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International Conference on Animal Identification and Traceability

Buenos Aires, 23-25 March 2009

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S3. Overview of Available Tools and Technology: Small Ruminants



Francisco de Zurbarán
Agnus Dei

Current tools and technologies for the identification and traceability of small ruminants



G. Caja, S. Carné, M.A. Rojas-Olivares & J.J. Ghirardi

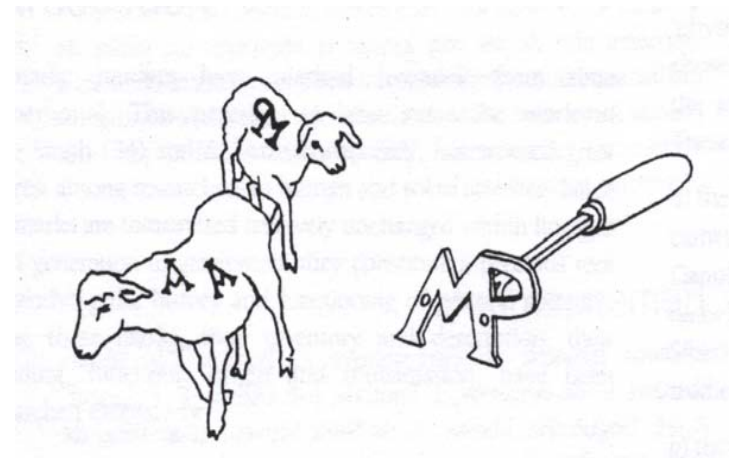
Group of Ruminant Research (G2R), Department of Animal and Food Sciences,
Universitat Autònoma de Barcelona, 08193 Bellaterra (Barcelona), Spain.

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Outline: 1/3

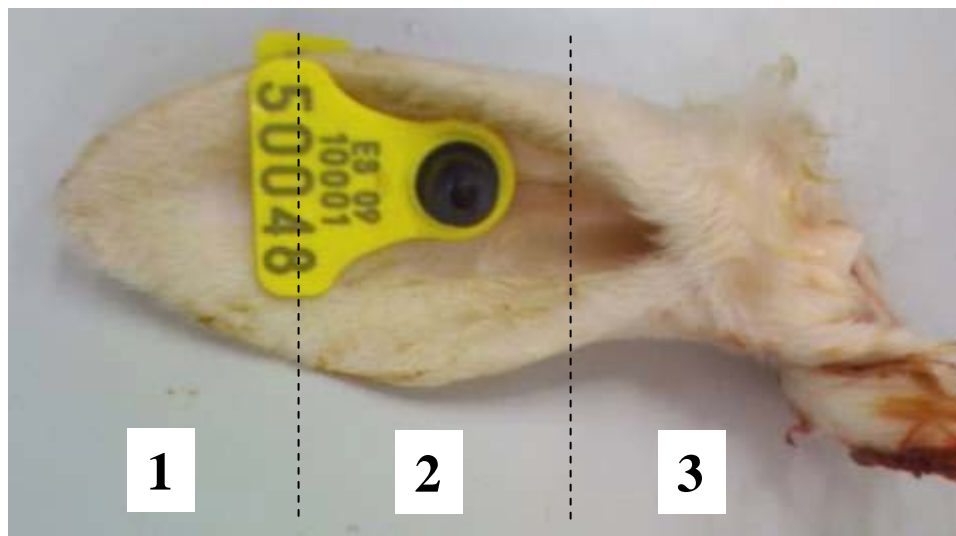
- **Small ruminant ID scenario and constraints**
- **Conventional systems**
 - **Artificial & permanent marks**
- **New technologies: Individual ID**
 - **Imaging**
 - Retinal imaging
 - **Molecular genetics (DNA)**
 - Nucleotide polymorphisms: STR & SNPs
 - **Radiofrequency (RFID)**
 - Injectable transponders
 - Ear tag transponders
 - Bolus transponders
- **Cost-benefit studies**
 - **Identification & Registration**
 - **Performance recording**
 - **Traceability**
- **Conclusions**



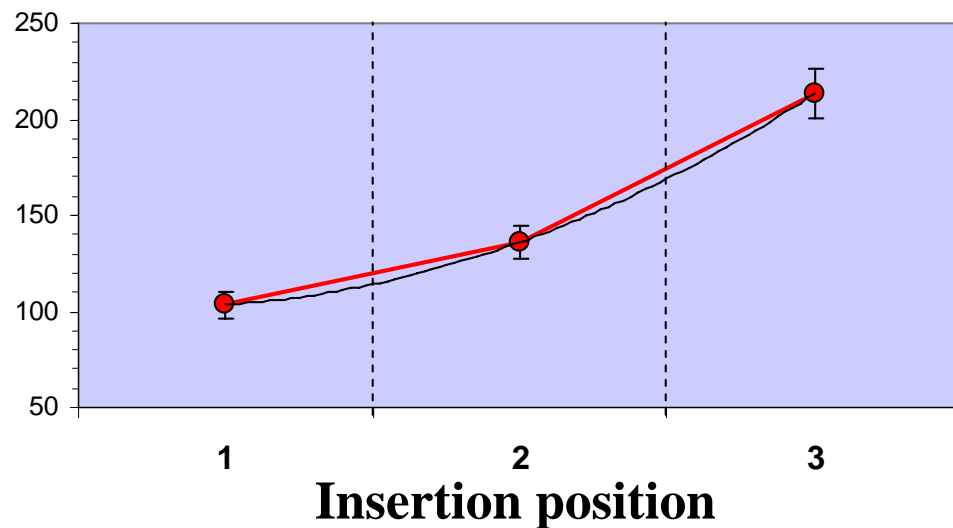
Small ruminant ID scenario and constraints

	Sheep	Goat
Farm size	Large	Medium
Milking	Occasional	Usually
Coat color	Usually white	Varied
Coat fiber	Wool	Hair
Skin thickness	Fine	Fine
Ear		
Length	Variable	Variable
Thickness	Fine	Fine
Dirtiness	Greasy	Clean
Behavior	Chewing	Chewing
Sheltering	Occasional	Usually
Grazing	Fences	Bush
Tics	Yes	Yes
Fly worms	Yes	Yes

Breaking resistance of lamb ears according to ear tag position (Caja et al., 2009; 60th EAAP Annual Meeting, Barcelona)



Breaking force (9.8 N = 1 kgf)



Tools & Technologies for Small Ruminant ID: 1/3

(A = age, V = visible, W = wellbeing, R = Reading, S = code size, T = tamper retention)

	Sheep	Goat	Constraint
Branding	Face	Yes	A- -W-R-S-T
Painting	Mid term	Short term	A- -W-R-S-T
Ear notching	Yes	Yes	-W-R-S-T
Tattooing	Yes	Yes	-R-S-T
Ear tags:			
Metallic	Yes	Yes	-W-R-S
Plastic	Yes	Yes	-W-R- -T
Collar	Temporary	Temporary	A- -R- -T
Leg band	Temporary	Temporary	A- -R- -T
Biomarks:			
Retinal imaging	Yes	Yes	R
DNA	Auditing	Auditing	R- -\$
Electronic:			
Injectable	Yes	Yes	V- -\$
Ear tag	Yes	Yes	W- -T-\$
Bolus	Yes	Yes	A-V- -\$
Leg band	Temporary	Temporary	A- -T-\$

Tools & Technologies for Small Ruminant ID: 2/3

(A = age, V = visible, W = wellbeing, R = Reading, S = code size, T = tamper retention, \$ = cost)

	Sheep	Goat	Constraint
Branding	x	x	x
Painting	x	x	x
Ear notching	x	x	x
Tattooing	Yes	Yes	-R-S-T
Ear tags:			
Metallic	Yes	Yes	-W-R-S
Plastic	Yes	Yes	-W-R- -T
Collar	x	x	x
Leg band	Temporary	Temporary	A- -R- -T
Biomarks:			
Retinal imaging	Yes	Yes	R
DNA	x	x	x
Electronic:			
Injectable	Yes	Yes	V- -\$
Ear tag	Yes	Yes	W- -T-\$
Bolus	Yes	Yes	A-V- -\$
Leg band	Temporary	Temporary	A- -T-\$


















Tools & Technologies for Small Ruminant ID: 2/3

(A = age, V = visible, W = wellbeing, R = Reading, S = code size, T = tamper retention, \$ = cost)

	Sheep	Goat	Constraint
Tattooing	Yes	Yes	-R-S-T
Ear tags:			
Metallic	Yes	Yes	-W-R-S
Plastic	Yes	Yes	-W-R- -T
Leg band	Temporary	Temporary	A- -R- -T
Biomarks:			
Retinal imaging	Yes	Yes	R
Electronic:			
Injectable	Yes	Yes	V- -\$
Ear tag	Yes	Yes	W- -T-\$
Bolus	Yes	Yes	A-V- -\$
Leg band	Temporary	Temporary	A- -T-\$

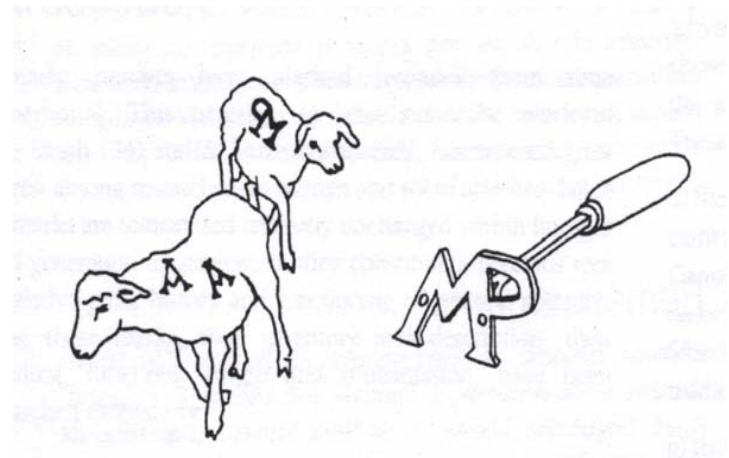
Tools & Technologies for Small Ruminant ID: 3/3

(A = age, V = visible, W = wellbeing, R = Reading, S = code size, T = tamper retention, \$ = cost)

