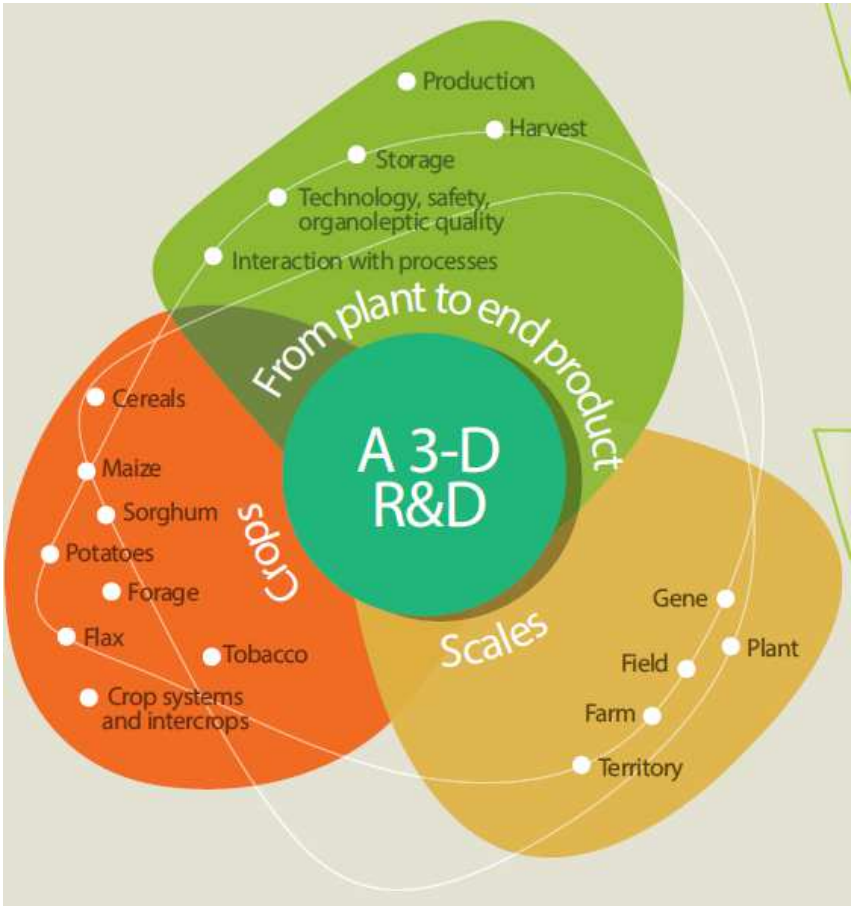
WORKSHOP

FROM ENERGY PRODUCTION TO FOOD AND FEED

SORGHUM SILAGE AND ITS COMPLEMENTARITY WITH MAIZE AS FEED DAIRY AND BEEF CATTLE

INSTITUTE DESCRIPTION

ARVALIS - INSTITUT DU VEGETAL: AN APPLIED AGRICULTURAL RESEARCH ORGANISATION



- **Partnerships with**
  - **French and international basic research (INRA, IRSTEA, and Universities)**
  - **Development organisms**
  - **Economic operators (co-ops…)**
- **410 collaborators**
- **27 local sites in France**
- **120 Research projects**

STRUCTURE

- **Nutritive value of sorghum silage**
- **Sorghum silage for dairy cows**

- **Sorghum silage for young bulls fattening**
- **Conclusion : main sorghum ID cards**

NUTRITIVE VALUE OF SORGHUM

HOW TO EVALUATE THE ENERGETIC VALUE?

- **Monocut sorghum: FR Post-registration evaluation for varieties (2010-2014)**

Chemical composition Measured values

	Silage use (n=87)		Dual-purpose use (n=224)	
	min	max	min	max
CP (%)	6.0	8.2	6.1	7.9
NDF (%)	48.7	59.1	48.6	56.0
ADL (%)	1.8	3.2	2.7	3.9
OM digestibility (%)	56.8	67.0	55.8	62.6
Starch (%)	0.0	17.4	8.9	21.3
Water Soluble Carbohydrates (%)	12.2	24.0	7.7	17.1

Nutritive value Calculated values

	Silage use		Dual-purpose use	
UFL « fresh » (/kgDM)	0.83	1.01	0.78	0.90
PDIN (/kgDM)	39	53	39	51
PDIE (/kgDM)	67	75	68	72

ARVALIS-Institut du végétal, 2015

NUTRITIVE VALUE OF SORGHUM

HOW TO EVALUATE THE ENERGY VALUE?

