

# Principle in Feed Formulation for Layer

## (Teknik formulasi ransum petelur)

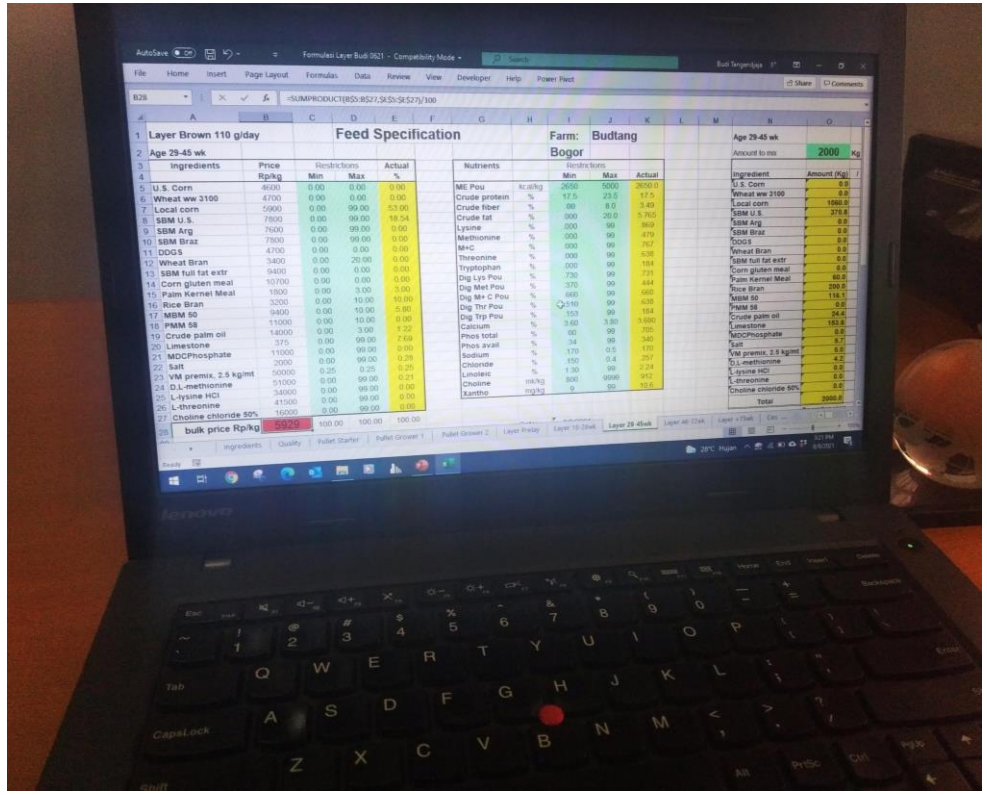
BUDI TANGENDJAJA, PHD

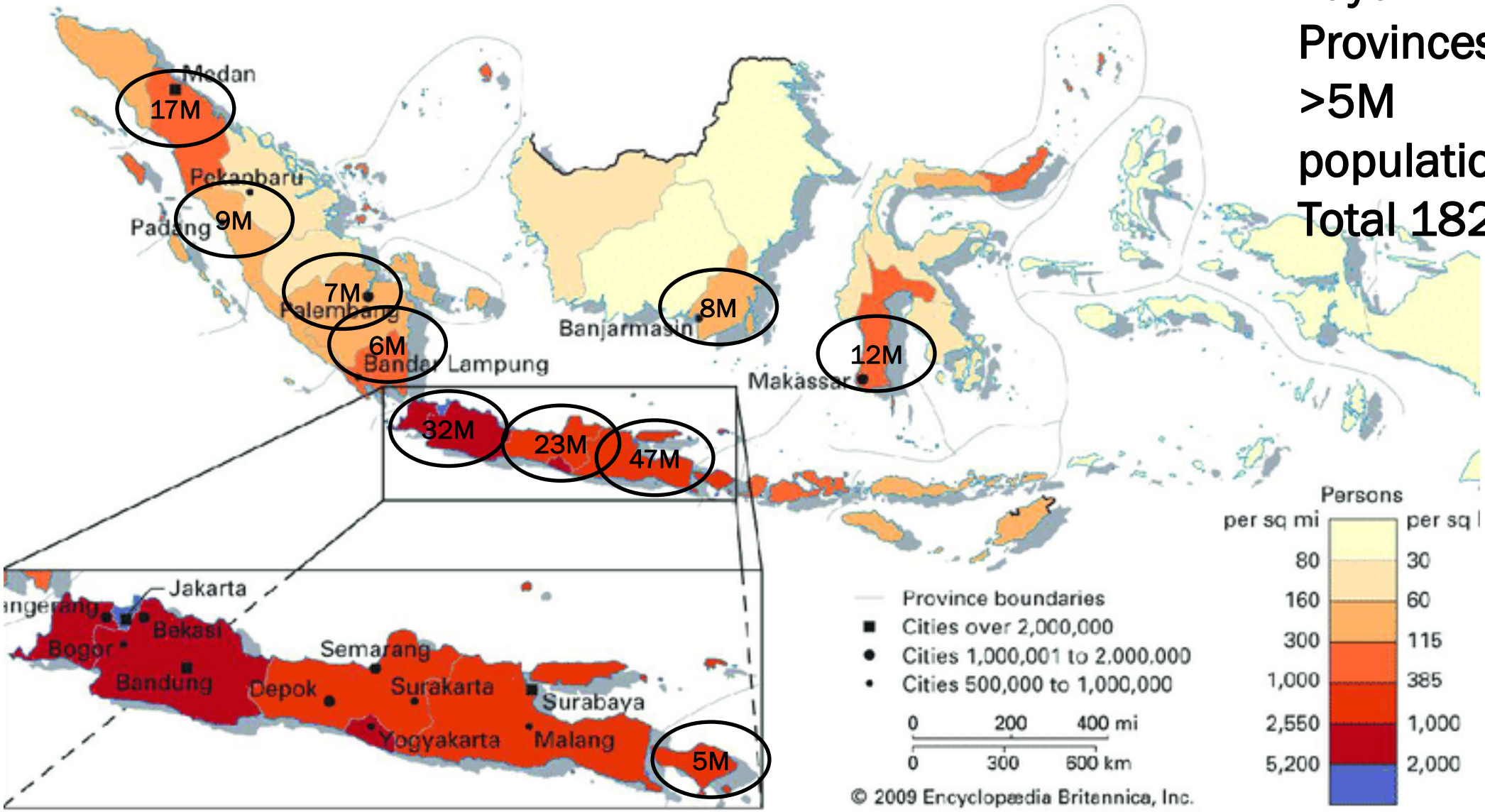
NUTRITIONIST AND FEED TECHNOLOGY

BOGOR, INDONESIA

# Agenda

- Introduction
- Why and how Formulation
- Linear Program
- Data (base and price)
- Constraints:
  - Nutrient
  - Ingredients
- Nutrient Requirement
- Live Demonstration in Layer Formulation




