Aplikasi Meta-analisis dalam Industri Feed Additive dan Obat Hewan Menuju Era 4.0

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Outline

A. Latar belakang
B. Pengenalan meta-analisis
C. Metode meta-analisis
D. Aplikasi meta-analisis pada industri feed additive dan obat hewan
E. Potensi kolaborasi

A. Latar belakang

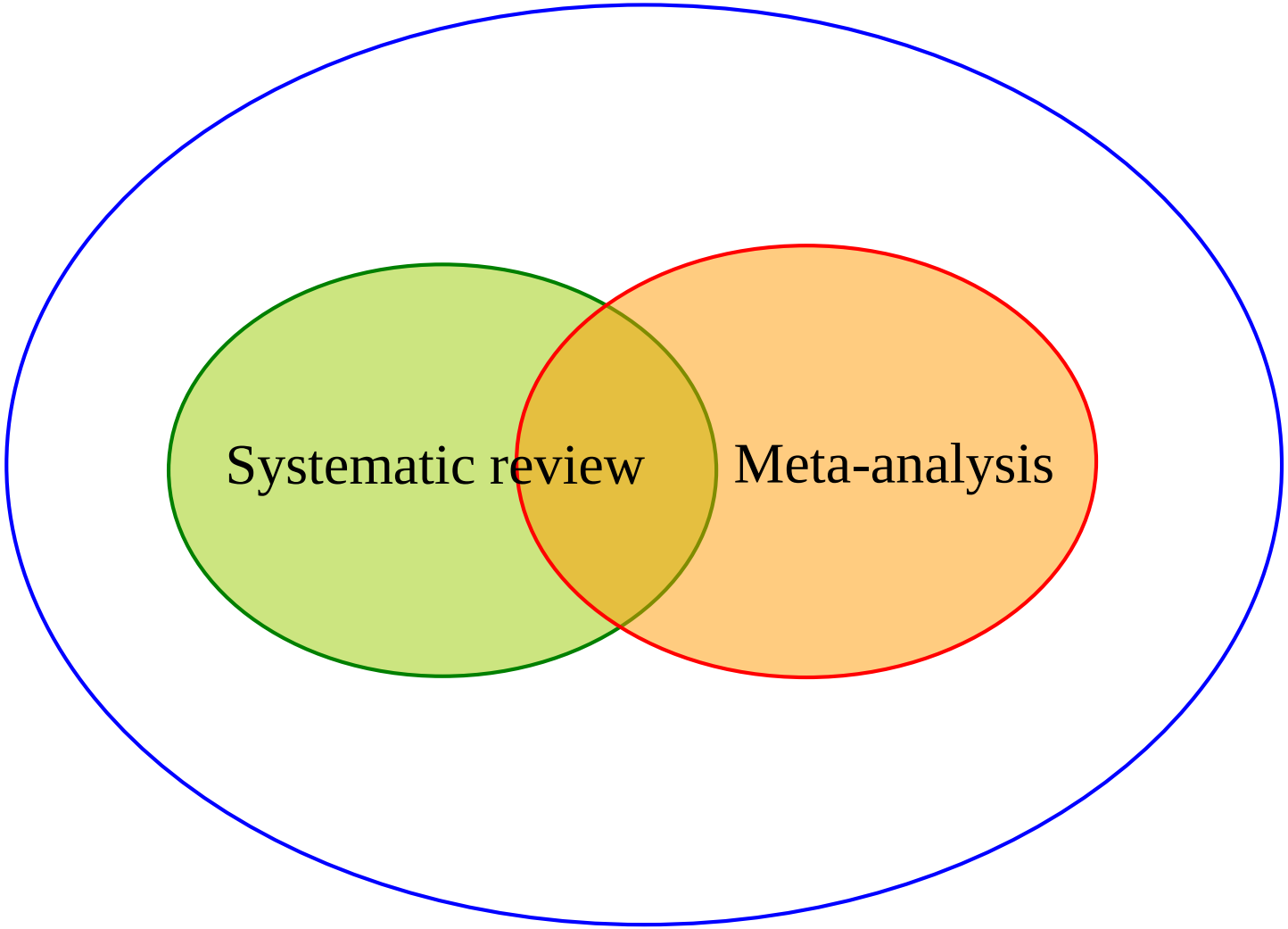
- Semakin banyaknya data tersedia (publikasi ilmiah, data R&D industri, laporan, dsb.)
- Bervariasinya kualitas data antar studi
- Lemahnya pengambilan kesimpulan berdasarkan studi atau eksperimen tunggal
- Revolusi industri 4.0 → big data utilization
- Pentingnya “forecasting” dan “decision” dalam industri feed additive dan obat hewan

B. Pengenalan meta-analisis

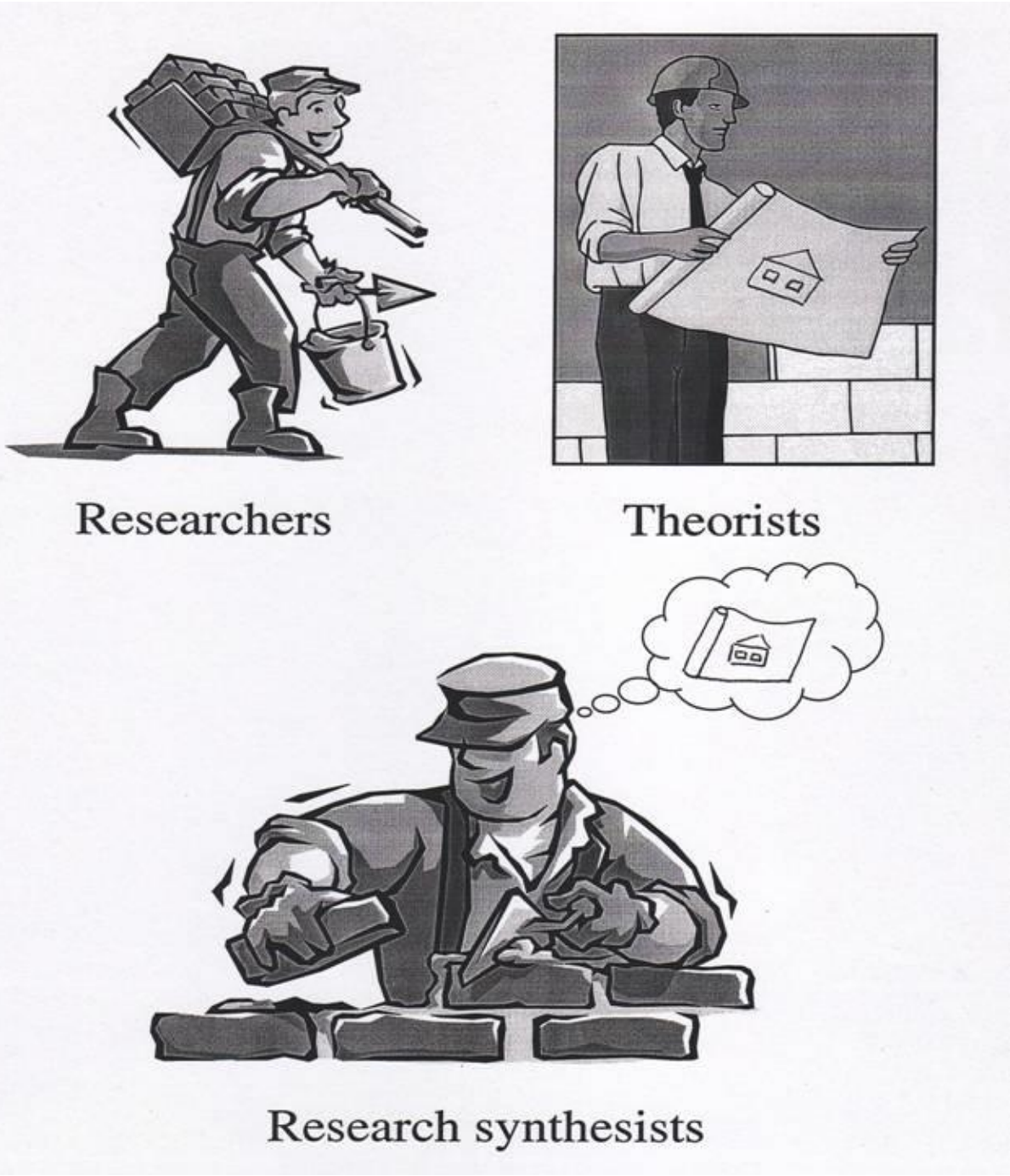
- **Research synthesis =** review of primary research on a given topic with a purpose of integrating the findings (creating generalizations, conflict resolution)

