

Milk production of suckler cows: Phenotyping and automation of measurement

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In France: 3.7 millions suckler cows (SPIE BDNI¹)



35% increase in concentrate distributed to calves from 2005 (Veysset et al², 2015)



Increase in production costs

**Milk major component of performance:
1 kg extra milk = 60 to 80 g more growth**

→ optimize milk production

Objectives

- Simplify and automate the measurement process
- Update references on milk production of beef cows
- Identify the relevant variables to phenotype milk production
- Characterize the links between milk production and calf growth

How to measure milk production of suckler cows?

Experimental farm, standard method

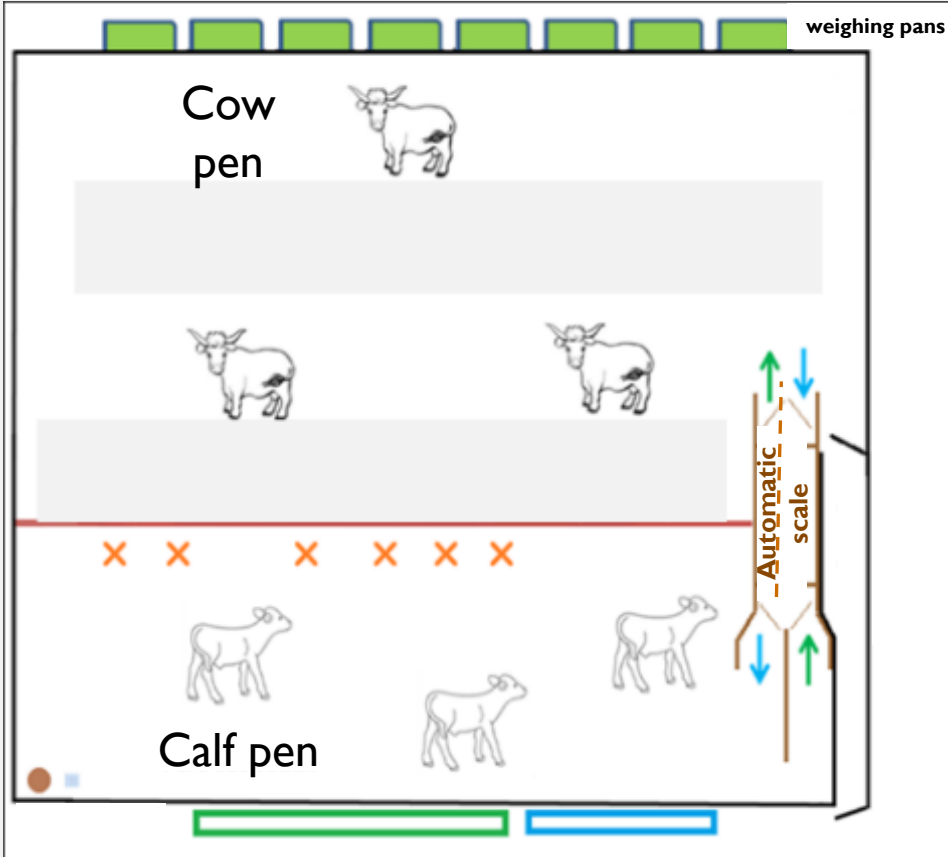
Weight-Suckle-Weight → Weighing the calf before and after suckling on two consecutive days

(Le Neindre et al., 1973)

D1 morning	D1 evening = H0 hour	D2 morning	D2 evening : H1 hour
Calf mother separation	Emptying the udder	Weighing the calf before and after suckling	Weighing the calf before and after suckling

- Measurement of milk drunk and not produced (beginning of lactation)
- 1 control = 2 measures / day indoors (beginning of lactation) then 1 / day at the pasture
- Only few measures possible!

Automatic weighing system, electronic identifiers, sorting and separation of calves: prototype developed by INRAE Herbipôle unit



An attractive calf pen!