Layer
Provinces with >5M population
Total 182 M
Medan
17M
Pekanbaru
Padang
9M
7M
Palembang
6M
Bandar Lampung
Banjarmasin
8M
12M
Makassar
32M
23M
47M
Jakarta
Bekasi
Bogor
Bandung
Depok
Semarang
Surakarta
Surabaya
Yogyakarta
Malang
5M
Province boundaries
Cities over 2,000,000
Cities 1,000,001 to 2,000,000
Cities 500,000 to 1,000,000
0 200 400 mi
0 300 600 km
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Persons
per sq mi
per sq
80
160
300
1,000
2,550
5,200
30
60
115
385
1,000
2,000

# REDUCE FEED COST AND IMPROVE PERFORMANCE (FCR)

**FEED COST FROM RP 6500 TO RP5500/KG AND FCR FROM 2.3 TO 2.15 (24.2 KG IN 85 WK)**

| | | |
|---|---|---|
| **Feed** | 2.3 kgxRp6500 (FCR 2.3) | **Rp 14.950 (84.4%)** |
| **Pullet** | Rp 70.000 | Rp 3.043 |
| **Vaccine & Medicine** | Pullet and layer (3500) | Rp 150 |
| **Labor, electricity, depreciation** | Rp 30.000/23 | Rp 1.300 |
| **Total** | Cull Rp 40000/23 | **Rp 19.443-** Rp 1740= **Rp 17.703** |

| | | |
|---|---|---|
| **Feed** | 2.15 kgxRp**5500** (FCR 2.15) | **Rp 11.825 (85.4%)** |
| **Pullet** | Rp 62.000 | Rp 2.562 |
| **Vaccine & Medicine** | Pullet and layer (Rp 2500) | Rp 103 |
| **Overhead include depreciation** | Rp 30.000/24.2 | Rp 1.239 |
| **Total** | Cull Rp Rp40000/24.2 | **Rp 15.729-** Rp 1652= **Rp 14.077** |

*Formulation is mathematical calculation to get the lowest cost of formula… "It's critical to know behind the number."*

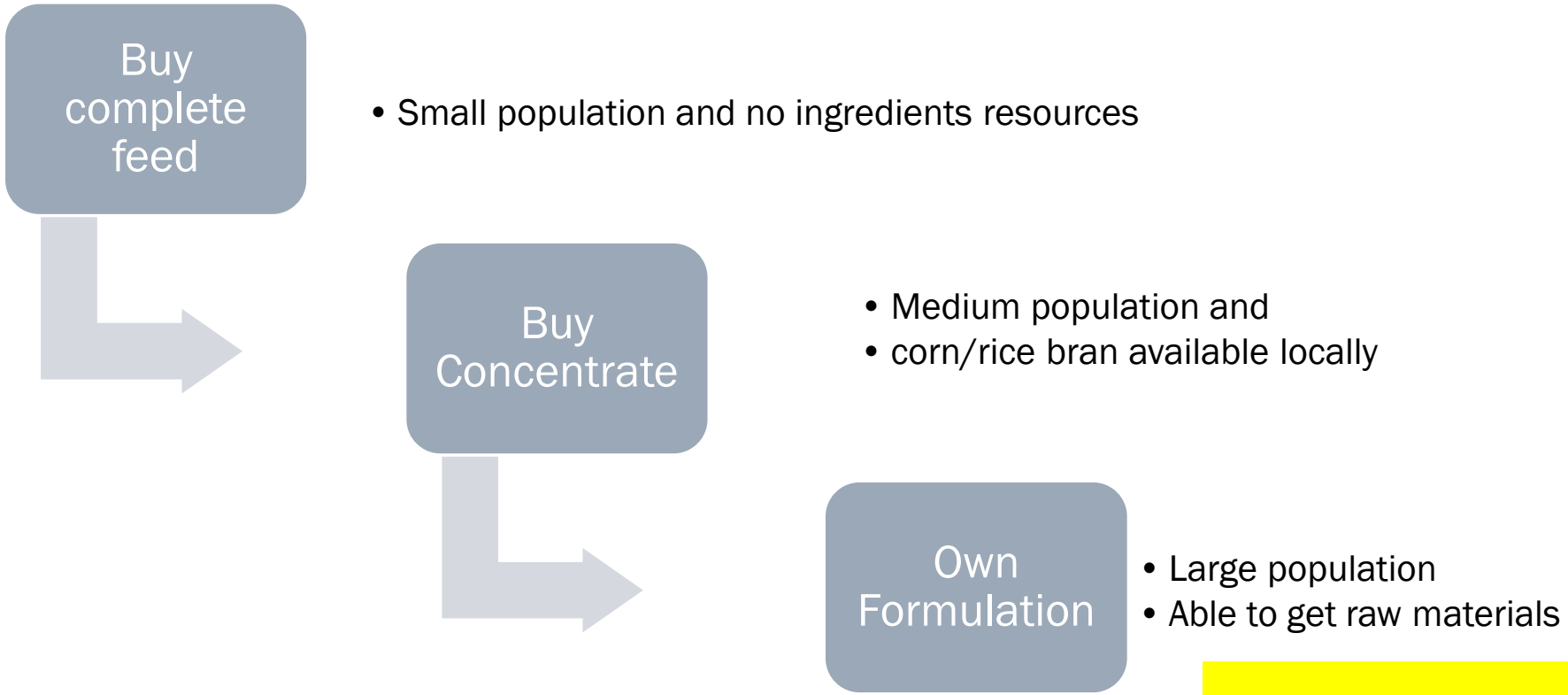
- BUDI TANGENDJAJA

# Feeding of Layer Farm Indonesia

1. Buy Complete Feed
2. Buy Concentrate mix Corn and Rice Bran
3. Formulate your own (self-mixing)
   - by hand
   - Spreadsheet
   - Academic software
   - Commercial systems
     - Microsoft Excel, Lotus 1-2-3
     - FeedLIVE, Ultramix, Wuffda
     - Brill, Format, Best Mix, CFC, Mix-It