- **Systematic review** = the type of research synthesis on a precisely defined topic using systematic and explicit methods to identify, select, critically appraise and analyze relevant research

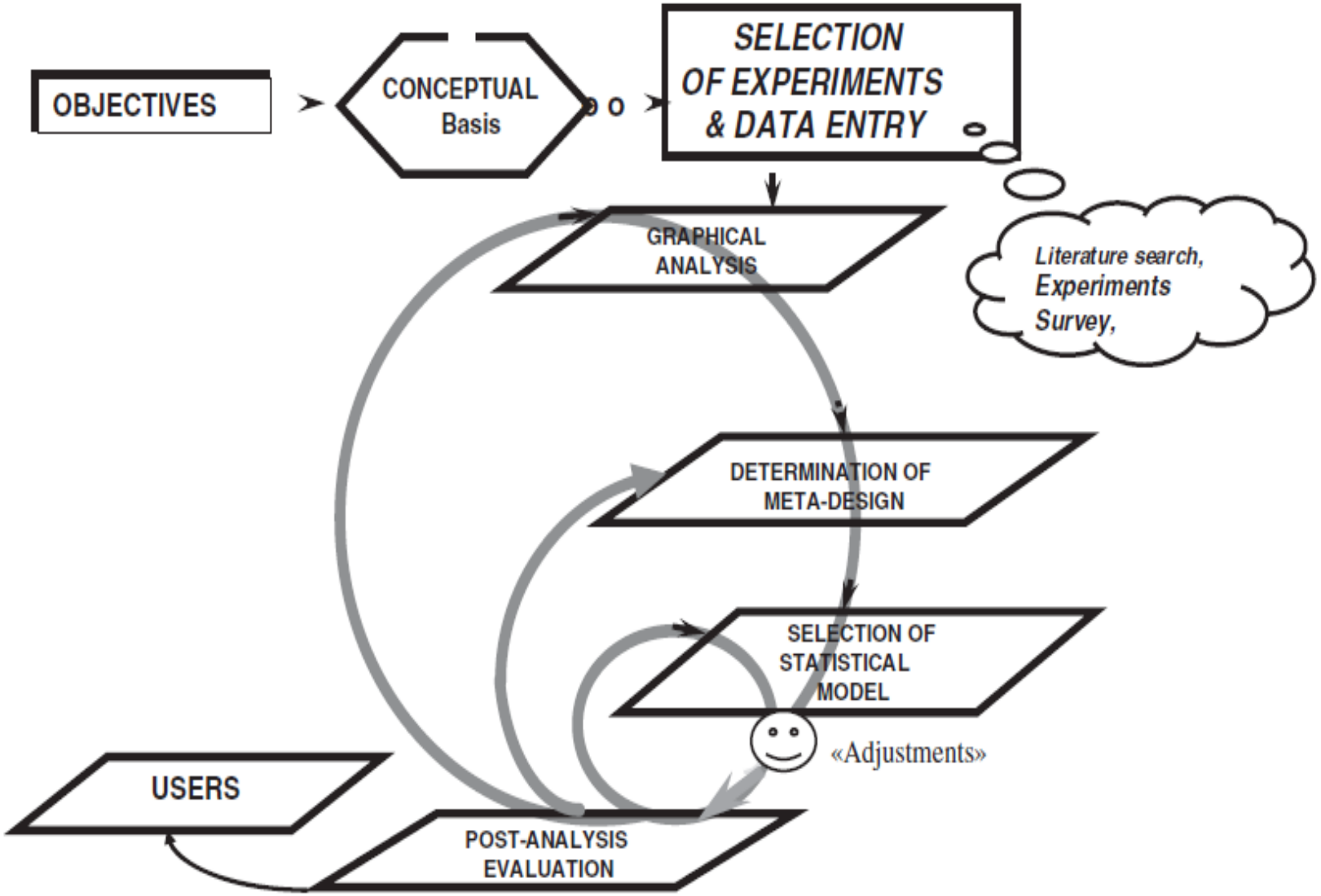
- **Meta-analysis =** statistical synthesis of the results of separate studies (quantitative research synthesis)



Research synthesis


Researchers
Theorists
Research synthesists

C. Metode meta-analisis



Tahapan meta-analisis

1. Question formulation stage
2. Data collection stage
3. Data evaluation stage
4. Analysis and interpretation stage
5. Public presentation stage

Kombinasi studi

Effect size

- Hedges’ d
- Response ratio
- Original data (ANOVA-based MA)

Hedges' d

Standardized mean difference between means (Hedges' d)

