



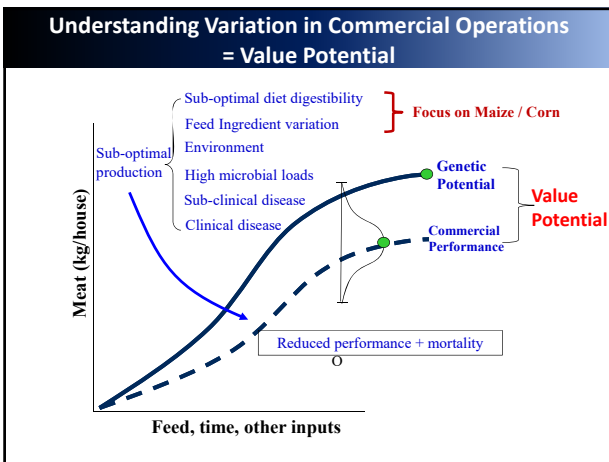
### Understanding the variation in the energy value of South African maize to improve diet formulation

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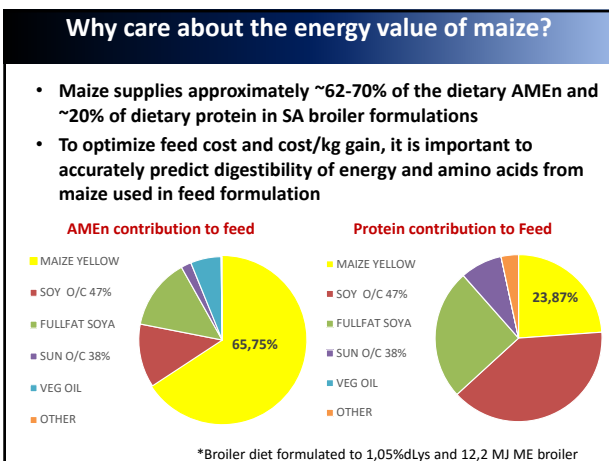
Your Animals, Our Science

### How do we grow this genetics to its optimum potential?

### Assessment of Variation of Corn in SA

- ✓ SAGL routinely analyse corn samples collected from Silo's
- ✓ Data from 27 regions over 4 harvest years from 2012-2017
- ✓ 2188 maize samples analysed (1162 White; 1026 Yellow)

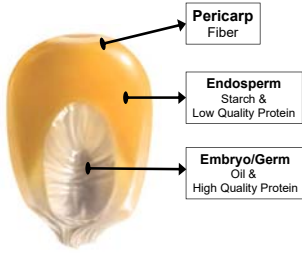



### Where does corn energy (AMEn) come from?

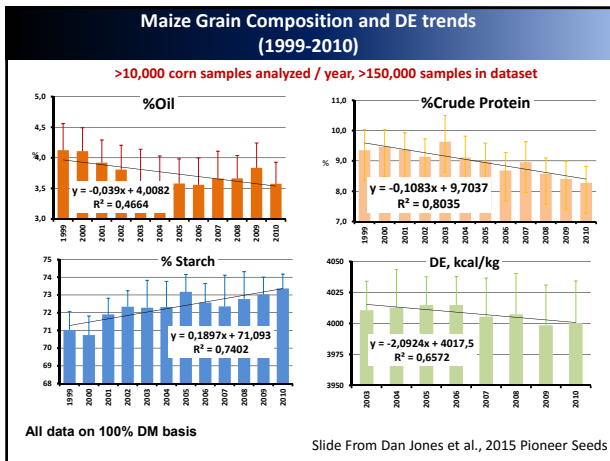
#### Corn Morphology

**AMEn from corn**

- ~66% from starch
- ~8% from oil
- ~7% from protein
- ~19% from fibre & free sugars



Reference: Noblet (INRA)