A double electronic scale with a sas to manage the calf's entrance and exit

Balance 3M Laqueuille Date début: 13/05/2021 Date fin: 20/05/2021

Paramètres Veaux Pesées (1187 valides, 6 invalides) Tébées (509 valides, 88 invalides, 21 ignorées)

Paramètres	Veaux	Pesées (1187 valides, 6 invalides)	Tébées (509 valides, 88 invalides, 21 ignorées)
Heure début (h:mm)	0600		
Poids des veaux (kg)	13 150		
Mélange de poids max lors d'une tée (kg)	10		
Perte de poids (g/ml)	8		
Durée d'une séie (min)	13 120		
Durée maximum entre 2 pesées (s)	32		
Production veaux (kg)	4 10		
Durée maximum de production veaux (s)	21		

Ass.	Date heure aller	Date heure retour	Durée	Poids aller	Poids retour	Poids soie tée	Poids p/ta	Poids p/ta natif	Production lait
1386	17/05/2021 08:20:14	17/05/2021 09:23:33	00:30:56	966.07	966.07	966.07	9.08	0.00	0.00
1484	17/05/2021 08:38:25	17/05/2021 09:27:29	00:51:11	1037.19	1037.23	1037.24	9.09	0.00	0.00
1328	17/05/2021 08:43:56	17/05/2021 09:50:06	00:54:11	1071.22	1071.22	1071.22	9.10	0.00	0.00
1380	17/05/2021 08:49:33	17/05/2021 09:43:39	00:52:38	985.23	985.23	985.23	9.08	0.00	0.00
1381	17/05/2021 09:16:19	17/05/2021 10:19:49	00:54:30	1427.89	1427.89	1427.89	9.11	0.00	0.00
1310	17/05/2021 10:23:36	17/05/2021 10:46:40	00:23:04	1226.40	1226.40	1226.40	9.09	0.00	0.00
1484	17/05/2021 10:26:05	17/05/2021 10:53:01	01:17:36	1006.90	1006.90	1006.90	9.09	0.00	0.00
1344	17/05/2021 10:27:06	17/05/2021 10:21:07	00:44:07	966.57	967.21	967.00	9.10	0.00	0.00
1314	17/05/2021 10:28:47	17/05/2021 10:42:17	01:03:30	1066.60	1066.60	1066.60	9.11	0.00	0.00
1302	17/05/2021 10:48:14	17/05/2021 10:52:11	00:03:57	1066.34	1066.34	1066.34	9.10	0.00	0.00
1307	17/05/2021 10:49:42	17/05/2021 10:49:46	00:00:04	1024.68	1024.70	1024.69	9.10	0.00	0.00
1327	17/05/2021 10:49:16	17/05/2021 10:33:27	00:00:11	1063.61	1063.61	1063.61	9.10	0.00	0.00
1396	17/05/2021 10:52:21	17/05/2021 10:51:30	00:00:51	1483.33	1483.33	1483.33	9.10	0.00	0.00
1341	17/05/2021 10:57:21	17/05/2021 10:47:30	01:19:59	1063.86	1063.81	1063.80	9.10	0.00	0.00
1388	17/05/2021 11:08:17	17/05/2021 11:49:18	01:11:11	1044.98	1044.98	1044.98	9.10	0.00	0.00

Productions laitières (84 valides, 69 invalides)

N°veau	Jour	Tébes valides	Tébes invalides	Production (kg)	Durée	Prod.	Production (kg)
1380	17/05/2021	7	0	9.054	24:00:00	0.054	9.054
1380	17/05/2021	0	0	0.271	24:00:00	0.271	9.326
1454	17/05/2021	0	0	0.000	24:00:00	0.000	9.000
4766	17/05/2021	0	0	9.571	24:00:00	9.571	9.571
5379	17/05/2021	0	0	3.065	24:00:00	3.065	3.065
4767	17/05/2021	3	0	0.000	24:00:00	0.000	9.000
4768	17/05/2021	4	0	0.027	24:00:00	0.027	9.027
8360	17/05/2021	5	0	0.002	24:00:00	0.002	9.002
8431	17/05/2021	3	0	80.600	24:00:00	80.600	80.600

A specific software

Experimental scheme

Charolais and Salers cows, calving in January, measured from February to May.
Milk production recorded during 5 years with 6 periods of 14 d/y

One period corresponds to:

- 3 days of measurement with «the standard method»:
- 10 days of «free suckling» measurement with:
 - Free circulation of calves
 - Automatic weighing required to suck
 - Data storage
 - Recalculation of drinking milk (specific software)
 - Behavior datas

