM)
- $DMI = (0.372 \times 4\%FCM + 0.0968 \times BW^{0.75}) \times (1 - e^{(-0.192x((DIM/7)+3.67))})$ (NRC, 2001)
  - $4\%FCM = 0.4 \times Milk + 15 \times (FAT\%/100) \times Milk$

3. Determine Group Requirements

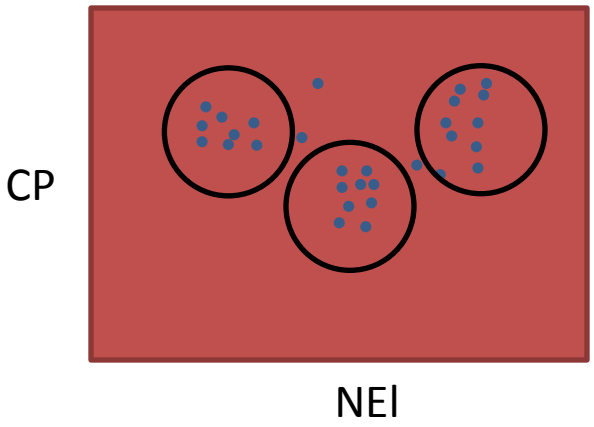
- Diet is formulated based on:
  - 83rd percentile (mean + 1 standard deviation) of the group nutrient requirements (Stallings and McGilliard, 1984; St-Pierre and Thraen, 1999)
  - 83rd percentile of NEl and 83rd percentile of CP

4. Determine Number Groups

- Very little or no additional gain after more than 4 groups (McGilliard et al., 1983; St-Pierre and Thraen, 1999)
- Empirical analyses confirmed no more gains after 4 groups
- More than 4 groups for lactating cows may be impractical
- Possible number of groups: 2, 3, or 4
- Depends on the farm facilities, equipment and management

5. Criteria for Grouping

- Farm own criteria, if any
- Main criteria that could be compared:
  - Days after calving (DIM)
  - Fat corrected milk (FCM)
  - Merit = FCM/$BW^{0.75}$
  - Cluster = Cows alike in NEl and CP requirements



6. Assign Cows to Groups (Optimize)

- Price NEl and CP
  - No market price fo NEl or CP
  - Deducted from “referee” feeds like corn and SBM
    - Corn %CP + Corn Mcal NE = $/lb corn
    - SBM %CP + SBM Mcal NE = $/lb SBM
  - Other “referee” feeds could be used
  - Nutritionists or farmers could have these values already available

6. Assign Cows to Groups (Optimize)

$$Max(\text{IOFC}) = \sum_{group=1}^{G} (IOFC_{group})$$

$$IOFC_{group} = (Milk_{group})(Milk\ Price) - (FeedCost_{group})$$

$$FeedCost_{group} = (83\%tileCP_{group})(CP\ Price)$$

$$+ (83\%tileNEl_{group})(NEl\ Price)$$

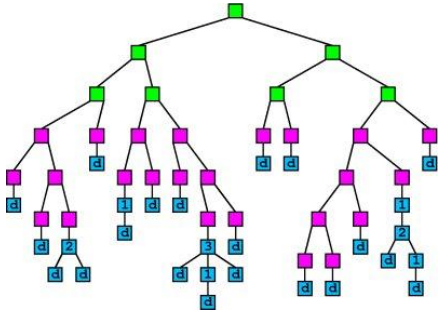
$IOFC$ = Income Over Feed Cost, G = total number of groups: 2, 3, or 4

7. Calculate Net Return

- Include additional costs and returns
  - Additional cost of management for having more feeding groups
  - Milk production depression cost because of social behavior by moving cows among groups
  - Cost savings on additives giving only to some group(s)
  - …

8. Analyses Options

- Farmer does group, but can’t do more groups:
  - Compare grouping criteria
  - Optimize animals in each one of the groups
- Farmer does group and can do more groups:
  - Select the right number of groups
  - Select the right group criterion
  - Optimize animals in each one of the groups



8. Analyses Options

- Farmer does not group, but farm has capabilities of grouping:
  - Increase the number of feeding groups
  - Select the right grouping criterion
  - Optimize animals in each one of the groups

Decision Support System

Home | Tools | Projects | Publications | Presentations | LGM-Dairy | Links

About | Contact | Comments | News | People | Opportunities | Gallery

Grouping Strategies for Feeding Lactating Dairy Cattle

Overview | **Upload Farm Details** | **Group Cows** | **Reap Benefits** | **Sample Farm: Total Cows = 470**