$$d = \frac{(\bar{X}e - \bar{X}c)}{s} J$$

Xe – mean of the experimental group

Xc – mean of the control group

s – pooled standard deviation

J – correction term that removes small-sample-size bias

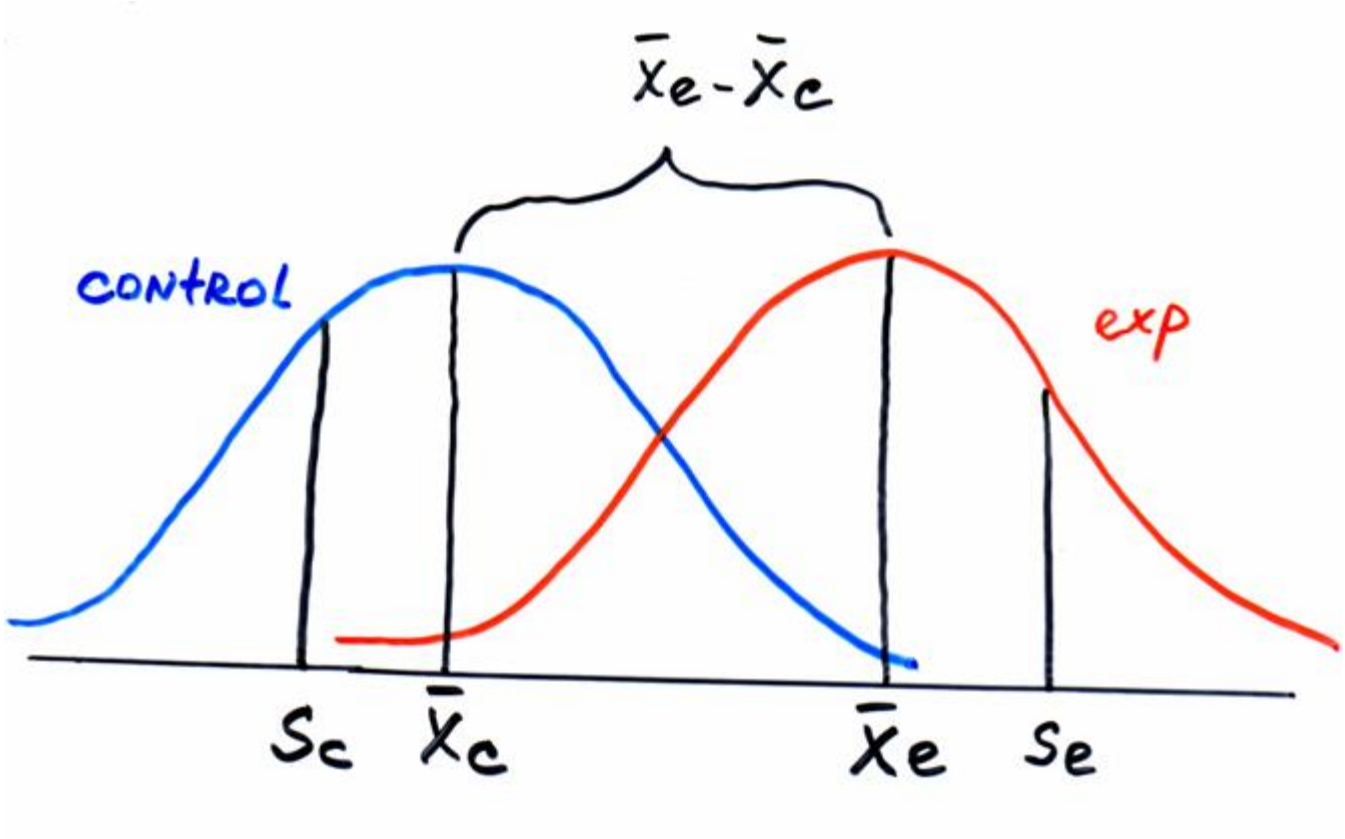
Pooled standard deviation:

$$s = \sqrt{\frac{(N_e - 1)s_e^2 + (N_c - 1)s_c^2}{N_e + N_c - 2}}$$

Correction term:

$$J = 1 - \frac{3}{4(N_e + N_c - 2) - 1}$$

Standardized difference between means



The variance of Hedges' *d*

$$\nu_d = \frac{N_e + N_c}{N_e N_c} + \frac{d^2}{2(N_e + N_c)}$$

Ne – sample size of the experimental group

Nc – sample size of the control group

Interpretation of magnitude of *d*

- Cohen's benchmarks:
  - |d | = 0.2 – small effects
  - |d | = 0.5 – moderate effects
  - |d | = 0.8 – large effects

Response ratio

$$\ln R = \ln\left(\frac{\overline{X}_e}{\overline{X}_c}\right) = \ln(\overline{X}_e) - \ln(\overline{X}_c)$$

Variance:

$$v_{\ln R} = \frac{(s_e)^2}{N_e(\overline{X}_e)^2} + \frac{(s_c)^2}{N_c(\overline{X}_c)^2}$$

Advantages of response ratio

- Easily interpretable
- Results of primary studies are often presented in the form of response rations
- Effect sizes are not affected by different variance in control and experimental groups
- SD/SE are not needed for calculation of the effect size (but needed to calculate variance)

Pearson's correlation coefficient (*r*)

- easy to interpret
  - varies from –1 to +1
  - Cohen's "rules-of-thumb":
    - | *r* | = 0.10 – small
    - | *r* | = 0.25 – medium
    - | *r* | = 0.40 - large
  - coefficient of determination (r^2)
  - r^2= % of variance explained

ANOVA based MA

Model with discrete predictor variable(s)
A linear mixed model easily models this situation as follows:

$$Y_{ijk} = \mu + S_i + \tau_j + S\tau_{ij} + e_{ijk}, \qquad (4)$$

where Y_{ijk} = the dependent variable, μ = overall mean, S_i = the random effect of the ith study, assumed $\sim_{iid} N(0, \sigma^2_S)$, τ_j = the fixed effect of the jth level of factor τ, $S\tau_{ij}$ = the random interaction between the ith study and the jth level of factor τ, assumed $\sim_{iid} N(0, \sigma^2_{S\tau})$, and $eijk$ = the residual errors, assumed $\sim_{iid} N(0, \sigma^2_e)$. e_{ijk}, $S\tau_{ij}$ and S_i are assumed to be independent random variables.

Statistical models

```
PROC MIXED DATA = Mydata CL COVTEST;
        CLASSES study tau;
        MODEL Y = tau;
        RANDOM study study * tau;
        LSMEANS tau;
RUN;
```

Model with continuous predictor variable(s)

A linear mixed model also easily models this situation.

$$Y_{ij} = B_0 + S_i + B_1 X_{ij} + b_i X_{ij} + e_{ij}, \qquad (6)$$

where Y_{ij} = the dependent variable, B_0 = overall (inter-study) intercept (a fixed effect equivalent to μ in (4)), S_i = the random effect of the ith study, assumed $\sim_{iid} N(0, \sigma_S^2)$, B_1 = the overall regression coefficient of Y on X (a fixed effect), X_{ij} = the value of the continuous predictor variable, b_i = the random effect of study on the regression coefficient of Y on X, assumed $\sim_{iid} N(0, \sigma_b^2)$, and e_{ij} = the residual errors, assumed $\sim_{iid} N(0, \sigma_e^2)$. Also, e_{ij}, b_i and S_i are assumed to be independent random variables.

```
PROC MIXED DATA = Mydata CL COVTEST;
        CLASSES study;
        MODEL Y = X/SOLUTION;
        RANDOM study study * X;
RUN;
```

Model with both discrete and continuous predictor variable(s)

Statistically, this model is a simple combination of (4) and (6) as follows:

$$Y_{ijk} = \mu + S_i + \tau_j + S\tau_{ij} + B_1 X_{ij} + b_i X_{ij} + B_j X_{ij} + e_{ijk}, \quad (8)$$

where B_j = the effect of the jth level of the discrete factor τ on the regression coefficient (a fixed effect).

```
PROC MIXED DATA = Mydata CL COVTEST;
        CLASSES study tau;
        MODEL Y = tau X tau * X;
        RANDOM study study * tau study * X;
        LSMEANS tau;
RUN;
```

