



Dietary fibres in poultry

Bernard B. Carré

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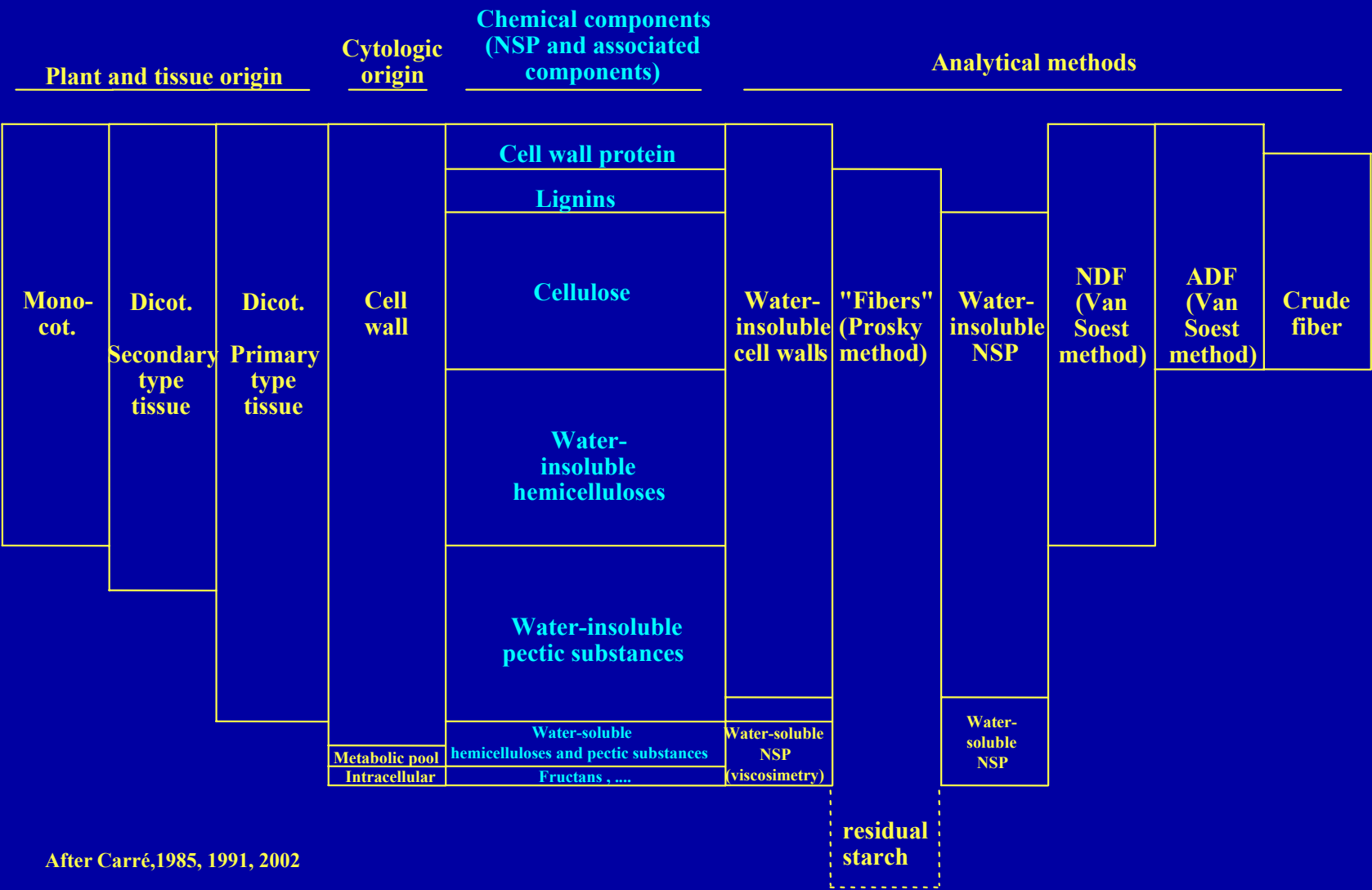
Dietary fibres in poultry

B. CARRÉ

**Avian Research Unit
INRA
37380 Nouzilly, France**

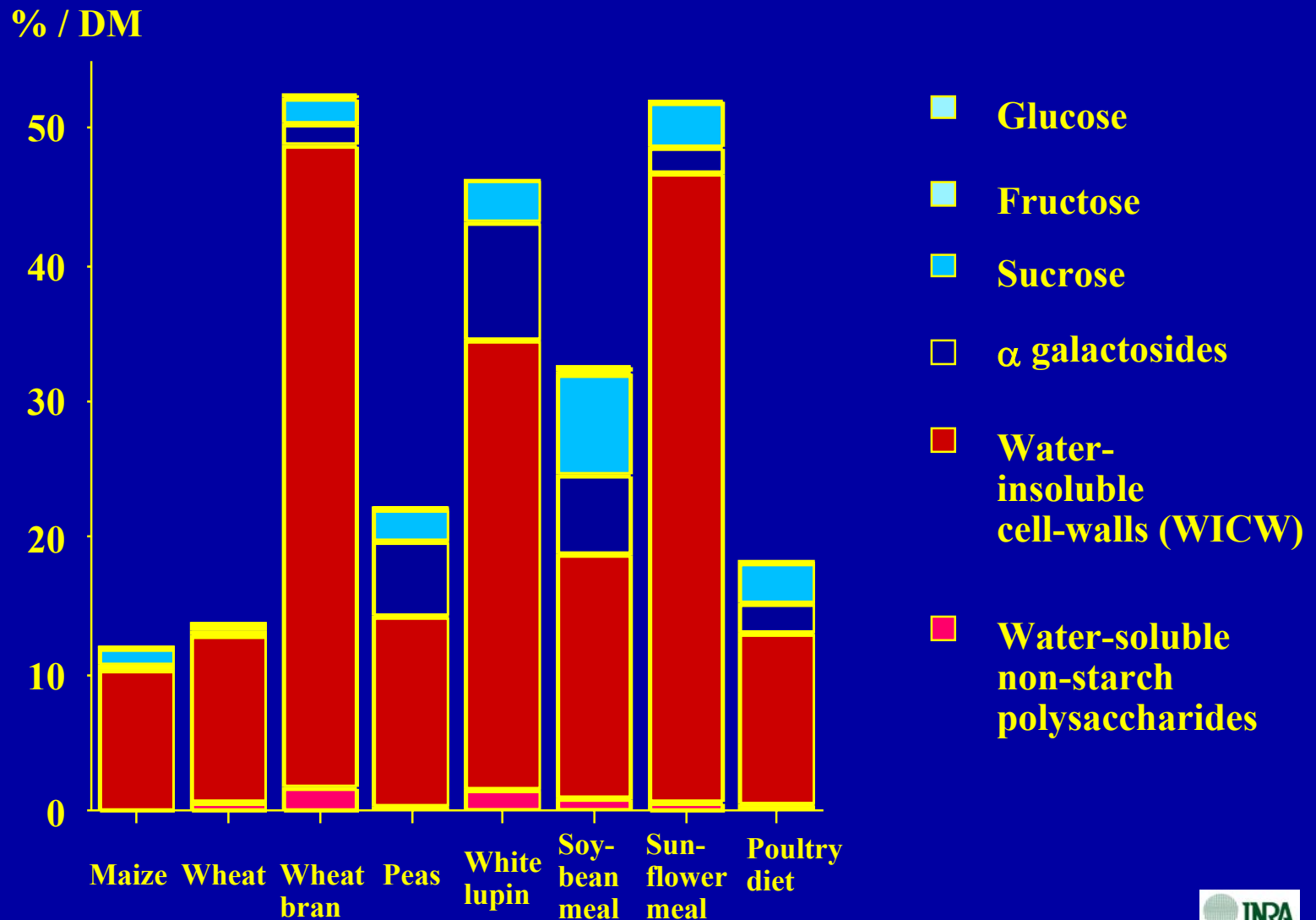
- 1-Fibre chemistry and analyses: Chem**
- 2-Fibre digestibility in poultry: Dig**
- 3-AMEn prediction using the WICW parameter: ME**
- 4-Fibres and energy intake: bulk**
- 5-The box effect of fibres: box**
- 6-The fibre water-retention capacity and the water excretion:
Water ret.**
- 7-The viscosity of water-soluble NSPs and their nutritional
effects: Visco.**
- 8-The physical effect of water-insoluble fibres on digestive
physiology: Coarseness**