120 cows tested → 4800 milk yield validated

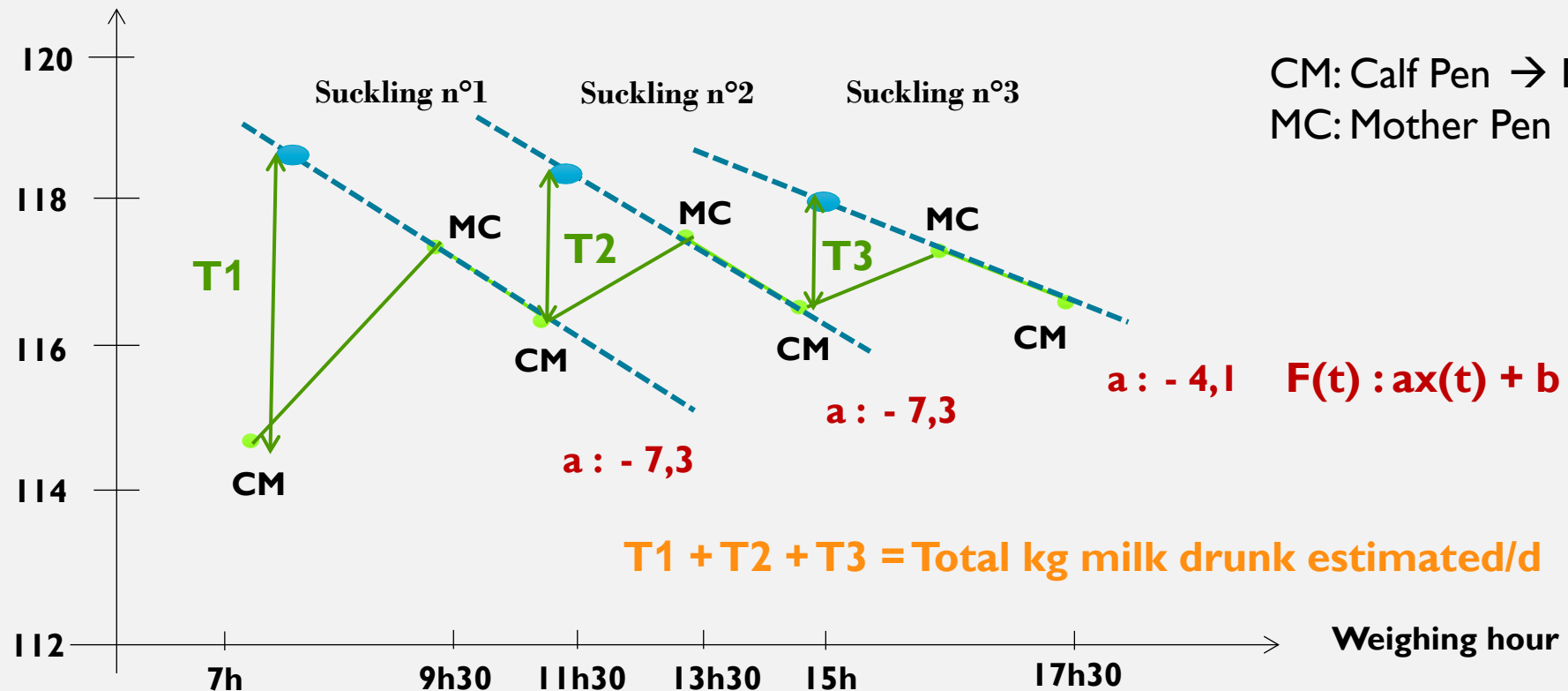
Estimation method of milk yield

Method : *datas* = Calf identification number, weight hour, weight + **Regressed weight loss calf intra day**

(a)