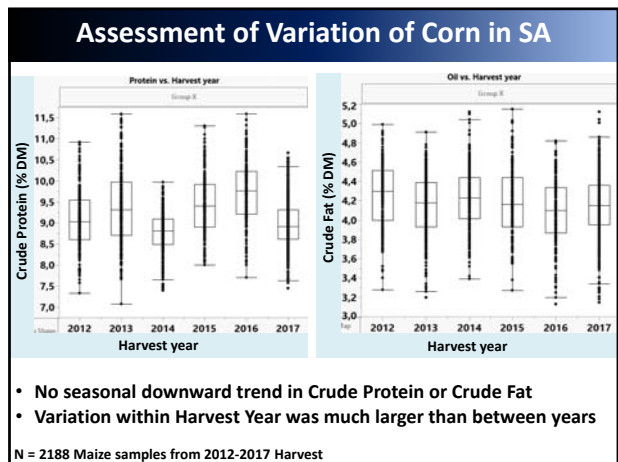
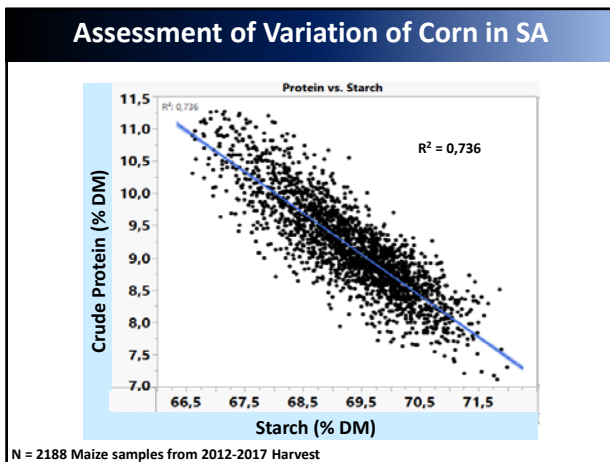


### Selection for higher starch and lower protein?

No, but there are strong genetic correlations between grain traits and yield

Table 1. Genetic correlations between yield and quality traits

Trait Name	Corn	Soy
Oil	-0.16 ± 0.037	-0.13 ± 0.027
Protein	-0.41 ± 0.032	-0.24 ± 0.026
Starch	0.43 ± 0.037	
DE	-0.10 ± 0.040	



### We can adjust AMEn for variation in proximate composition

- ✓ **WPSA (1986)** AMEn (kJ/kg) = 15.51 x CP + 34.31 x C.Fat + 16.69 x starch + 13.01 x sugars
- ✓ **CVB 2007:** AMEn (kJ/kg) = 15.56xdig.CP + 38.83xdig.C.Fat + 17.32xdig.NfE
- ✓ **Rostock:** AMEn(kJ/kg) = 18.8xdig.CP + 39.8xdig.C.Fat + 17.3xdig.Starch + 16.0xdig.Sugars + 17.2xdig.NFR
- ✓ **Brazilian tables (2011)** ME = 18,04xdigCP + 38,88xdig.C.Fat + 17,32 x digNfEd

Crude Fat (%)

### We can adjust AMEn based on variation in proximate composition

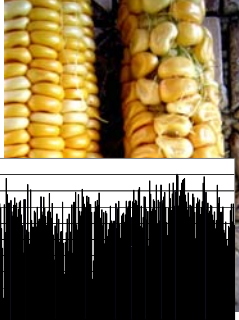
Rostock equation:  
 $AME_n(kJ/kg) = 18.8xdig.CP + 39.8xdig.C.Fat + 17.3xdig.Starch + 16.0xdig.Sugar + 17.2xdig.NFR$

Nutrient	Corn		ME value	Digestibility (%)	ME contribution (KCAL/KG)	
	Corn A	Corn B			Corn A	Corn B
DM	88	88				
CP	7,5	8,5	4,50	81,6	275	312
Fat	3,5	4	9,51	86,4	288	329
Starch	68	67	4,13	92,17	2 592	2 553
Sugars	2	2	3,82	35	27	27
NFR	4,5	4	4,11	35	65	58
Ash	2,5	2,5			3 246	3 278
					<b>Difference</b>	<b>32 kcal/kg</b>

Energy contribution (kcal/kg feed) = Amount of substrate (g substrate / kg feed) X Increment of ileal digestibility of substrate (g substrate / kg feed) X Energy contribution of substrate (kcal / g substrate)

### Prediction Equations to estimate AMEn

$AME_n(kj/kg) = 18.8 \times \text{dig.CP} + 39.8 \times \text{dig.C.Fat} + 17.3 \times \text{dig.Starch} + 16.0 \times \text{dig.Sugar} + 17.2 \times \text{dig.NFR}$



Same chemical values.  
=  
same AMEn or NE content?

What about variation in digestibility of Protein, Fat, or starch?