Sorghum bicolor

- **Energy value: maize equations are NOT reliable for sorghum with poor starch content**
- **Instead, specific equation needs to be used for all ensiled sorghum forage:**

***Aufrère et al., 2013*:**

DM digestibility = 0,643 * silage DM dig.$_{in\ vitro}$ + 23,99 ; (R^2=67% ; RMSE=2,25)

DM digestibility = 0,684 * silage DM dig.$_{in\ vitro}$ + 21,67 ; (R^2=65% ; RMSE=2,61)

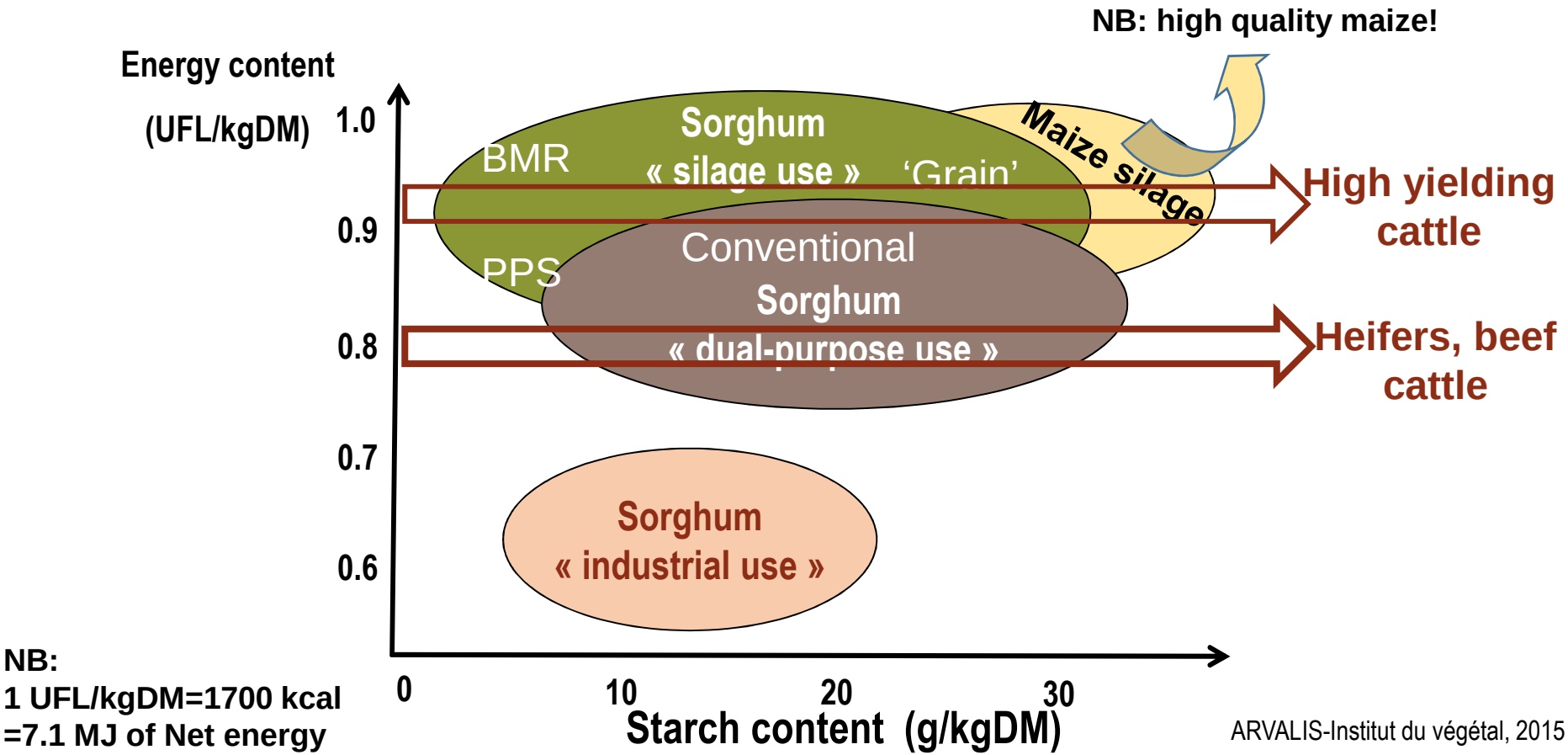
Sudan grass and *Sudan grass*sorghum bicolor*

- **INRA references → nutritive value varies with maturity stage → ~ tall-fescue**
- **Grass equations can be used**

NUTRITIVE VALUE OF SORGHUM

HOW TO EVALUATE THE ENERGETIC VALUE?