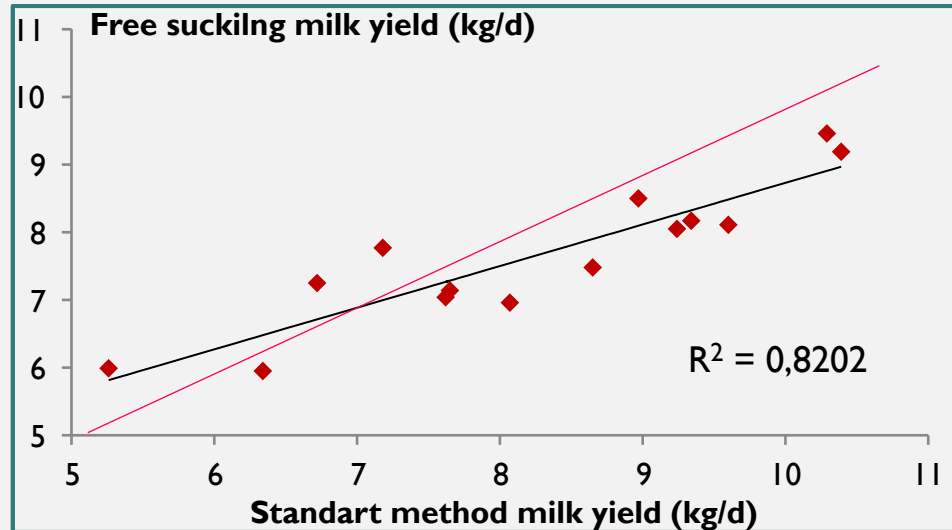
➤ **Slope** between weights → calculation of a theoretical weight after feeding

➤ **Sum of weight variations** per 24 hours



Correlation with the standard method: Ex of 2022

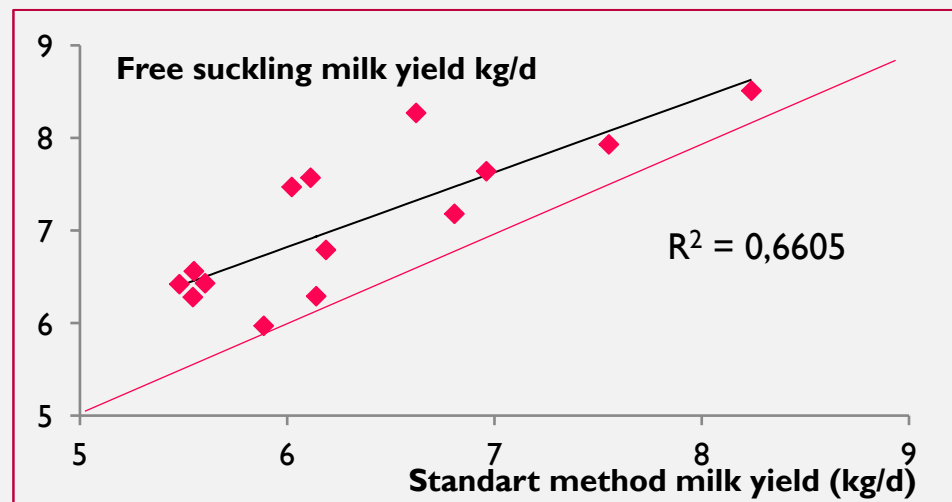
period 1 (two months after calving) and period 4 (4 months after calving)



Period 1

- Relationship between weight variations "free suckling" and "standard method"

$R^2 : 0.82$



Period 4

- Medium quality relationship $R^2=0.66$ → Hypothesis: Age? Hay intake?
- Creation of sorting thresholds according to the time spent in the mothers' pen 0-1h: 27% of suckling → $R^2=0.92$

Database analysis

More than 2000 lactations available (3 breeds), corresponding to:

- **Winter calving from December to April between 1999 and 2022**
- **7 dairy controls per lactation throughout the all lactation and at least 4 controls during grazing period (1/month)**