**What does your business need?**

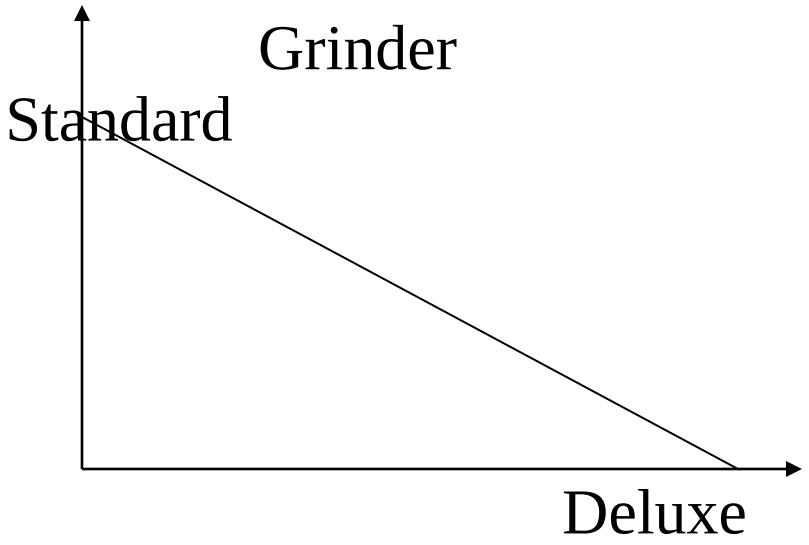
# Stage of Layer Farming in relation to Feed

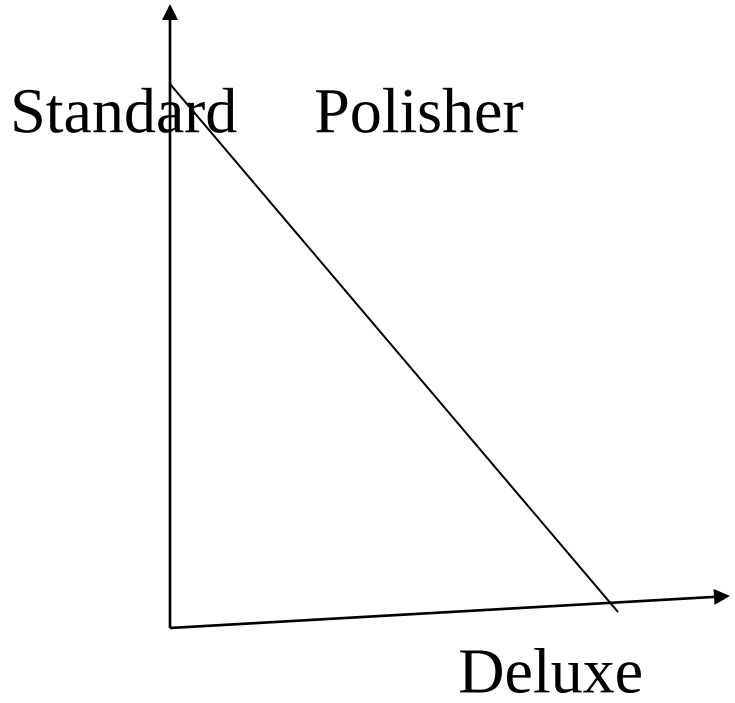


# Basis of Formulation: Linear Program

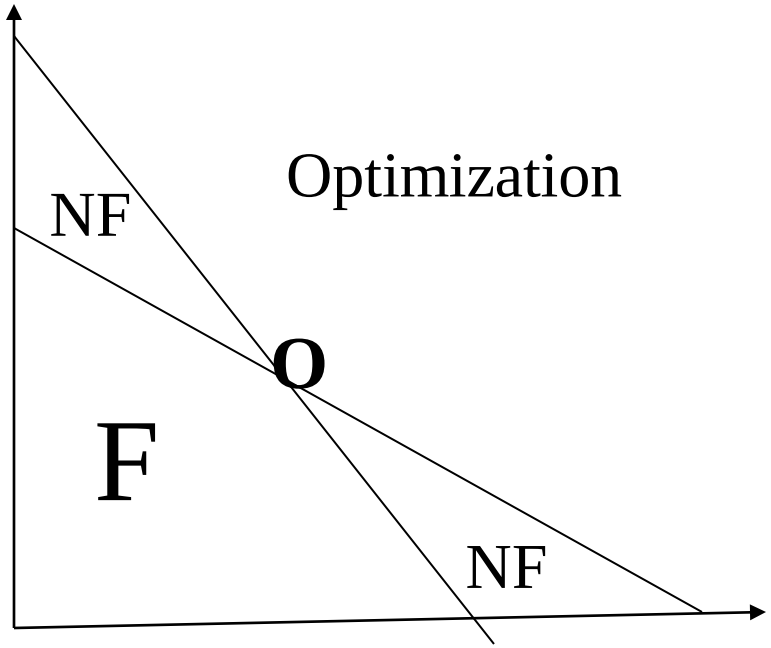
Mathematical technique to allocate resources (raw materials, labors, land etc) optimally to achieve specific purpose (maximize profit or minimize cost) when several alternatives can be chosen

It uses  SIMPLEX method




# Optimization In a factory




NF: Non Feasible
F: Feasible
O: optimum

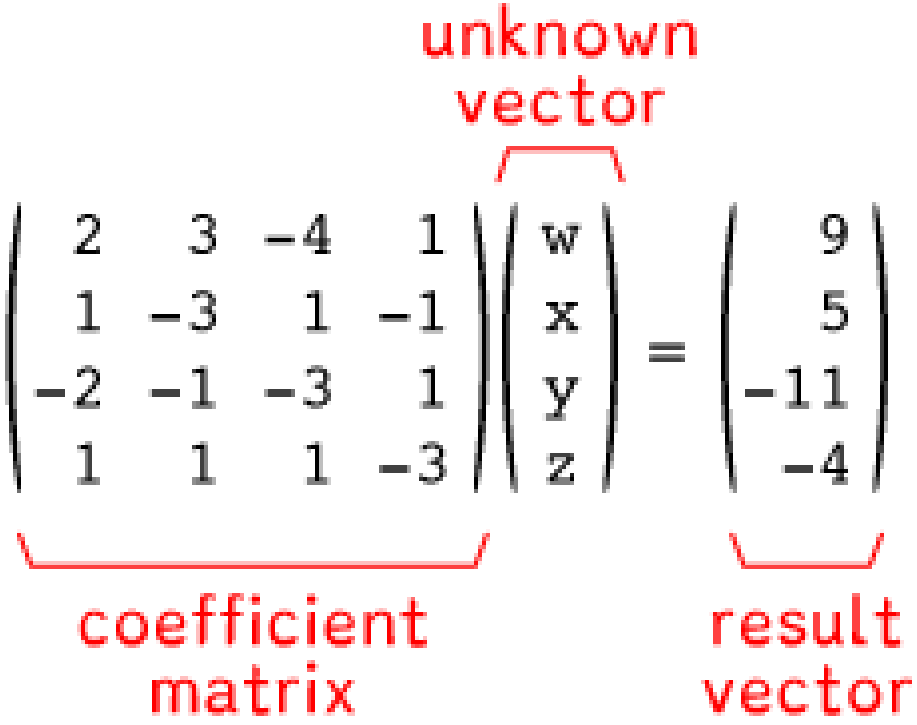
# Mathematical model can be created as follow:

**Equation**

1. Total weight: C + RB + SBM + Ca + MBM = 100
2. Protein: C (9) + RB (12) + SBM (48) + Ca (0) + MBM (50) > 17
3. Energy: C (3300) + RB (2600) + SBM (2500) + Ca (0) + MBM (2200) > 2700
4. Calcium: C (0.02) + RB (0,07) + SBM (0.3) + Ca (38) + MBM (10) > 3.4
5. Calcium: C (0.02) + RB (0,07) + SBM (0.3) + Ca (38) + MBM (10) < 3.6
6. Crude Fiber: C (2.2) + RB (10) + SBM (3.5) + Ca (0) + MBM (1) < 6
7. Cost price: C (5500) + RB (4000) + SBM (7500) + Ca (350) + MBM (8500) = Lowest Cost

# Solving problem

- Require mathematical model
- Matrix algebra
- Inverse matrix difficult if more than 3x3
- Require computer to help
- Trial and error may not result to minimum cost
- Require specific program



# Data requirement for linear program



- Raw materials nutrient composition
- Constraint or limitation divide into 2:
    1. Targeted nutritive value of the diet to be formulated
    2. Limitation of raw materials usage
- Price of raw materials





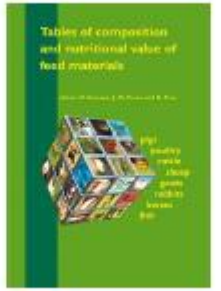


*“garbage in garbage out”*

# Raw materials composition

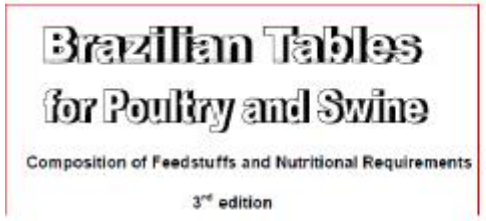
- From Table obtained from NRC,CVB, FEDNA, Adisseo, Evonik, Novus, Ajinomoto, ADM, ARC, local publication etc.
- Self generated data from Laboratory analyses and predicted nutrient using published equations
- Consultant advice I.e. from USGC or USSEC


















AMINODat 5.0

# Set-up a worksheet

1. Ingredient data base
2. Nutrients Requirements
3. Constraints of ingredients usage and nutrient limit

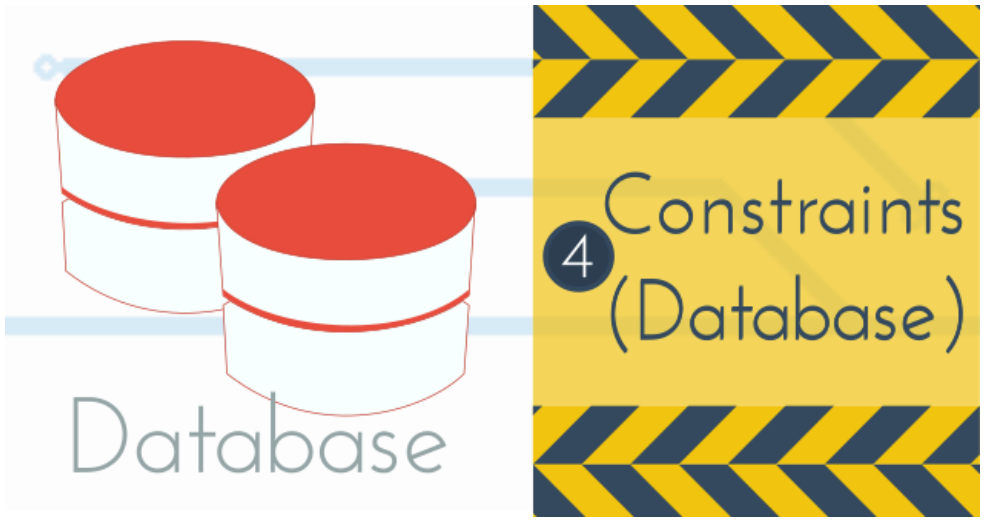
**LP FORMULATION WORKSHEET**

| No | Name | Unit | Min | Max |
|---|---|---|---|---|
| 1 | Weight | kg | | |
| 2 | Dry Matter | % | | |
| 3 | M.E. | Kcal/kg | | |
| 4 | Protein | % | | |
| 5 | Fat | % | | |
| 6 | Linoleic | % | | |
| 7 | Fiber | % | | |
| 8 | Calcium | % | | |
| 9 | P Total | % | | |
| 10 | P Avail | % | | |
| 11 | Sodium | % | | |
| 12 | Lysine | % | | |
| 13 | Methionine | % | | |
| 14 | Met+Cys | % | | |
| 15 | Tryptophane | % | | |
| 16 | Threonine | % | | |
| 17 | Arginine | % | | |
| 18 | Glycine | % | | |
| 19 | Serine | % | | |
| 20 | Histidine | % | | |
| 21 | Isoleucine | % | | |
| 22 | Leucine | % | | |
| 23 | Phenylalanine | % | | |
| 24 | Tyrosine | % | | |
| 25 | Valine | % | | |
| 26 | Gly+Ser | % | | |
| 27 | Phen+Tyr | % | | |
| 28 | D(Lys) | % | | |
| 29 | D(Meth) | % | | |
| 30 | D(Met+Cys) | % | | |
| 31 | D(Tryp) | % | | |
| 32 | D(Thre) | % | | |
| 33 | Meq(Na+K)/Cl | | | |
| 34 | Meq(K+Cl)-Na | | | |
| 35 | Xanthophyll | % | | |

# Nutrient content and variability

- For most major ingredients there is good **data base on "average"** nutrient composition
- With good local **QC program** these data may generally be adjusted in proportion to moisture, CP changes
- For **minor ingredients or by-product** feeds that may vary widely in composition less reliance placed on tabular values
- Continual evaluation with **adjustments** to tabular values needed for these

# Constraints or Limitation




1. **Nutritional:** Animal requirement

2. **Feed Ingredients** Usage

# Constraint requirements

1. Sufficient accuracy to meet animal requirements
2. Flexible so that the choice can be performed
3. Normally there are max, min and fix
4. Not necessary that all nutrient to be included

# Nutritional constraint

Type of nutrient and amount

---

Minimize, maximize or fixed

Nutrient grouping:

1. Proximate (Moi, protein, fat, fiber and ash)
2. Mineral (Ca, Av. P, Na, electrolyte)
3. Amino acids (several essential) and
   its digestibility.