Ilustrasi meta-analisis

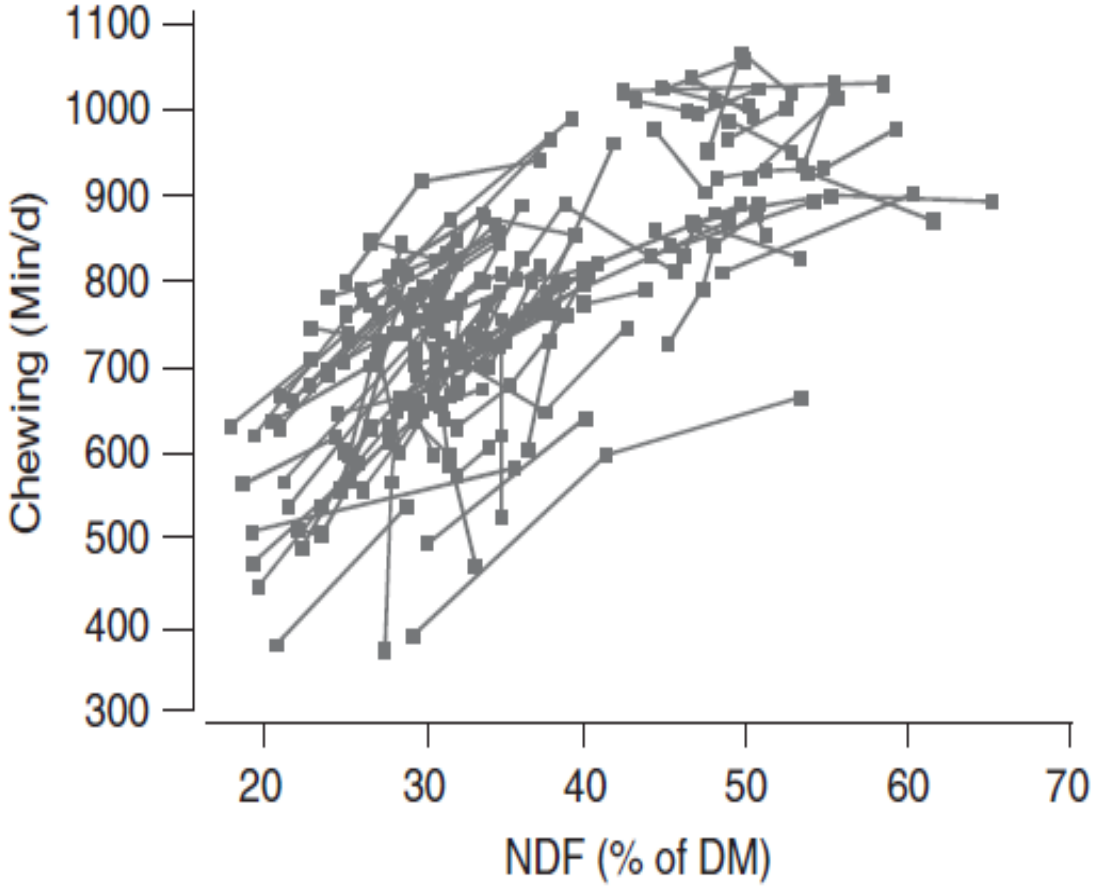


Figure 3 Effect of dietary neutral detergent fiber (NDF) content on chewing activity in cattle. Data are from published experiments where the NDF content of the diet was the experimental treatment.

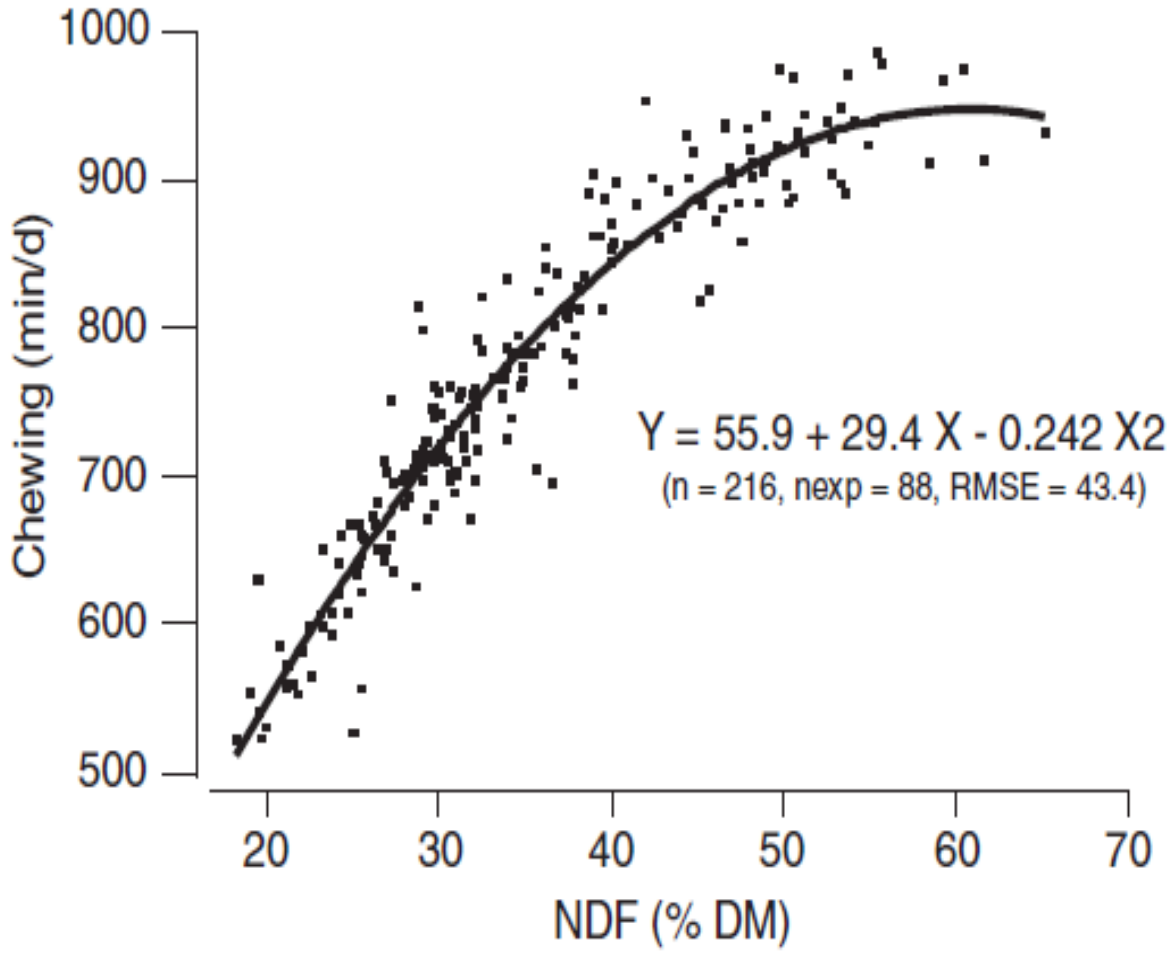
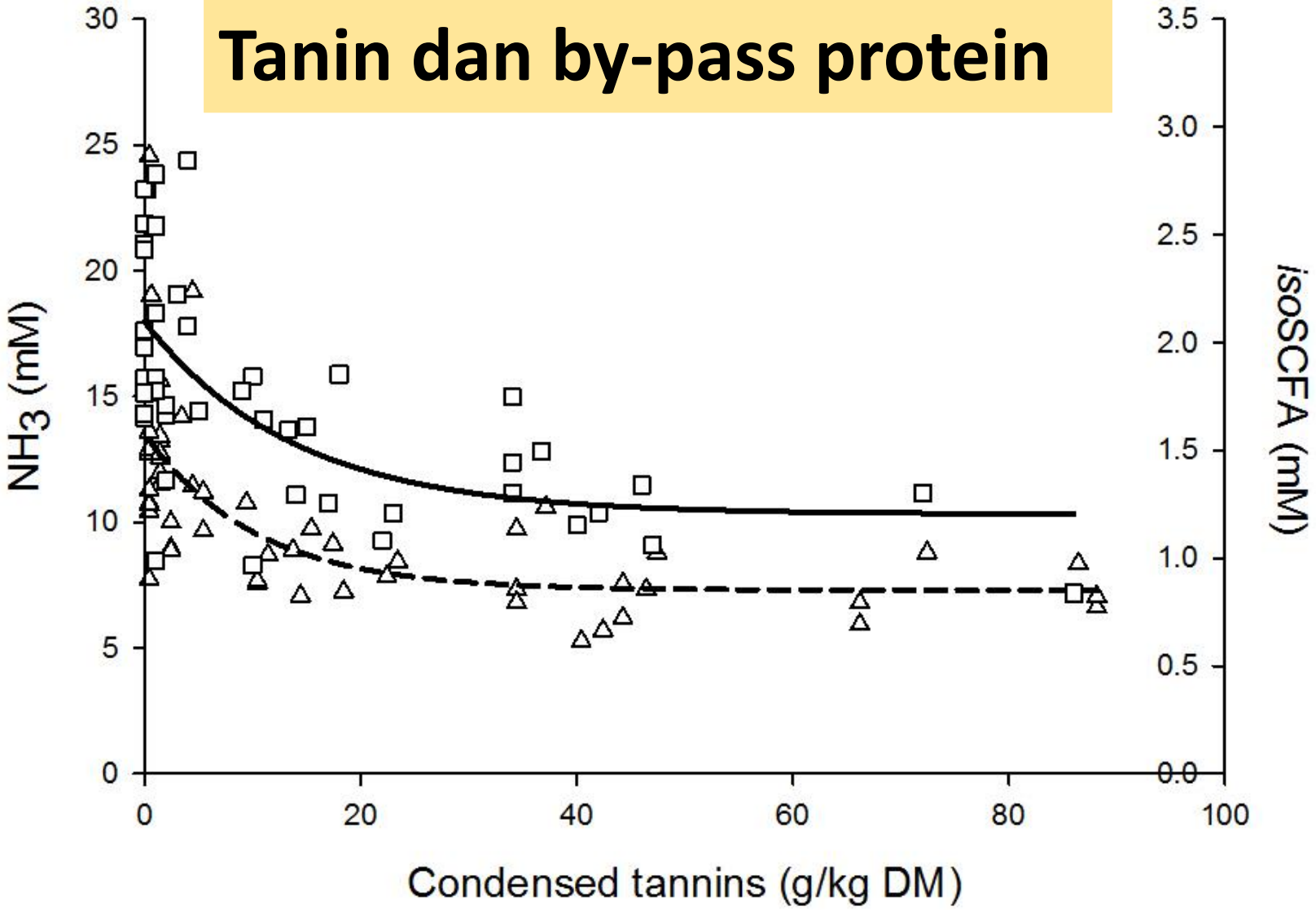