A very wide diversity of *sorghum bicolor*



NB:
1 UFL/kgDM=1700 kcal
=7.1 MJ of Net energy

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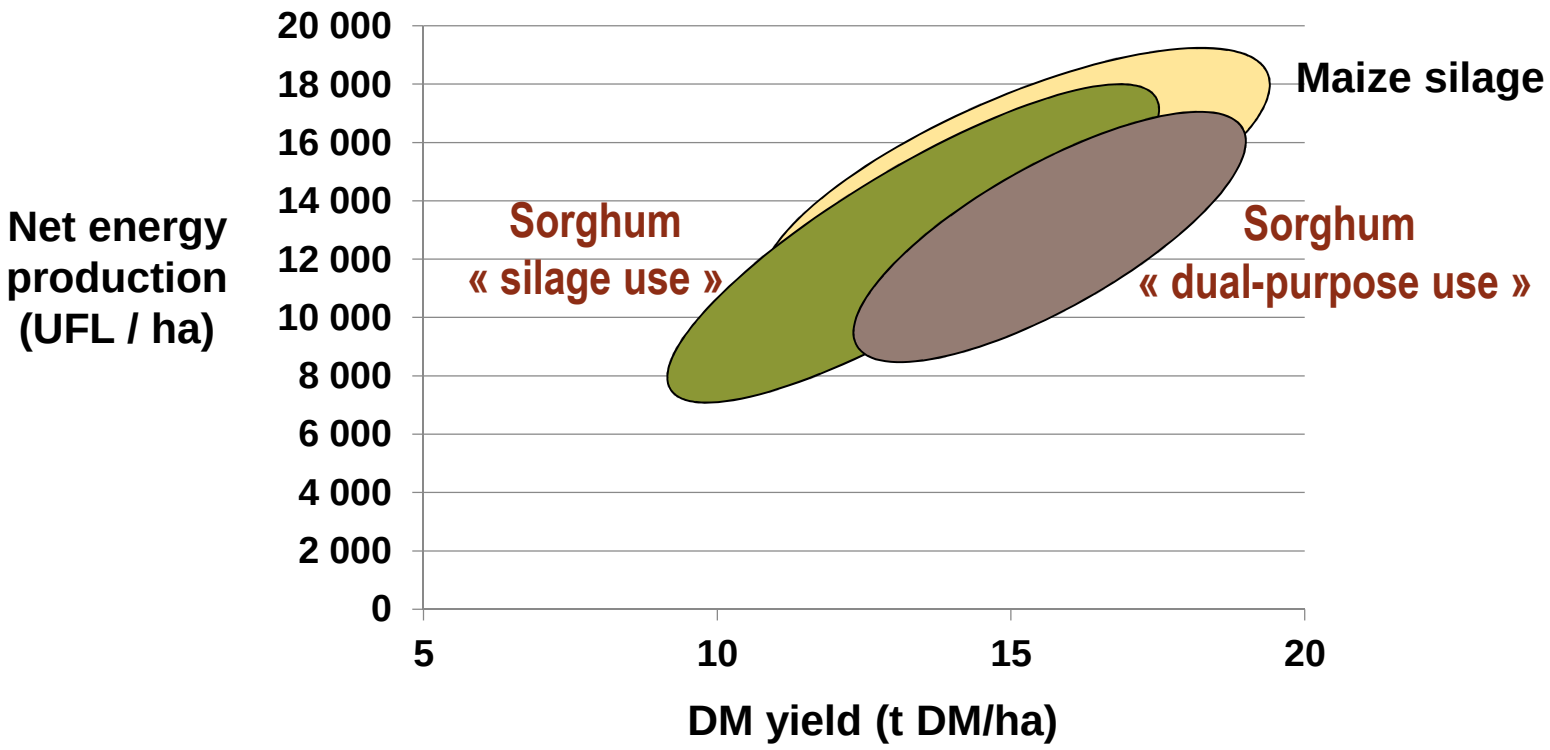
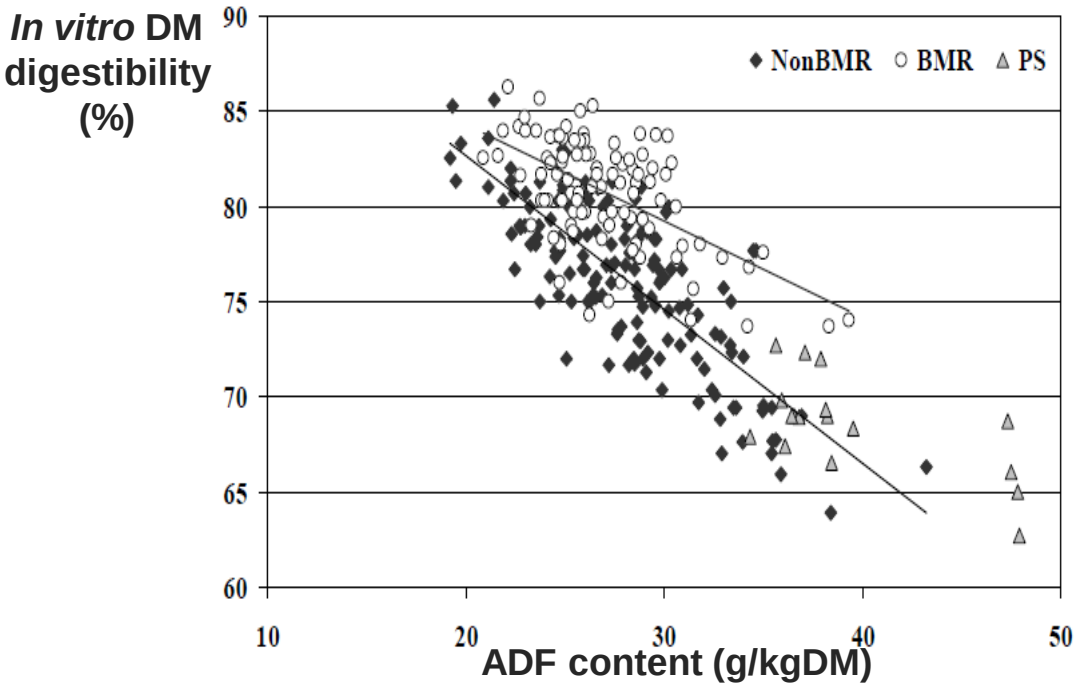
HOW TO EVALUATE THE ENERGETIC VALUE?