Nutrient ratios: Dig. A.A/ME, Ca/P Av

Others may not be nutrient: xanthophyll, aflatoxin etc

# Development in Formulation

## Future target: Net Energy and Ideal Dig. AA




total AA

ileal digestible AA

std. ileal digestible AA

ideal AA profile

- GE is very old system
- Total AA is not recommended
- Metabolizable Energy and SID AA
- Net Energy is the future for poultry

# Set-up a worksheet

## 2.Nutrients Requirements

Other nutrients : D(Val), D(Isoleu), D(Arg) (min)
Moist, Chloride, Aflatoxin (max)

**LP FORMULATION WORKSHEET**

| No | Name | Unit | Min | Max |
|---|---|---|---|---|
| 1 | Weight | kg | | |
| 2 | Dry Matter | % | | |
| 3 | M.E. | Kcal/kg | ✖ | |
| 4 | Protein | % | ✖ | |
| 5 | Fat | % | | |
| 6 | Linoleic | % | ✖ | |
| 7 | Fiber | % | | ✖ |
| 8 | Calcium | % | ✖ | ✖ |
| 9 | P Total | % | | |
| 10 | P Avail | % | ✖ | |
| 11 | Sodium | % | ✖ | ✖ |
| 12 | Lysine | % | | |
| 13 | Methionine | % | | |
| 14 | Met+Cys | % | | |
| 15 | Tryptophane | % | | |
| 16 | Threonine | % | | |
| 17 | Arginine | % | | |
| 18 | Glycine | % | | |
| 19 | Serine | % | | |
| 20 | Histidine | % | | |
| 21 | Isoleucine | % | | |
| 22 | Leucine | % | | |
| 23 | Phenylalanine | % | | |
| 24 | Tyrosine | % | | |
| 25 | Valine | % | | |
| 26 | Gly+Ser | % | | |
| 27 | Phen+Tyr | % | | |
| 28 | D(Lys) | % | ✖ | |
| 29 | D(Meth) | % | ✖ | |
| 30 | D(Met+Cys) | % | ✖ | |
| 31 | D(Tryp) | % | ✖ | |
| 32 | D(Thre) | % | ✖ | |
| 33 | Meq(Na+K)/Cl | | ✖ | |
| 34 | Meq(K+Cl)-Na | | | |
| 35 | Xanthophyll | % | ✖ | |

# Feed Ingredients Constraint: raw materials usage

- Toxicant that affect animal performance
- Palatability to animals
- Variability in the field
- Possible physical effects such as: smell of fish meal, pellet quality, bulk density in production

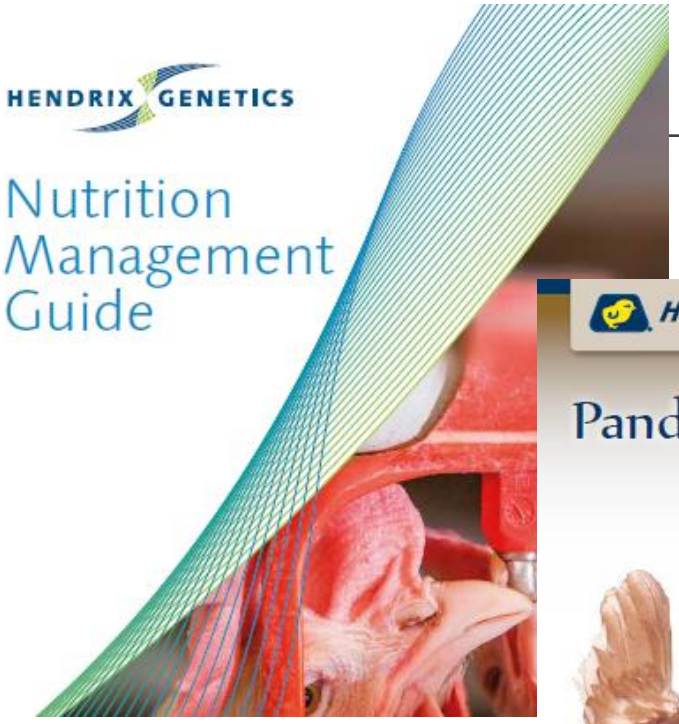
**Experience Nutritionist should be able to advice**

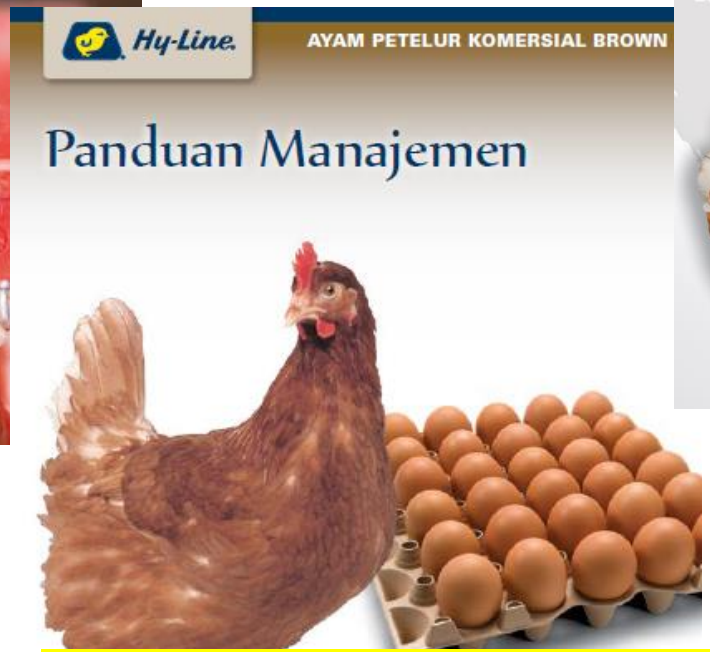
# Maximum limits of raw materials in feeds for pullets and layers