Distribution and analytical methods for NSP and their associated components

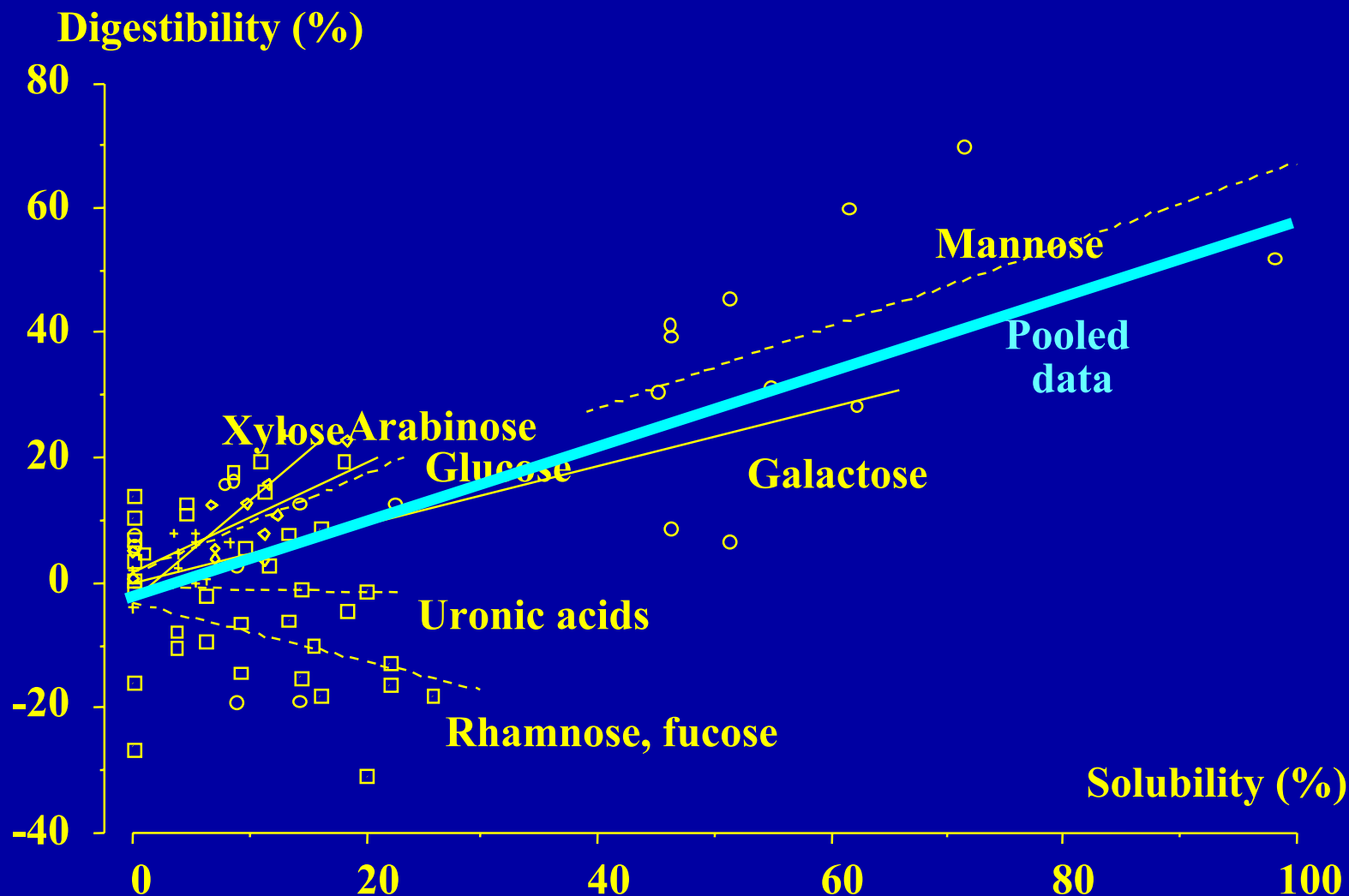


After Carré,1985, 1991, 2002

Non-starch carbohydrates of some feedstuffs

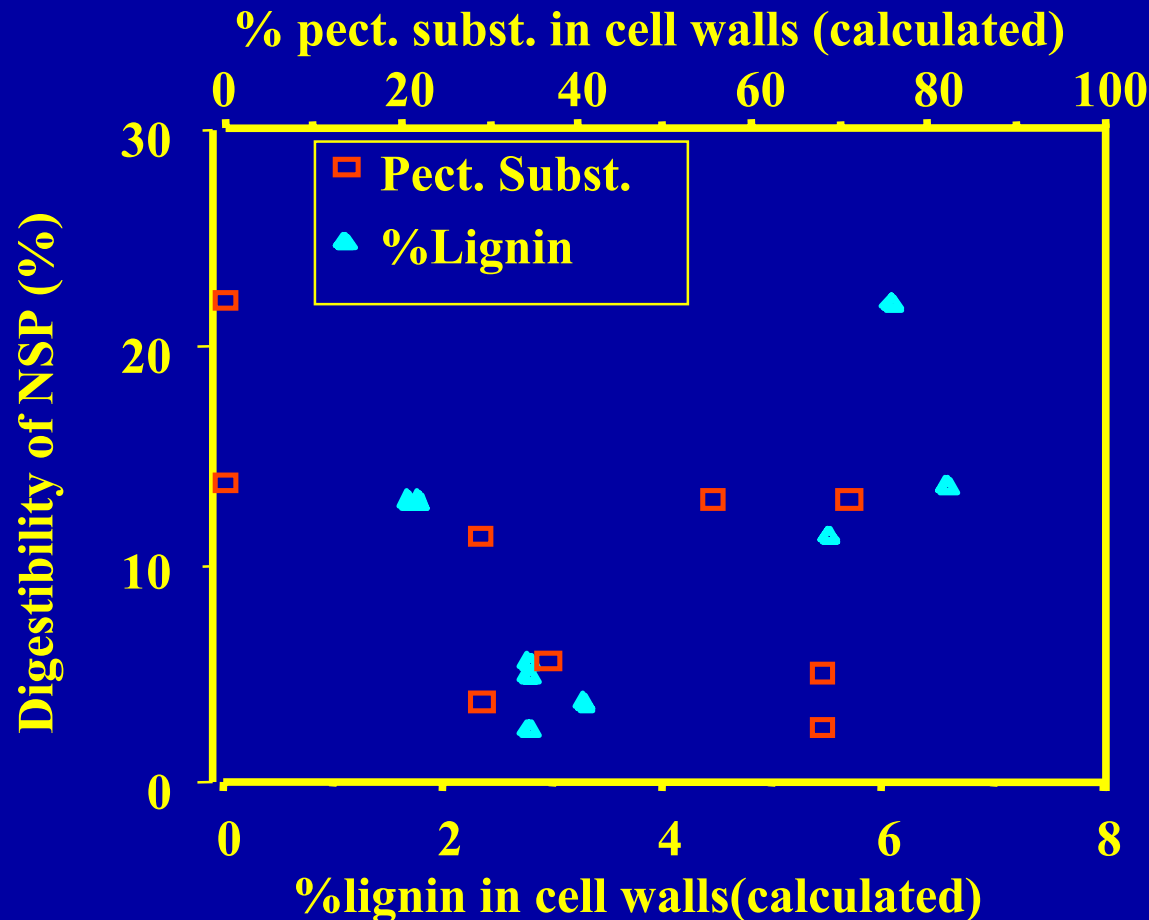


Digestibility of NSP sugars in poultry: relationship with water-solubility .



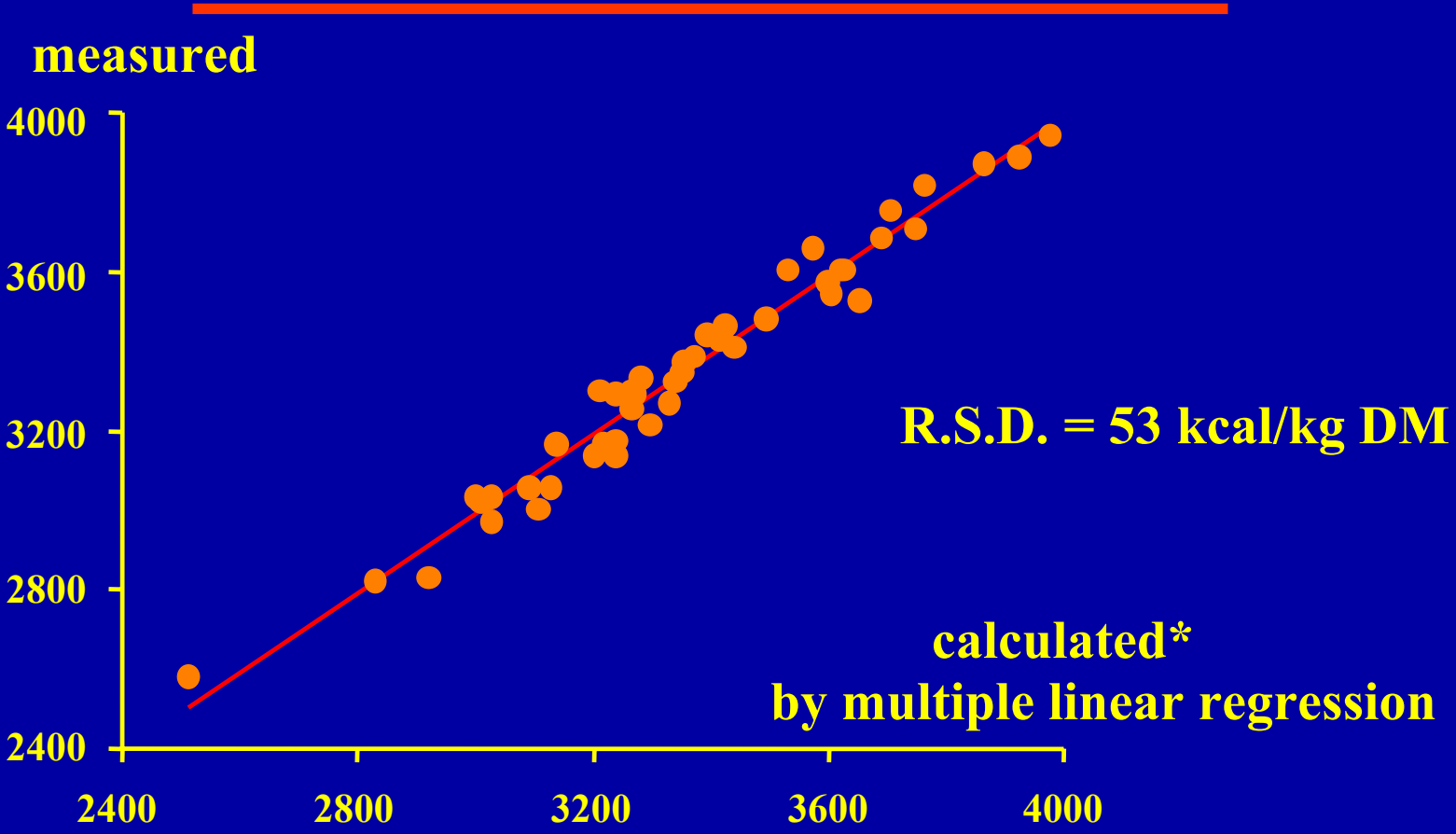
After Carré and Leclercq (1985), Carré *et al.* (1990 , 1992, 1995)

Digestibility of NSP in poultry and chemical features of cell-walls



No
relationship

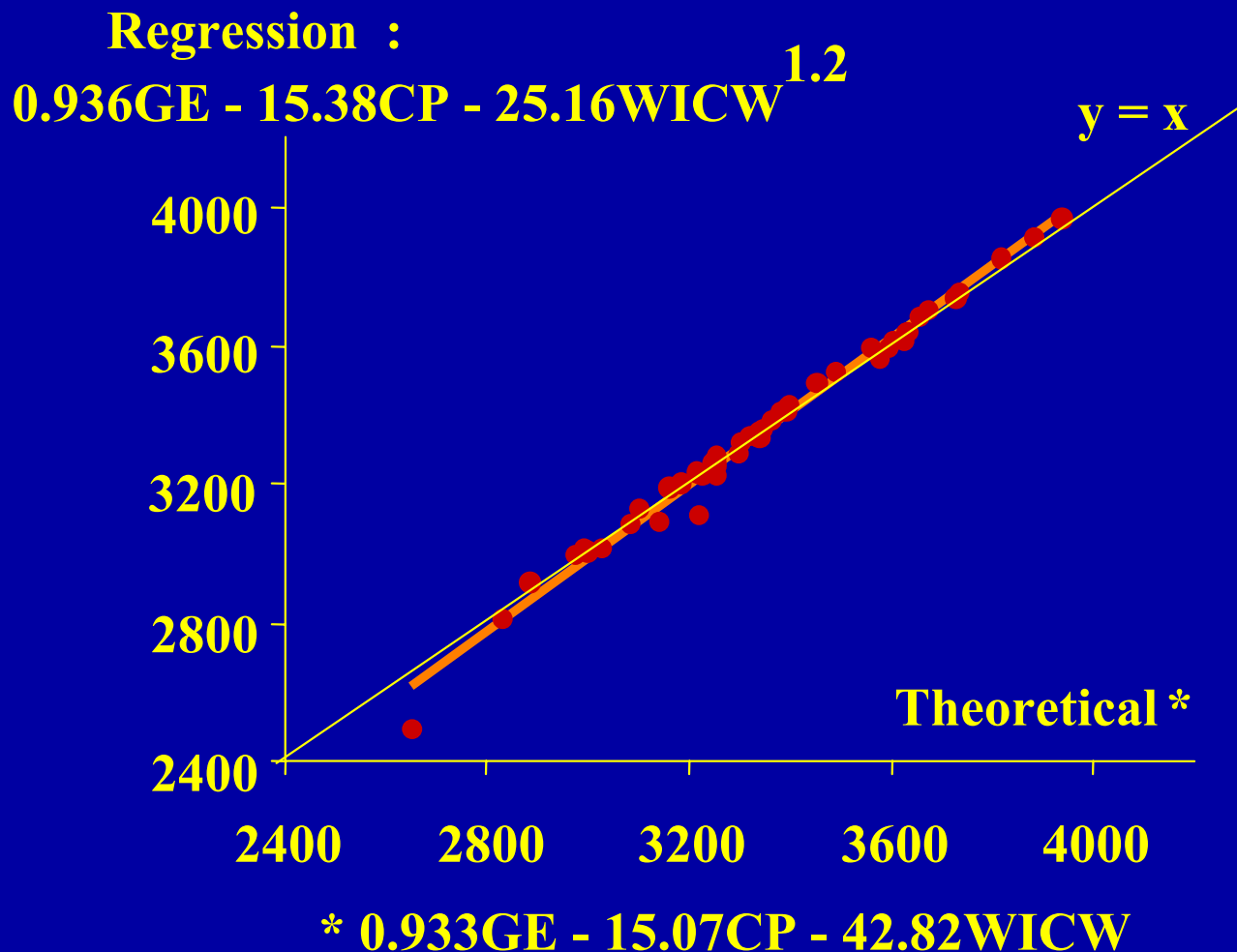
**Comparison between measured and regression calculated
(WICW based equation) AMEn values of diets , in adult cockerels
(mean values)**