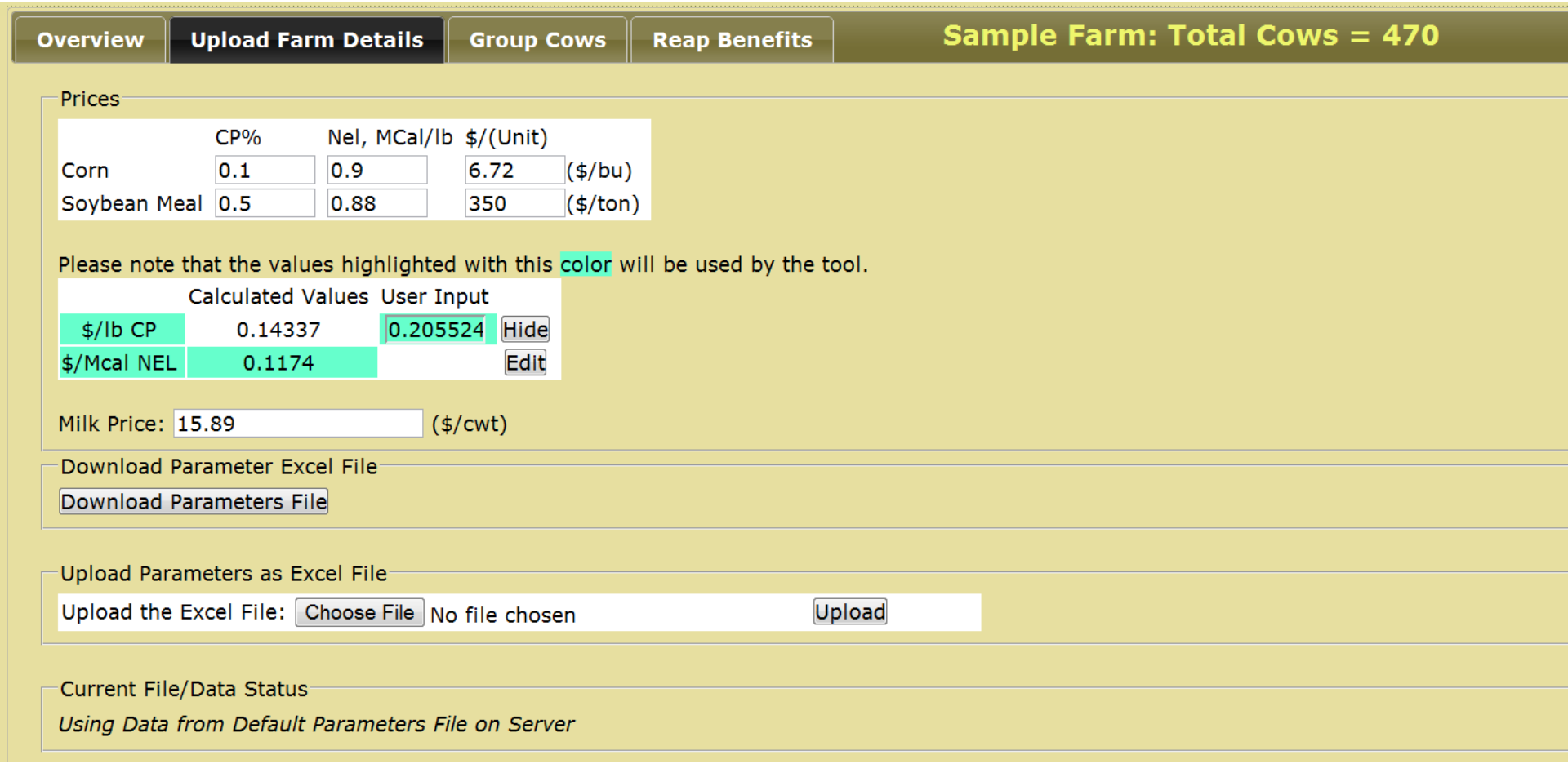
This tool evaluates feeding grouping strategies in lactating cows. It uses different criteria to group, finds the cows to conform a group (optimizes), suggests a group diet ration based on Net Energy (NEL, MCal/lb) and Crude Protein (CP, %), compute the expected Income Over Feed Cost (IOFC), and the additional economic benefit of feed grouping after management of additional groups and an expected milk depression on lactating cows regrouped.