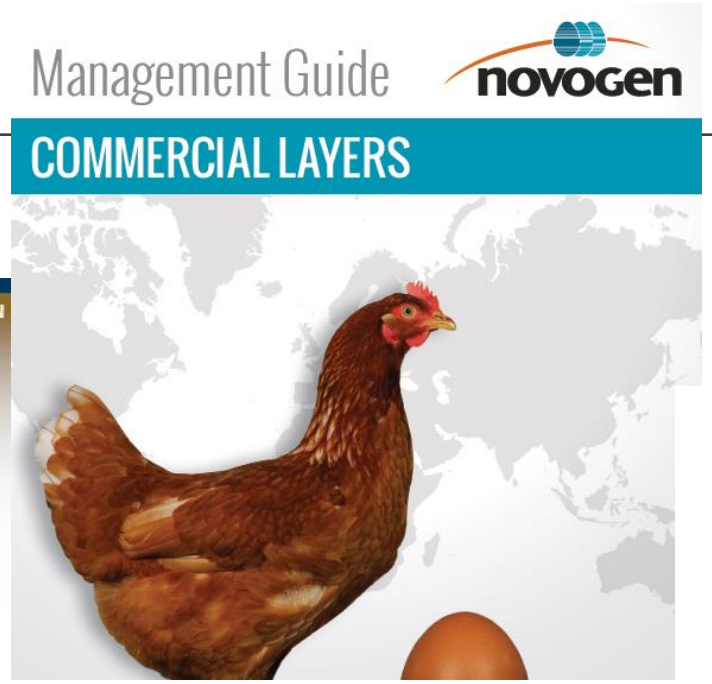
| Raw material | Negative or limiting factors | Pullet | | Layer |
|---|---|---|---|---|
| | | Starter | Grower | |
| **Cereal and by-products** | | | | |
| Wheat | Non-starch polysaccharides | 40 | 40 | 40 |
| Maize | - | 100 | 100 | 100 |
| Barley | β-glucans - fibre | 20 | 30 | 50 |
| Oats | Fibre | 10 | 15 | 30 |
| Rye | Polyphenols - β-glucans | 15 | 15 | 25 |
| Sorghum tannins - | - | 100 | 100 | 100 |
| Sorghum tannins + | Tannins | 20 | 25 | 40 |
| Tapioca | Cyanogen derivatives - ashes | 15 | 20 | 30 |
| Wheat middling | Variability | 10 | 10 | 10 |
| Wheat bran | Variability - fibre | 10 | 10 | 10 |
| Rice bran | Ashes - fibre | 10 | 10 | 10 |
| **Industrial by-products** | | | | |
| Molasses | Potassium - water content | 2 | 2 | 2 |
| CGM | Less binder effect | 3 | 5 | 5 |
| Corn DDGS | Variability | 5 | 10 | 15 |
| Corn gluten feed | Variability - tannins | 5 | 5 | 8 |
| Yeast | Nucleic acid content | 3 | 5 | 5 |

| Raw material | Negative or limiting factors | Pullet | | Layer |
|---|---|---|---|---|
| | | Starter | Grower | |
| **Oilseed meals** | | | | |
| Soybean ** | - | 100 | 100 | 100 |
| Sunflower | Fibre | 15 | 15 | 20 |
| Rape seed-0-0 | Glucosinolates - sinapine | 5 | 5 | 0 |
| Rape seed-00- | - | 5 | 5 | 5 |
| Peanut | Afaltoxin | 10 | 10 | 10 |
| Cottonseed | Gossypol | 8 | 8 | 8 |
| Linseed | Pilysaccharides | 5 | 5 | 5 |
| Palm Kernel Meal | Fibre (ADF, Lignin), NSP, Digestibility | 3 | 5 | 5 |
| Coconut | Fibre | 5 | 5 | 5 |
| **Animal meals** | | | | |
| Meat & bone | Variability - ashes | 6 | 6 | 6 |
| Fish | Desaturated fatty acids | 8 | 8 | 8 |
| Hydrolysed feathers | Digestibility | 2 | 3 | 3 |
| Poultry by-products | Variability - fat content | 5 | 5 | 5 |
| Skimmed milk powder | Lactose - hygroscopicity | 10 | 10 | 10 |
| **Animal fat/vegetal oil** | **Liquid - fatty acid composition** | 3 | 3 | 3 |

# Nutritional Requirement of Layer:
## Management Guide of Breeding Companies







**What is the basis?**

# Establishing Nutrient Specifications

## Many sources available

- NRC are minimum, no margins of safety
- Several ingredient suppliers especially producers of amino acids
- Some university or extension groups
- Industry survey data

Sources vary in anticipated safety margins

**ME requirement for Layer**

| BW (kg) | Temp (oC) | Daily Gain (g) | HD (%) | Egg Wt (g) | EM (g/bird) | FCR |
|---|---|---|---|---|---|---|
| 1.9 | 28 | 1 | 95 | 63 | 59.85 | 1.96 |

ME feed (kcal/kg): 2700

| ME req.(kcal/day) | NRC'94 | Brazil 2017 | Zoly |
|---|---|---|---|
| Maintenance | 191.6 | 182.9 | |
| Growth | 5.5 | 6.7 | |
| Production | 123.9 | 143.6 | |
| Temp Correction | | -33.7 | |
| Total | 321.0 | 299.5 | 303 |
| Daily feed (g/day) | 118.9 | 110.9 | 112.3 |

Change blue fille
By: Budi Tangenc

| Phase | Peaking | Phase 1 | Phase 2 | Phase 3 | Phase 4 |
|---|---|---|---|---|---|
| Current Production | First Egg / Peak -2% | Peak - 2% / 90% | 89% - 85% | 84% - 80% | <80% |
| *Input feed intake* | 97 | 100 | 102 | 100 | 98 |
| Crude Protein % | 17.53 | 16.75 | 15.69 | 15.50 | 15.31 |
| Calcium ; % | 4.33 | 4.40 | 4.51 | 4.80 | 5.00 |
| Available Phsforus; % | 0.51 | 0.44 | 0.39 | 0.38 | 0.37 |
| Na; % | 0.19 | 0.18 | 0.18 | 0.18 | 0.18 |
| Cl; % | 0.19 | 0.18 | 0.18 | 0.18 | 0.18 |
| Linoleic Acid (C18:2 n-6), ; % | 2.06 | 2.00 | 1.57 | 1.50 | 1.43 |
| Choline; mg / Kg | 1,340 | 1,300 | 1,275 | 1,300 | 1,327 |
| | | | | | |
| Digestib - Lysine; % | 0.85 | 0.80 | 0.76 | 0.76 | 0.76 |

