

# Animal breeding and ethical values

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DI MILANO

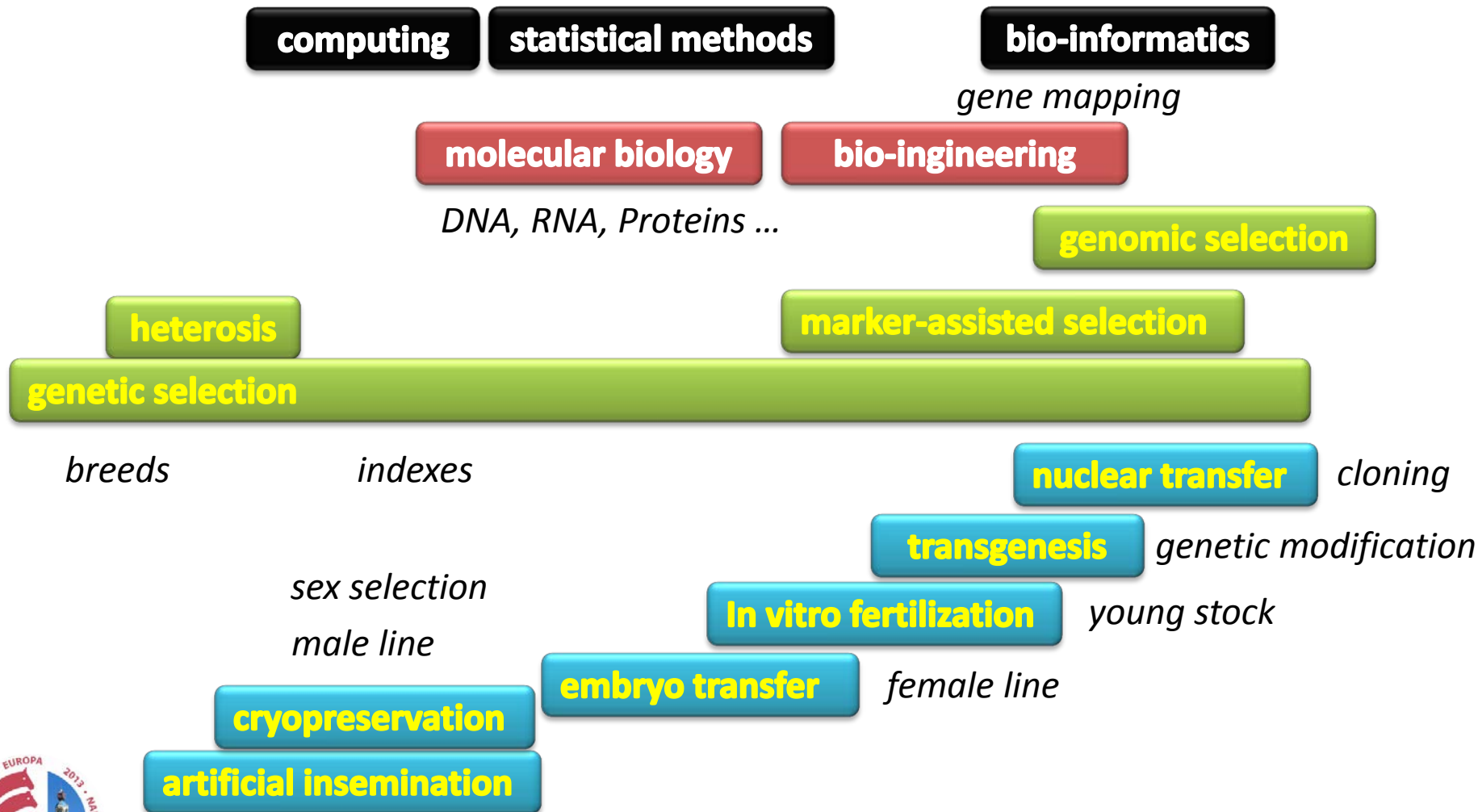


**EAAP 64<sup>th</sup> Annual Meeting, Nantes, France, August 26<sup>th</sup>-30<sup>th</sup>, 2013**

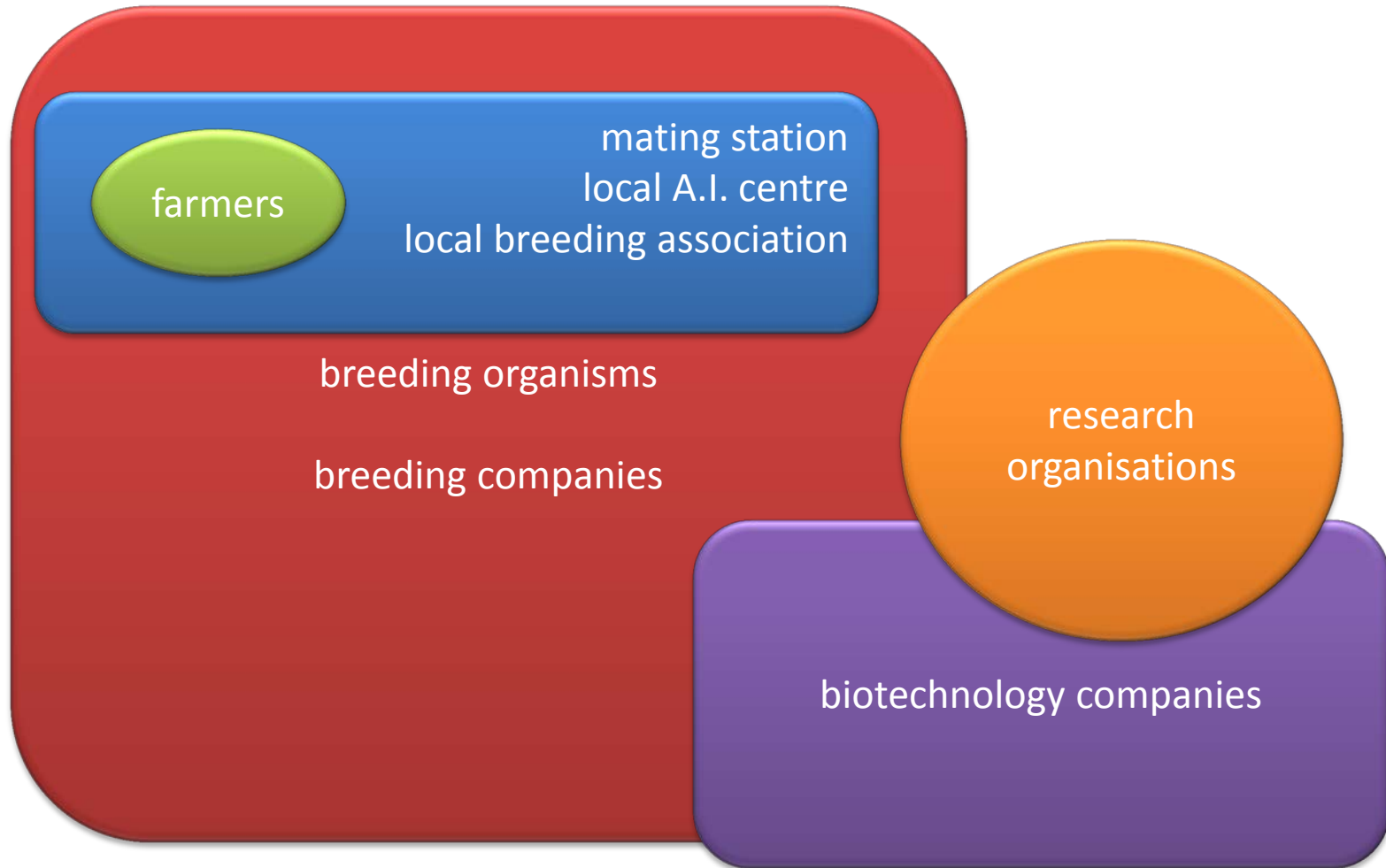
# Breeding

Breeding implies actions on the genome of a population in order to keep it stable (homozygous lines, cloning) or to modify it (selection, crossbreeding), which can be combined with reproductive techniques such as A.I., E.T., I.V.F., transgenesis, cryopreservation, semen/embryo sexing