*** 0.936GE - 15.38CP - 25.16WICW^{1.2}**

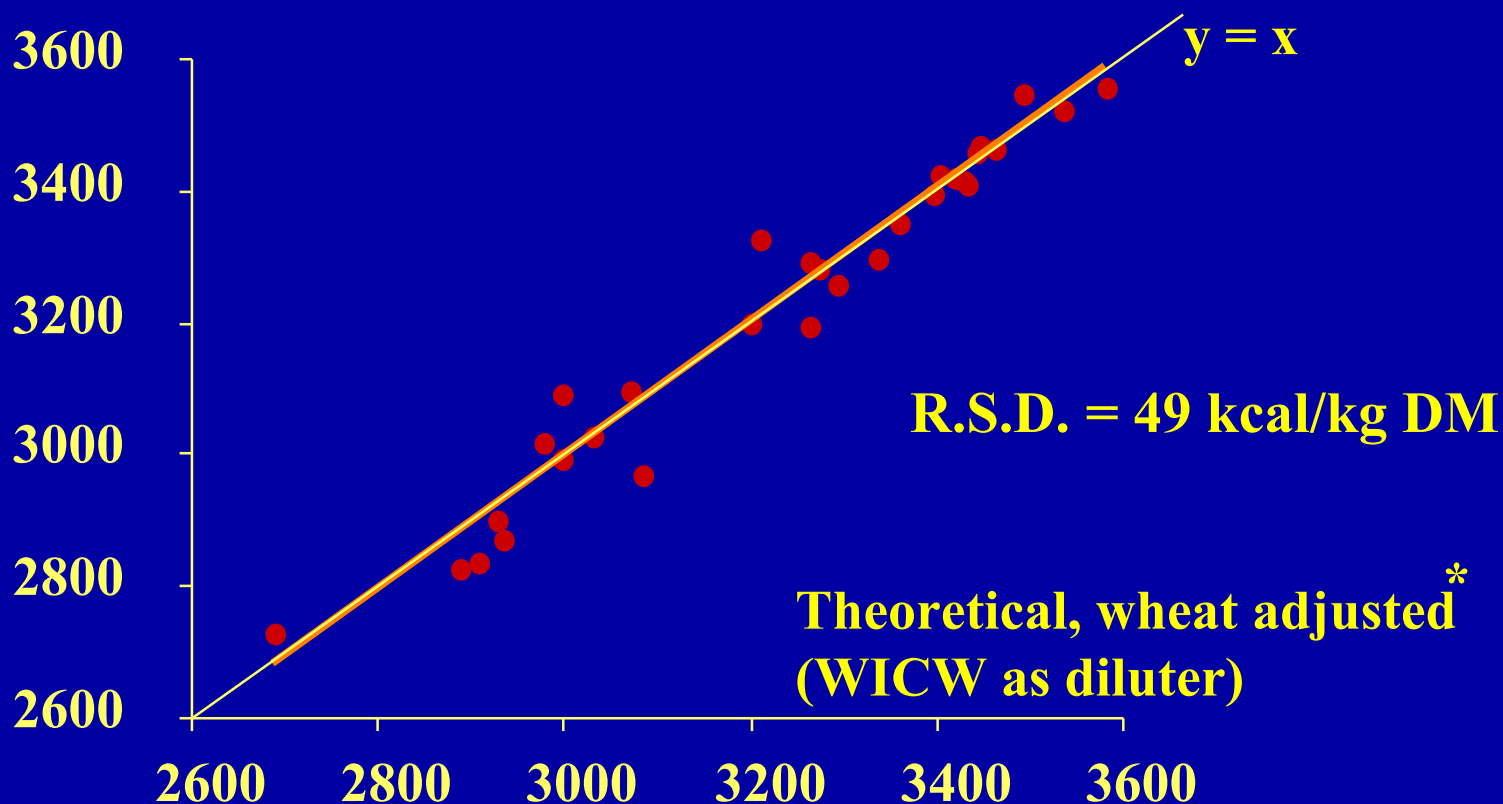


Comparison between theoretical and regression calculated equations (WICW based) for predicting AMEn values of diets, in adult cockerels.



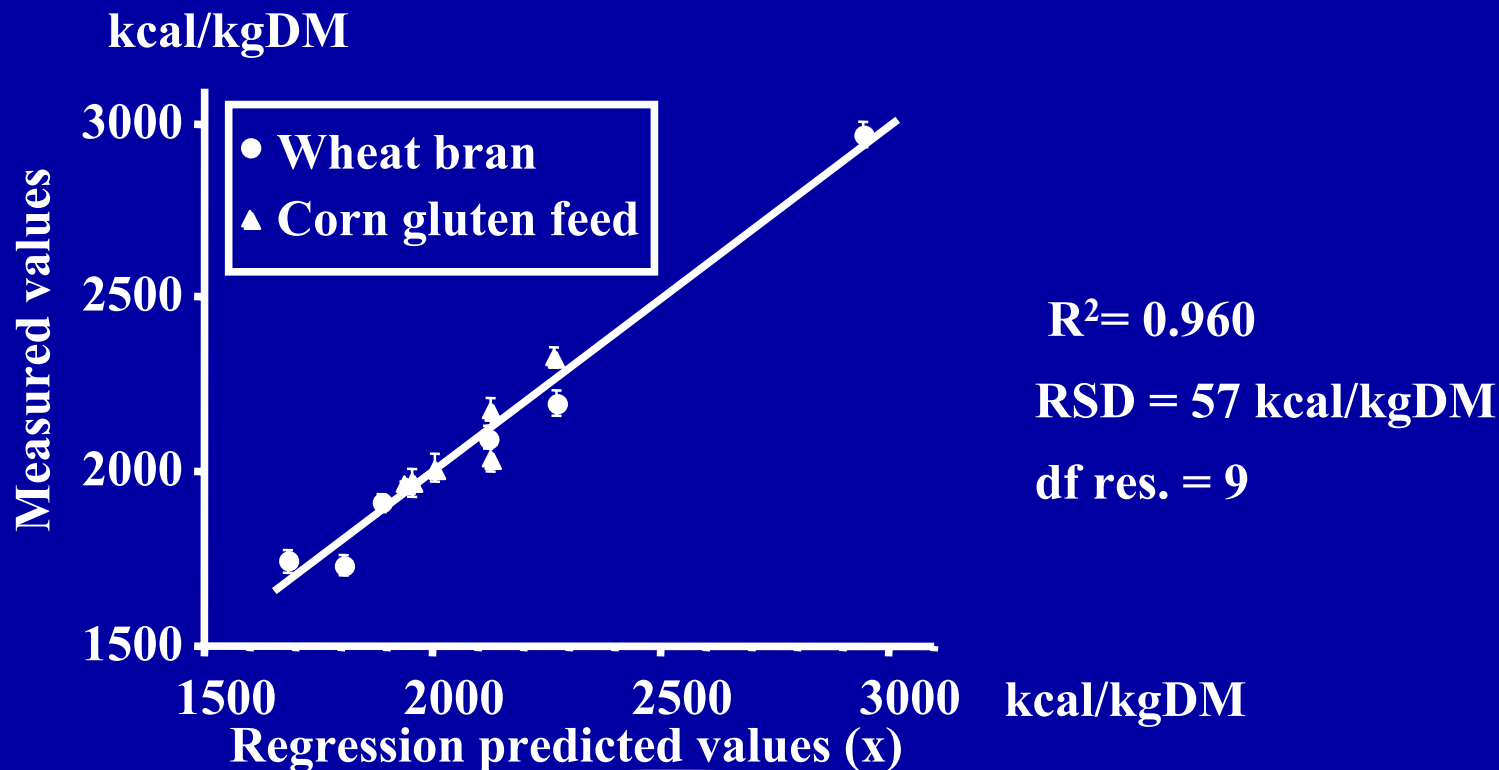
Comparison between measured and theoretical (WICW based) AMEn values of diets, in 4 w broilers

measured



* $0.924GE - 15.70CP (\%) - 40.68WICW (\%) - 4.63Wheat (\%)$

AMEn prediction for wheat brans and corn gluten feed, in adult cockerels (mean values)

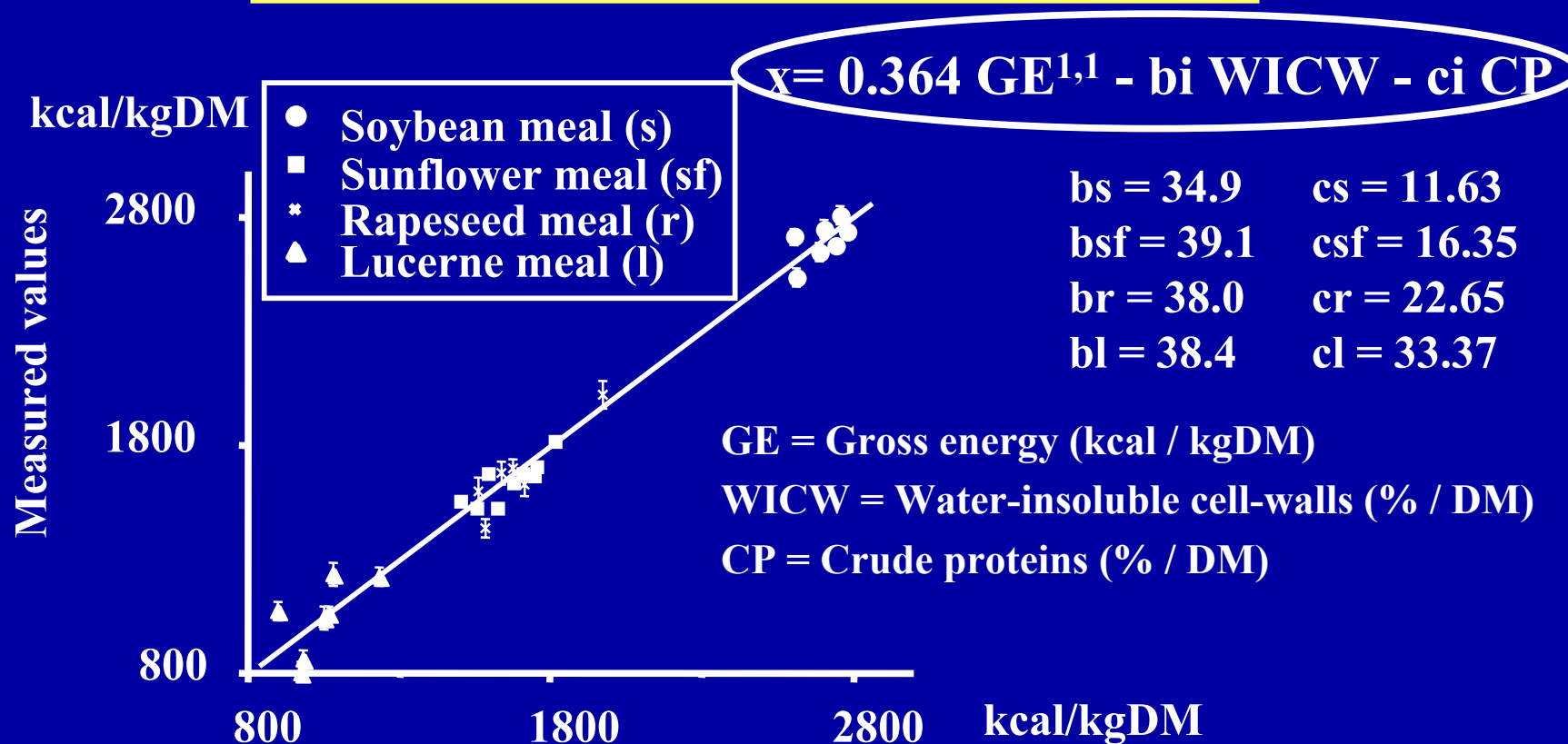


$$x = 3887 - 52 \text{ Ashes} - 37.5 \text{ WICW}$$

Ashes (% / DM)

WICW = Water-insoluble cell-walls (% / DM)

AMEn prediction for protein feedstuffs, in adult cockerels (mean values)