2 summary tables

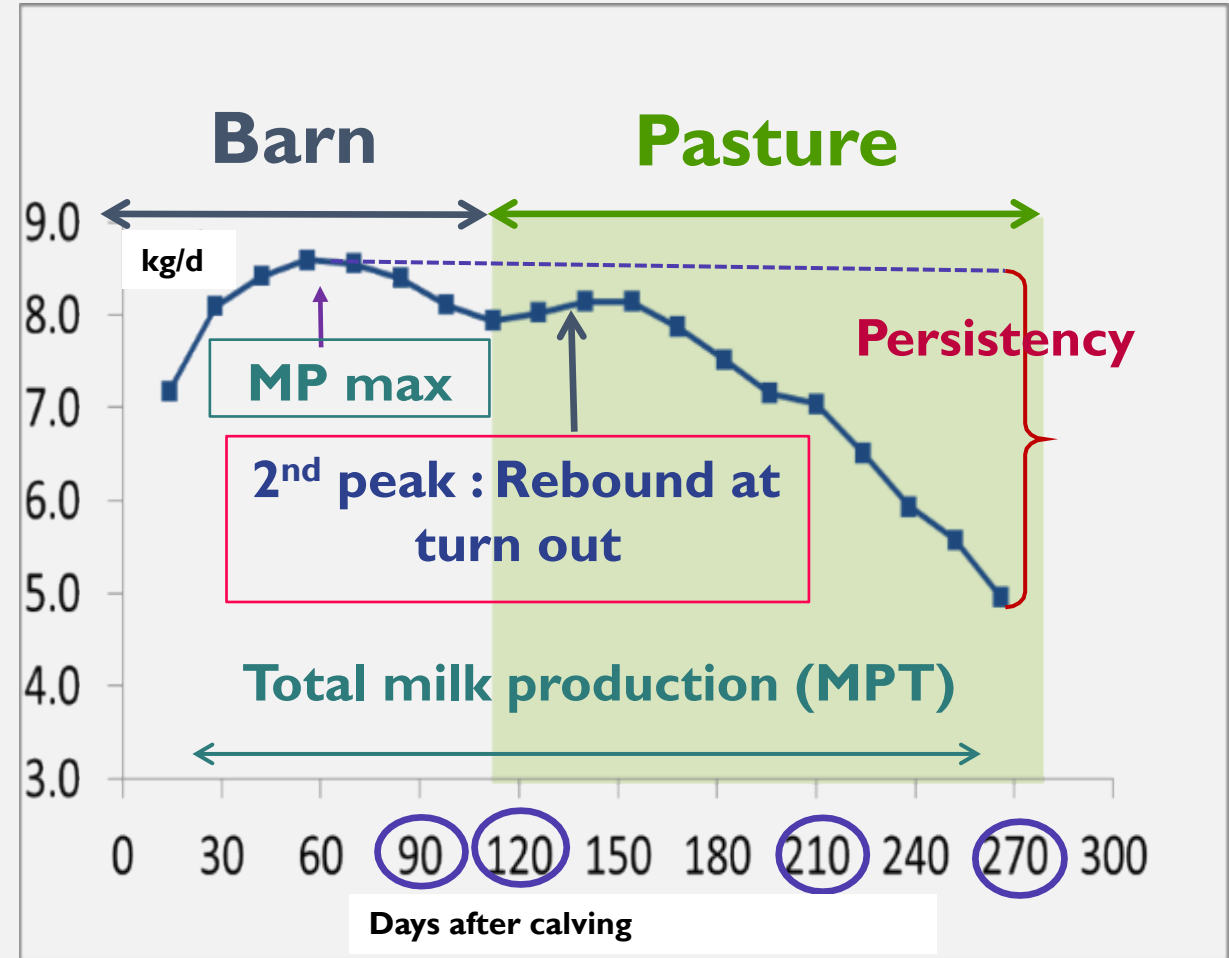


Milking production
(drunk milk per 24h)
n=1260

**Growth of calves from birth
to weaning**
(calves mothers couples) **n=900**

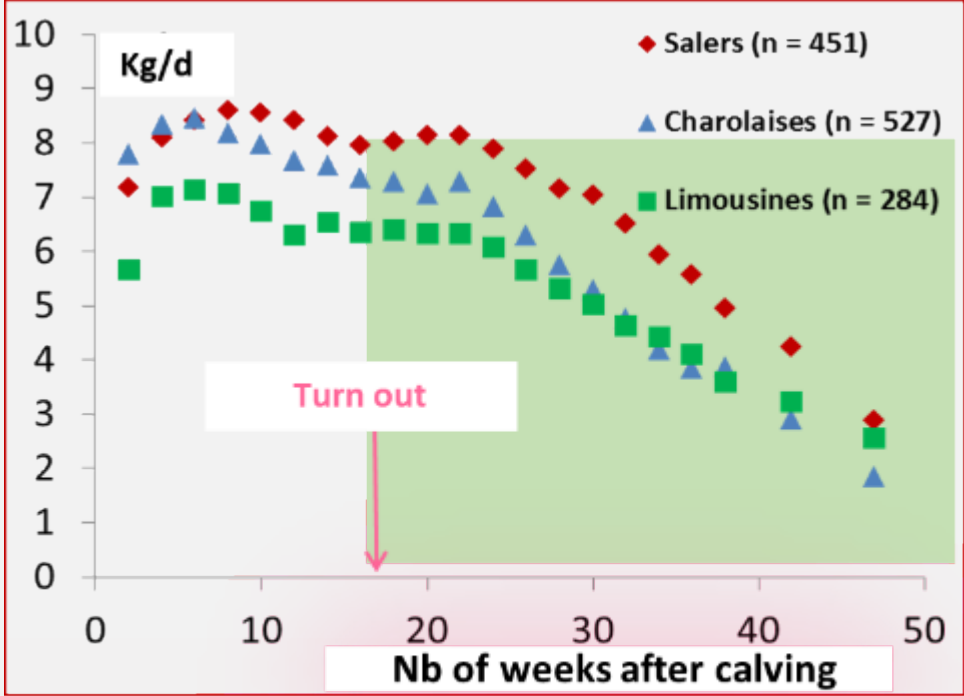
Lactation curve: available variables

- Total milk production, 0-90 d, 0-210 d, calving-weaning, total production
- Rebound at turn out
- Persistency (milk lost after max of production (MP max) $PERS (g/d) = (MP_{max} - MPF) \times 1000 / D$ (with MP_{max} et MPF (kg/d))