Figure 6 Effect of dietary neutral detergent fiber (NDF) content on chewing activity in cattle. Data are from published experiments where the NDF content of the diet was the experimental treatment. Observations were adjusted for the study effect before being plotted, as suggested by St-Pierre (2001). *n* = number of treatments; *n*exp = number of experiments.

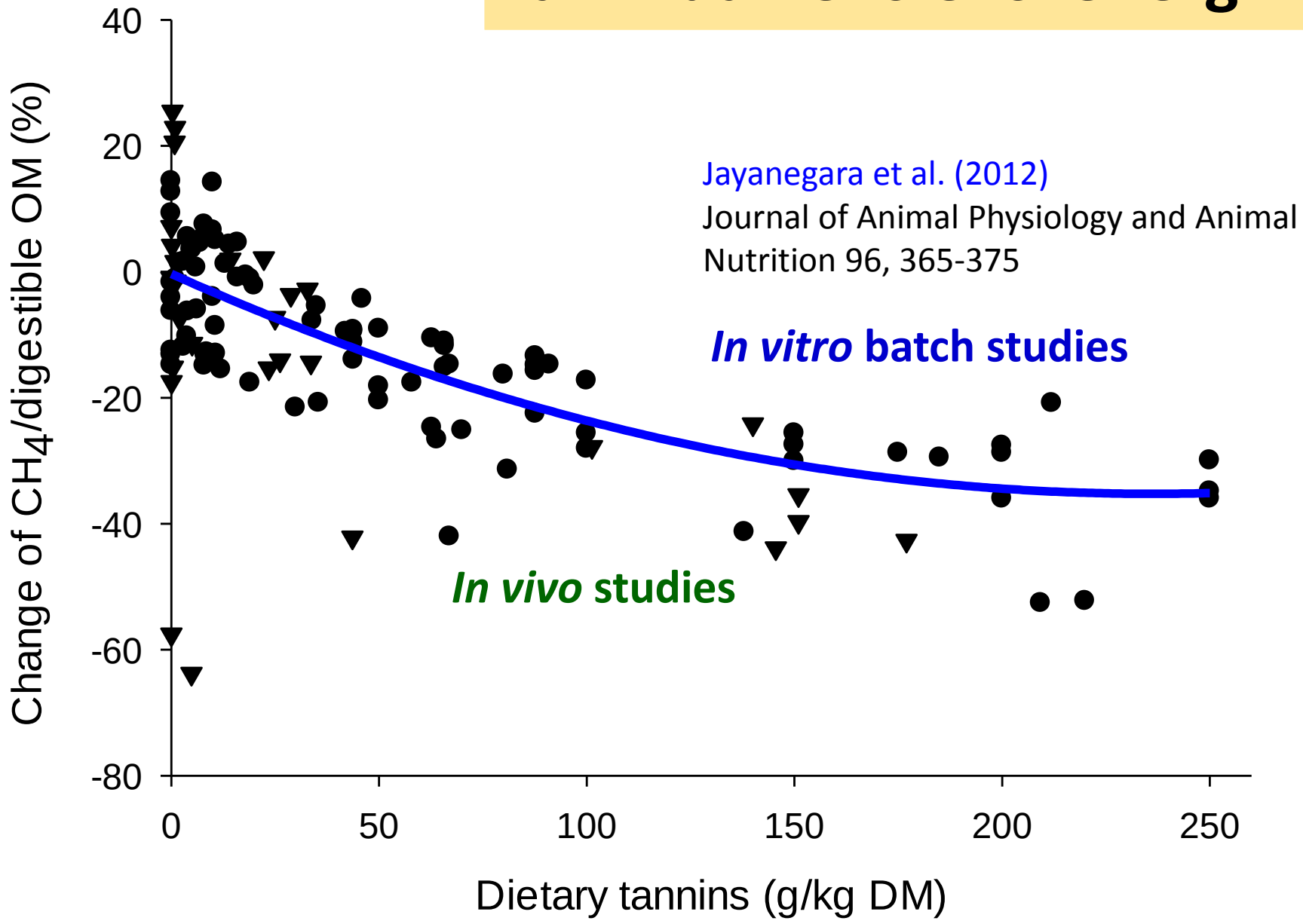