$R^2 = 0.975$

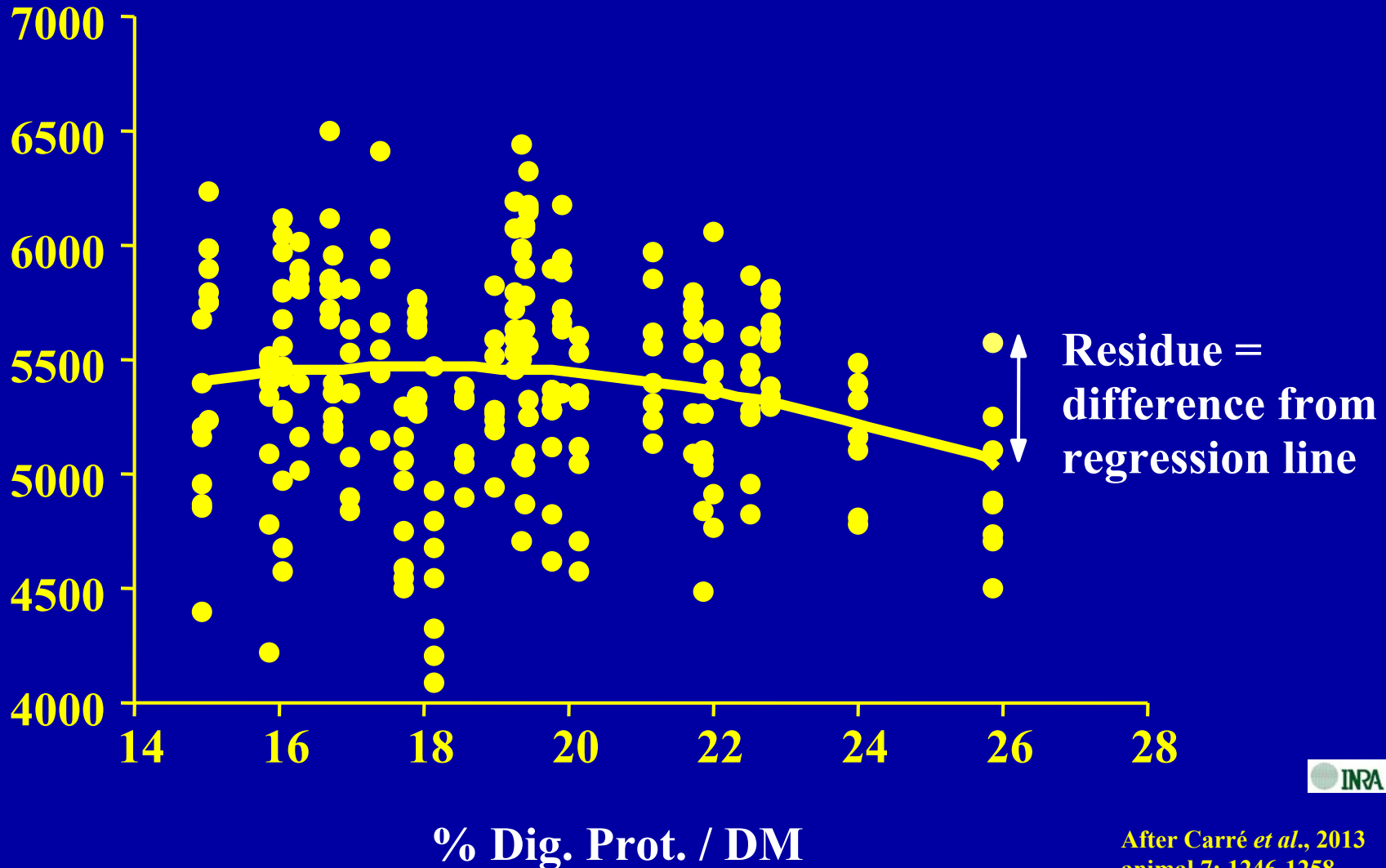
RSD = 95 kcal/kgDM

df res. = 21



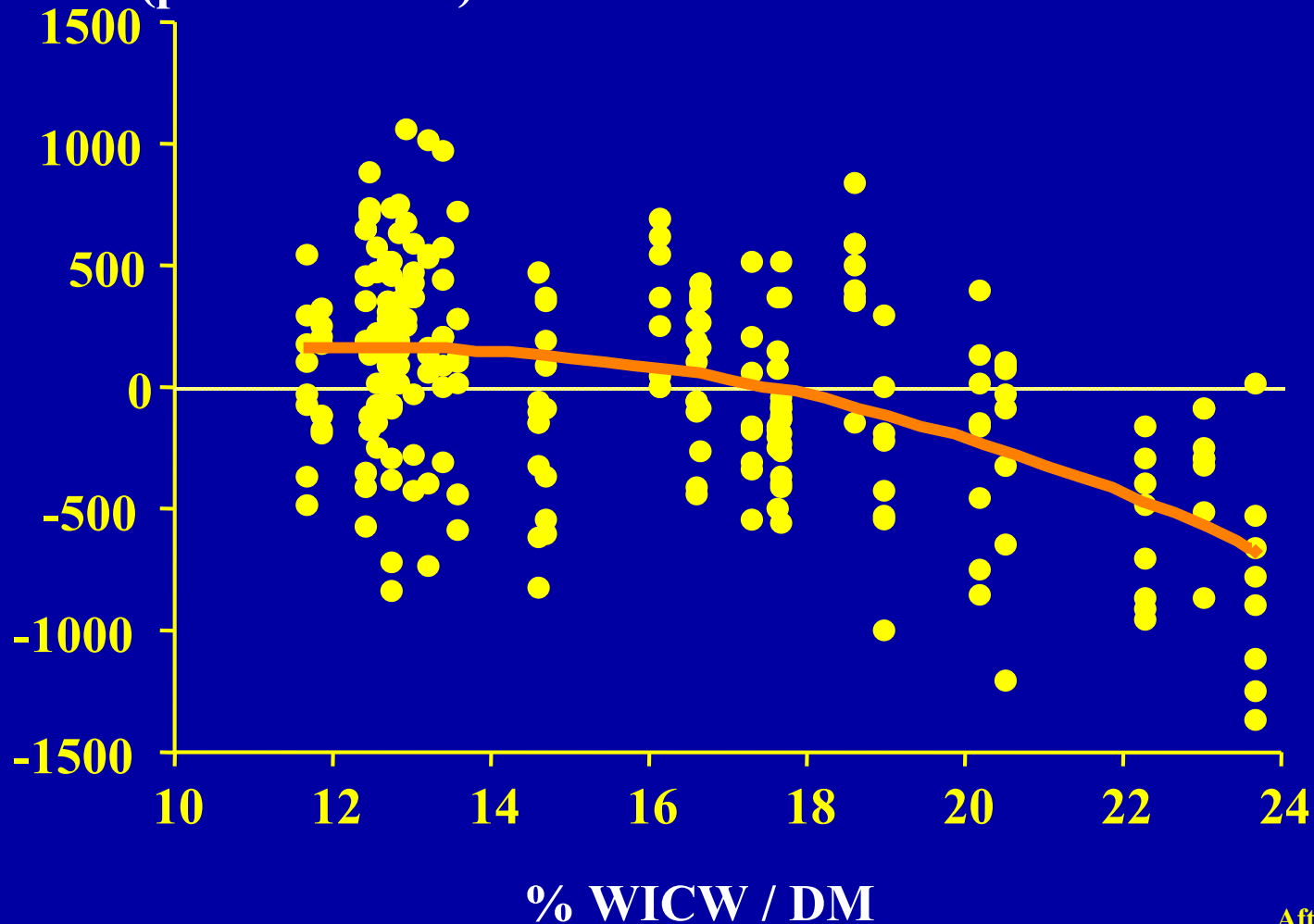
bulk

ME intake (21 - 35 days) (kcal) of chickens



bulk

Residues of ME intake
as f (%Dig. prot.),
in chickens
(previous slide)



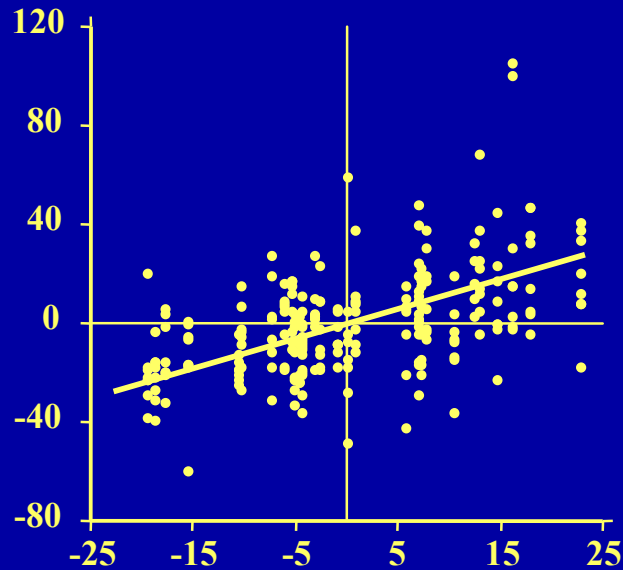
Water-insoluble fibres are cell boxes that can produce barrier effects in coarse particles, reducing diffusions of enzymes and hydrolysates and, thus, resulting in reduced digestibilities.

This was especially observed in dicotyledonous seeds (peas, rapeseed, soybean). Some wheats, such as hard wheats, can also be affected, with smaller effects compared with dicotyledonous seeds.

Mechanical treatments (grinding or pelleting) of dicotyledonous seeds are very efficient in the reduction of such box effect.

Water ret.

Residues of water excretion (g)
as f (g feed intake for 24h),
in chickens



Fitted Values

Fitted Values =

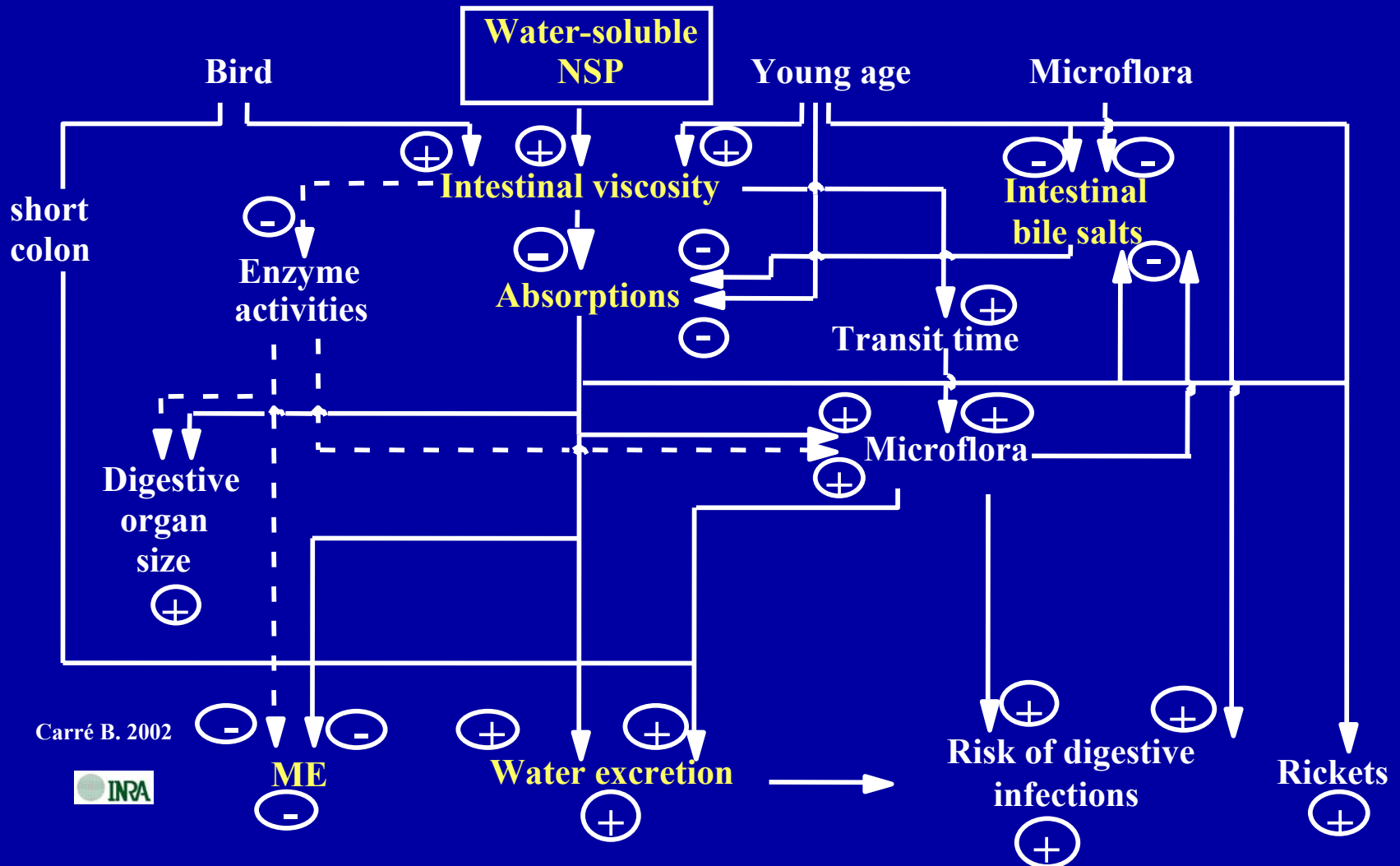
	Coef.	(SE)
WaterWICW (g/g DM)*	31.5	(5.2)
Ferm. Sugars (g/kg DM)	0.40	(0.11)
Sucrose + Glc (g/kg DM)	0.23	(0.10)
Chloride (g/kg DM)	25.9	(5.9)
Intercept	-144	(20.2)

After Carré *et al.*, 2013
animal 7: 1246-1258

*Carré *et al.*, 1995. INRA Prod.Anim., 8: 331-334.

Visco.

Consequences of the intestinal viscosity produced by water-soluble NSPs, in growing chickens



Methods for measurement of water extract viscosity in feed

Potential Viscosity

3.5 g sample
(0.5 mm ground)

↓

**1h treatment in
hot ethanol:water 80:20**

↓

Centrifugation

↓

Drying of the residue

↓

30 mL buffer pH 4.5
ambient temperature
1h treatment

↓

Centrifugation extract

↓

**Viscosity with
an apparatus
able to measure
the viscosity of water**

Real Viscosity

3.5 g sample
(0.5 mm ground)

↓

30 mL buffer pH 4.5
ambient temperature
1h treatment

↓

Centrifugation extract

↓

**Viscosity with
an apparatus
able to measure
the viscosity of water**

Applied
Viscosity
(mL/g)

=

$[\text{Ln (rel. Visco.)}] /$
 $(3.5 / 30)$

Carré *et al.*, 1994,
Prod. Anim. 7: 369-379.