### Not all Maize Protein and Starch is Made The Same



**Vitreous Endosperm**  
**Flinty Endosperm**

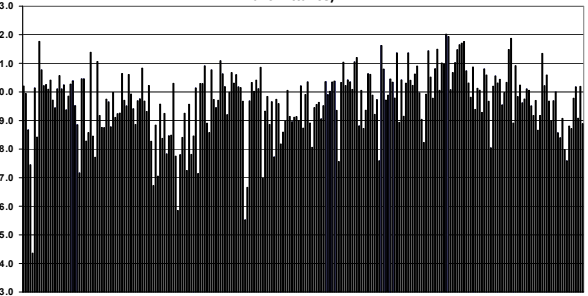
A Starch granule Prolamin Zein Protein matrix  
 B Starch granules in opaque corn endosperm with less extensive encapsulation by prolamin-proteins (Gibbon et. al., 2003).

Scanning electron microscopy of starch granules in corn: A) starch granules heavily imbedded in prolamin-protein matrix, B) starch granules in opaque corn endosperm with less extensive encapsulation by prolamin-proteins (Gibbon et. al., 2003).

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### Energy Digestibility is Highly Variable for Hybrids

Pioneer Seeds used In-Vivo studies on the more than 300 corn samples fed to broilers to develop direct prediction of GE and GE digestibility (AMEn) using NIT (Near Infra Red Transmittance)



Energy digestibility of >300 characterized hybrids

Slide from D.Jones, 2015

### How do we manage variation?

**Measured in the past**


- ✓ Protein
- ✓ Starch
- ✓ Oil
- ✓ Crude Fibre
- ✓ Ash

DE or NE calculated by Prediction equations\*

**Measured now Direct measurement**

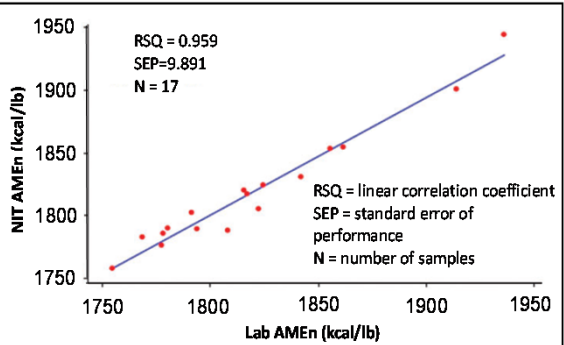
- ✓ DM
- ✓ Protein
- ✓ Fat
- ✓ AMEn and DE via NIT

Near Infra-Red Transmittance Prediction



\* Fixed digestibility of Protein, Fat, Starch and NFR

### Validation of NIT Predicted vs. Actual AMEn



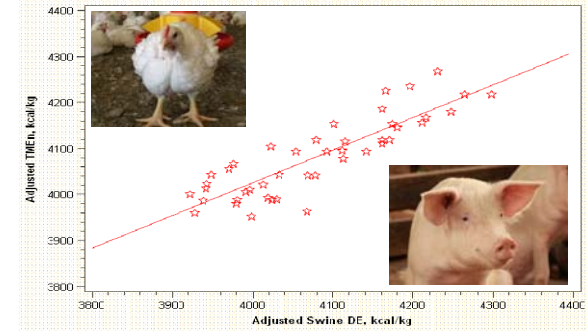
RSQ = 0.959  
 SEP = 9.891  
 N = 17

RSQ = linear correlation coefficient  
 SEP = standard error of performance  
 N = number of samples