- The week of lactation of the maximum Milk Production (MP max)
- Calves weights at standard age (90, 120, 210 days) and weaning (270)



Total milk production

Breed	Total MP (kg)		Average MP (kg/d)	
	Average	SD	Average	SD
Salers	2247 ^a	470	8.3 ^a	2.1
Charolaise	1840 ^c	355	6.9 ^c	1.5
Limousine	1628 ^b	313	5.9 ^b	1.2



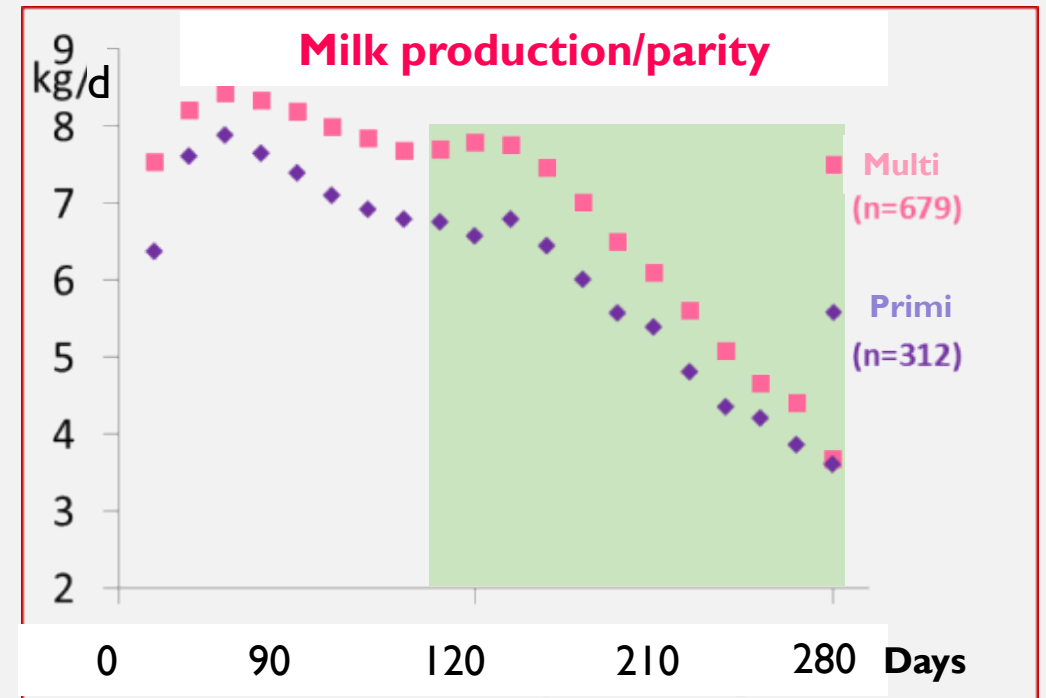
For the same duration of lactation (270 days)