Potential viscosity :
Endogenous enzymes are inactivated
before water extraction

Real viscosity :
Endogenous enzymes remain active
in water extract

**The « applied » viscosity :
an expression of viscosity measurements
resulting in additivity of viscosity data**

**Relative viscosity =
Absolute viscosity of extract / Absolute viscosity of buffer**

$$\boxed{\text{Applied viscosity (ml / g) =}} \\ \text{(Ln (relative viscosity)) / } \\ \text{Feed concentration in extraction volume}$$

**Potential Applied Viscosity
(PAV)**

**Real Applied Viscosity
(RAV)**

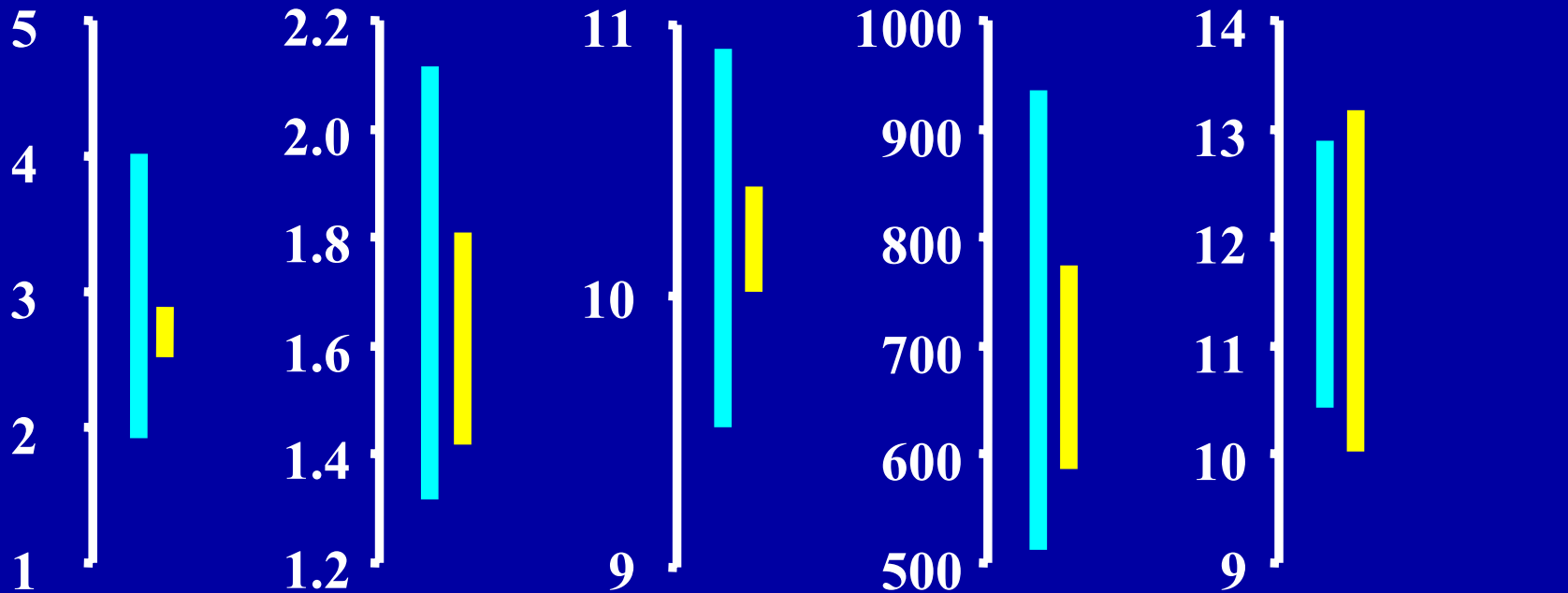
Carré et al. 1994

Visco.

Wheat variations from varieties and environments

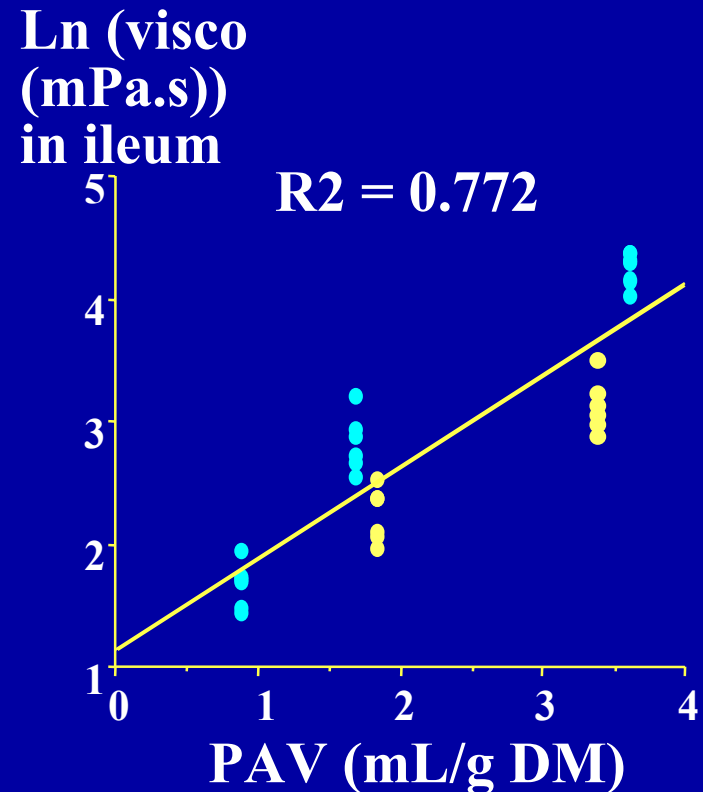
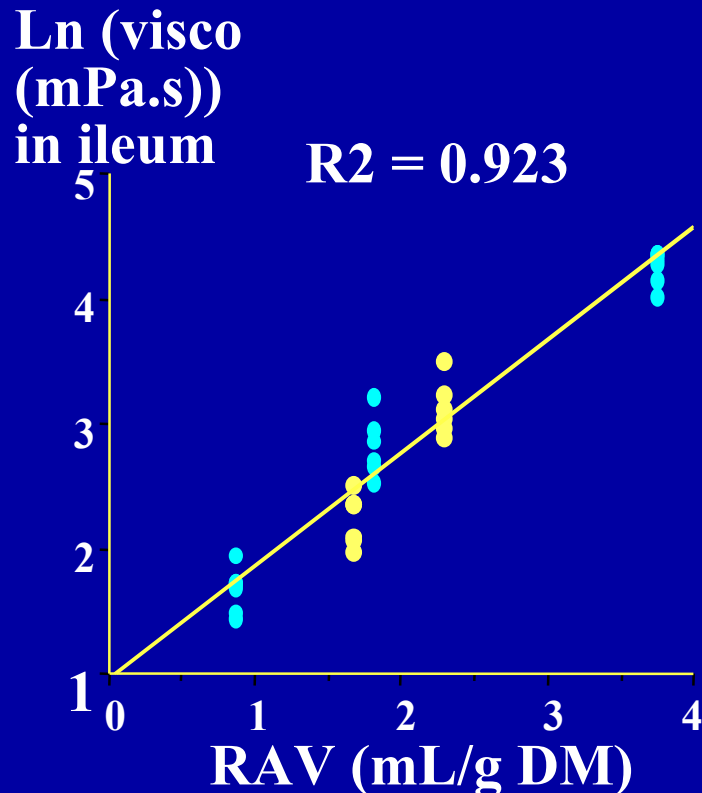
Maxi
Mini : ■ Varieties (12) ▮ Environments (6)

PAV RAV WICW Phytase Proteins



Relationships between *in vitro* (RAV and PAV) and ileum viscosities, in 3 w. broiler chickens

- Diets “Corn” and “Corn + guar gum”
- Diets “Wheat”



PAV is convenient for wheat cultivar characterization

**Since 2005,
the french official catalogue of plant cultivars
uses the PAV determination*
as the viscosity parameter assigned to a wheat cultivar.**

***PAV using the ethanolic pretreatment**

RAV values are well correlated to *in vivo* viscosities

**RAV is convenient
to characterize a diet,
in order to predict *in vivo* viscosity**

The pelleting temperature affects the diet RAV viscosity

$$RAV = 1.24 \times 10^{-5} (PAV_{cal} \times T)^2 + 0.012 T$$

$$R^2 = 0.78 ; RSD = 0.46 ; n = 27$$

$$68^{\circ}\text{C} < T < 100^{\circ}\text{C}; 0.78 < PAV_{cal} < 4.84$$

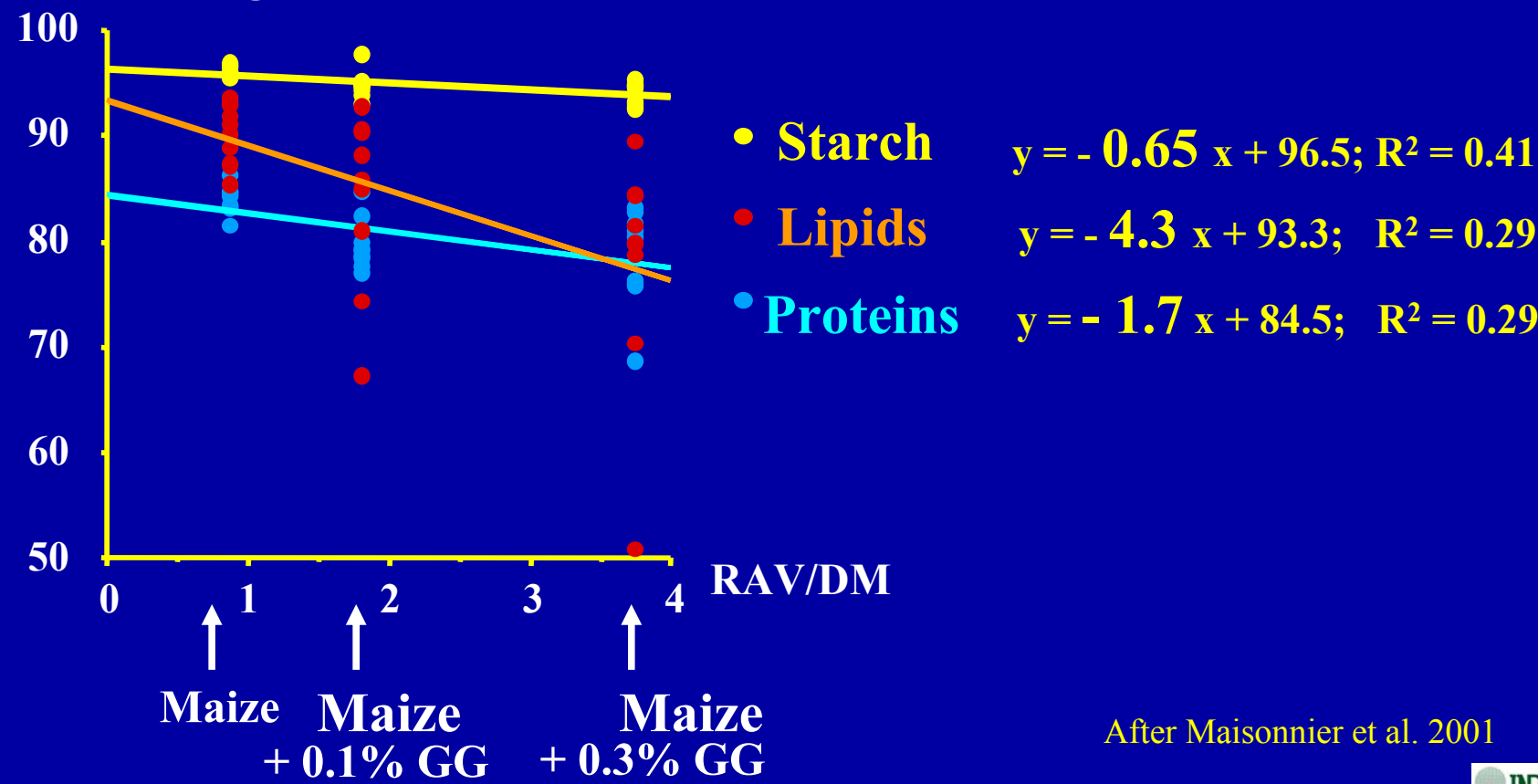
RAV : RAV of pelleted diet

PAV_{cal} : diet PAV calculated by additivity
according to feedstuffs PAV values

T : temperature of pellets on die outlet

Relationship between digestibilities and diet RAV, in broiler chickens fed maize diets added with guar gum (0, 0.1 and 0.3 %)