- **High production of net energy / ha**



HOW TO EVALUATE THE ENERGETIC VALUE?

- **Sorghum 'silage use' : focus on the 2 main types of sorghum without starch**



Compared to conventionnal sorghum

	BMR	PS
Energy value	+	-
DM yield	-	+
Lodging risk	-	=
Energy/ha	= or +	= or +

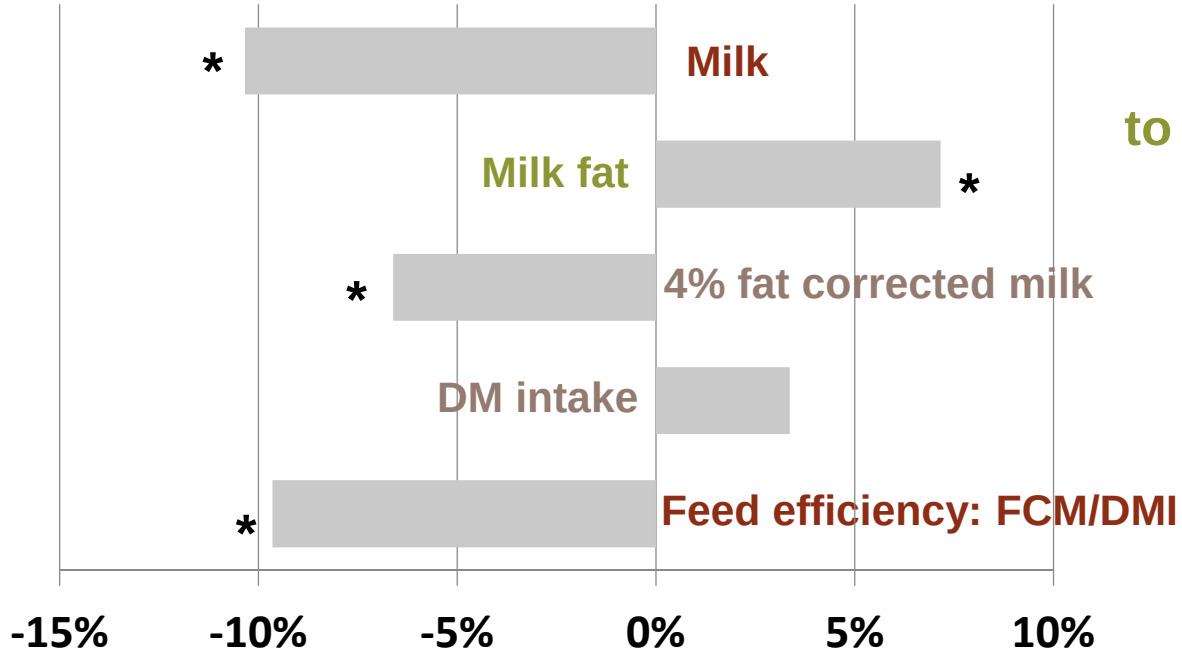
Data summarized by TAWC in 2016 from Bean, B. and T. McCollum (2006). Summary of six years of forage sorghum variety trials