	Sheep	Goat	Constraint
	Regulations (CE) 21/2004 & 933/2008		
Tattooing (2nd)	Yes 	Yes 	-R-S-T
Ear tags:			
Metallic (2nd)	Yes 	Yes 	-W-R-S
Plastic (2nd)	Yes 	Yes 	-W-R- -T
Leg band (2nd)	Temporary 	Temporary 	A- -R- -T
Biomarks:			
Retinal imaging	Yes	Yes	R
Electronic:			
Injectable (2nd)	Yes 	Yes 	V- -\$
Ear tag (1st)	Yes 	Yes 	W- -T-\$
Bolus (1st)	Yes 	Yes 	A-V- -\$
Leg band (2nd)	Temporary 	Temporary 	A- -T-\$

Outline: 2/3

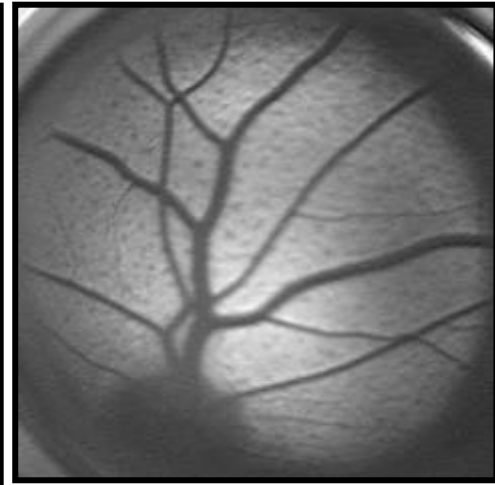
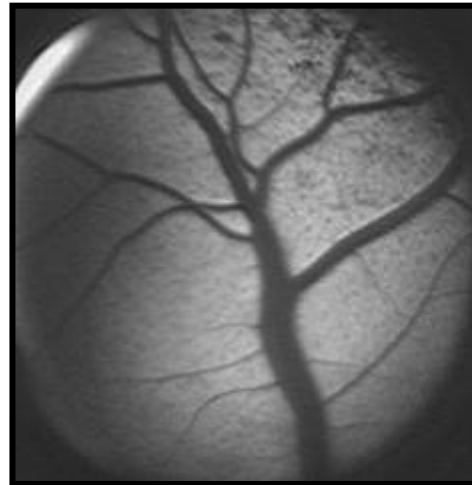
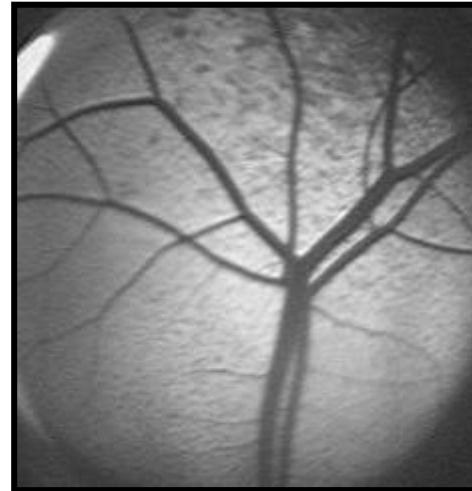
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Retinal imaging of live sheep using the Optibrand system

Sheep

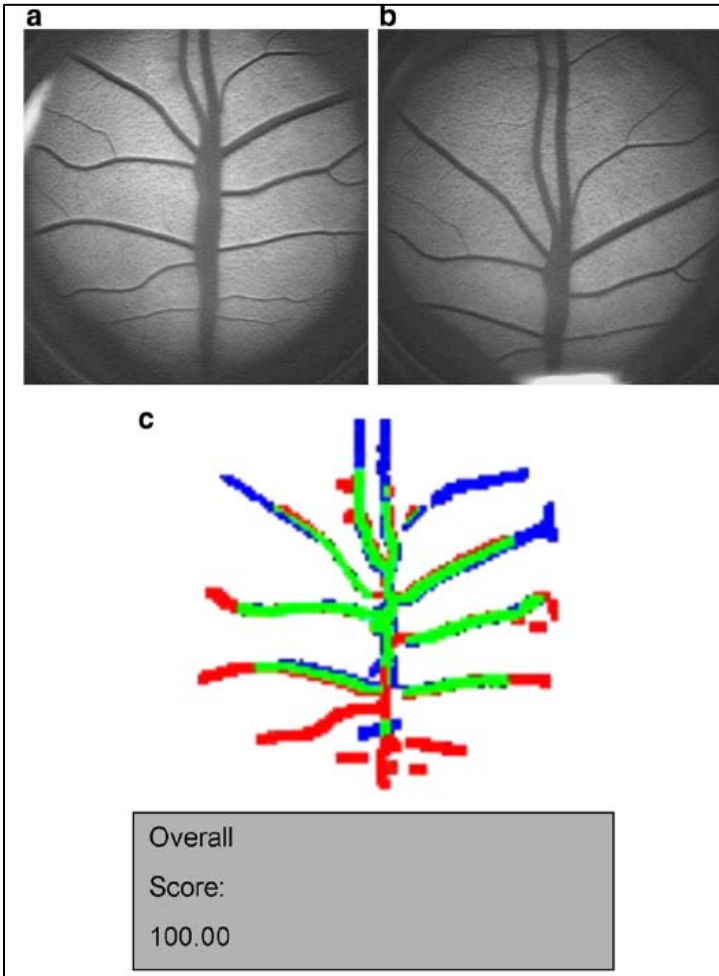
Goat



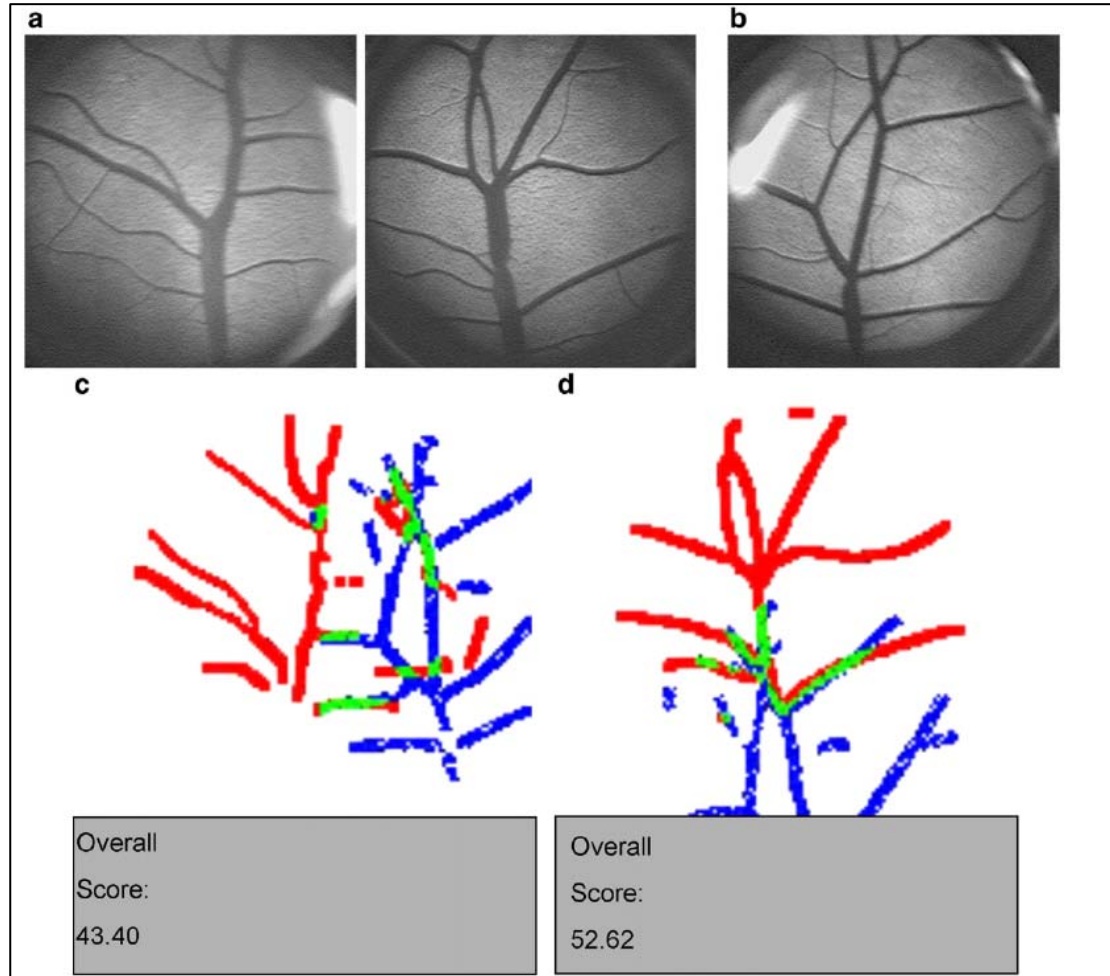
**Operational time: 0.2-1.5 min
(restrained animals)**

Retinal images from the same eye matched (score > 75) and unmatched (score < 75) by the Optibrand system (Allen et al., 2008)

Matched (score > 75)



Unmatched (score < 75)



Matching score in sheep according to age using the Optibrand system (Rojas-Olivares et al., 2008)

Sheep, n	BW, kg	Same eye		Different age	
		Left	Right	Left	Right
Live lambs:					
152	22.3 ± 0.2	93.9 ± 0.7 (93.4%) ¹	95.1 ± 0.7 (93.3%) ¹		
58	41.6 ± 0.9	98.1 ± 0.4 (100%) ¹	94.3 ± 1.1 (94.8%) ¹	93.8 ± 1.1 (93.1%) ¹	88.1 ± 1.9 (79.3%) ¹
Slaughtered lambs (cut heads):					
50	24.3 ± 0.2	66.0 ± 2.6 (22.2%) ¹	69.2 ± 2.5 (34.0%) ¹	59.6 ± 2.0 (8.0%) ¹	57.3 ± 2.2 (14.0%) ¹

¹Declared as the same between replicates (matching >80%)