Salers > Charolais **Salers > Limousine** **Charolais > Limousine**

+18%
+28%
+12%

Total milk production: Parity effect

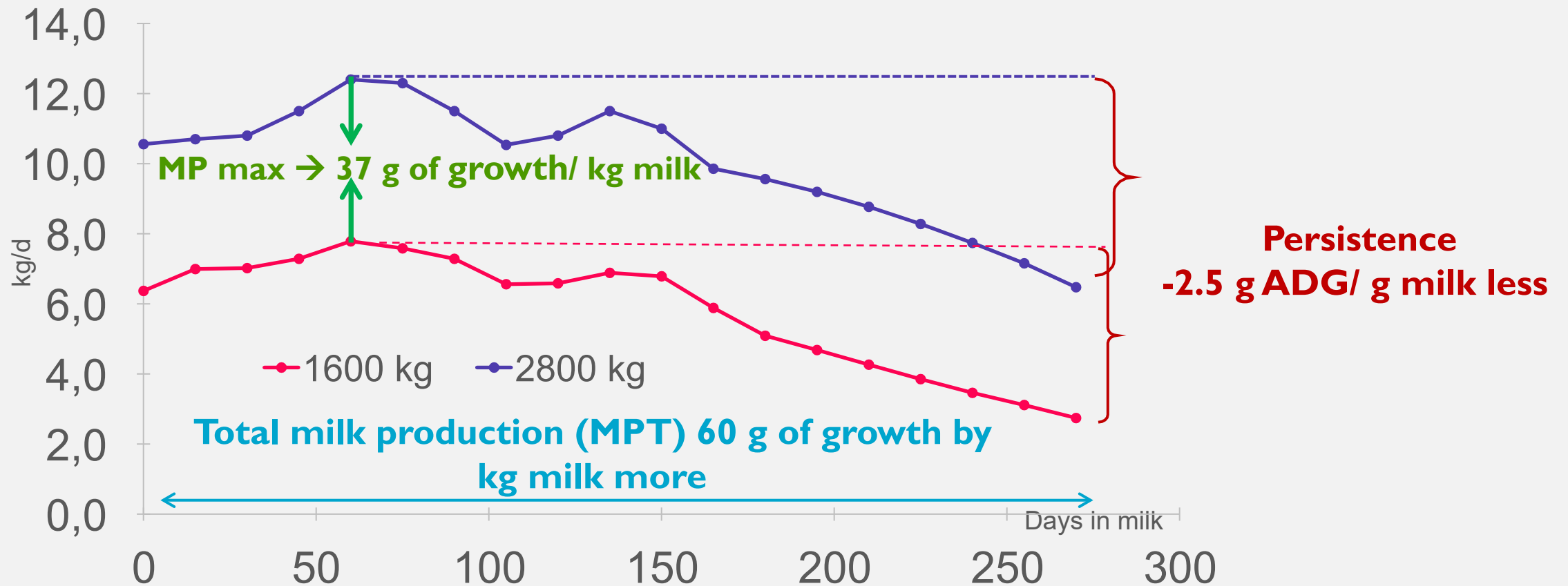
Breed	Parity	MPT (kg)		Δ (kg)
		average	SD	
Salers	multi	2298	478	-280
	primi	2008	343	
Charolaise	multi	1932	338	-200
	primi	1732	344	
Limousine	multi	1662	310	-180
	primi	1482	287	