# Breeding: timeline



# Actors in breeding: from local to global



# Cases and values

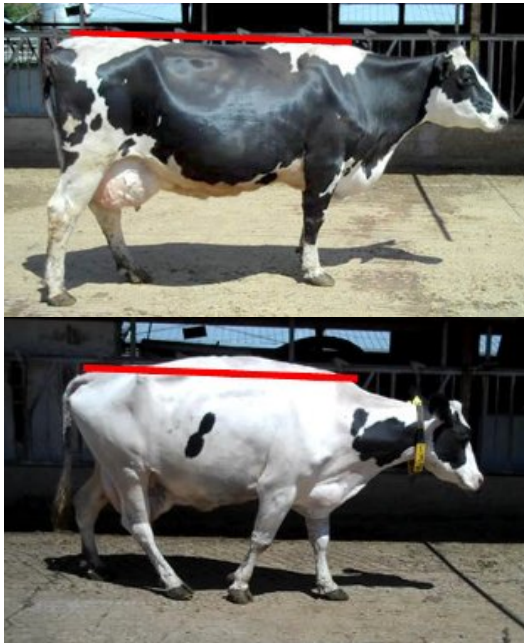
Welfare  
Autonomy  
Justice  
Intrinsic value  
Integrity  
Naturalness  
Caution  
Aesthetics

		W	A	J	IV	I	N	C	Ae
Genetic selection	breeding goals, blind hens, featherless chicken, polled ruminants								
	artificial insemination								
	embryo transfer								
	in vitro fertilization								
Sex selection	calves, chicken								
Genomic selection	breeding goals								
Transgenesis	production animals (transgenic fish), transplantation, bio-pharmaceuticals								
Cloning	meat cattle competition horses								



# Genetic selection and breeding goals

- Increase of productivity: negative effects on health and welfare

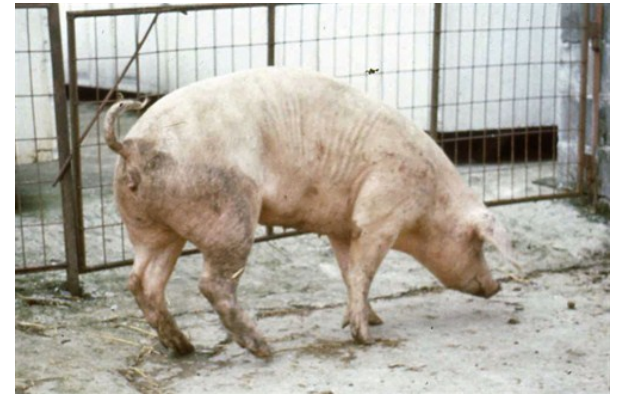


*metabolic disorders,  
lameness, fertility*



*INRA Productions Animales, Février 2004*

*leg weakness*



*leg weakness, osteochondrosis*

Sandoe (1996, 1999), Rauw (1998)  
Allen (2001), Larrère (2003)  
Olson (2004), Busch (2005),  
Gamborg & Sandoe (2005)  
Neeteson (2006), Star (2006)  
Aerts (2006), McArthur Clark (2006)  
Decuyper (2010), Nielsen (2011)

**welfare, autonomy, justice**

# Genetic selection and breeding goals

- Increase of productivity: major alterations

- Behaviour

Jones (1999), D'Eath (2010)

- Blind hens

Gjerris & Sandoe (2006)

- Featherless chickens

Fraser (2001), Wells (2012)

- Polled cattle

Gottards (2011), King-Eveillard (2013)



# Intrinsic value



- **T. Regan (1983):**
  - Animals have beliefs, desires, perceptions which make them **ends-in-themselves**.
  - They have **direct rights**, and human have direct duties towards their well being
- **P. Taylor** (*Respect for nature*, 1986):
  - Animals and living beings have **inherent worth** (their life)
  - for this they **matter morally**
- **Animal Health & Welfare Act (NL, 1992)**