EID attaching system: 1) Injectable transponders

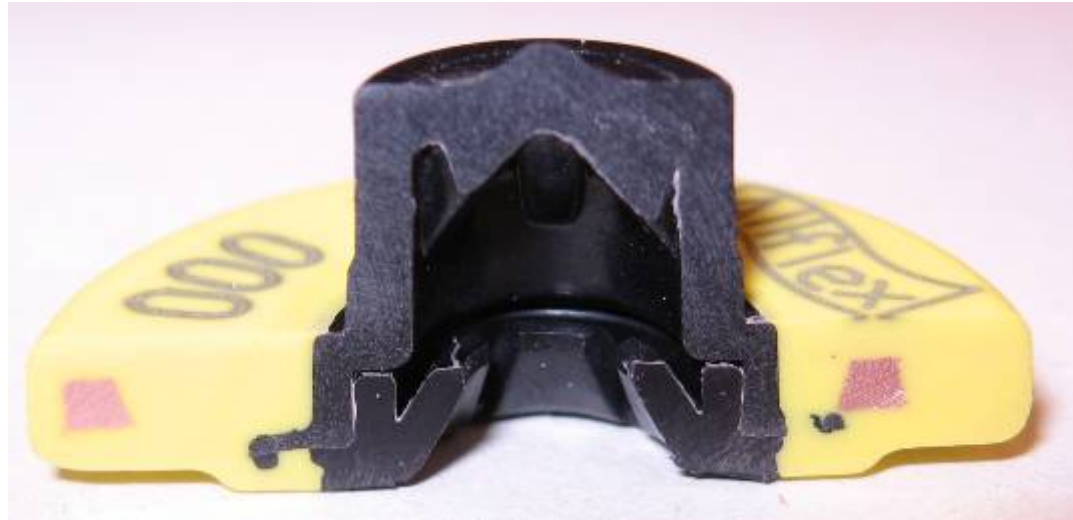


EID attaching system: 1) Injectable transponders

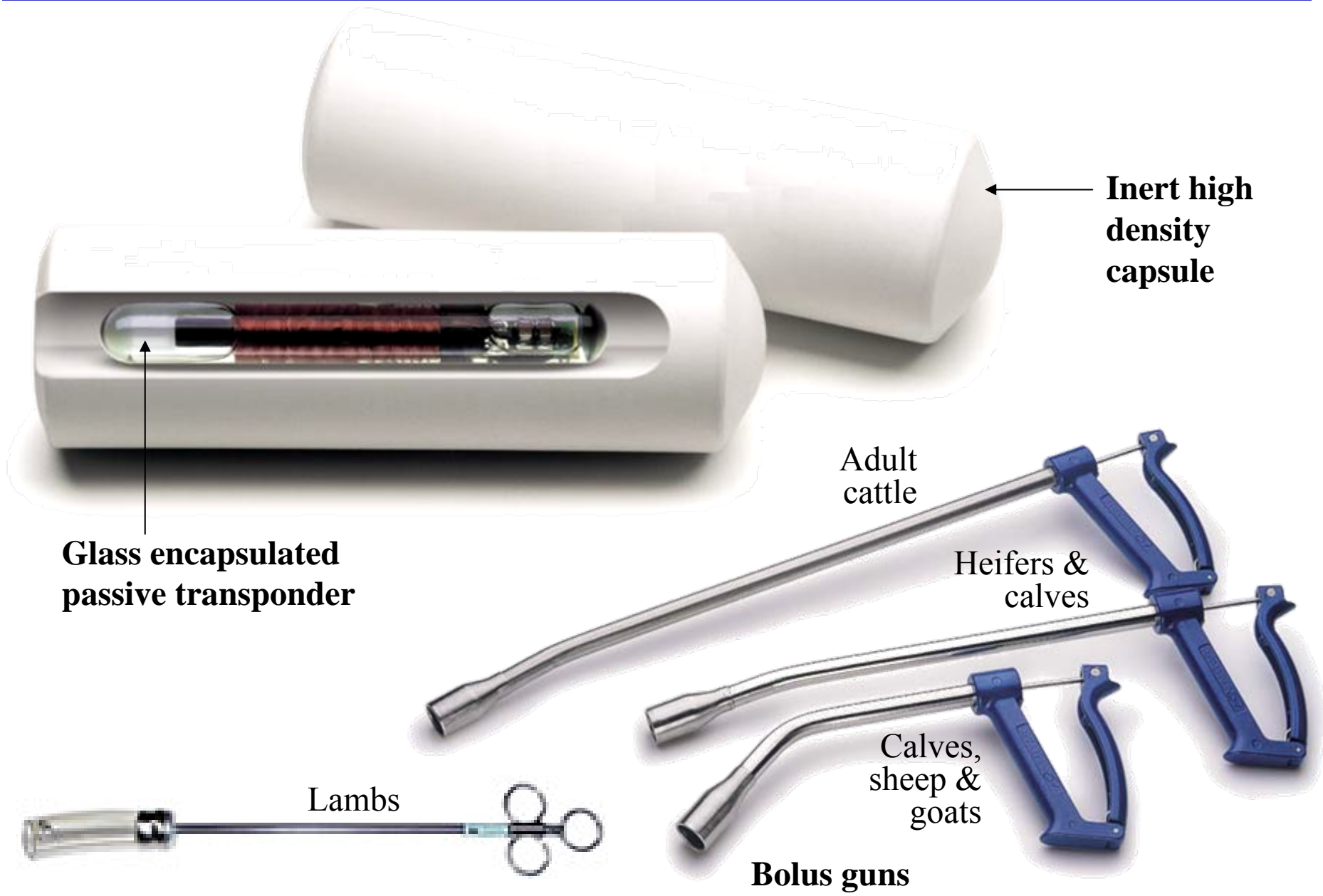
Injection in the metacarpial area of goat kids



EID attaching system: 2) Ear tag transponders



EID attaching system: 3) Bolus transponders



Bolus administration in a suckling lamb (> 8 kg BW)



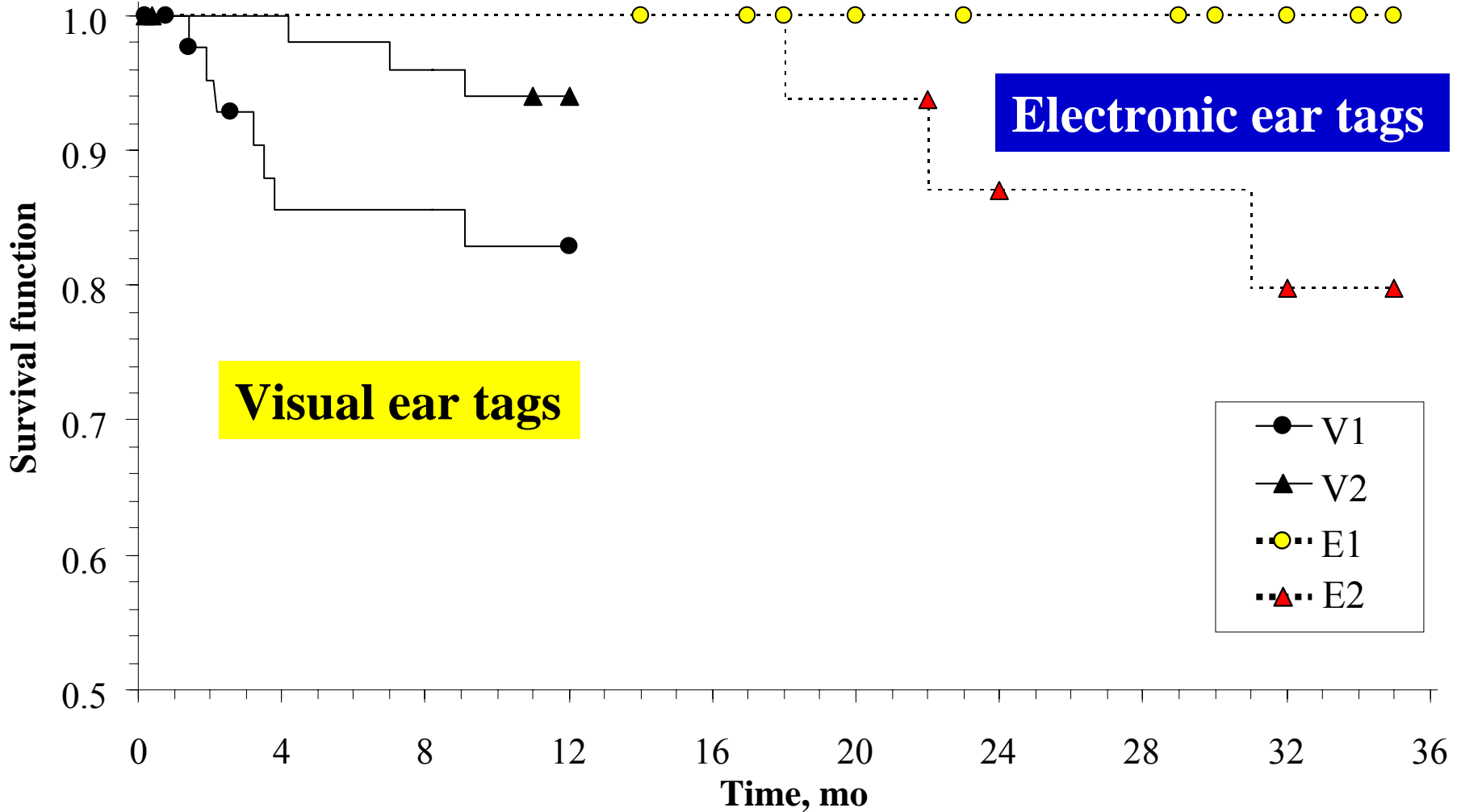
Mini-bolus 20 g in a Ripollesa lamb, UAB, Bellaterra (Spain).