SORGHUM SILAGE FOR DAIRY COWS

COMPLEMENTARITY SORGHUM – MAIZE SILAGE

Replacing 50% of maize silage by sorghum silage 'dual-purpose use' (0.81 UFL, 30% of DM, 13% of starch)

Comparison in % to control = maize silage only



Sorghum silage permits

to reduce diet starch content

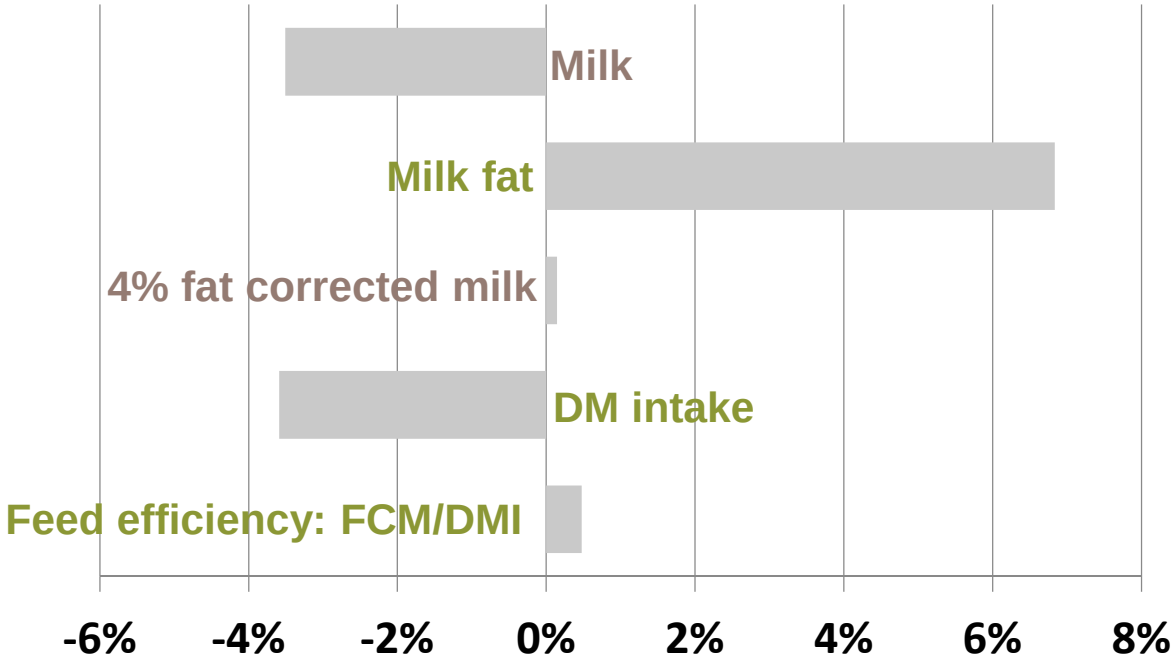
to boost milk fat

Brunschwig P. et Lamy J.M. 2008

COMPLEMENTARITY SORGHUM – MAIZE SILAGE

Replacing 50% of maize silage by BMR sorghum silage 'silage use' (0.92 UFL, 26% of DM, 6% of starch)