"Any right accorded by or pursuant to this Act shall be exercised in recognition of the **intrinsic value** of animal life"

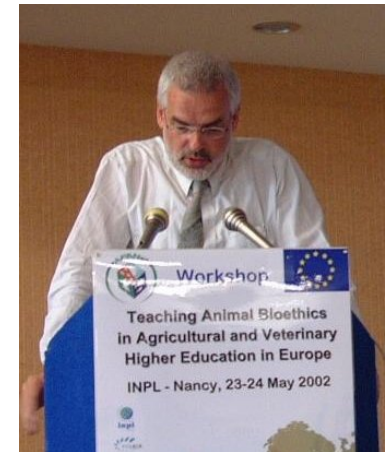


# Integrity as a value

- Animal **integrity**: « the **wholeness** of the animal and the **species-specific balance** of the creature, as well as the animal's capacity to **maintain itself independently** in an environment suitable to the species »

B. Rutgers (1999)

Christiansen (2000), Bovenkerk (2002)

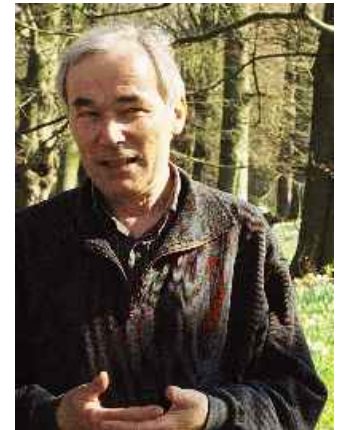


# Naturalness as a value

The value of naturalness refers to a basic respect for the intrinsic value of nature, i.e., the *value nature* has, independent of the benefits it may have for humans.

This manifests itself in three ways:

- (1) in the use of natural substances,
- (2) in respecting the self-regulation of living organisms and ecosystems
- (3) in **respecting the characteristic (species-specific) nature of living organisms.**



**H. Verhoog, E.T. Lammerts Van Bueren, M. Matze and T. Baars (2007), NJAS wageningen journal of life sciences, 54, 333-345.**

Macnaghten (2004)

# Cases and values

Welfare  
Autonomy  
Justice  
Intrinsic value  
Integrity  
Naturalness  
Caution  
Aesthetics

		W	A	J	IV	I	N	C	Ae
Genetic selection	breeding goals, blind hens,	x	x	x				x	
	featherless chicken, polled ruminants	x	x	x	x	x	x		x

		Well-Being	Autonomy	Justice
Cows	H			<i>Equity of conditions of life</i>
	D	<i>Welfare</i>	<i>Freedom of behaviour</i>	
	P			
Farmers	H	<i>Income,</i>	<i>Freedom of action</i>	<i>Commercial equity</i>
	D	<i>Working conditions, Risks</i>		
	P			
Society	H		<i>Informed choice</i>	<i>Affordability</i>
	D	<i>Security, Quality of life</i>		
	P			
Environment	H		<i>Biodiversity</i>	<i>Sustainability</i>
	D	<i>Conservation</i>		
	P			

Horned	Well-Being	Autonomy	Justice
Cow			
Farmer			
Society			
Environmt			

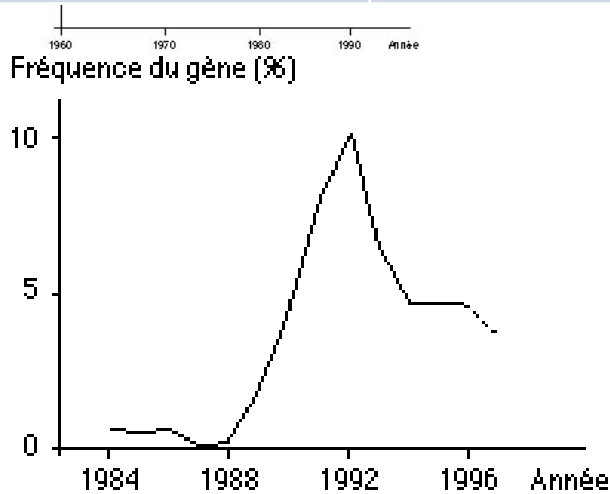
Deprived	Well-Being	Autonomy	Justice
Cow			
Farmer			
Society			
Environmt			