Readability of injectable and bolus transponders in sheep under semi-intensive conditions in Spain

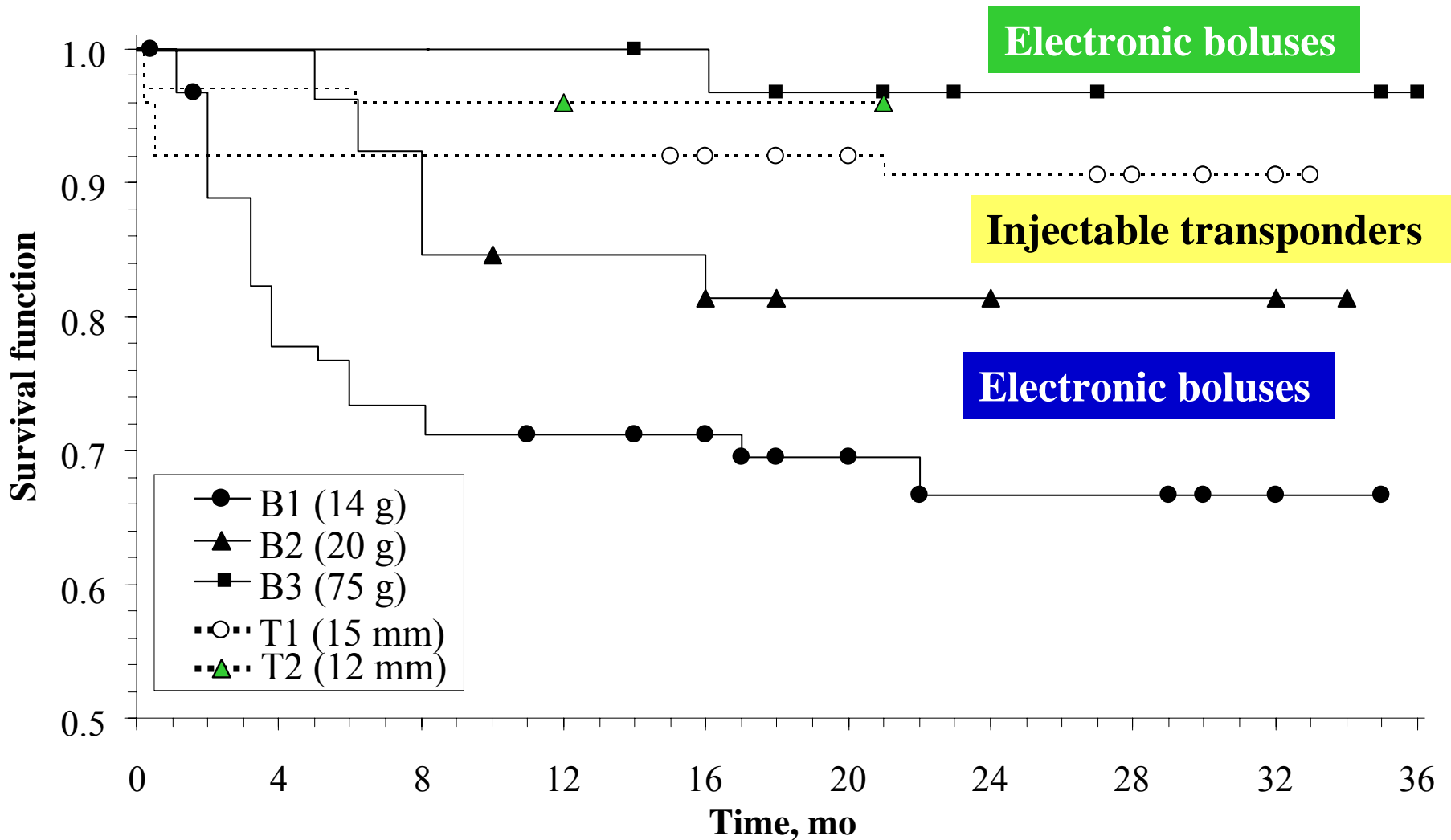
(Caja et al., 1999; 50th EAAP Annual Meeting, Zurich)

Body site	Transponders	Losses (%)	Breakage (%)	Elec. Fails (%)	Readability (%)
Armpit	4854	83 (1.7)	15 (0.3)	2 (0.04)	4754 (97.9)
Ear-base	1053	50 (4.7)	26 (2.5)	1 (0.09)	976 (92.7)
Reticulum / rumen	882	0	0	0	882 (100)

Retention rate of visual (V) and electronic (E) ear tags in dairy goats (Carné et al., 2009; J. Dairy Sci., 92)

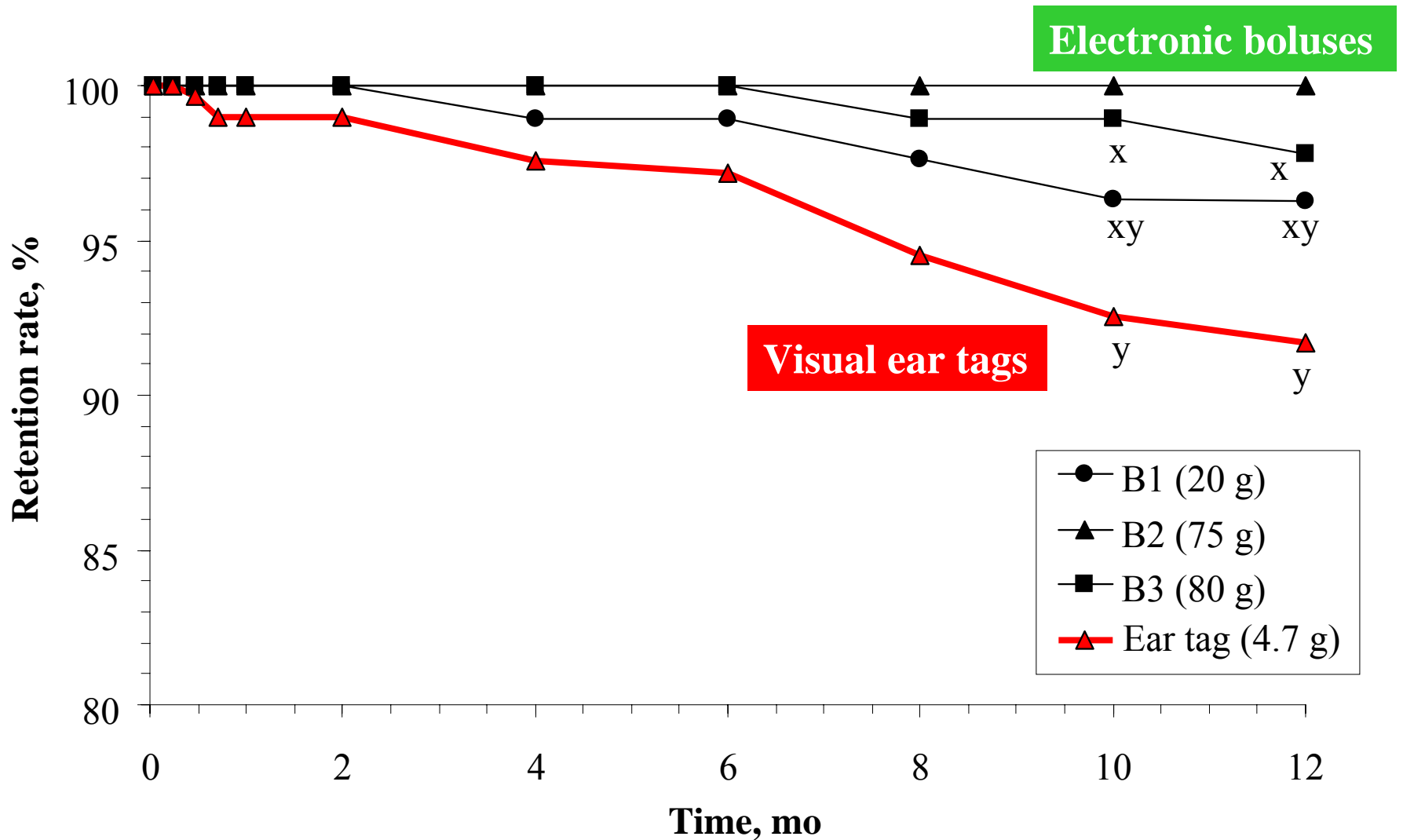


Retention rate of electronic boluses (B) and injectable transponders (T) in goats (Carné et al., 2009; J. Dairy Sci., 92)



Retention rate of visual ear tags and electronic boluses in goats under USA grazing conditions

(Carné et al., 2009: J. Animal Sci. 87: *in press*)



Bolus retention rate logistic models in small ruminants

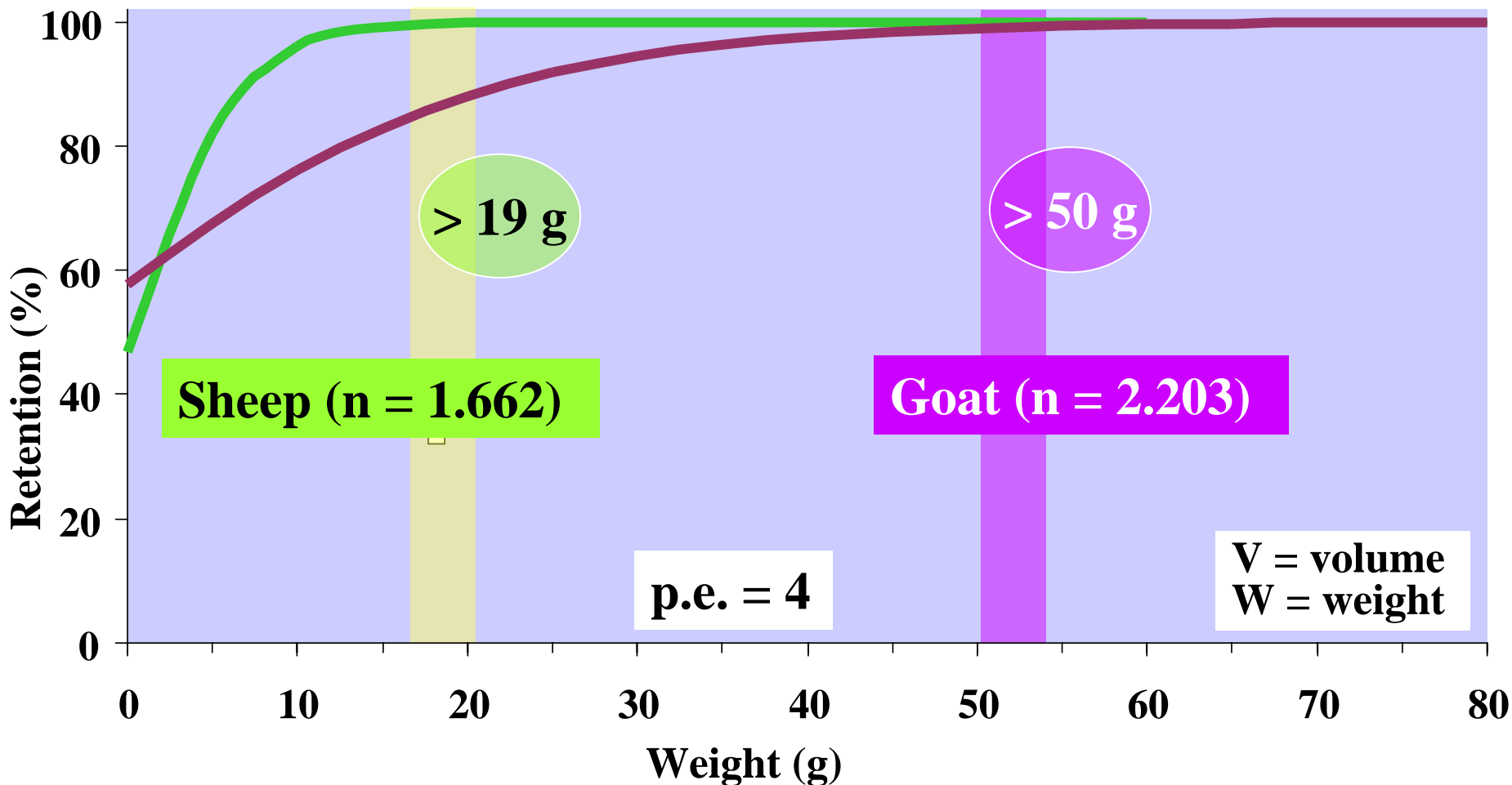
(Ghirardi et al., 2006, J. Anim. Sci. 84; Carné et al., 2009, J. Anim. Sci. *submitted*)