Multiparous produce 12% more milk than primiparous regardless of breed

The best milk production is obtained at the 4th or 5th calving

Relation between milk production (MP) and growth of calves

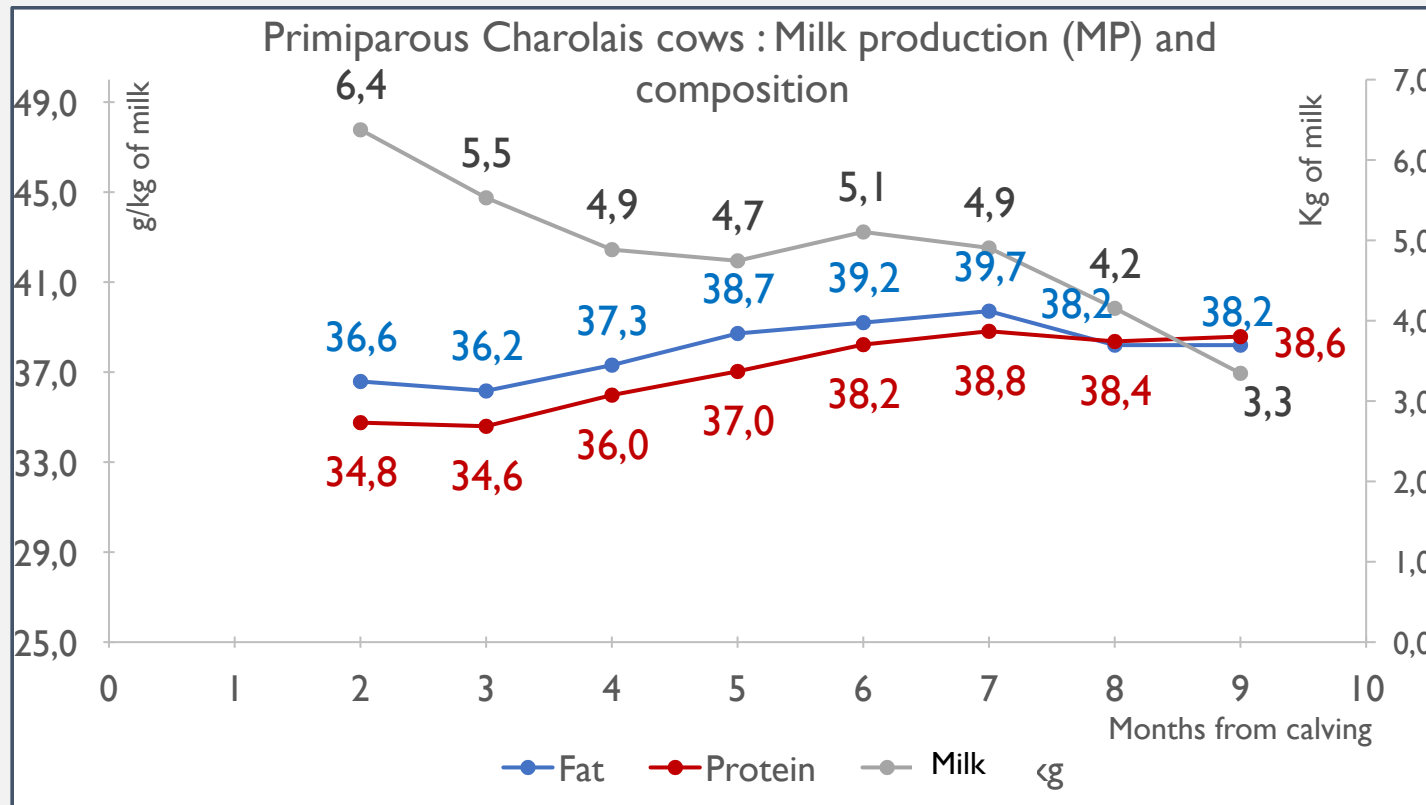


ADG of 270 g or a total calf weight gain of 70 kg between a MP of 1600 kg (6 kg/d) and a MP of 2800 kg (10.6 kg/d)

→ 1 kg of milk drunk in addition leads to 60g more growth

Milk composition

INRAE: Herbipole unit farms	Fat (g/kg of milk)	Protein (g/kg of milk)	Lactose (g/kg of milk)
Salers cows (n=44)	37.3 ± 5.4	34.8 ± 10	51.8 ± 2.4
Charolais cows (n=14)	37.1 ± 2.4	36.2 ± 2.0	49.2 ± 0.9
Holstein cows (n=100)	40.2 ± 1.0	32.0 ± 0.7	48.7 ± 2.0



- Difficulties in sampling milk from suckler cows to measure composition
- Milk composition of Charolais and Salers breeds appears to be the same.
- The variation in the composition of milk drunk by calf would have relatively little effect on its growth (Mc Gee 1997).
- Suckler cows have less fat than dairy cows but more protein

Conclusion and perspectives

The milk production data collected allow :

- Improvement quantification of breed and parity effects on milk production
- Grass of good quality and in sufficient quantity increases the MP after grazing, with a rebound till 1.2 kg / day depending on the breed
- Estimation of persistency: -17 to -30 g milk / day depending on breed and production level
- Upgraded links milk production / calf growth (60 g/ kg more milk), always very strong regardless of the level of MP

Conclusion and perspectives

- Automation of milk production measurement is a relevant tool to phenotype and quantify the effect of breed and parity on milk production
- The new milk production measurement device is now validated



Development and distribution are handled by a manufacturer



Device is available to order

Thank you for
your attention



Photo : NICOLAS Bertrand/INRAE