D. Aplikasi pada industri feed additive

Tanin dan by-pass protein

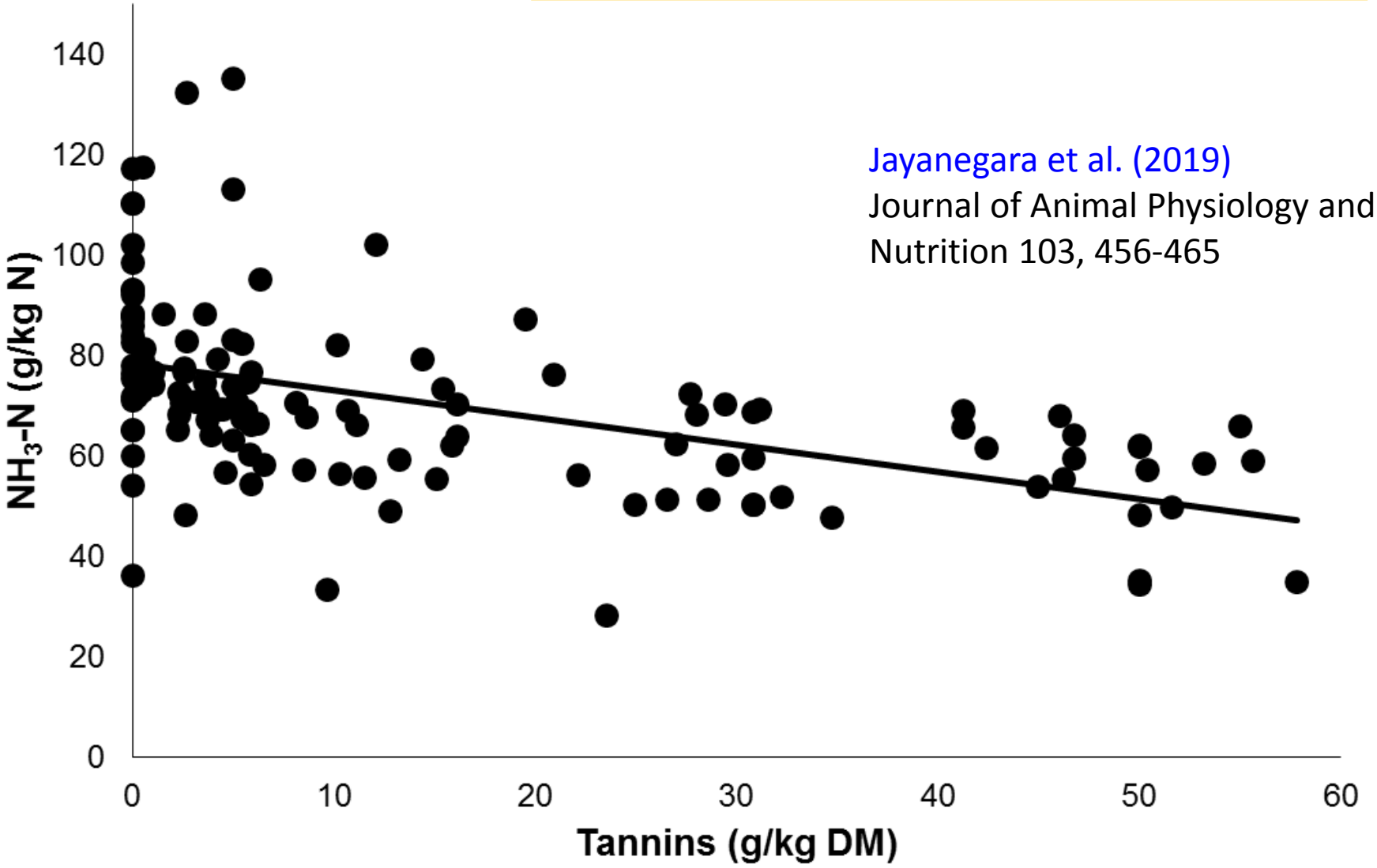


Jayanegara and Palupi (2010)
Media Peternakan 33, 176-181

Tanin dan efisiensi energi

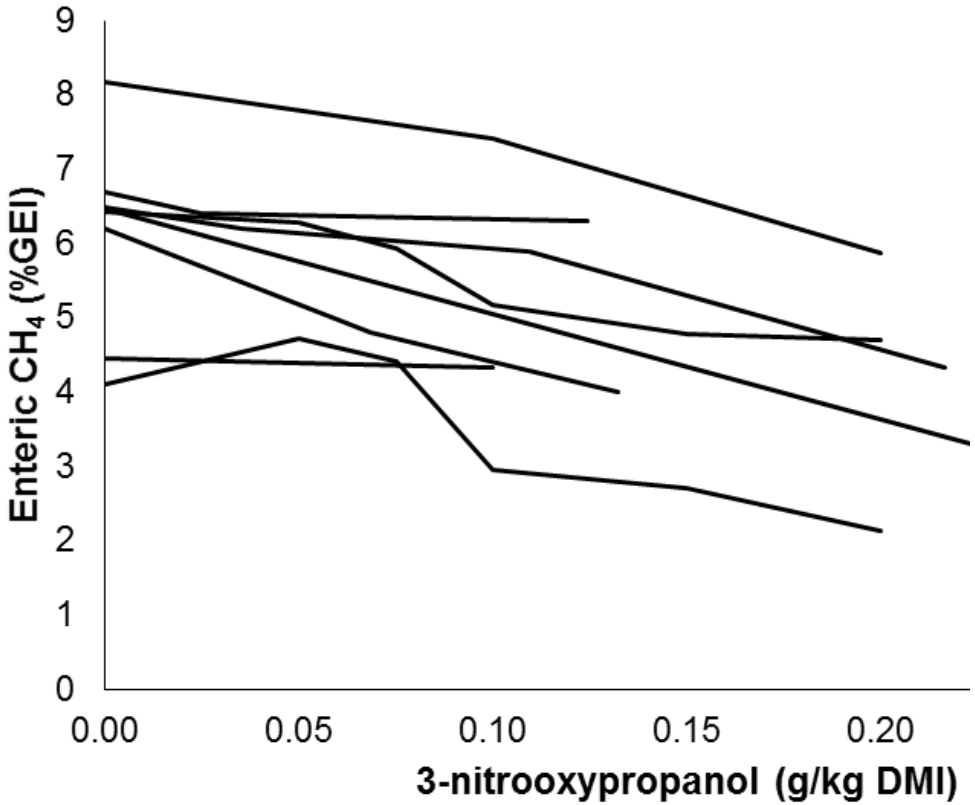


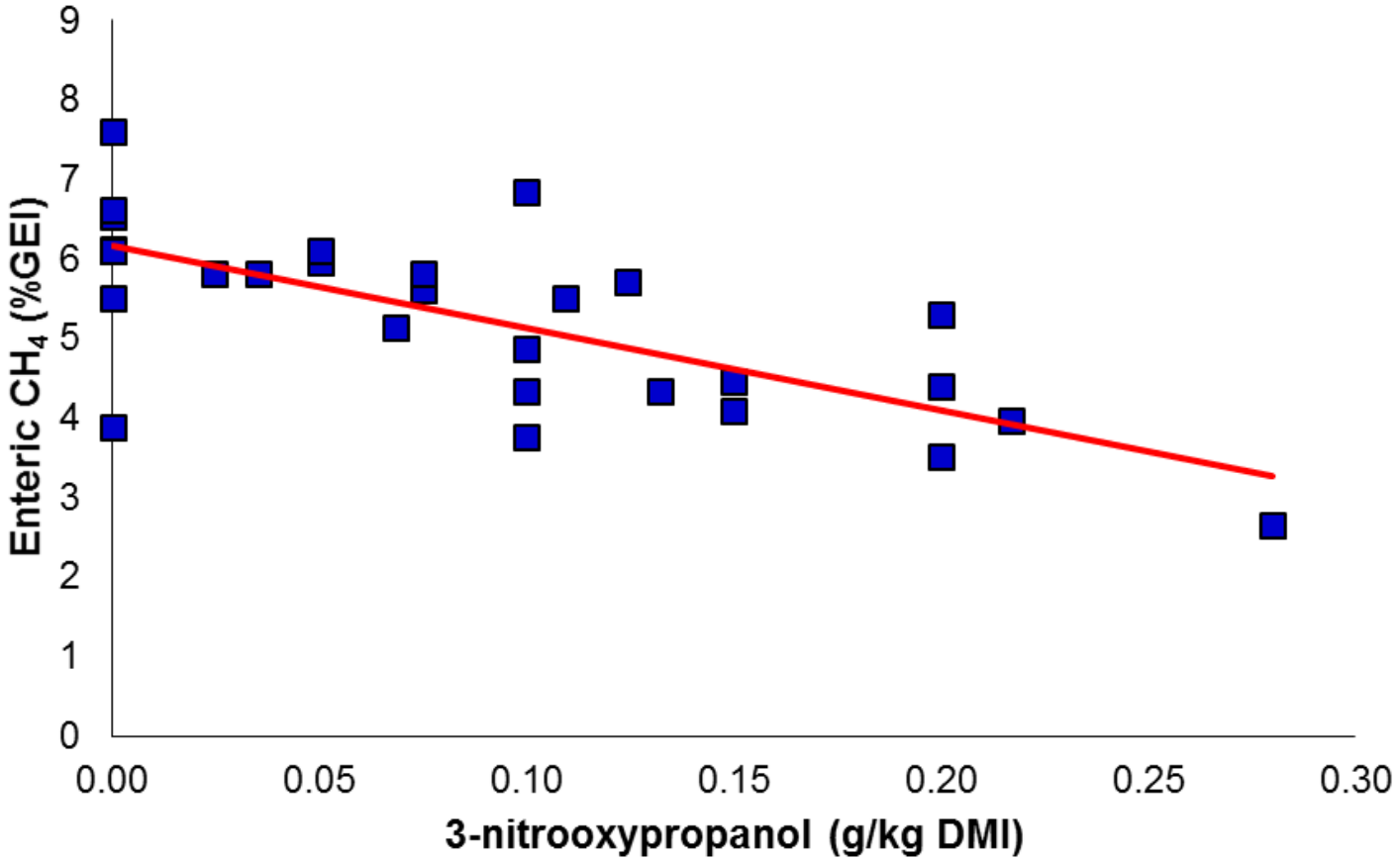
Tanin dan kualitas silase



Jayanegara et al. (2019)
Journal of Animal Physiology and Animal Nutrition 103, 456-465