$$R_s = 1/(1+1.14 \cdot e^{0.76 \cdot V - 0.50 \cdot W})$$

$R^2 = 0.97$ ($P < 0.001$)

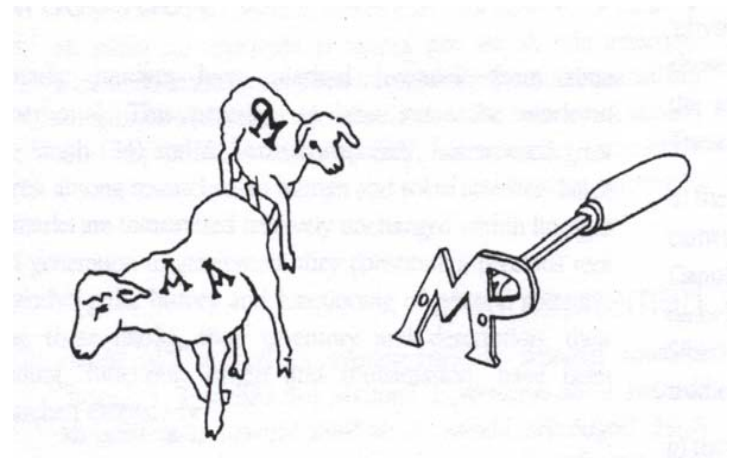
$$R_g = 1/(1+0.73 \cdot e^{0.79 \cdot V - 0.26 \cdot W})$$

$R^2 = 0.98$ ($P < 0.001$)



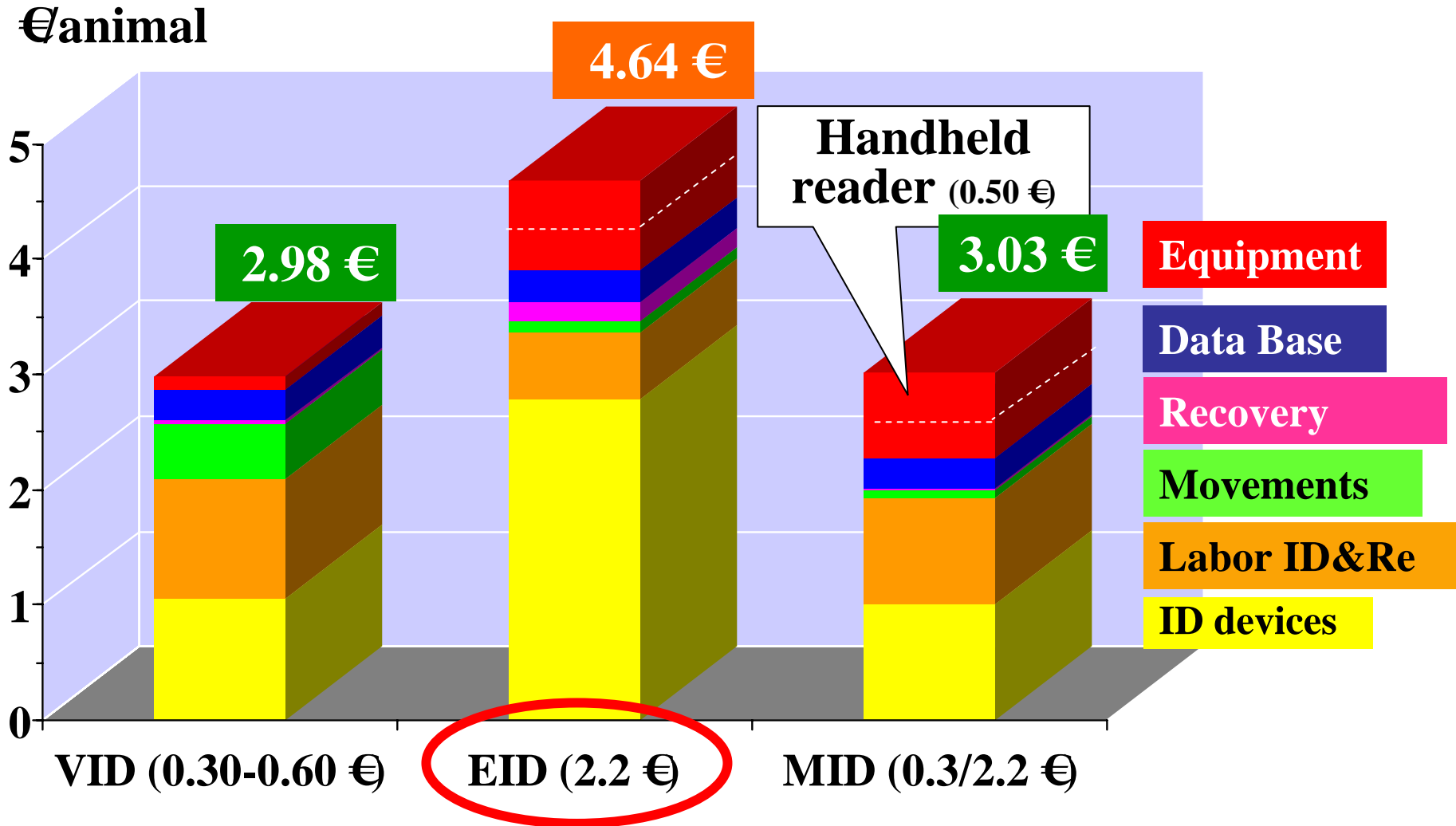
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Cost for sheep & goat ID in Spain according to Regulation CE 21/2004

(VID = plastic ear tag, EID = e-bolus; MID = ear tag + e-bolus)
(Saa et al., 2005; J. Animal Sci. 83)