Polled	Well-Being	Autonomy	Justice
Cow			
Farmer			
Society			
Environmt			

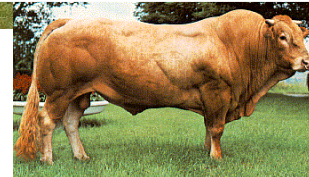


# Genetic selection through A.I.

		Welfare	Autonomy	Justice	Intrinsic value	Integrity	Naturalness	Caution	Aesthetics
		W	A	J	IV	I	N	C	Ae
Genetic selection	artificial insemination	x	x	x				x	



**Bovine Leucocyte Adhesion Deficiency gene**



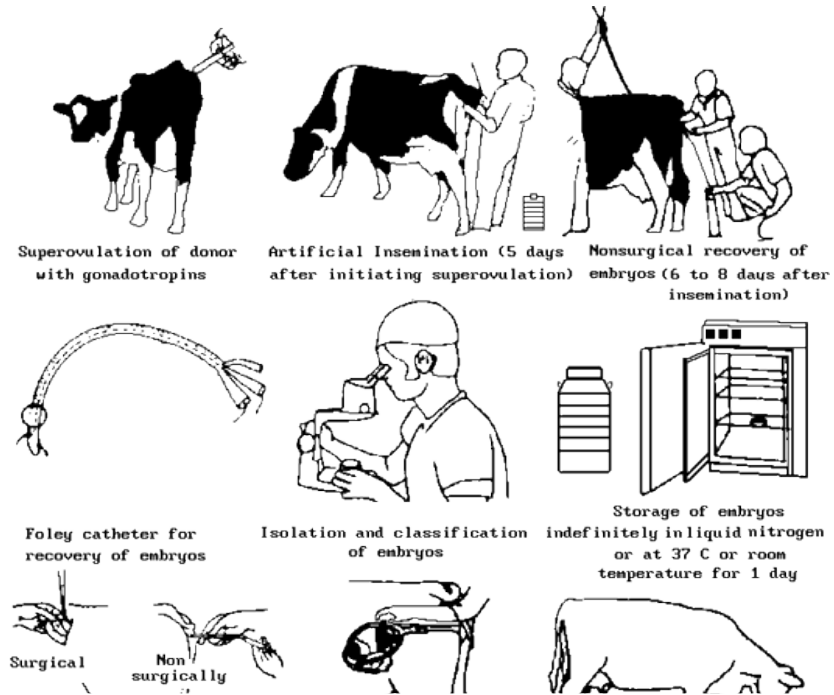
Biodiversity (intra-breed, inter-breed)  
Health risks

Olson (2004)  
McArthur (2006)  
Boonen (2009)



# Genetic selection through Embryo Transfer

- Positive:
  - Better genetic improvement
  - Access to the embryo
  - Genetic heritage conservation
  - International exchanges
- Negative:
  - Welfare issues (surgical method in some species)
  - Hormonal treatments
  - Unnaturalness (organic production)