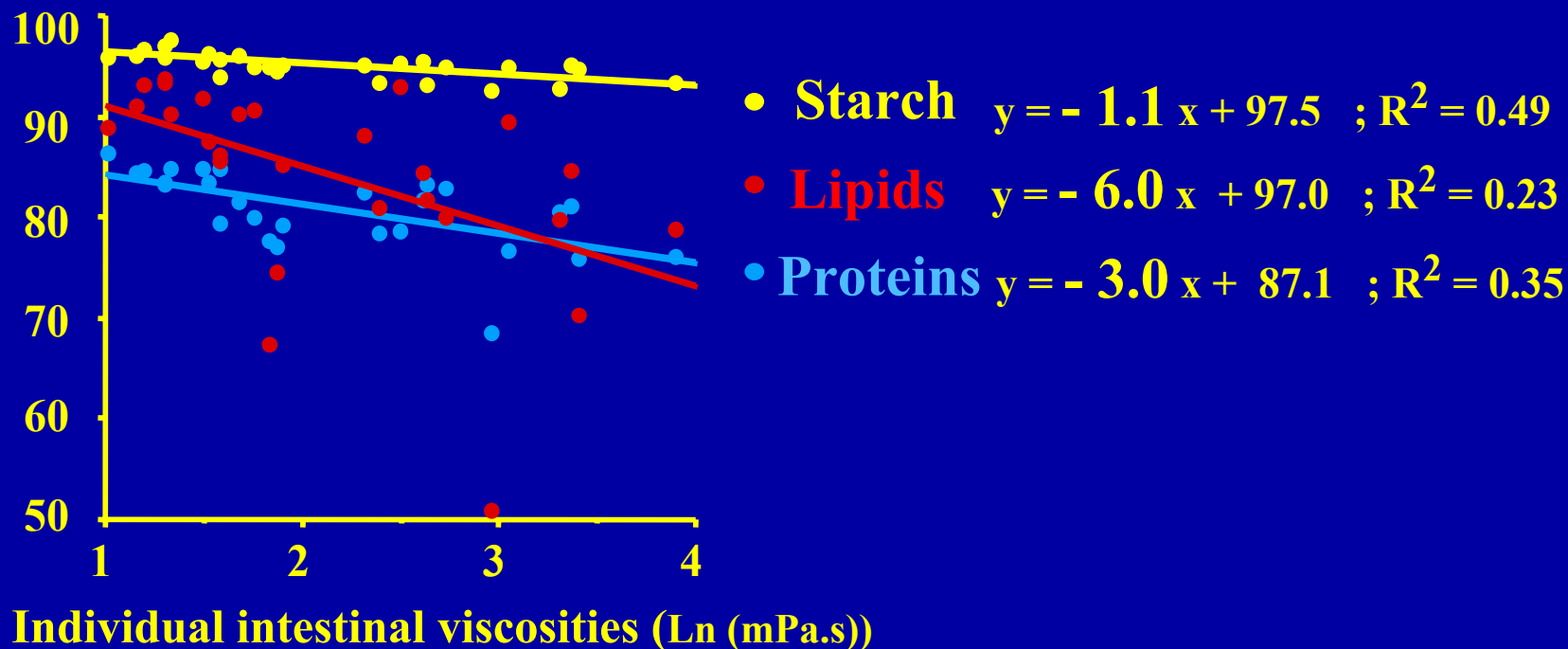
Individual digestibilities (%)



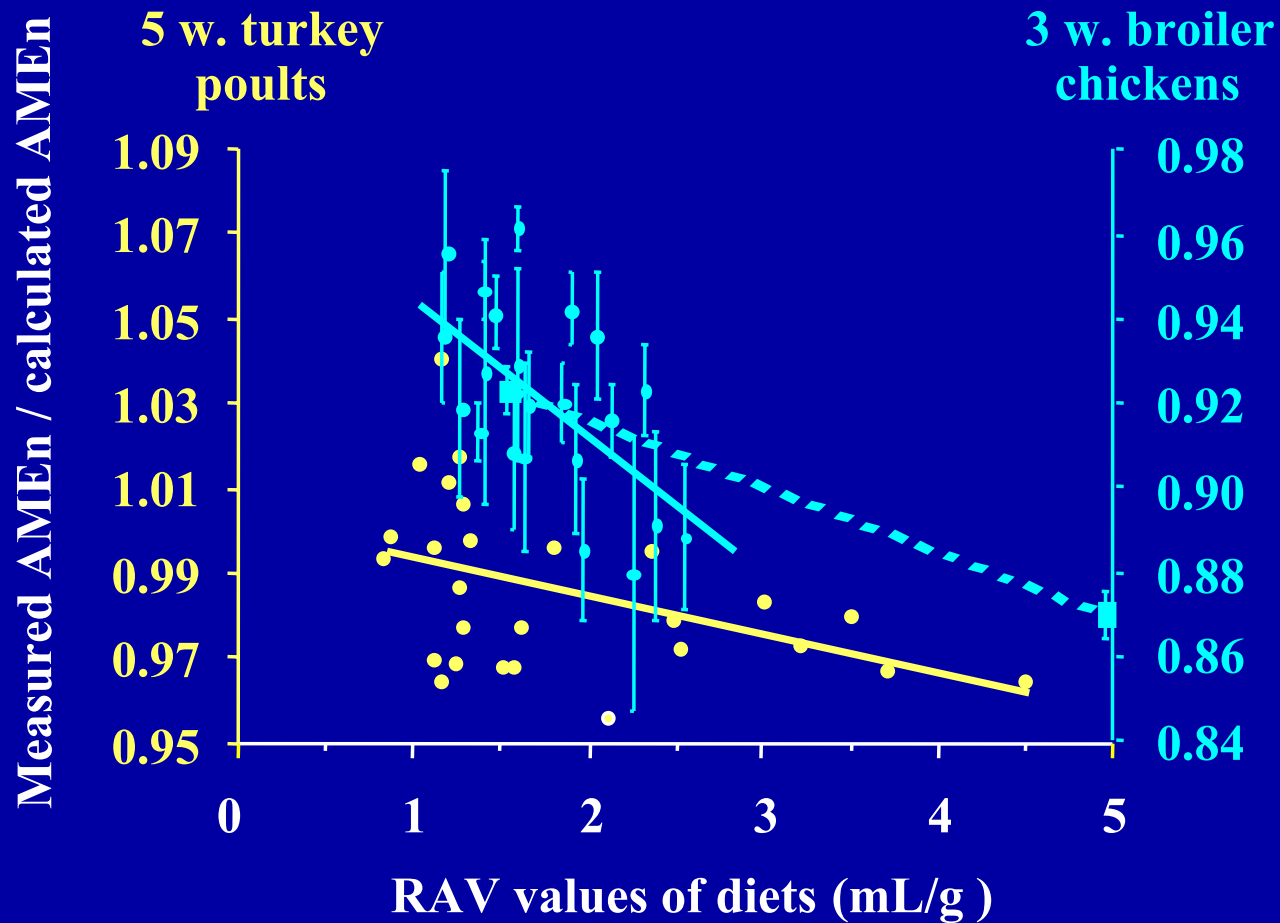
After Maisonnier et al. 2001

Digestibility variations due to intestinal viscosity, in broilers fed with maize diets added with graded levels of guar gum (0, 0.1 and 0.3 %)

Individual digestibilities (%)



Relationships between AMEn values and diet viscosity values (means and standard errors).



Carré et al. 1994, unpublished

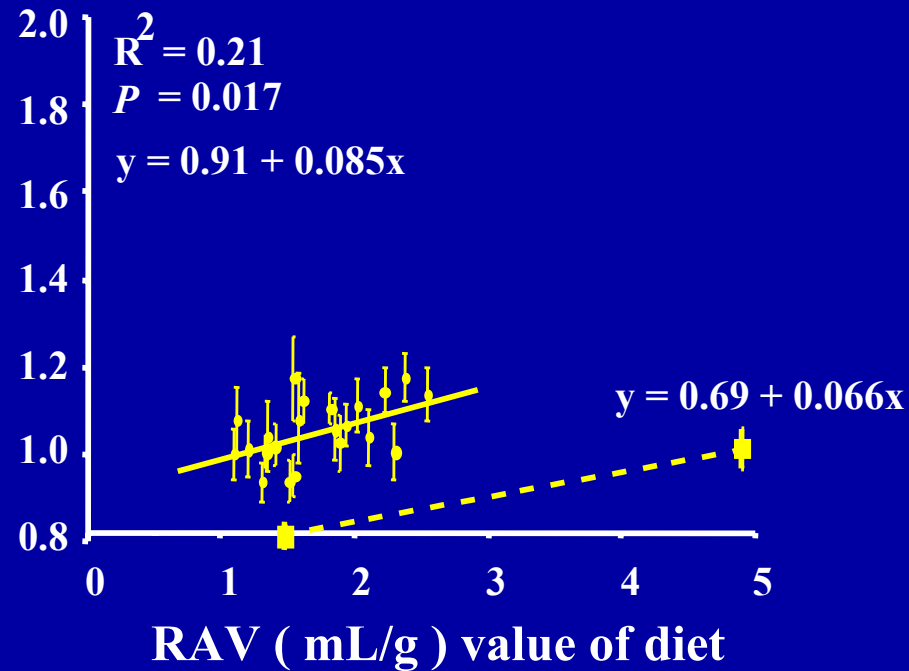
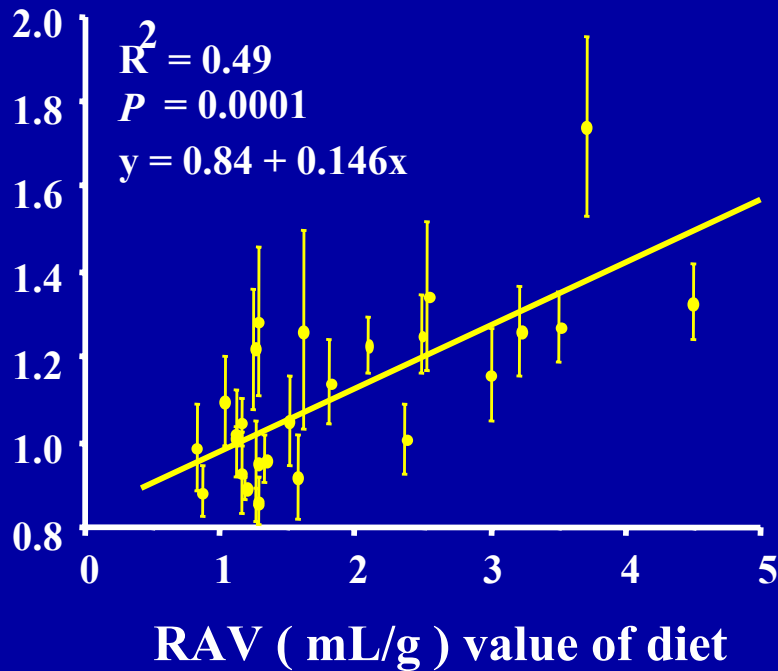
Carré et al.1995 (- -)
Carré et al. 2002 (—)

Effect of viscosity of diets on water excretion in turkey poults and broiler chickens

5 w. turkey poults

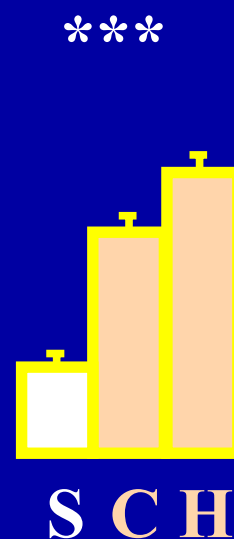
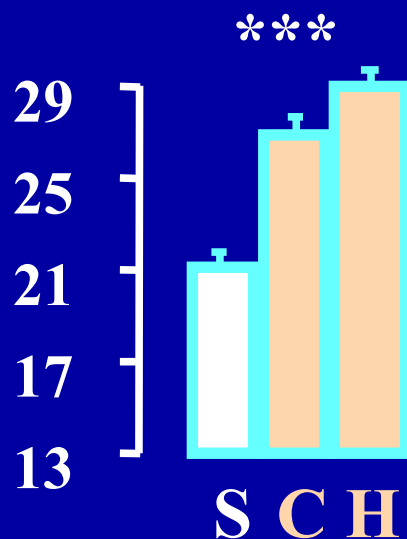
3 w. broiler chickens