Milking & milk recording process in dairy goats: 1/3

Entrance at random

12 to 24 goats

Random order

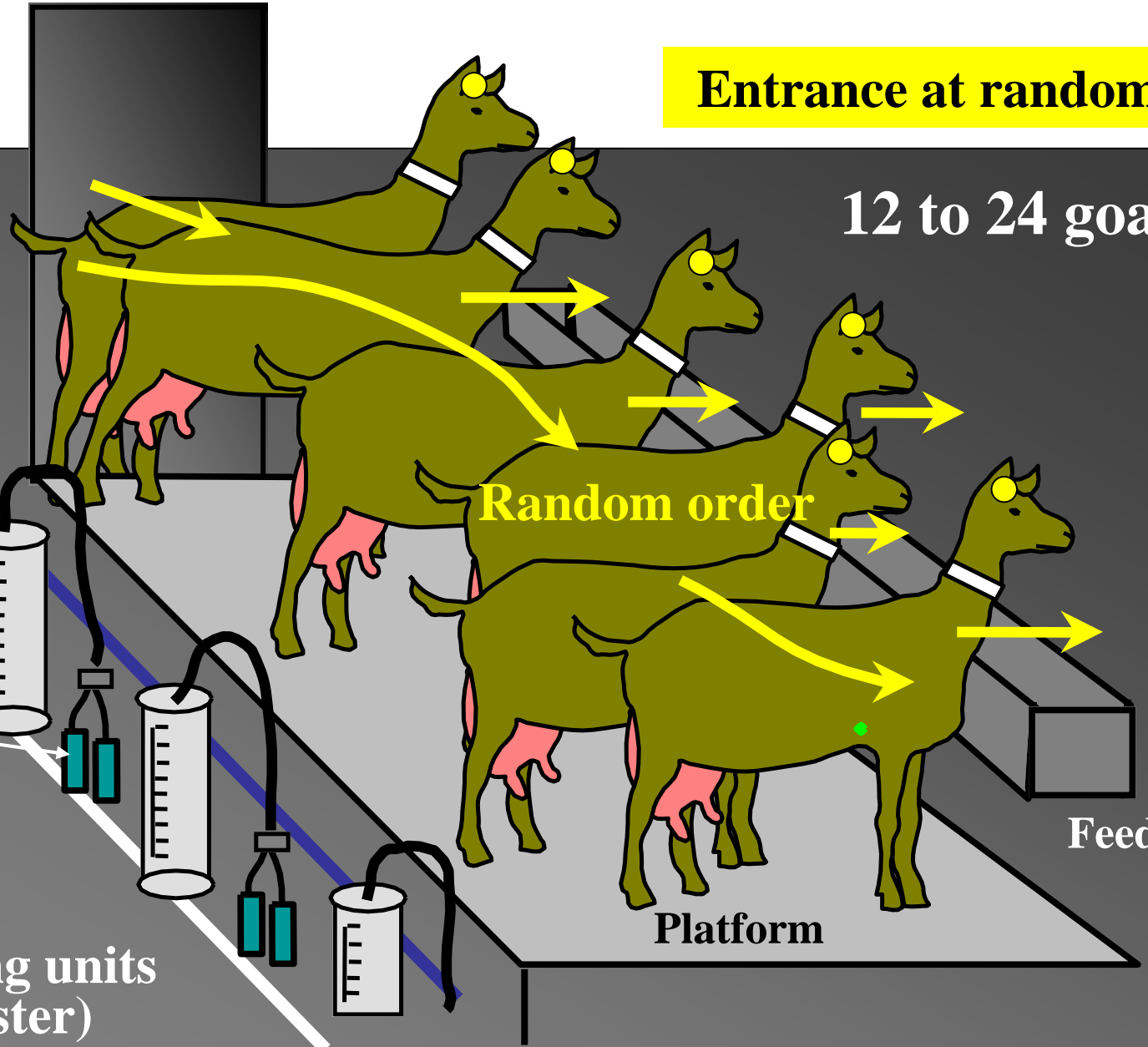
Milk jars

Cluster

Feeder

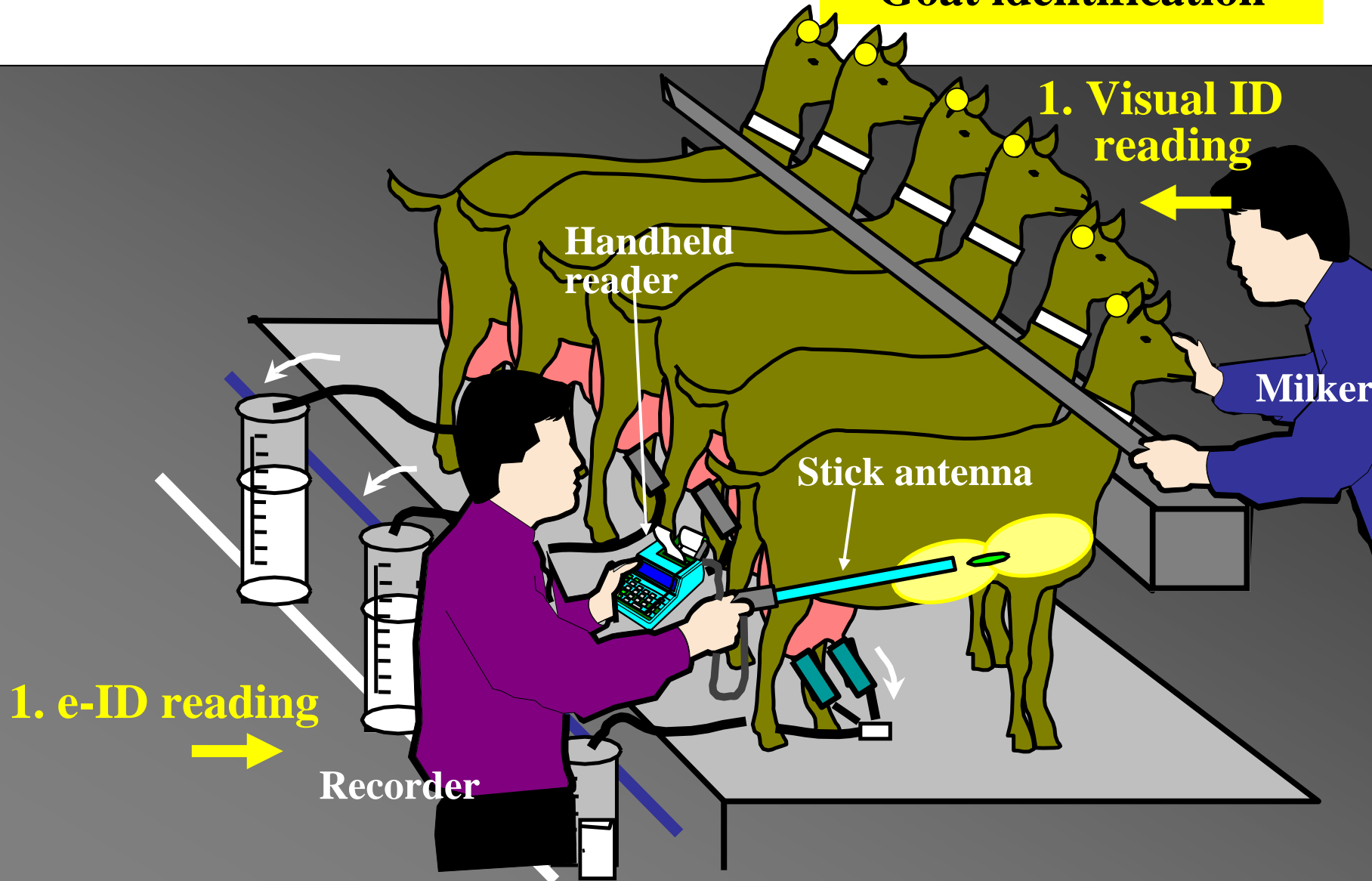
Platform

3 to 12 milking units
(2 goats/cluster)



Milking & milk recording process in dairy goats: 2/3

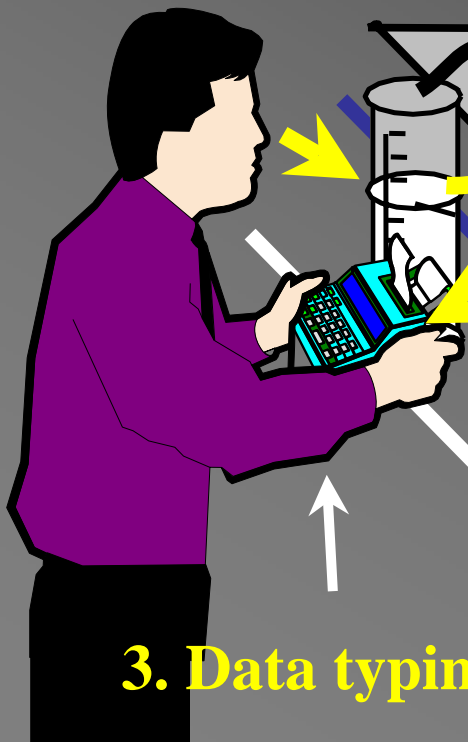
Goat identification



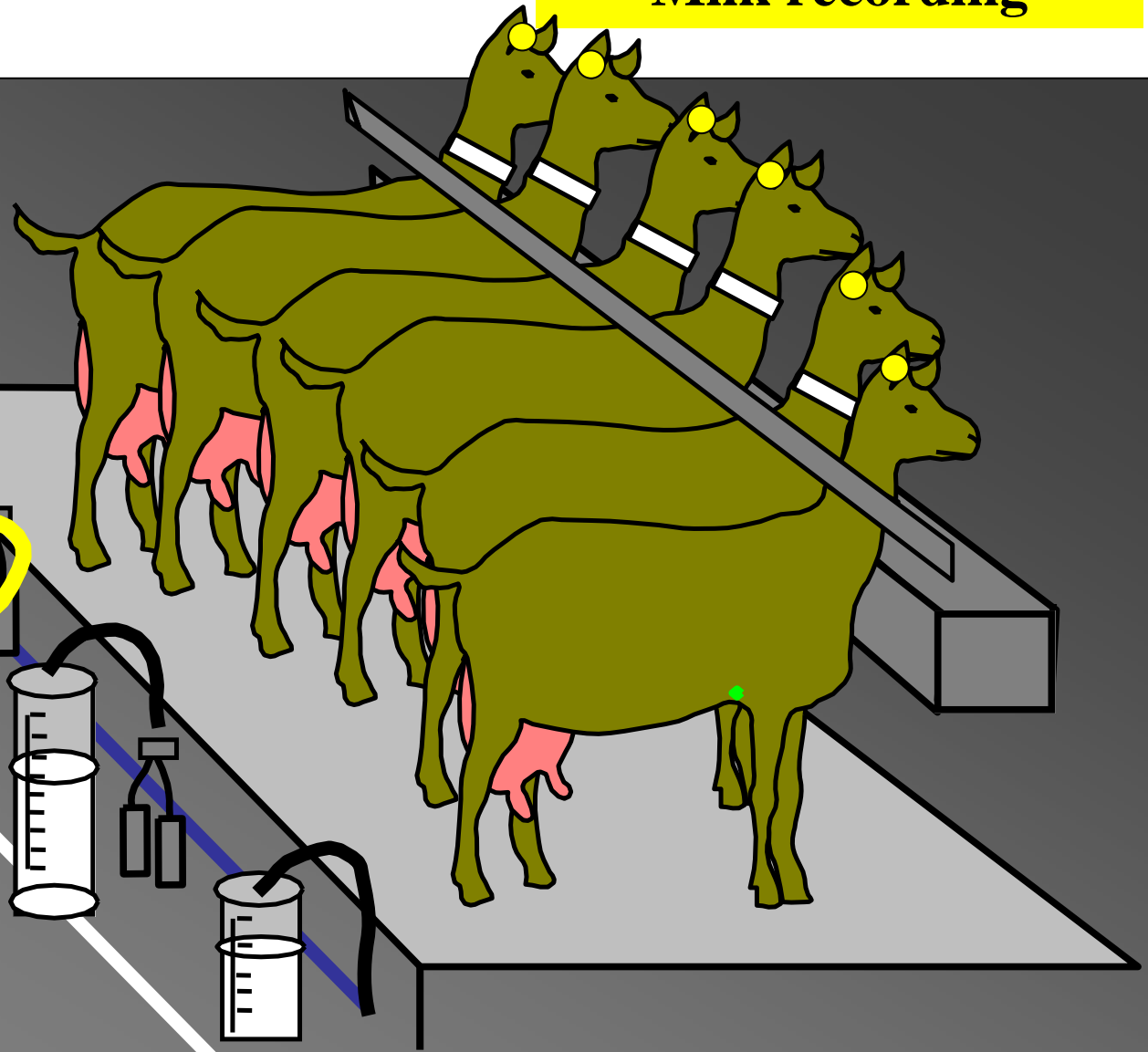
Milking & milk recording process in dairy goats: 3/3