Hruby, 2015

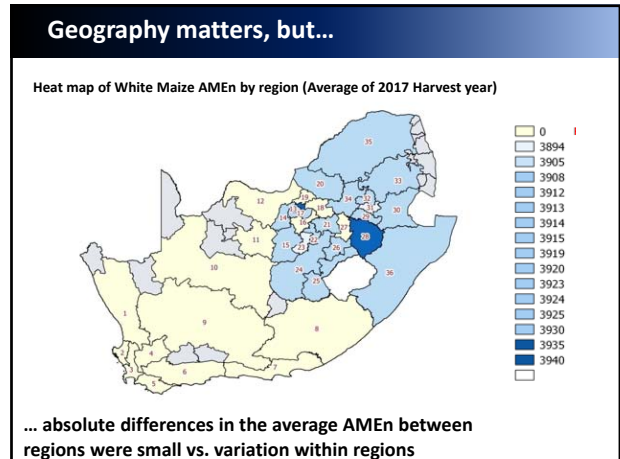
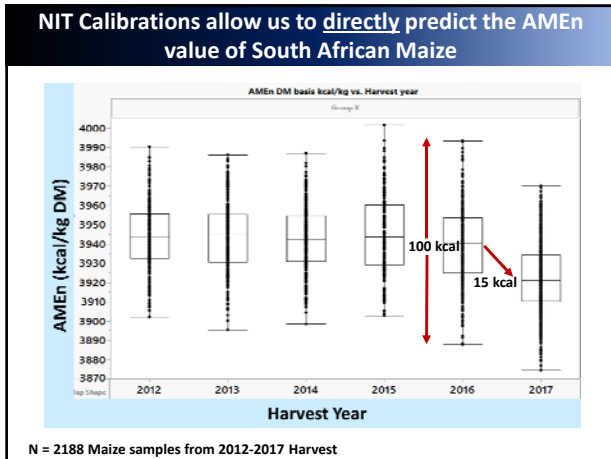
### NIT models to predict nutritional traits

#### Poultry AMEn vs Swine DE



Adjusted Poultry AMEn, kcal/kg

Adjusted Swine DE, kcal/kg

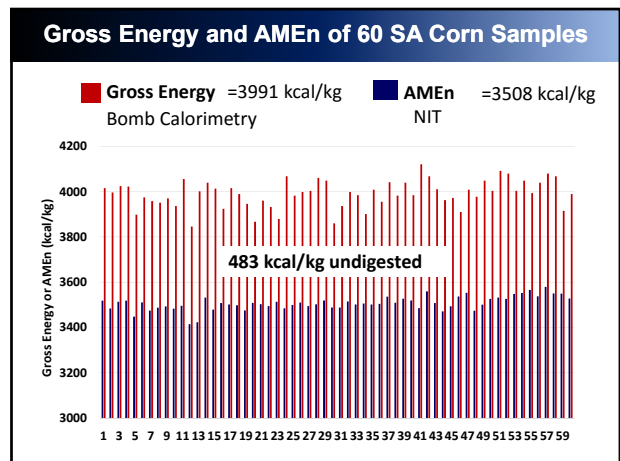
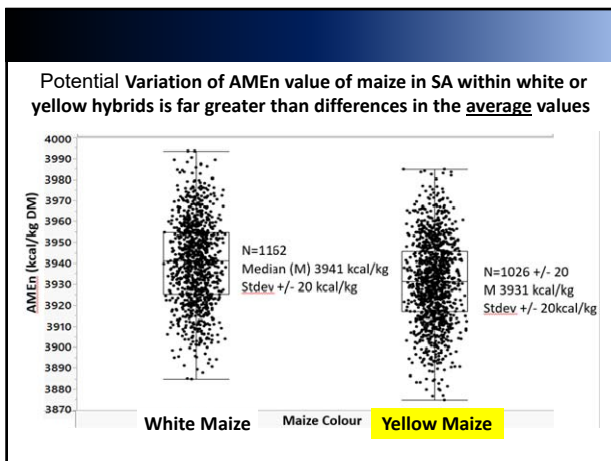