Comparison in % to control = maize silage only

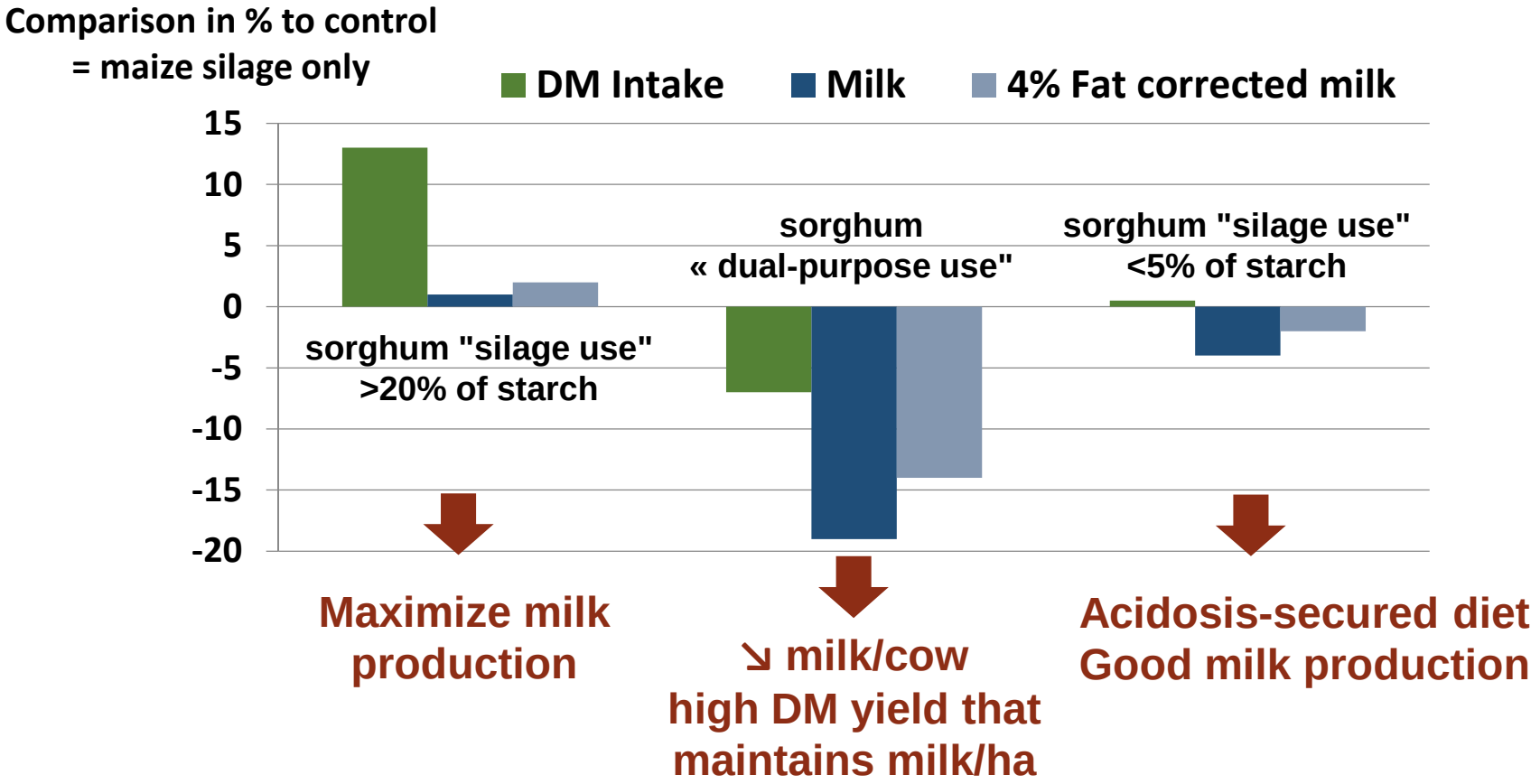


Sorghum boosts milk fat

BMR Sorghum lower diet starch content
➔ Improves diet digestibility and feed efficiency

ARVALIS synthesis of 5 trials in experimental farms.

SORGHUM SILAGE AS SOLE FORAGE



ARVALIS synthesis of trials in experimental farms.