Milk recording

2. Yield reading

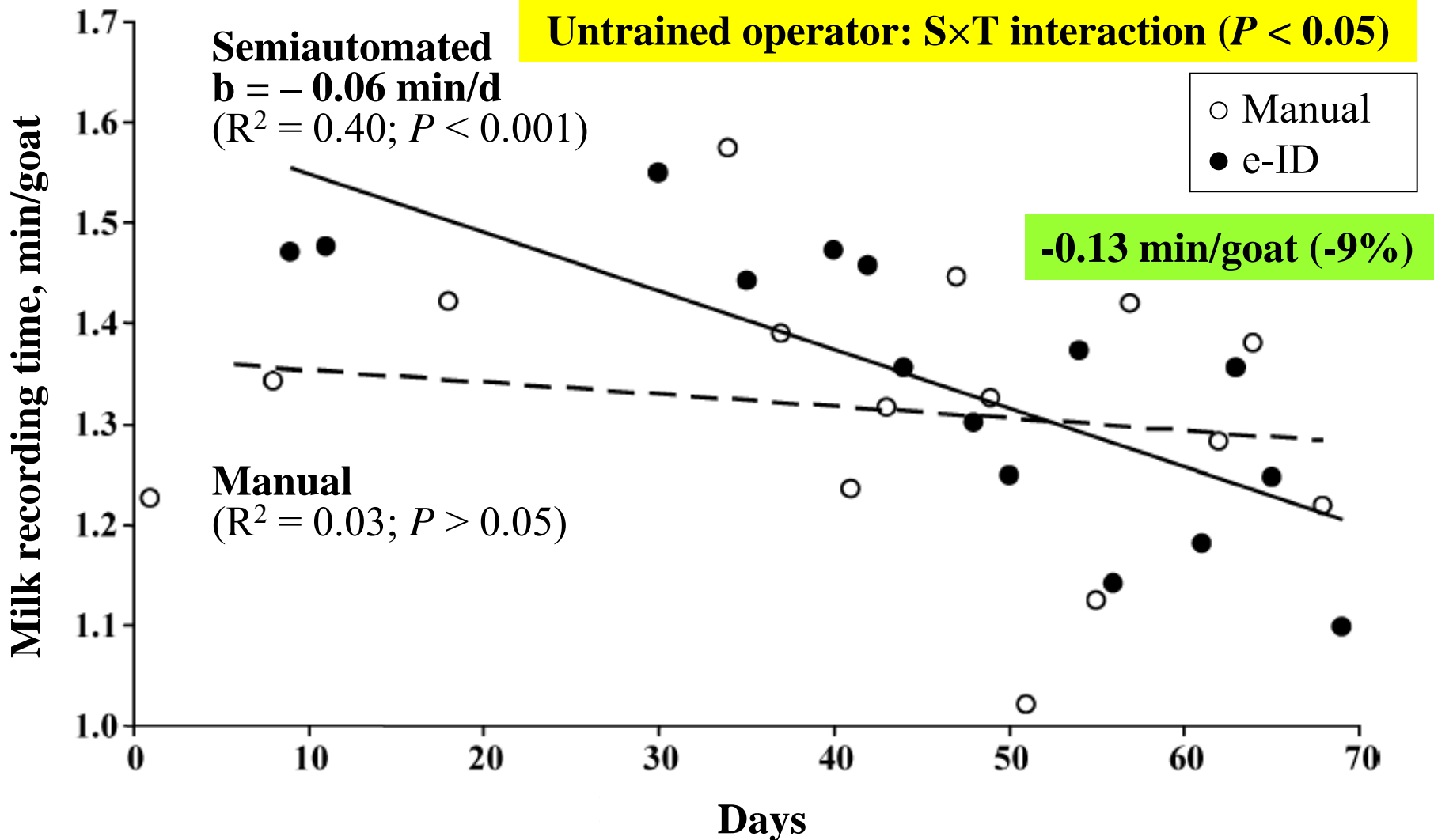


3. Data typing



Manual vs. Semiautomated milk recording systems in dairy goats milked once daily: System×Time interaction

(Ait-Saidi al., 2008; J. Dairy Sci. 91)



Comparison of manual and semiautomated milk recording in x1 dairy goats: Herd savings

Milking parlor = 2 × 12 (side-by-side)
Yield = 40 to 200 goats/h
Herd size = 24 to 480 goats
Work wage = 10 €/h

Savings/milk recording:
0.13 min/goat (3.01 min/24 goats)

Savings/milk recording:
0.5 to 12.9 €/recording

Milk test-days/lactation = 6
e-ID cost = 1.4 €
Goat life span = 5 yr
Reader prize = 400 €
Reader's use = 5 yr
Readings/yr (200 d × 100 goats/d) = 20,000

e-ID investment
2.2 €/goat

Extra costs/milk recording = 0.051 €/goat

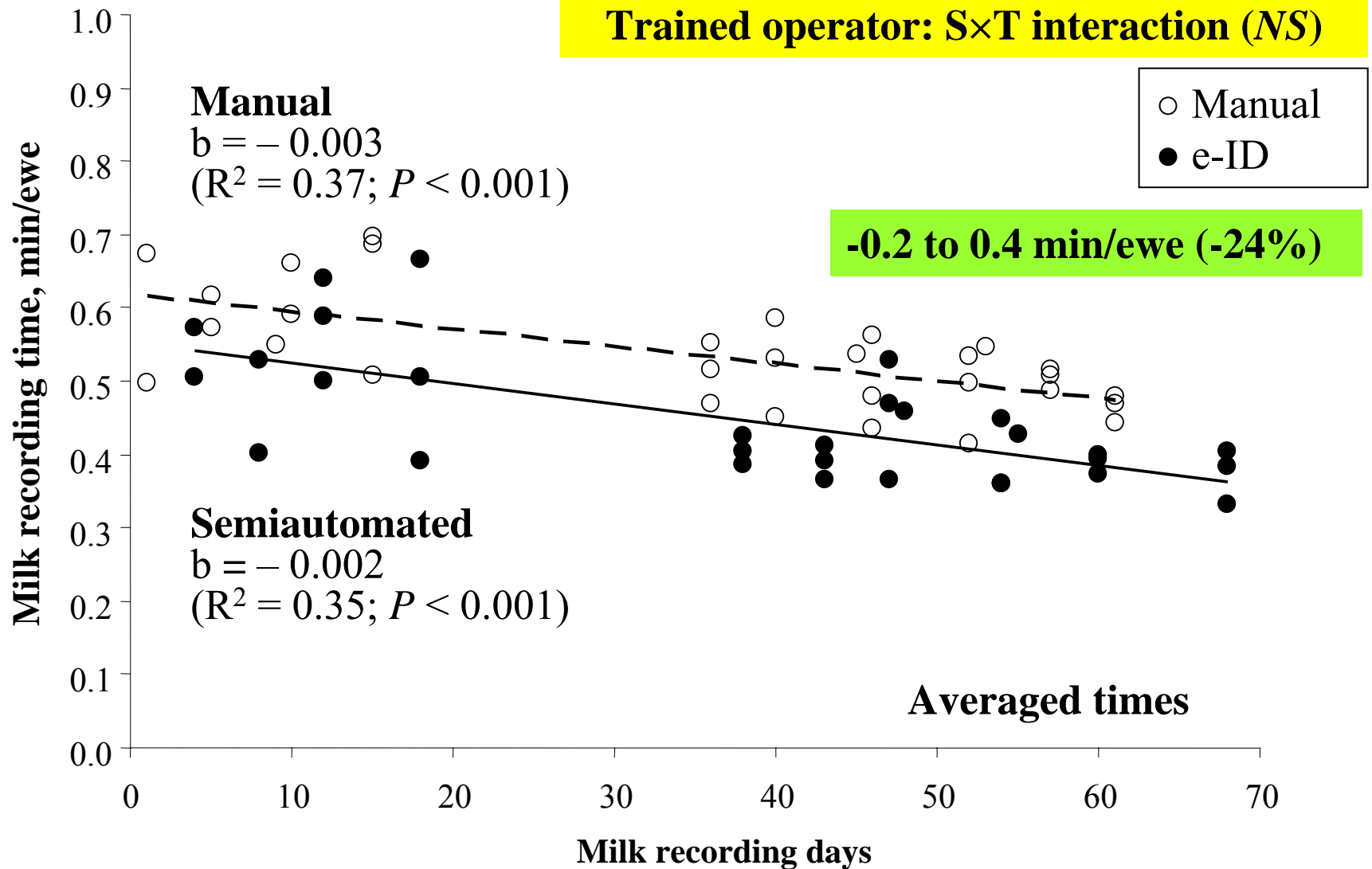
Paying back
40% investments

Net costs/milk recording:
0.5 to 12.9 €

Extra cost/milk recording:
1.22 to 24.48 €

Comparison of manual and semiautomated milk recording in dairy sheep: System \times Time interaction

(Ait-Saidi al., 2009; unpublished data)



Benefits of implementing e-ID for performance recording in dairy & meat sheep farms in Spain

(Ait-Saidi al., 2008; *unpublished data*)

	Dairy		Meat	
	×1 (AT)	× 2 (A4)	Extensive	Intensive
Sheep, n	400	400	700	700
Savings, €sheep yr⁻¹				
Milk recording	0.126	0.266	-	-
Flock book	0.095	0.095	0.095	0.142
Weighing	0.188	0.188	0.125	0.188
Inventory	<u>0,060</u>	<u>0,060</u>	<u>0,060</u>	<u>0,060</u>
Total, € sheep yr⁻¹	0.469	0.609	0.280	0,390
Benefits	93%		87%	
€sheep yr ⁻¹	-0.037	0.099	-0.047	0.030
€flock yr ⁻¹	-14.60	39.80	-32.67	21.00
Breaking point, n sheep	477	279	1.110	565
		> 100%		> 100%

Key points of an animal and meat traceability scheme:

- **ID devices:** permanent and individual
- **Movement registration** system
- **Data Base** permanently updated
- **Independent auditing system**