Excreted water /
feed intake



Gizzard / body weight (g/kg) at 26d

(Means and SE)

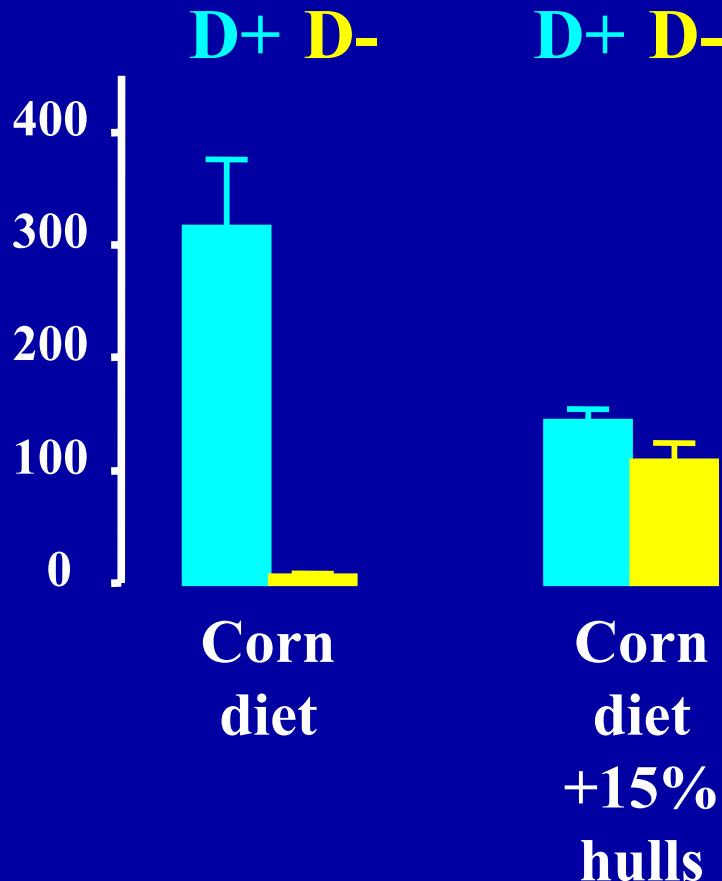
D+ line**D- line** (6th generation)Corn
diets

(S) Standard

(C) Standard with half of corn as **coarse** particles(H) Standard + 7% **coarse** cereal hull

Mean retention times (min) of coarse particles in gizzard + proventriculus of 4 w old chickens from D+ and D- lines (G8).

Coarseness

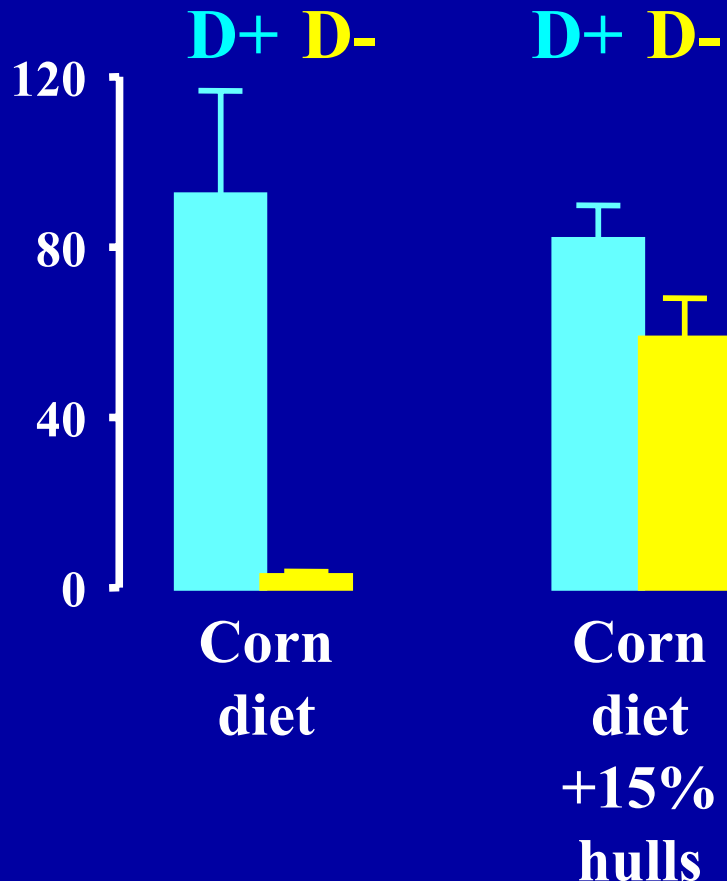


effects		<i>P</i>
Line	:	0.0001
Diet	:	NS
Line x Diet	:	0.0007

Rougière and Carré, 2010.
Animal, 4: 1861.

Mean retention times (min) of fine particles in gizzard + proventriculus of 4 w old chickens from D+ and D- lines (G8).

Coarseness



effects		<i>P</i>
Line	:	0.0003
Diet	:	NS
Line x Diet	:	0.02

Rougière and Carré, 2010.
Animal, 4: 1861.

4 w old chickens from D+ and D- lines (G8)

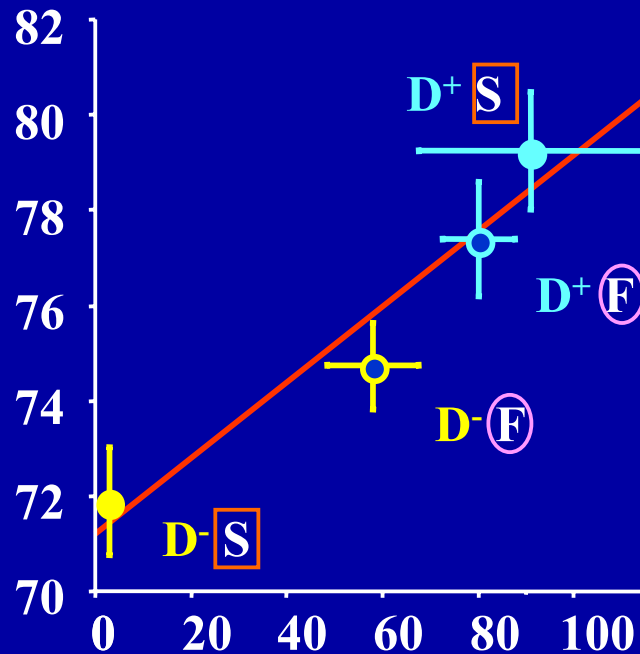
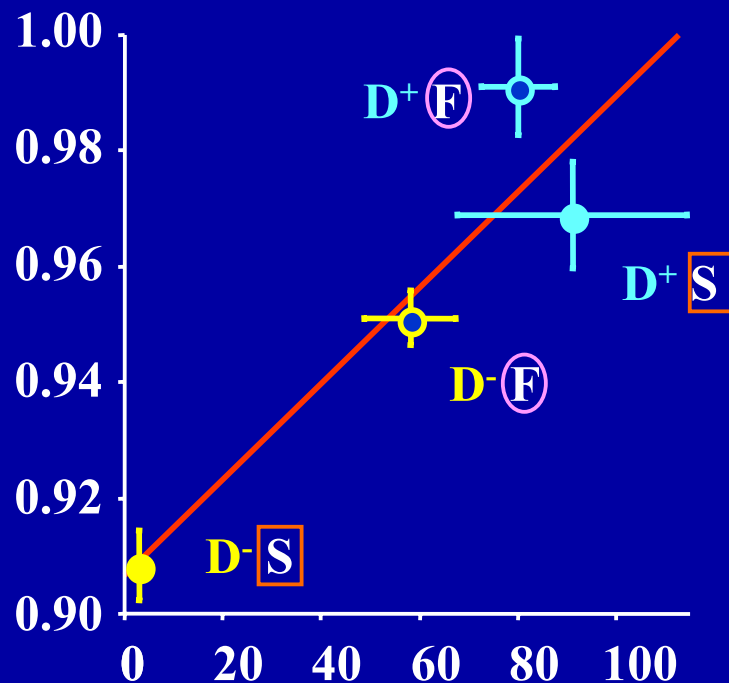
Coarseness

■ D+ line ■ D - line

Measured AMEn /
calculated AMEn

Protein
digestibility (%)

■ S Stand. Diet
○ F Fibre diet

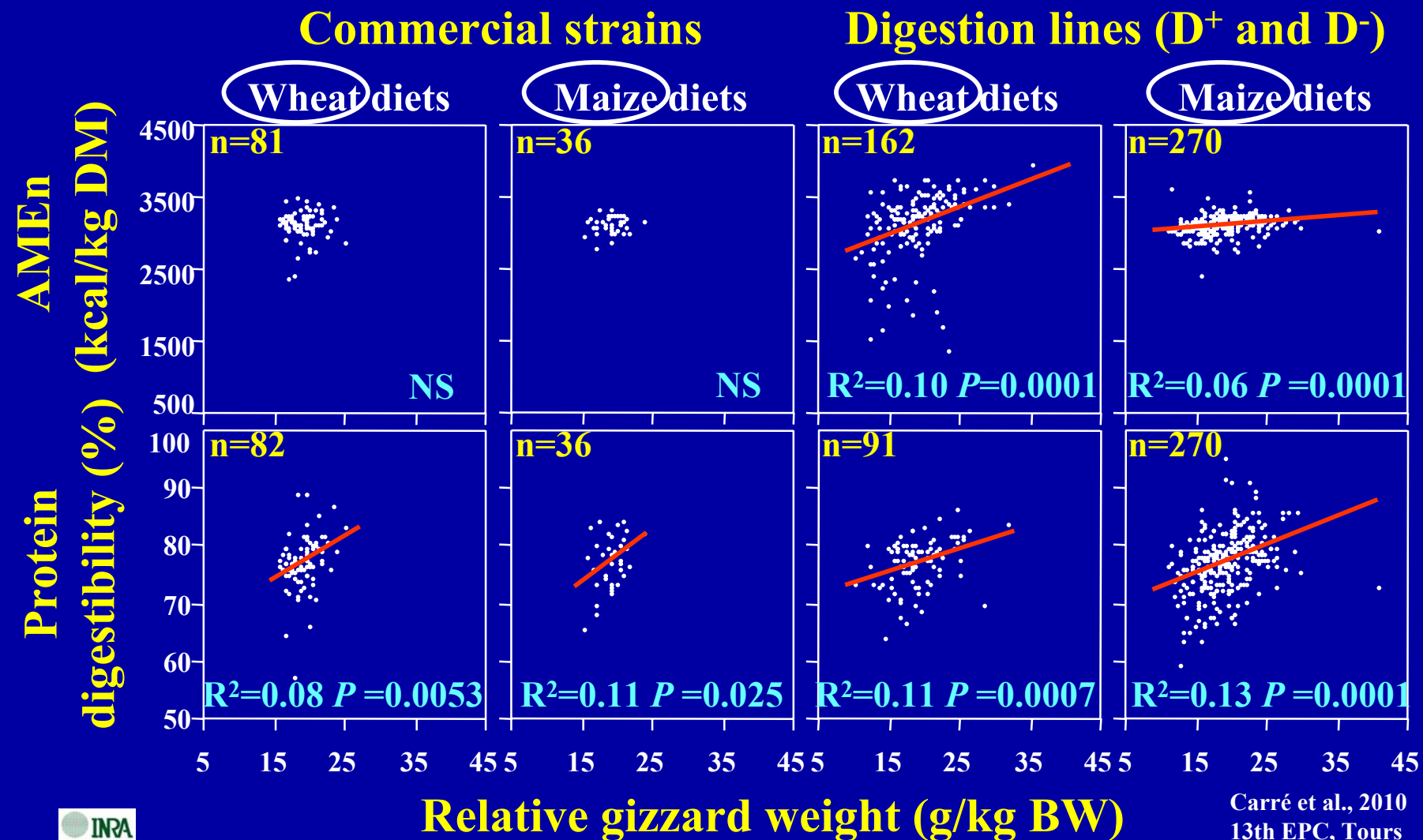


Mean retention time (min) of fine particles in gizzard-proventriculus system

RELATIONSHIPS BETWEEN INDIVIDUAL DIGESTION EFFICIENCIES AND INDIVIDUAL DIGESTIVE ANATOMY IN 3 WK BROILERS.

Database from 8 studies, corrected for diet and age effects.