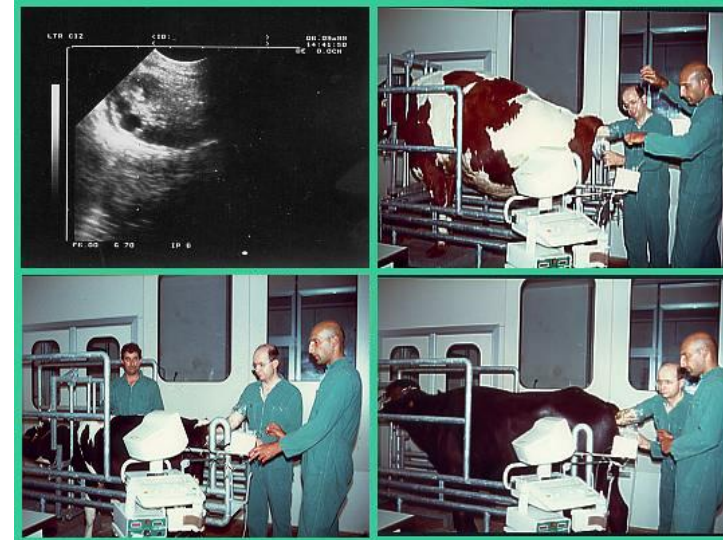


Welfare  
Autonomy  
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Aesthetics

		W	A	J	IV	I	N	C	Ae
Genetic selection	embryo transfer	✗	✗	✗		✗	✗		

# Genetic selection through I.V.F.

- Steps
  - Ovum pick-up
  - Maturation, fertilization, culture, transplantation
- Drawbacks
  - Success rate: 4% of oocytes to birth
  - High offspring weight (big calf syndrome)



		Welfare	Autonomy	Justice	Intrinsic value	Integrity	Naturalness	Caution	Aesthetics
		W	A	J	IV	I	N	C	Ae
Genetic selection	in vitro fertilization	x	x	x		x	x		

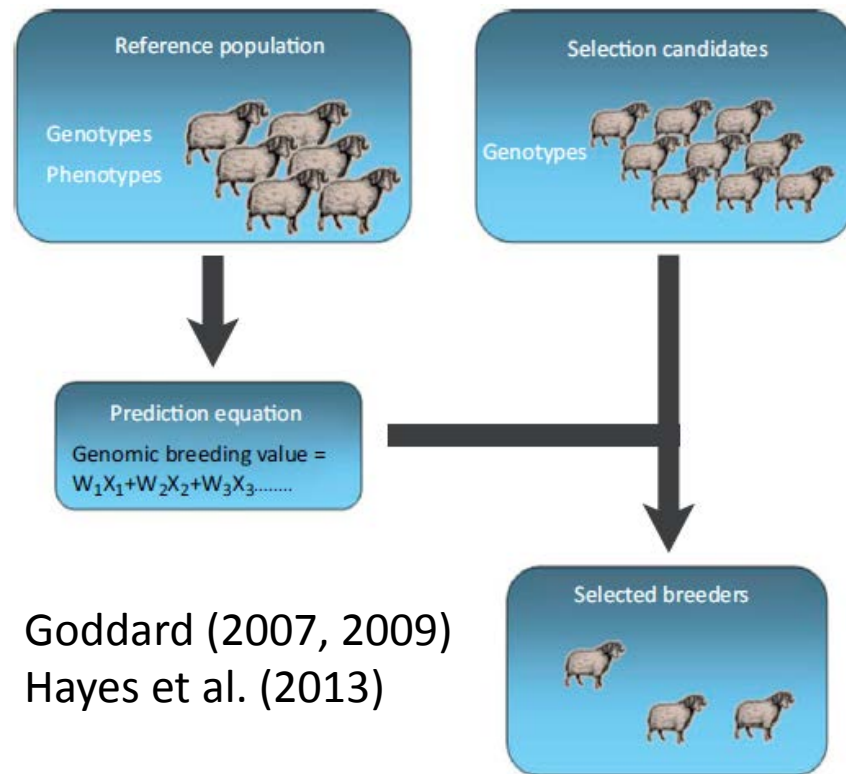
# Genomic selection

- Breeding goals ?
  - Production–related traits
  - Meat quality
  - Functional food
  - Disease resistance
  - Environment-friendly animals

Jacobs (2003)

Twine (2006)

Mark & Sandoe (2010)

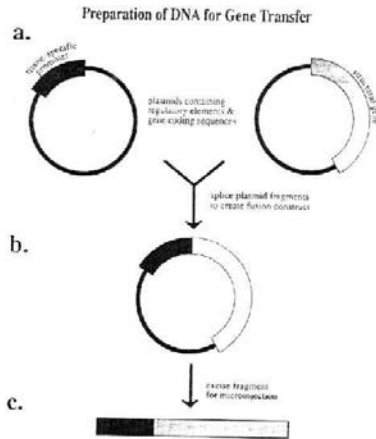


Welfare  
Autonomy  
Justice  
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Aesthetics