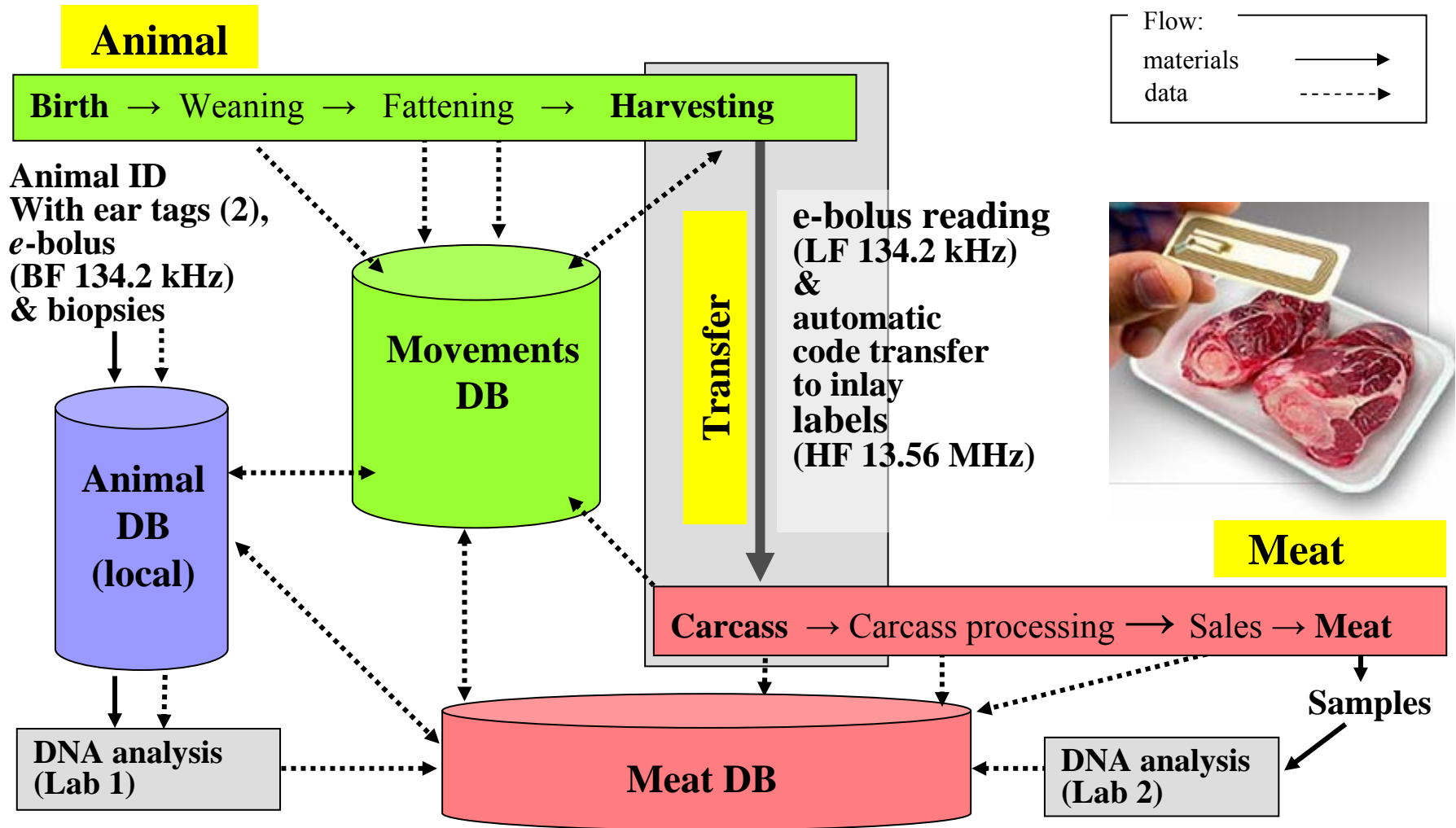
DNA

e-ID

Double system of traceability & auditing 'e-ID+DNA'
(Project EU FAIR5-QLk1-02229: 2001-2006)

'e-ID + DNA': Data management from animal to meat

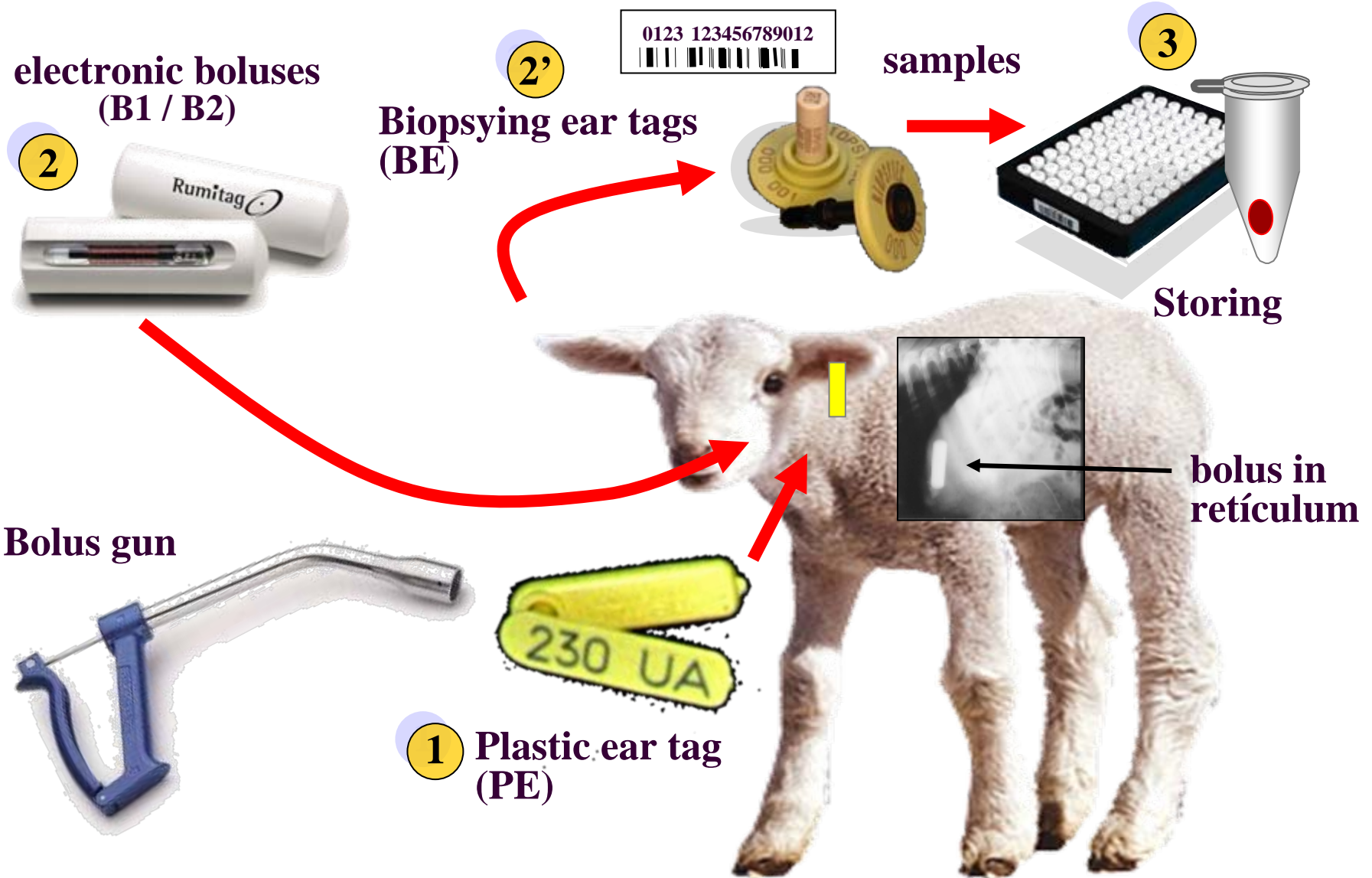
(Project FAIR 5, QLk1-02229 EID+DNA Tracing)



From 'farm to fork' Data & DNA matching

'e-ID + DNA' : electronic ID & ear biopsying

(EU Project FAIR 5, QLk1-02229)



Device for DNA sampling (Biopsy-tag) and high frequency inlay labels for carcasses (13.56 MHz)



'e-ID + DNA Tracing': Traceability results in 'Pascual' lambs (harvested 24 kg BW, 3 mo; n = 1,908)



	Ear tag		Mini-bolus	
	Tip-tag	Biopsier	B1 (9 g)	B2 (20 g)
Applied, n	1,908	980	1,091	817
Lost, %	2.1	0.3	1.6	0
No readable, %	1.1	0	0	0
On-farm traceability, %	96.8^c	99.7^b	98.4^b	100^a
Slaughtered, n			998	797
Bolus read on-line, %			99.7	99.9
Labeled carcasses, %			98.0	100
Empty labels, %			2.0	0
Slaughterhouse traceability, %			97.7^b	99.9^a
Total traceability, %			96.1^b	99.9^a
Biopsies, n	868			
DNA analyses, %	5.8			
No matching, %	2.0			
Coincidence, %	98.0			

a,b,c $P < 0.05$

Conclusions & implications:

- **Many tools & techs able to be implemented in the sheep & goat industry for individual ID:**
 - **Retinal imaging & DNA**
 - **Electronic ID (RFID)**
- **Technology is ready but on-farm management devices and user-friendly software is needed.**
- **Cost-benefit studies proved that electronic ID is affordable at current prices for many uses.**
- **Non-contact ID systems are key for telemetry and automation: e-ID is the ‘first step’ for today?**
- **Who is the user generation?: Operator training is today needed!**

Thanks for your attention. For more information visit:

<http://www.uab.es/tracing/>

EID+DNA+TRACING



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Research

Quality of Life and Management of Living Resources Programme

Implemented under the Fifth Framework Programme (1999-2002)



Electronic Identification and Molecular Markers for Improving the Traceability of Livestock and Meat (EID+DNA Tracing) _ QLK1-CT-2001-02229



13793 Visits from 19 Apr 2002

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Web designed by: J.H.Mockett, M.Hernández-Jover and G.Caja



The European Commission (5th Research Program)
Project QLK1-2001-02229: 'EID + DNA Tracing'