In order to use this tool a herd test file is needed. This should contain information regarding Cow ID, Lactation, Days in Milk (DIM), Milk Produced, and Milk Fat Content. Optionally, for more accurate calculations, Body Weight (BW) could be added (if BW is not provided, the tool calculates BW based on lactation and DIM after a user-entered average BW for primiparous and multiparous cows). The tab with name upload farm details helps the user upload an excel file with those parameters. It is suggested to first download the parameters file to a local computer and then use this as a template to enter farm specific data. Once the data are entered, the file could be back uploaded. The tool will indicate which file is being used. The number of lactating cows in the file will be automatically counted and displayed. Also, in this tab, the user defines indirectly the price of feed energy ($/MCal) and feed protein ($/ lb CP), which are based on nutritive content and prices of refereed feeds (Corn and Soybean meal). The user can over-write these values if desired.

Once the data have been entered, the user could move to the tab with name 'Group Cows'. This tab is self-explanatory and follows a decision tree structure to help the user analyze grouping strategies. After following the questions in the decision tree, the user could hit the 'Analyze' button and get the results in the 'Reap Benefits' tab. This last tab of the tool ('Reap Benefits') displays the economic benefit of different group strategies compared to the farm defined current strategy.

Home | Tools | Projects | Presentations | Publications | LGM-Dairy | Links

Enter the Data



Enter the Data

COWID	Lactation	Days in Milk	(lb) Milk	(%) Fat	(lb) body weight (Optional)
6234	1	84	62	4.2	1111
132	7	118	73	4.6	1176
6196	1	198	85	4.3	1246
5516	4	199	114	3.1	1641
5561	4	280	108	3.1	1516
5961	2	173	91	3.5	1291
6149	1	253	88	2.9	1136
5667	4	138	92	3.7	1406
5960	3	159	110	3	1616
5817	2	244	115	4.1	1842
6191	1	190	90	4.4	1386
5045	7	370	108	4.3	1727
178	3	249	80	4	1131
5933	2	211	99	3.4	1431
190	2	211	74	4	1031
5677	3	310	115	2.5	1581
6161	1	190	86	3.8	1246
5764	3	145	97	3.8	1541
3273	6	288	112	2.8	1591
5896	2	283	109	2.8	1541
5778	3	121	73	4.8	1241
5852	2	301	105	2.5	1421
6190	1	131	80	3.1	1151
6194	1	145	77	4.6	1236
5909	2	173	105	3	1546
5570	4	180	106	4.6	1832

Enter the Data

Overview | Upload Farm Details | Group Cows | Reap Benefits | User File(cluster_input ....xls): Total Cows = 400

Prices

	CP%	Nel, MCal/lb	$/(Unit)	
Corn	0.1	0.9	6.72	($/bu)
Soybean Meal	0.5	0.88	350	($/ton)

Please note that the values highlighted with this color will be used by the tool.

	Calculated Values	User Input	
$/lb CP	0.14337		Edit
$/Mcal NEL	0.1174	0.110497	Hide

Milk Price: 20 ($/cwt)

It had been found that the BW details for each cow has not been entered in the input spreadsheet.
Please enter the following details in order for it to be calculated automatically by the tool.

BW Primiparous 1100 (lb)
BW Multiparous 1400 (lb)