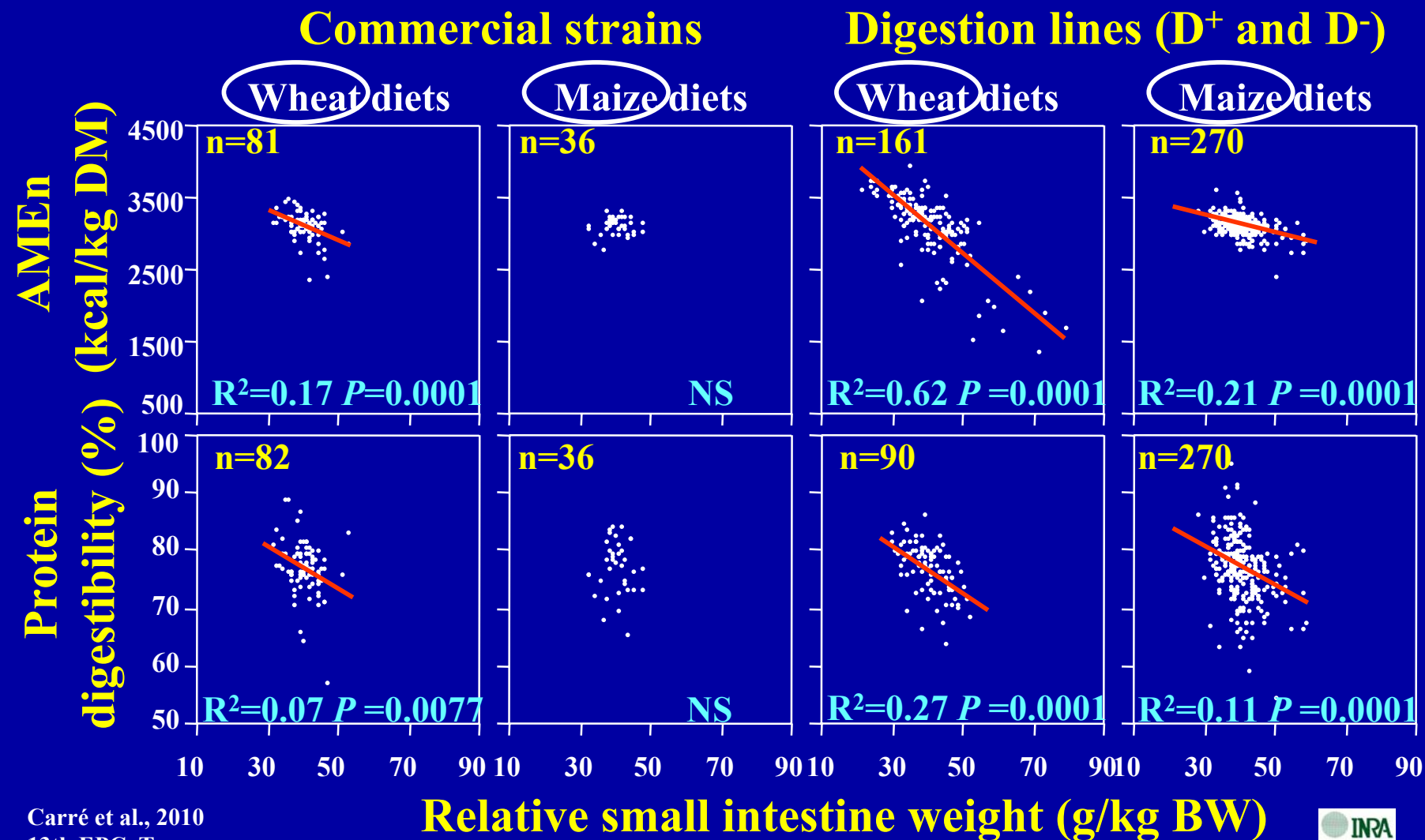
Coarseness



RELATIONSHIPS BETWEEN INDIVIDUAL DIGESTION EFFICIENCIES AND INDIVIDUAL DIGESTIVE ANATOMY IN 3 WK BROILERS.

Database from 8 studies, corrected for diet and age effects.

Coarseness



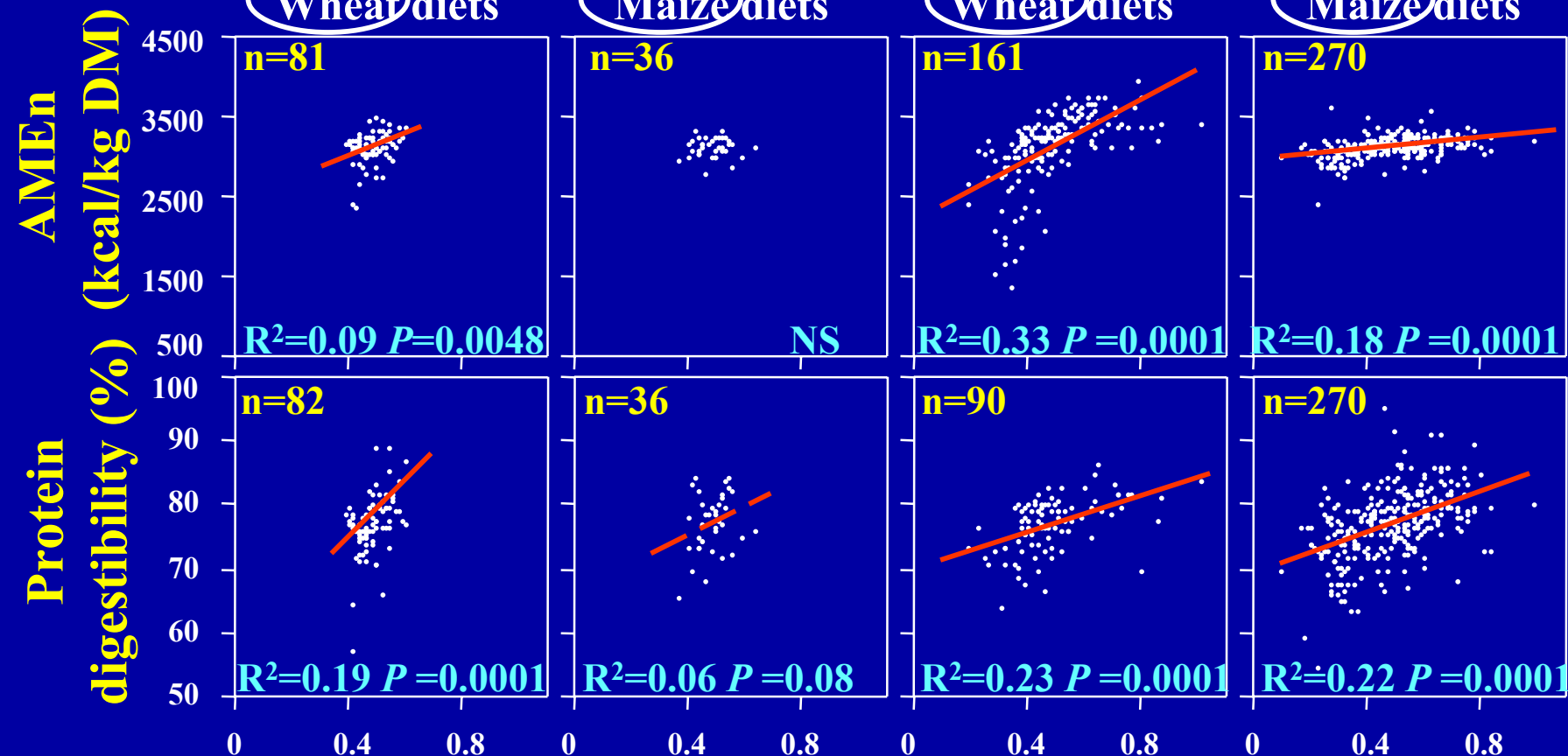
RELATIONSHIPS BETWEEN INDIVIDUAL DIGESTION EFFICIENCIES AND INDIVIDUAL DIGESTIVE ANATOMY IN 3 WK BROILERS.

Database from 8 studies, corrected for diet and age effects.

Coarseness

Commercial strains

Digestion lines (D⁺ and D⁻)

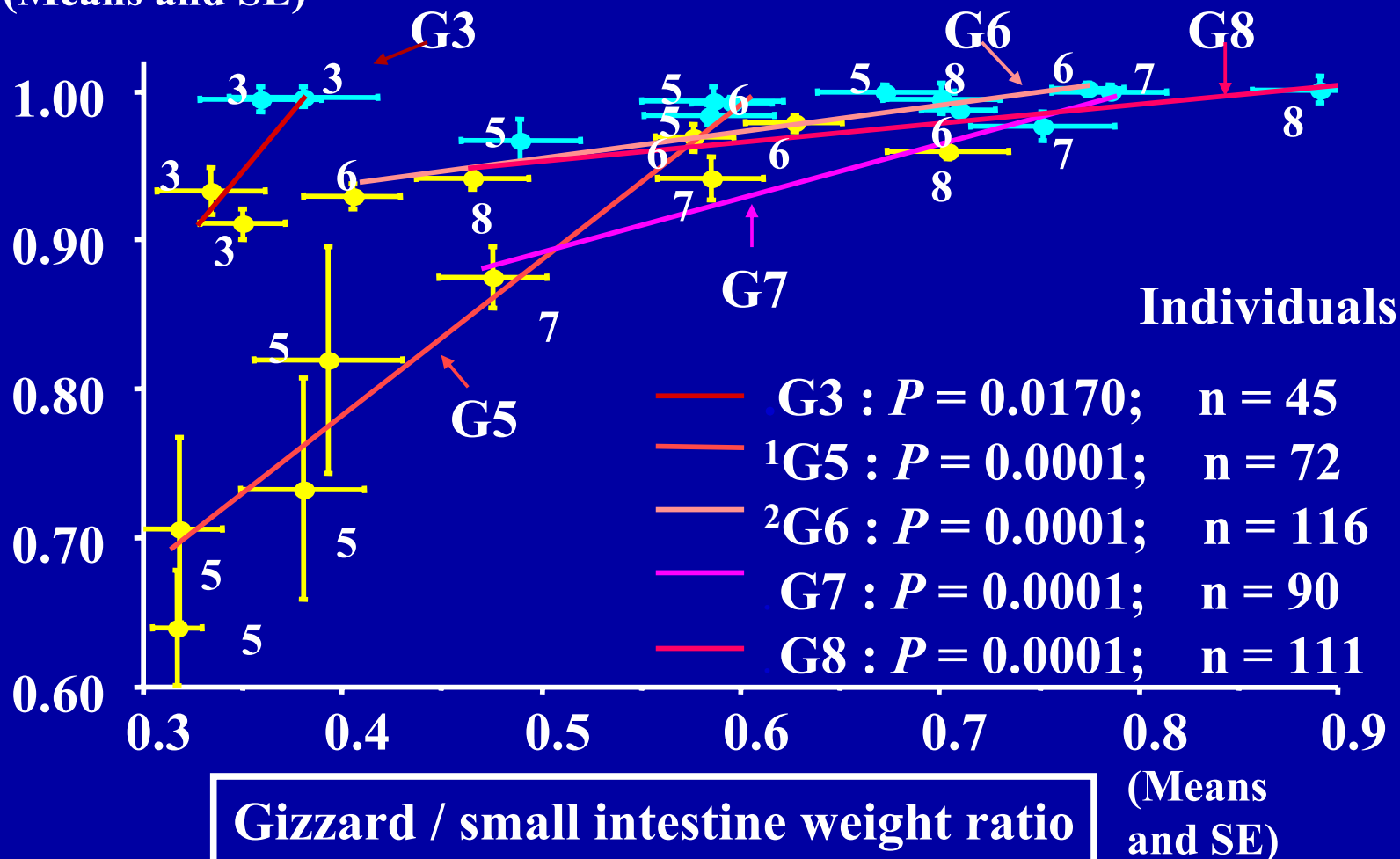


Gizzard / small intestine weight ratio

Measured AMEn (3 weeks) /
Calculated AMEn

(Means and SE)

• D+ line • D- line



¹García *et al.*, 2007. *Animal*, 1: 1435.

²Rougière *et al.*, 2009. *Poultry Science*, 88: 1206

The coarse particles produced by fibres have difficulty in passing through the pylorus, which stimulates growth and functions of upper parts of digestive tract in growing chickens.

This stimulation improves digestibilities of non fibre components, with the most important effects being observed with the lowest digestibilities, independently of the origin of these low digestibilities, dietary or genetic.

Conclusion

The effects of fibres on feed efficiency are often negative in poultry.

Coarseness of insoluble fibres is positive for growth and functions of upper parts of digestive tract in growing chickens, with effects depending on genetics of chickens.