3-NOP dan emisi CH_4





Jayanegara et al. (2018)
Italian Journal of Animal Science 17, 650-656

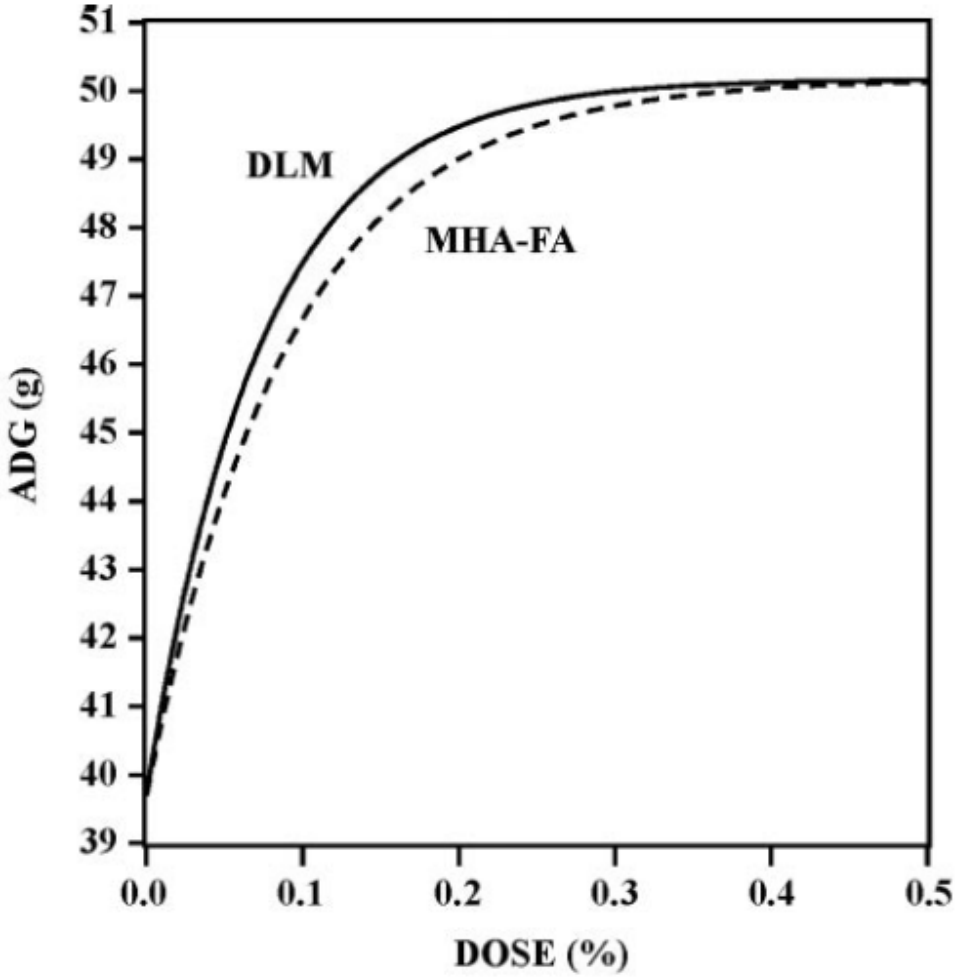
Zn organik vs anorganik

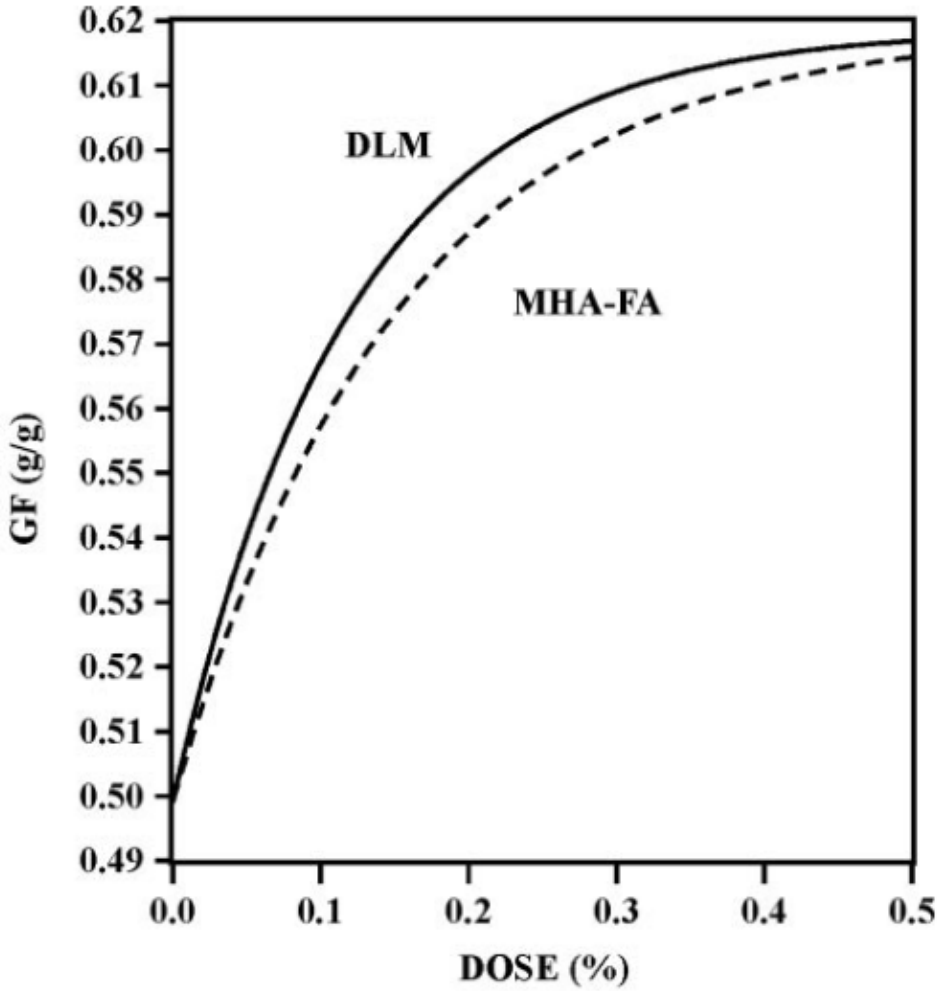
Hidayat et al. (2019)
Asian Australasian Journal of Animal Sciences, in press

					Zinc Form		
No	Response parameter	Unit	N	Control	Organic	Inorganic	P-value
	Dose average	mg/kg		0	62.83	62.89	
	Production Performance						
1	Average Daily Gain	g/bird/day	195	39.2	42.2	41.4	0.222
2	**Feed Conversion Ratio (FCR)**	**g feed/ g gain**	**154**	**1.78^{b}**	**1.72^{a}**	**1.73^{a}**	**0.017**
3	Mortality	%	12	0	1.28	1.30	0.707
4	Average Daily Intake	g/bird/day	174	70.4	72.6	72.3	0.56
5	Carcass	%	14	68.1	69.4	69.5	0.448
6	Abdominal Fat	%	11	1.18^{a}	0.98^{ab}	0.68^{b}	0.034

Sauer et al. (2008)
Poultry Science 87, 2023-2031

DL metionin vs MHA