Download Parameter Excel File

Download Parameters File

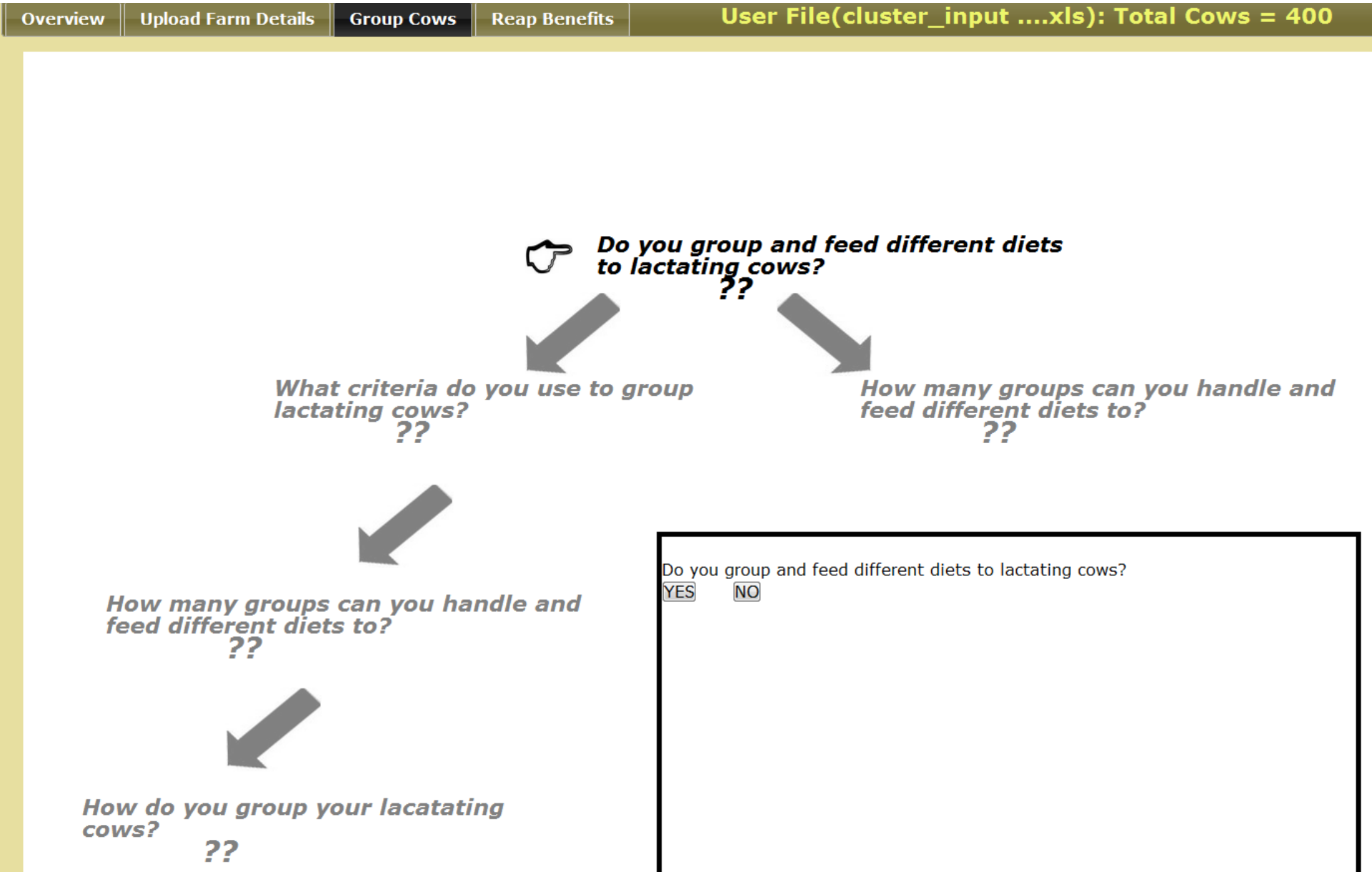
Upload Parameters as Excel File

Upload the Excel File: Choose File No file chosen Upload

Current File/Data Status

Using Data from user Uploaded file

Make Choices



Do you group and feed different diets to lactating cows?

NO

What criteria do you use to group lactating cows?

??

How many groups can you handle and feed different diets to?

??

How many groups can you handle and feed different diets to?

??

How do you group your lacatating cows?

??

BACK

How many groups can you handle and feed different diets to?

- Two
- Three
- Four

Please enter the size of each group that you can handle.

Group	Group1	Group2	Group3
Size	100	100	200

Please enter the CP and NEL values currently being used:

NE (Mcal NEL/lb)	CP(%)
0.82	18

Additional cost (labor, management, and machinery) of feeding and grouping lactating cows into 3 groups instead of 1 ($/herd/month): 500

Estimate milk depression caused due to re-location of lactating cows :