		W	A	J	IV	I	N	C	Ae
Genomic selection	breeding goals	✗	✗	✗		✗	✗	✗	



# Genetic breeding through transgenesis



## Uses: (Frewer, 2013)

- Production efficiency
- Bio-pharmaceuticals
- Xenotransplantation

## Low efficiency

(Eyestone, cattle, 1999)

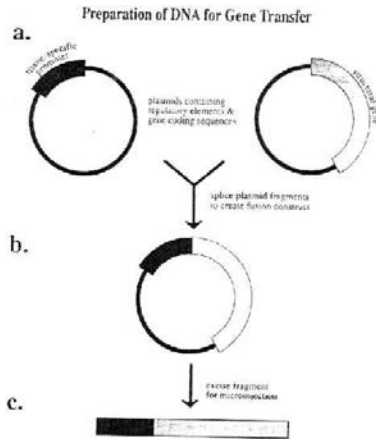
- microinjection: 36500
- transfers: 1470 (= 4%)
- births: 226 (15% = 0,60%)
- transgenic: 18 ( 8% = 0,05%)
- Transmission: 3 to 54 %

## Issues:

- Animal welfare
- Environmental effects
- Autonomy
- Intrinsic value
- Integrity
- Naturalness



# Genetic breeding through transgenesis

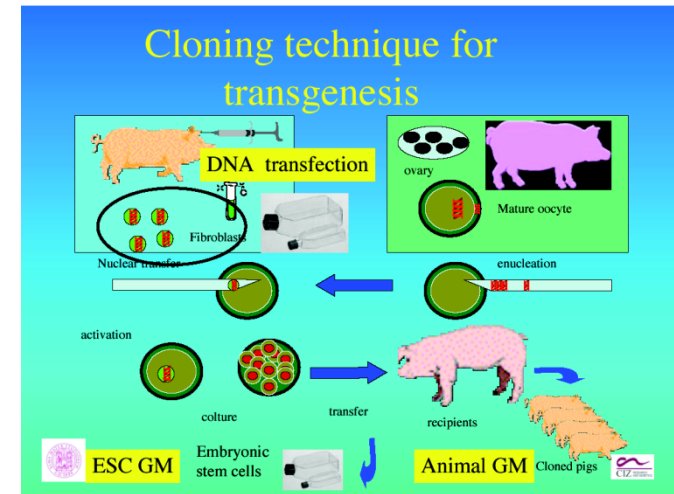
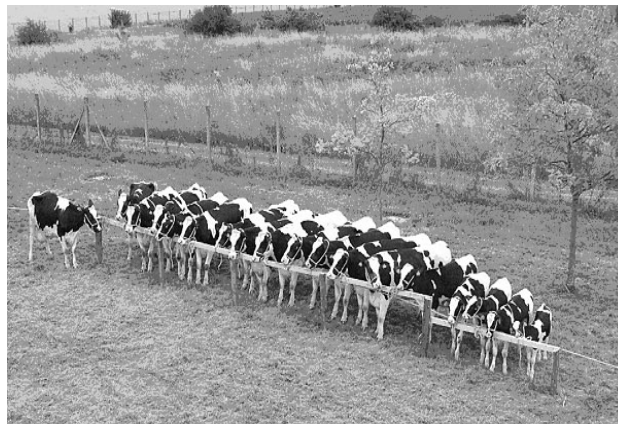
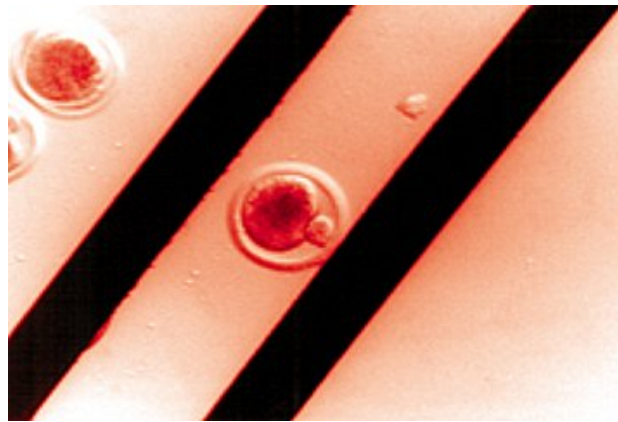
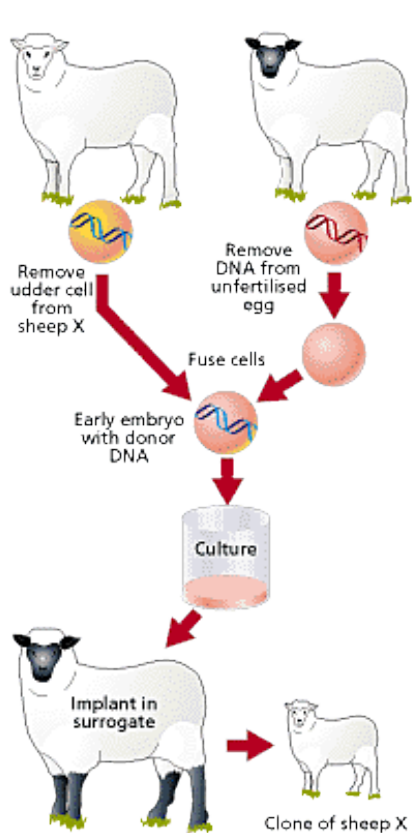