——— Dose DLM (% supplemented methionine to the diet)
– – – – Dose MHA-FA (% supplemented methionine to the diet)

——— Dose DLM (% supplemented methionine to the diet)
– – – – Dose MHA-FA (% supplemented methionine to the diet)

Kualitas susu organik

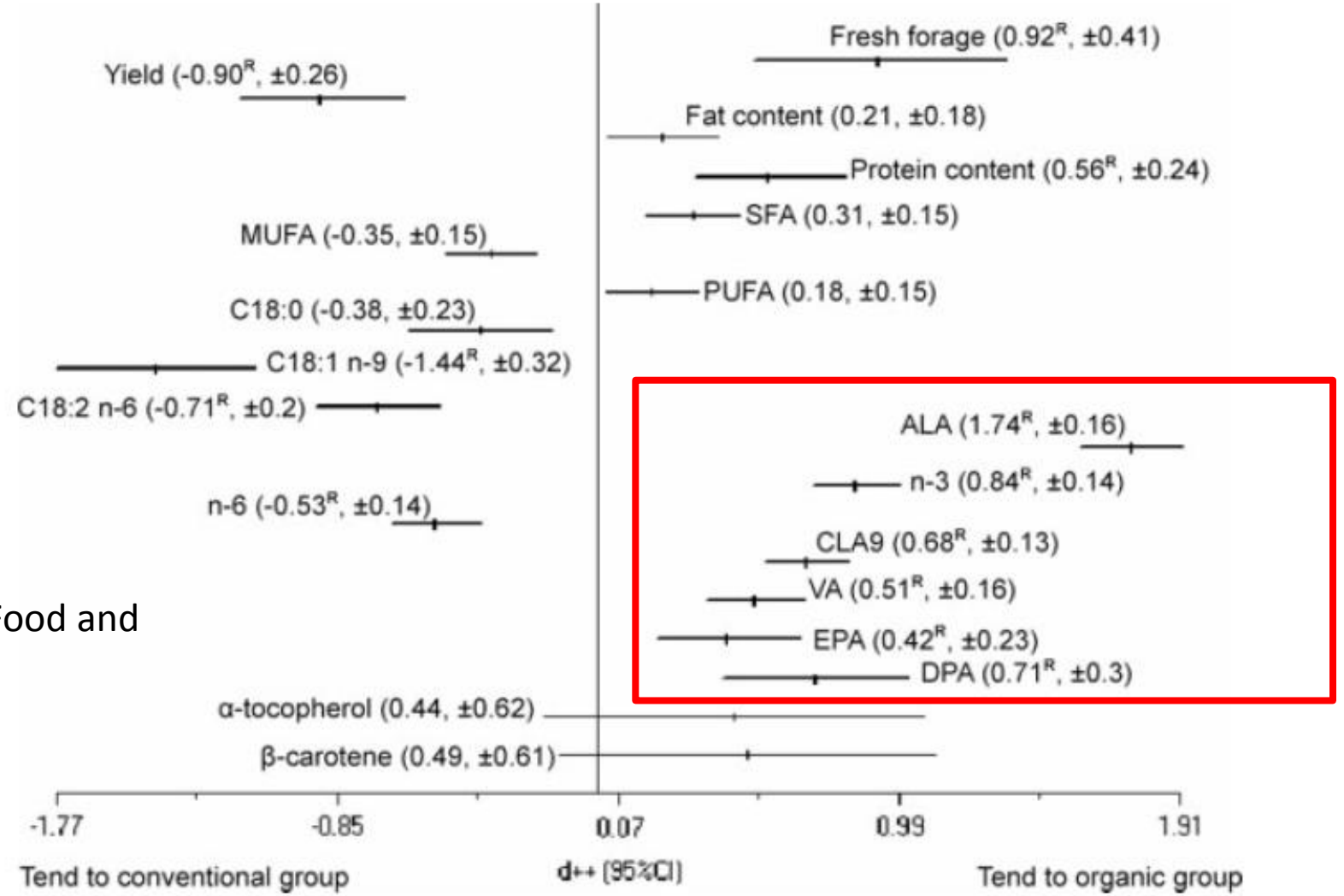


Figure 1. Forest plot of cumulative effect size (d_{++}) and 95% confidence interval (CI) of some nutritional parameters comparing conventional and organic dairy products. Bold lines indicate the robust model.

Palupi et al. (2012)
Journal of the Science of Food and Agriculture 92, 2774-2781

E. Potensi kolaborasi

- Penentuan dosis optimum suatu feed additive/supplement/OH
- Komparasi efektivitas di antara feed additive/supplement/OH yang sejenis
- Klaim keunggulan suatu produk
- Dsb.

Interested? Please kindly contact AINI

Thank you very much for your attention!