Loss of milk production (lb/d): 4

Number of days the loss continues (d): 5

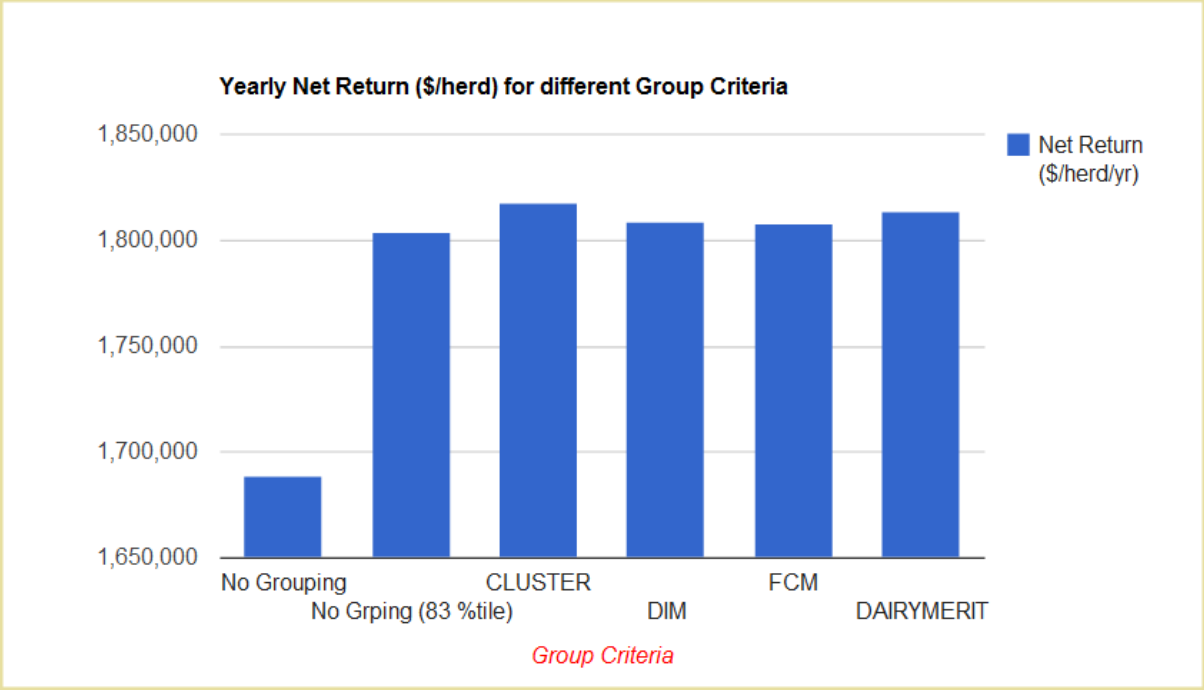
Would you save money because of using less feed addtives with more groups? If yes, how much would you save? 100 $/herd/month

Press analyze to know the benefits of grouping.

Analyze

Make Decisions

Overview | Upload Farm Details | Group Cows | Reap Benefits | User File(cluster_input ....xls): Total Cows = 400



Make Decisions

Click on the Group Criteria names (in blue/red) to know the actual distribution of cows across different groups.