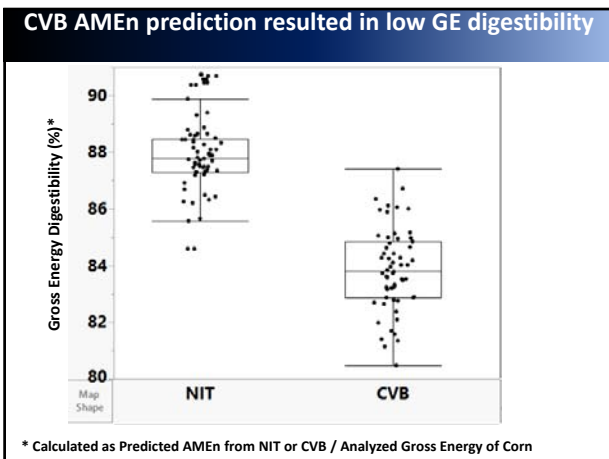
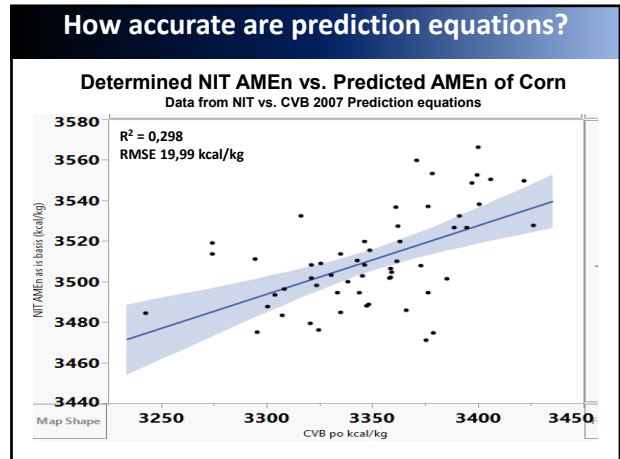
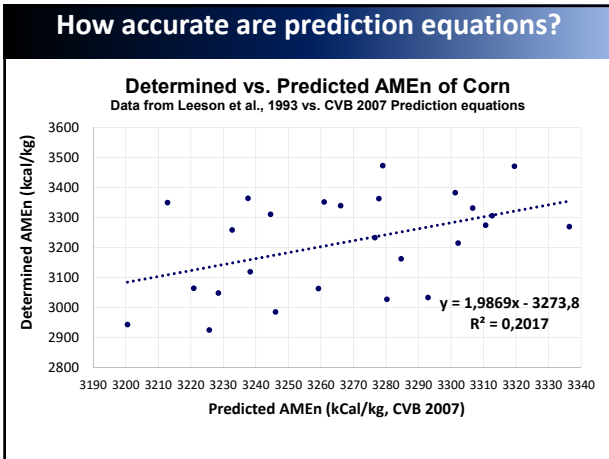
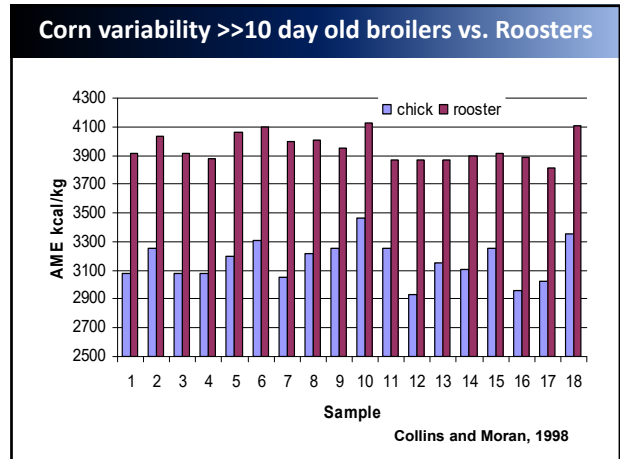
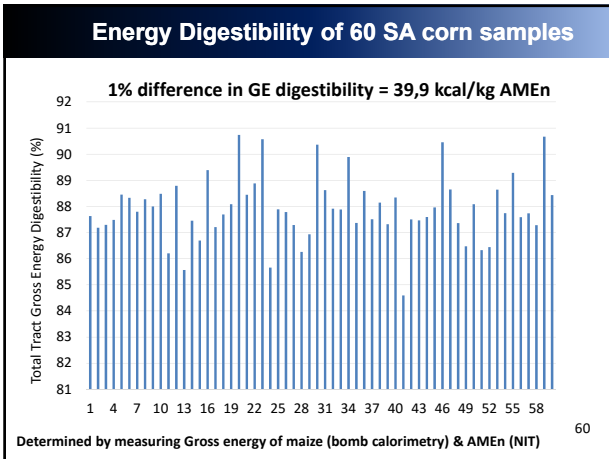
### Do White and Yellow Maize have the same nutritional value?