SORGHUM SILAGE FOR DAIRY COWS

SORGHUM 'SILAGE USE':
FOCUS ON THE 'GRAIN' TYPE

- **Chemical composition close to maize**
- **Ingestibility higher than maize**
- **Maintain milk production**
- **Needs to be harvested at milk-dough stage**
  - **→30-33% of DM (with 25% of starch)**
  - **→short length of cut and processing rolls tightened to crack the kernels**

/!\ Caution:

harvest at DM>35% → decrease by 10% milk and feed efficiency

COMPLEMENTARITY SORGHUM – MAIZE SILAGE

- **Introducing 50% of BMR sorghum in a maize-based diet**

Feed cost variation/1000kg of milk

€ / 1000 kg milk		DM yield[1] of BMR maize (tDM/ha)			
		8	10	12	14
DM yield[1] of BMR sorghum (tDM/ha)	8	5	0	-4	-6
	10	10	5	1	-3
	12	14	8	5	1
	14	16	12	8	5

Rouillé et al., 2010

Where BMR sorghum can grow normally

→ 0 to 16€/1000L i.e. 0 to 15% of reduction of feed costs for milk production

[1] Non-irrigated crop

SORGHUM SILAGE FOR DAIRY COWS

COMPLEMENTARITY SORGHUM – MAIZE SILAGE

- **Introducing 50% of grain or dual-purpose sorghum in a maize-based diet**



↘ inputs/ha of forage crop (seeds, irrigation, fertilisation)	↗ Milk Fat ↘↘ Milk yield
Stabilise the DM yield/ha of forage especially in case of continental conditions	Reduce feed efficiency by 10%

➔ **Usually, feed cost/1000 kg of milk will be reduced if DM yield $_{sorghum}$ > 1.1* DM yield $_{maize}$**

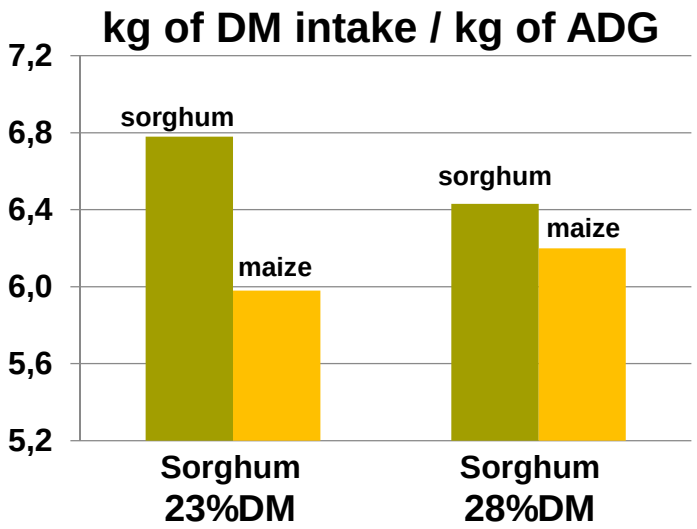
SORGHUM SILAGE FOR BEEF CATTLE

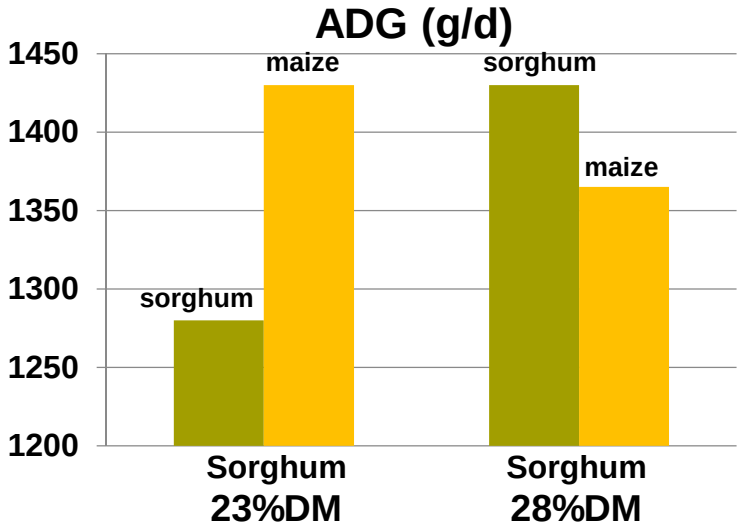
→ INDOOR YOUNG BULLS FINISHING

SORGHUM SILAGE INGESTIBILITY: THE KEY POINT

Fattening trial with Limousine young bulls until 420-430 kg carc. weight

Diet: [100% BMR sorghum silage vs 100% Maize silage] + concentrate





BMR sorghum has high ingestibility if DM>25%

If ingestibility is high →ADG similar to maize control

Guillaume et al., 2014

SORGHUM SILAGE INGESTIBILITY: THE KEY POINT

Fattening trial with Charolais young bulls until 435 kg carc. weight

3 Diets compared:	**3 kg barley + 1,7 kg rapeseed meal**		
	Control 100% maize silage	**50% maize silage + 50% grain sorghum ensiled**	**Mixed silage (maize + BMR sorghum)**
DM intake (kgDM/d)	**10,0**	**+ 0,30**	**- 0,15**
ADG (g/d)	**1610**	**+ 10**	**+ 30**
Fattening duration (d)	**220**	**- 3**	**- 3**
DM intake / kg of carcass gain	**10,3**	**=**	**- 0,6**

ARVALIS-Institut du végétal, 2014

BMR sorghum: ~ very good wilted grass ➔ very positive on growing perf.