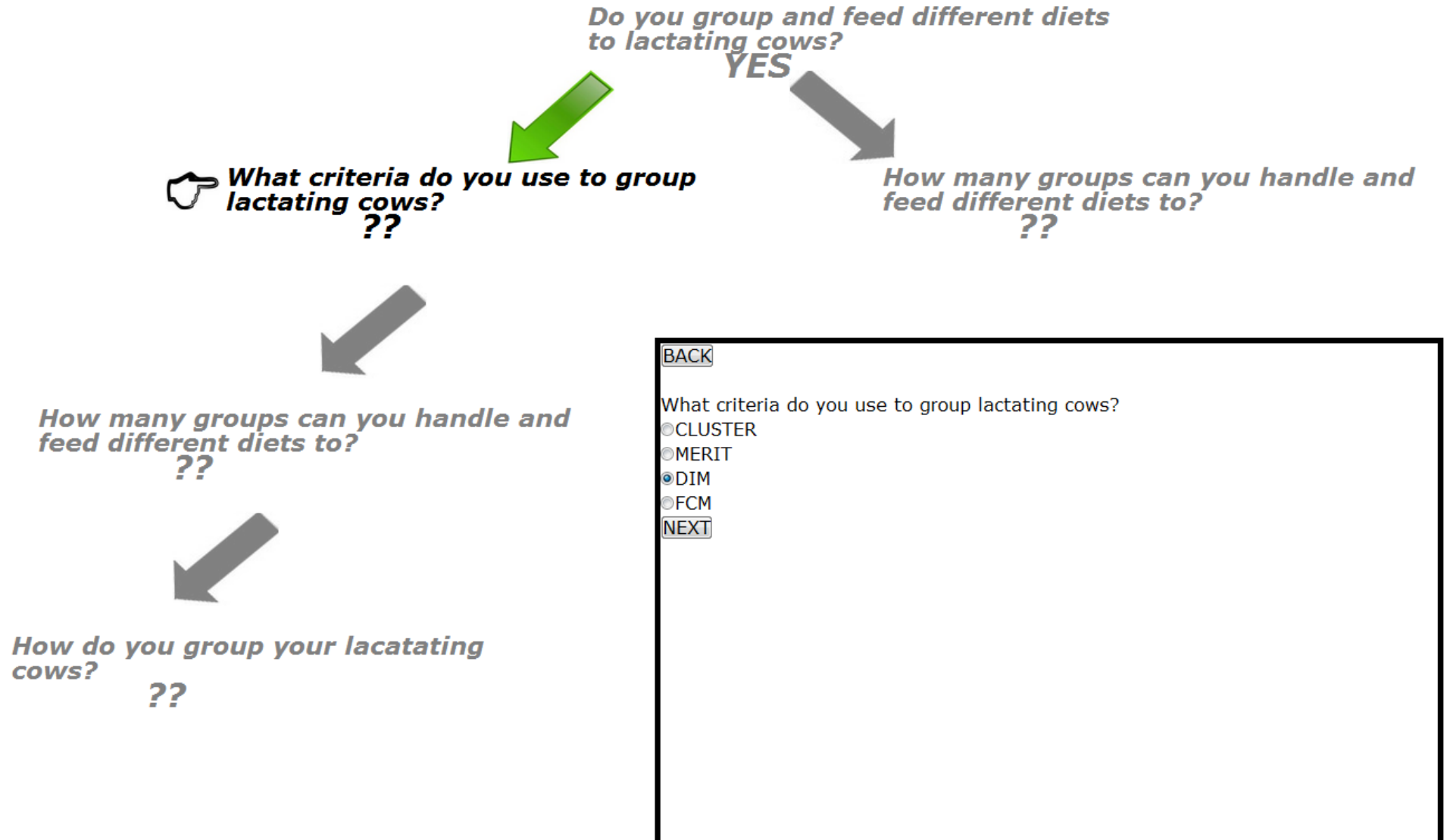
Group Criteria	Group Number	Number Cows	NEL (Mcal/lb)	CP (%)	IOFC	Cost of Management ($/cow/d)	Cost Milk Depression ($/cow/d)	Savings on Additives ($/cow/d)	Total ($/cow/d)	Total ($/herd/yr)
NO GROUPING (No Optimization)	1	400	0.82	18.00	11.57					
	Mean		0.82	18.00	11.57	-0.00	-0.00	0.00	11.57	1,688,873
NO GROUPING (83 Percentile)	1	400	0.72	16.43	12.36					
	Mean		0.72	16.43	12.36	-0.00	-0.00	0.00	12.36	1,803,905
CLUSTER	1	100	0.75	17.44	15.12					
	2	200	0.70	15.80	12.56					
	3	100	0.66	14.40	9.76					
	Mean		0.70	15.86	12.50	-0.04	-0.02	0.02	12.45	1,817,221
DIM	1	100	0.75	17.42	13.5					
	2	200	0.70	16.03	12.57					
	3	100	0.68	15.19	11.11					
	Mean		0.71	16.17	12.44	-0.04	-0.02	0.02	12.39	1,808,412
FCM	1	100	0.75	17.44	15.57					
	2	100	0.71	16.18	13.35					
	3	200	0.68	15.30	10.41					
	Mean		0.71	16.05	12.43	-0.04	-0.02	0.02	12.38	1,807,828
DAIRYMERIT	1	100	0.75	17.44	15.06					
	2	200	0.70	15.87	12.43					
	3	100	0.66	14.54	9.98					
	Mean		0.70	15.93	12.47	-0.04	-0.02	0.02	12.42	1,813,926