### Do White and Yellow Maize have the same nutritional value?

	White Maize	Yellow Maize	Prob > F
N analyzed	1026	1162	
Moisture	10,98 +/- 0,88	10,92 +/- 0,83	NS
Protein (% DM)	9,07 +/- 0,73	9,28 +/- 0,79	<0,001
Starch (% DM)	69,57 +/- 0,87	69,07 +/- 1,04	<0,001
Fat (% DM)	4,28 +/- 0,26	4,04 +/- 0,33	<0,001
AMEn (kCal/kg DM)*	3941 +/- 20	3931 +/- 20	<0,001
DE (kCal/kg DM)*	4040 +/- 18,5	4031 +/- 18,4	<0,001

\* AMEn and DE were determined using DuPont NIT analysis of whole maize kernels



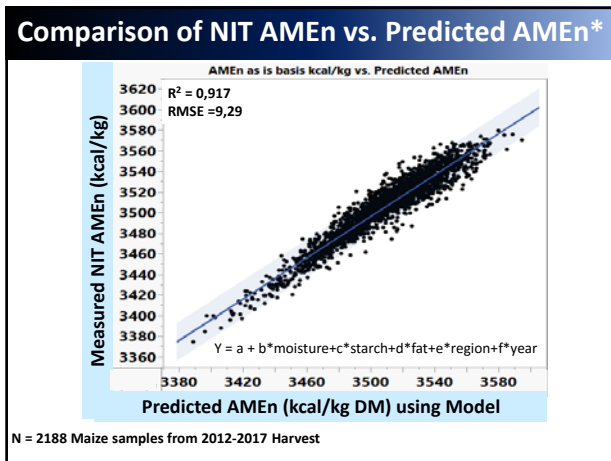


### Multiple regression model to predict AMEn

Stepwise regression of analysed parameters of 2200 white and yellow maize samples

Term	Estimate	Std Error	Prob > F
Intercept	7418,67	310,1	<0,001
Moisture	-35,76	0,32	<0,001
Protein (% DM)	11,80	0,60	<0,001
Starch (% DM)	1,16	0,50	<0,021
Fat	34,97	0,80	<0,001
Colour	0,23	0,25	0,3495
Region	-0,18	0,03	<0,001
Harvest Year	-1,91	0,15	<0,001

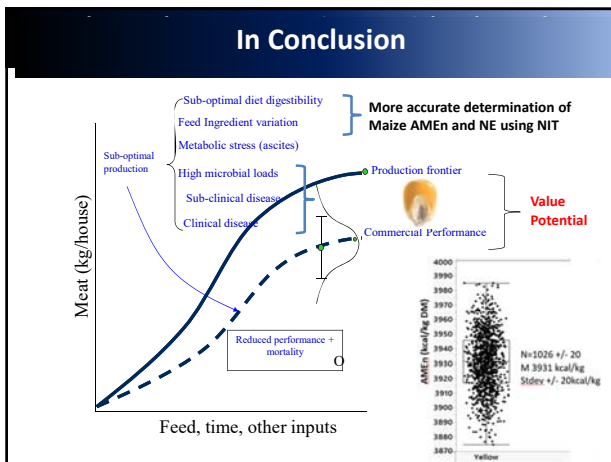
- Model  $R^2 = 0.92$  with Root Mean Square Error of 9.2 kcal/kg.
- Colour not significant!
- Not including region and year reduced  $R^2$  to 0.72



### What is the opportunity ?

- ✓ Gross energy digestibility of SA maize is not as constant as previously thought
- ✓ Differences in hybrids, as well as seasonal and regional growing conditions significantly affect AMEn value of corn. This is not currently factored into existing prediction equations of AMEn.
- ✓ CVB Predictions don't seem to account for all of the potential variation in AMEn
- ✓ NIT calibrations that directly determine GE and AMEn allow better estimates of changes in digestibility of incoming corn vs. formulated values
- ✓ Understanding variation in nutrient digestibility / AMEn of maize will also allow better predictions of enzyme response
- ✓ Improved performance and carcass yield by estimating the digestible energy more accurately

Near Infra-Red Transmittance Prediction



### Chemuniqué Maize Laboratory

#### Taking the Guesswork out of Maize Nutritional Value

- Determination of Proximate analysis of DM, CP, Fat, Starch and Gross energy of maize
- Direct determination of AMEn poultry and DE for pigs using the DuPont NIT assay
- Service available to SA Feedmills, Broiler and Swine producers from January 2019
- Please contact your Chemuniqué Laboratory for details about procedure and costs

### Thank you / Merci beaucoup

Research \$ & Facilities

Which came first, the chicken or the egg?

**QUESTIONS?**

Special Thanks

**Wiana Louw - SAGL**

**Corinda Erasmus (Stats)**