## Table 43 - Nutritional Requirements of Brown-Egg Layers (g/bird/day)

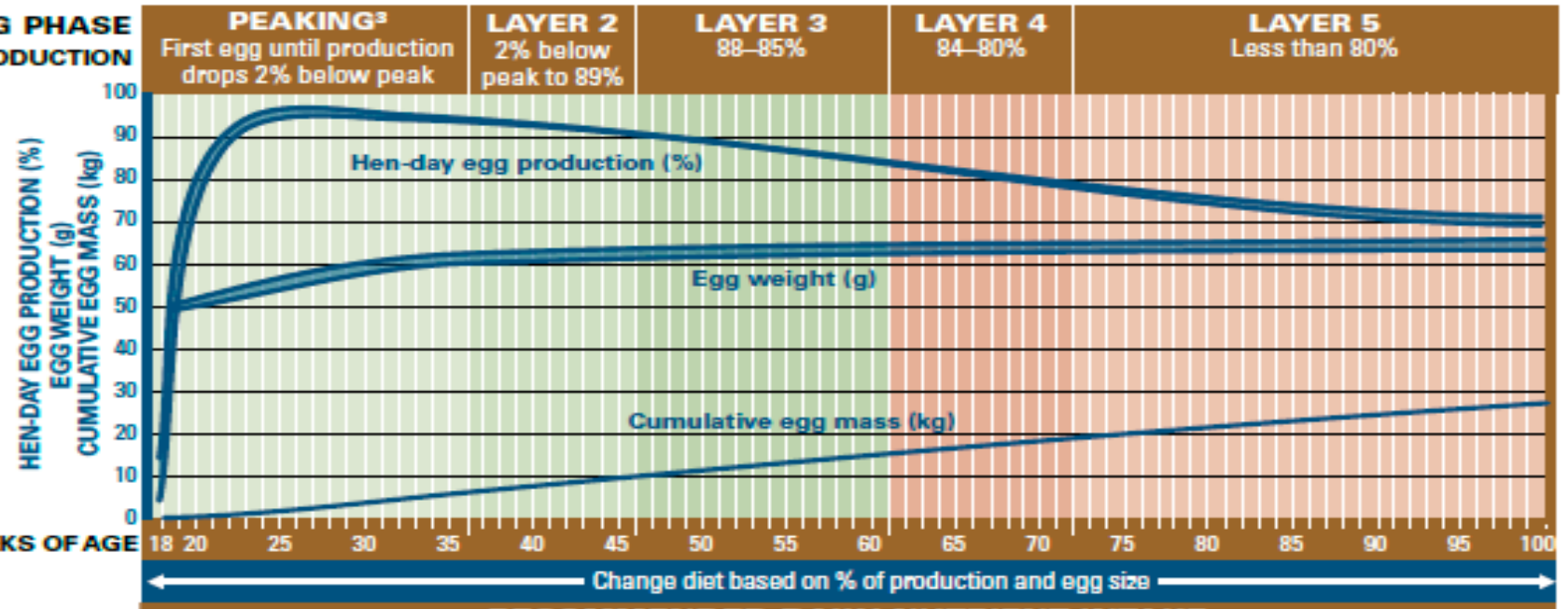
| Nutrient | Brown-Egg Layers | | | | | |
|---|---|---|---|---|---|---|
| Crude Protein | 17.0 | | | | | |
| Calcium | 4.2 | | | | | |
| Available Phosphorus | 0.375 | | | | | |
| Potassium | 0.590 | | | | | |
| Sodium | 0.230 | | | | | |
| Chloride | 0.210 | | | | | |
| Linoleic Acid | 1.210 | | | | | |
| Body Weight, kg | 1.600 | | 1.800 | | 1.900 | |
| Weight Gain, g/day | 2.00 | | 1.00 | | 0 | |
| Egg Mass, g/day | 55 | | 50 | | 45 | |
| Amino Acid[1] | Dig. | Total | Dig. | Total | Dig. | Total |
| Lysine | 0.815 | 0.916 | 0.750 | 0.843 | 0.679 | 0.763 |
| Methionine | 0.408 | 0.449 | 0.375 | 0.413 | 0.340 | 0.374 |
| Methionine + Cystine | 0.742 | 0.824 | 0.683 | 0.759 | 0.618 | 0.687 |
| Tryptophan | 0.187 | 0.211 | 0.173 | 0.194 | 0.156 | 0.175 |
| Threonine | 0.538 | 0.623 | 0.495 | 0.573 | 0.448 | 0.519 |
| Arginine | 0.815 | 0.879 | 0.750 | 0.809 | 0.679 | 0.732 |
| Glycine + Serine | - | 0.733 | - | 0.674 | - | 0.610 |
| Valine | 0.734 | 0.894 | 0.675 | 0.759 | 0.611 | 0.687 |
| Isoleucine | 0.676 | 0.760 | 0.623 | 0.700 | 0.564 | 0.633 |

Based on Daily Requirement

# Phase Feeding

5 phases

## Production Period Nutritional Recommendations[1,2]




| NUTRITION | RECOMMENDED DAILY NUTRIENT INTAKE | | | | |
|---|---|---|---|---|---|
| Metabolizable energy[4], kcal/bird/day | 315–330 | 310–325 | 305–320 | 300–315 | 300–315 |
| Metabolizable energy[4], MJ/bird/day | 1.32–1.38 | 1.30–1.36 | 1.28–1.34 | 1.26–1.32 | 1.26–1.32 |
| | Standardized Ileal Digestible Amino Acids / Total Amino Acids[5] | | | | |
| Lysine, mg/day | 820 / 898 | 800 / 876 | 780 / 854 | 760 / 832 | 740 / 810 |
| Methionine, mg/day | 410 / 441 | 400 / 430 | 390 / 419 | 380 / 409 | 370 / 398 |
| Methionine+Cystine, mg/day | 746 / 842 | 728 / 821 | 710 / 801 | 692 / 780 | 673 / 759 |
| Threonine, mg/day | 574 / 675 | 560 / 659 | 546 / 642 | 532 / 626 | 518 / 609 |
| Tryptophan, mg/day | 172 / 205 | 168 / 200 | 163 / 195 | 159 / 190 | 155 / 185 |
| Arginine, mg/day | 853 / 917 | 832 / 895 | 811 / 872 | 790 / 850 | 770 / 828 |
| Isoleucine, mg/day | 656 / 705 | 640 / 688 | 624 / 671 | 608 / 654 | 592 / 637 |
| Valine, mg/day | 722 / 796 | 704 / 776 | 686 / 757 | 669 / 738 | 651 / 718 |
| Crude protein[5], g/day | 17.00 | 16.75 | 16.00 | 15.50 | 15.00 |
| Sodium, mg/day | 180 | 180 | 180 | 180 | 180 |
| Chloride, mg/day | 180 | 180 | 180 | 180 | 180 |
| Linoleic acid (C18:2 n-6), g/day | 2.00 | 2.00 | 1.60 | 1.50 | 1.40 |
| Choline, mg/day | 130 | 130 | 130 | 130 | 130 |