Make Decisions

Distribution of Cows across 3 groups for the following group criterion - CLUSTER

GROUP	1	2	3
CP (%)	17.43951	15.79596	14.39925
NE (Mcal/Kg)	1.66383	1.53926	1.44882
COW ID	5691	5531	6159
COW ID	5680	6150	6087
COW ID	5344	6193	6162
COW ID	6045	5404	5736
COW ID	5709	6134	3407
COW ID	5807	5826	5906
COW ID	6235	6253	5929
COW ID	6005	6188	6204
COW ID	4884	6231	5416
COW ID	5995	5910	5849
COW ID	5803	6209	6176
COW ID	6290	5999	6135
COW ID	5954	5565	6075
COW ID	5629	5511	5582
COW ID	5563	6003	5963
COW ID	6058	5817	5291
COW ID	5383	5403	6000
COW ID	6227	6223	5892
COW ID	6272	5793	6143
COW ID	6260	6203	5781
COW ID	5597	5751	5860
COW ID	6048	5930	5749
COW ID	3249	5958	178
COW ID	6270	5570	5515
COW ID	6015	5314	5945
COW ID	5925	6191	5534
COW ID	5816	6195	6105
COW ID	6250	3443	6148
COW ID	6060	3272	6140
COW ID	5956	5959	6177
COW ID	5633	5971	5435
COW ID	6039	5924	5422
COW ID	5788	5160	6088
COW ID	5365	6169	5955
COW ID	5821	5979	6092
COW ID	6285	5980	5815
COW ID	6216	6183	5903
COW ID	6025	5909	6112
COW ID	6239	5561	5765
COW ID	5804	3403	5874
COW ID	5520	5975	6049
COW ID	5666	5760	5862
COW ID	6225	5957	6007
COW ID	6218	5988	5851
COW ID	5622	5776	5900
COW ID	5655	3436	5894
COW ID		5841	
COW ID		5896	
COW ID		6190	
COW ID		5489	
COW ID		6110	
COW ID		6165	
COW ID		5667	
COW ID		6174	
COW ID		71	
COW ID		5456	
COW ID		5952	
COW ID		6149	
COW ID		6199	
COW ID		6117	
COW ID		6036	
COW ID		5536	
COW ID		5789	
COW ID		5933	
COW ID		6016	
COW ID		5731	
COW ID		5928	
COW ID		6186	
COW ID		6214	
COW ID		6192	
COW ID		6187	
COW ID		5724	
COW ID		6182	
COW ID		6116	
COW ID		3424	
COW ID		5756	
COW ID	6224
COW ID	5263
COW ID	6198
COW ID	6090
COW ID	5557
COW ID	5950
COW ID	84
COW ID	5287
COW ID	5767
COW ID	6108
COW ID	5660
COW ID	5943
COW ID	5897
COW ID	5977
COW ID	6128
COW ID	5408
COW ID	6106
COW ID	5769
COW ID	6095
COW ID	6123
COW ID	6157
COW ID	6208
COW ID	5913
COW ID	6197
COW ID	5853
COW ID	6201
COW ID	5627
COW ID	6109
COW ID	5778
COW ID	6107
COW ID	5878
COW ID	132
COW ID	5768
COW ID	5869
COW ID	6121
COW ID	6098
COW ID	5567
COW ID	6133
COW ID	6127
COW ID	5948

Make Choices



Make Choices

Do you group and feed different diets to lactating cows?
YES

What criteria do you use to group lactating cows?
??

How many groups can you handle and feed different diets to?
??

How many groups can you handle and feed different diets to?
??

How do you group your lacatating cows?
??

BACK

How many groups do you have for your lactating cows?
- (•) Two
- ( ) Three
- ( ) Four

How many groups can you handle?
- ( ) Two
- ( ) Three
- (•) Four

Please enter the size of each group that you can handle.

Group	Size
Group1	100
Group2	100
Group3	100
Group4	100

NEXT

Make Choices

Do you group and feed different diets to lactating cows?
YES

What criteria do you use to group lactating cows?
??

How many groups can you handle and feed different diets to?
??

How many groups can you handle and feed different diets to?
four

How do you group your lacatating cows?
??

BACK

What are the size and nutrients of your current groups?

Groups	Size	NE (Mcal NEL/lb)	CP (%)
Total	400		
Group1	200	0.82	18
Group2	200	0.77	17