Grain sorghum: very high ingestibility and growing perf. = maize

SORGHUM SILAGE ECONOMIC INTEREST

- **Introducing 50% of BMR sorghum in a maize-based diet**

Feed cost variation / young bull carcass produced

€ / YB		DM yield[1] of maize (tDM/ha)			
		8	10	12	14
DM yield[1] of BMR sorghum (tDM/ha)	6	-4	-13	-19	-24
	8	11	-1	-9	-15
	10	27	11	1	-6
	12	42	23	11	3

ARVALIS-Institut du végétal, 2014

Where BMR sorghum can grow normally

→ 0 to 15% of reduction of feed costs per YB compared to maize

[1] **Non-irrigated crop**

SORGHUM SILAGE ECONOMIC INTEREST

- **Other sorghum in a maize-based diet – comparison to 100%maize**

	ADG	Feed costs with DM yield sorghum=maize	Feed costs with DM yield sorghum = 1.2 * maize
Grain sorghum UFV>0.85	**=**	**~ 0%**	**-3 %**
PPS sorghum UFV>0.80	**-1 to -3 %**	**~ 0%**	**-1 to -3 %**
Other sorghum UFV<0.80	**-5 to -10%**	**+3 to +10%**	**-1 to +5 %**

With 'silage use' sorghum
→ mostly positive on feed costs compared to maize control diets

SORGHUM DETAILS FORM

DIFFERENT SORGHUM FOR DIFFERENT USES: A SUMMARY

GRAZED SORGHUM

"SILAGE USE": BMR SORGHUM

"SILAGE USE": PPS SORGHUM

"SILAGE USE": GRAIN SORGHUM

"DUAL-PURPOSE USE"

SORGHUM DETAILS FORM

GRAZED SORGHUM

- **Sudan grass or hybids Sudan grass*sorghum bicolor**
- **Avoid toxicity by grazing not before 40 cm (Sudan grass), 50-60 cm (hybrids)**

  → **Usually 5-6 weeks after seeding**

- **BMR: +12% ADG (Trostle, 2004)**

SORGHUM DETAILS FORM

“SILAGE USE”: BMR SORGHUM

Same energy value as maize

Target: mini 25%DM at harvest

- **Improve whole diet digestibility**
- **Slight decrease of DMI**
- **Maintain milk production /ADG**
- **Positive effect on feed efficiency**
- **Profitable even if DM yield sorghum is 5% less than maize**

SORGHUM DETAILS FORM

“SILAGE USE”: PPS SORGHUM

Energy value is ~90% of maize

Target: at least 25%DM at harvest

High DM yield/ha

- **Improve whole diet digestibility**
- **Slight decrease of DMI, ADG and milk production if sole forage**
- **Recommanded associated with maize silage**
- **Profitable if DM yield sorghum ≥ maize**

SORGHUM DETAILS FORM

“SILAGE USE”: GRAIN SORGHUM

Energy value is ~95% of maize

Target: 30%DM at harvest

- **Increase by 5 to 10% the DM intake**
- **Maintain ADG and milk production if sole forage or associated**
- **Double use crop – no lodging**
- **Profitable if DM yield sorghum ≥ 1.15 * maize**

SORGHUM DETAILS FORM

“DUAL-PURPOSE USE”

Energy value is 80-90% of maize

Target: at least 25%DM at harvest

- **High DM yield of the crop**
- **Decrease by 5 to 10% DM intake, ADG and milk production**
- **Recommended as 2-4 kgDM/day/cow, heifers, beef cattle and young bulls with ADG potential<1500g/d**
- **Profitable if costs of sorghum ≥ 0.8 * maize**

CONCLUSION

DIFFERENT SORGHUM FOR DIFFERENT USES

High production of net energy/ha

DM intake:
↘ (no starch)
Or ↗ (grain)

Milk fat ↗

Milk production and ADG remain high