Hyline, 2019

# Major breed of brown layer and housing

Breed

- ISA
- Lohman
- Hyline
- Hisex

Housing

- Open
- Closed



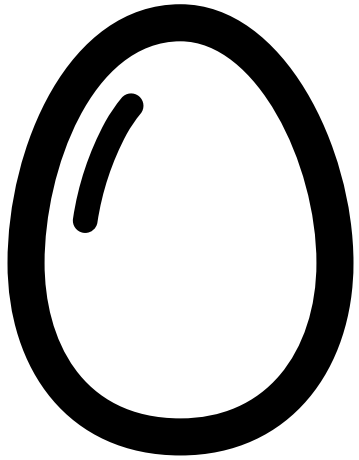






# Ideal Amino Acids Concept for producing egg in layer

| | |
|---|---|
| **Lysine** | **100** |
| **Methionine** | **49** |
| **TSAA** | **81** |
| **Arginine** | **120** |
| **Isoleucine** | **86** |
| **Threonine** | **64** |
| **Tryptophan** | **20** |
| **Valine** | **102** |



# Selecting Margins of Safety

Many factors must be considered

Quantity or extent of research which has been conducted on specific nutrient

Quality of ingredients used to provide nutrient

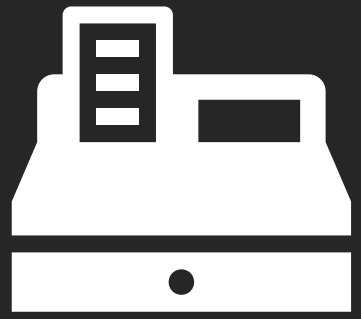
Variability in ingredient content

Ability to accurately mix the feed

Economics of nutrient in question

“Biological penalty” of failure to meet needs

# 3 principles in formulation



Brill, 2004

Limitation can be costly, both for Ingredients and Nutrient

Alternative ingredients: More ingredients to be offered

In order to reduce cost, you must have a lower cost ingredients

# Formulation Demo.

If you need a training, should be in person with computer on hand!

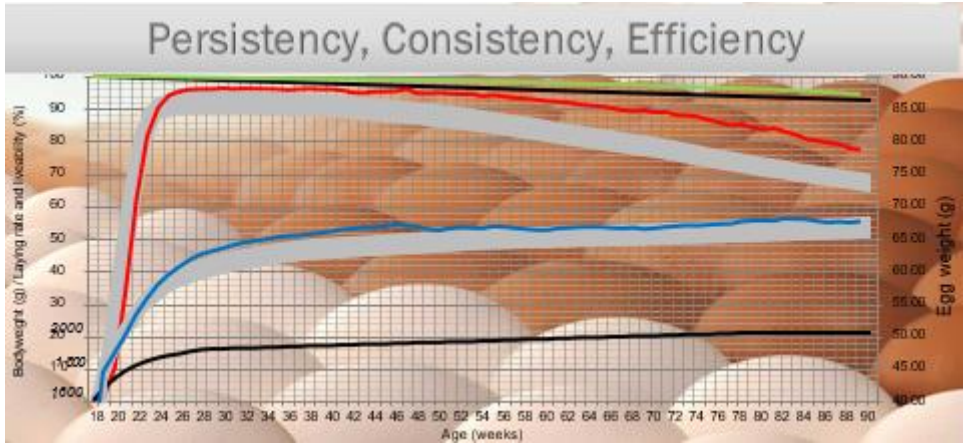




# Topics of Demo

1. Data in every sheet
2. Nutrition Change
3. Ingredient Change
4. Price Change
5. Cost of Production
6. Quality Change





# Interpretation of Formula

- Nutritive value
- Cost or price of diet
- Sensitivity analyses of raw materials and cost of nutrient (restriction cost or shadow price)
- Raw materials usage and rejection

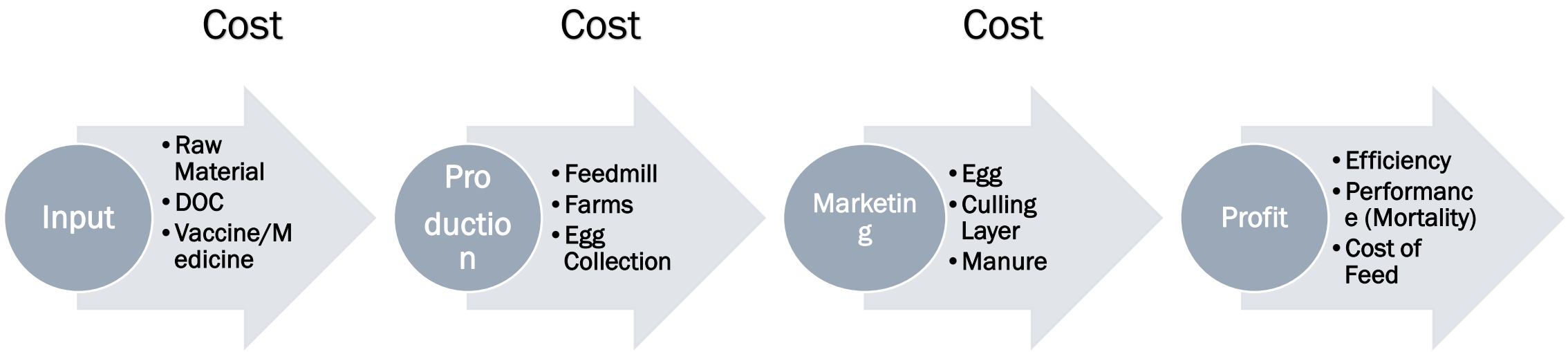
# SOME RULES IN FORMULATING

- The least cost program is a mathematical program
- The program will look for the lowest cost solution
- Regardless of what solution the program gives, it needs to be thoroughly checked
- Occasionally the program will give you an infeasible solution
- Occasionally you will get a feasible solution, but it is a **“nonsense”** solution
- Formulate with minimum restrictions
- It is always useful and interesting to check what your nutrient and ingredient restrictions are costing you

# Other consideration

- Particle size
- Enzymes usage
- Interaction between raw materials and additives
- Physical properties: color, smell
- Multiple products Formulation (MultiBlend)

# Integrated Layer farming




Should consider Least Cost Production

Cost to produce 1 kg or 1 piece of egg

# Conclusion