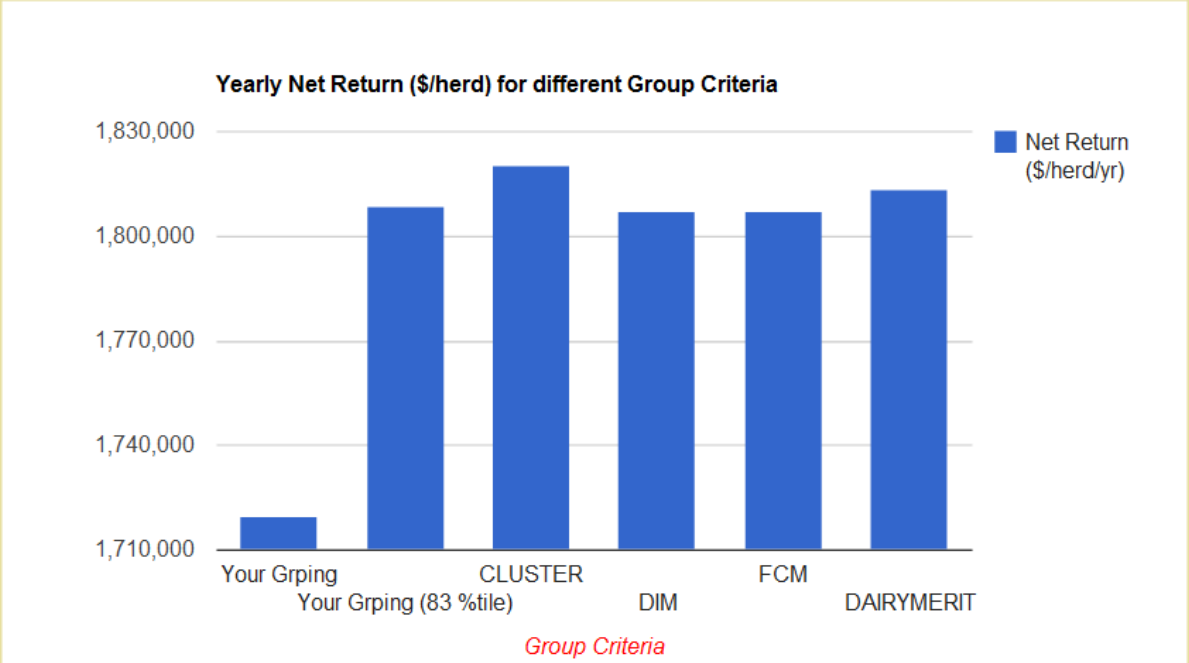
Additional cost (labor, management, and machinery) of grouping lactating cows and feeding($/herd/month): 1000

Estimate milk depression caused due to re-location of lactating cows:
Loss of milk production (lb/d): 4
Number of days the loss continues (d): 5
Would you save money because of using less feed addtives with more groups? If yes, how much would you save? 500 $/herd/month

Press analyze to know how you can gain more by grouping better.
Analyze

Make Decisions

Overview | Upload Farm Details | Group Cows | Reap Benefits | User File(cluster_input ....xls): Total Cows = 400



Click on the Group Criteria names (in blue/red) to know the actual distribution of cows across different groups.

Group Criteria	Group Number	Number Cows	NEL (Mcal/lb)	CP (%)	IOFC	Cost of Management ($/cow/d)	Cost Milk Depression ($/cow/d)	Savings on Additives ($/cow/d)	Total ($/cow/d)	Total ($/herd/yr)
YOUR GROUPING (Current Diets)	1	200	0.82	18.00	10.31					
	2	200	0.77	17.00	13.25					
	Mean		0.80	17.50	11.78	-0.00	-0.00	0.00	11.78	1,719,745
YOUR GROUPING (83 Percentile Diets)	1	200	0.69	15.53	11.34					
	2	200	0.74	16.99	13.43					
	Mean		0.72	16.26	12.39	-0.00	-0.00	0.00	12.39	1,808,697
CLUSTER	1	100	0.75	17.44	15.12					
	2	100	0.70	15.93	13.66					
	3	100	0.68	15.20	11.58					
	4	100	0.66	14.40	9.76					
	Mean		0.70	15.74	12.53	-0.08	-0.02	0.04	12.47	1,820,282
DIM	1	100	0.75	17.42	13.50					
	2	100	0.71	16.34	13.51					
	3	100	0.69	15.68	11.63					
	4	100	0.68	15.19	11.11					
	Mean		0.71	16.16	12.44	-0.08	-0.02	0.04	12.38	1,807,371
FCM	1	100	0.75	17.44	15.57					
	2	100	0.71	16.18	13.35					
	3	100	0.69	15.54	11.18					
	4	100	0.67	14.93	9.65					
	Mean		0.71	16.02	12.44	-0.08	-0.02	0.04	12.38	1,807,201
DAIRYMERIT	1	100	0.75	17.44	15.06					
	2	100	0.71	16.10	13.15					
	3	100	0.69	15.41	11.72					
	4	100	0.66	14.54	9.98					
	Mean		0.70	15.87	12.48	-0.08	-0.02	0.04	12.42	1,813,267

Check the online tool!!!

http://dairymgt.info/ → Tools → Feeding → Grouping Strategies for Feeding Lactating Dairy Cattle