		Welfare	Autonomy	Justice	Intrinsic value	Integrity	Naturalness	Caution	Aesthetics
		W	A	J	IV	I	N	C	Ae
Transgenesis	production animals, transplantation, bio-pharmaceuticals	x	x	x	x	x	x	x	

Buning (2000), van Reenen (2001), Verhoog (2003), Kaiser (2004), de Vries (2004), Millar (2006), Montaldo (2006), Gjerris & Sandoe (2006), Hagen (2007), Daar (2007), Greger (2010)



# Genetic breeding through cloning



PNAS

Transgenic engineering of male-specific muscular hypertrophy

Divyesh Patel<sup>1</sup>, Luc Gruber<sup>1</sup>, Aniketa Adenwalla<sup>1</sup>, Frederik Kemm<sup>1</sup>, Christian Hansen<sup>1</sup>, Henrik Das Schröder<sup>1</sup>, and Michael Gorenfeld<sup>1</sup>

1Department of Animal Production and Food Utilization, Department of Pathology and Microbiology, Faculty of Veterinary Medicine, University of Guelph, Guelph, Ontario, N1G 2W1, Canada; 2Biology Department, University of Guelph, Guelph, Ontario, N1G 2W1, Canada; 3Department of Pathology, University of Guelph, Guelph, Ontario, N1G 2W1, Canada; 4Department of Pathology, University of Guelph, Guelph, Ontario, N1G 2W1, Canada; 5Department of Pathology, University of Guelph, Guelph, Ontario, N1G 2W1, Canada; 6Department of Pathology, University of Guelph, Guelph, Ontario, N1G 2W1, Canada; 7Department of Pathology, University of Guelph, Guelph, Ontario, N1G 2W1, Canada; 8Department of Pathology, University of Guelph, Guelph, Ontario, N1G 2W1, Canada; 9Department of Pathology, University of Guelph, Guelph, Ontario, N1G 2W1, Canada; 10Department of Pathology, University of Guelph, Guelph, Ontario, N1G 2W1, Canada

Commentary by James E. Watson<sup>1</sup>, Susan Altmann<sup>1</sup>

10.1073/pnas.1211111109

Research Article

Cloned transgenic cattle produce milk with higher levels of  $\beta$ -casein and  $\kappa$ -casein

Rajat Singh<sup>1</sup>, David R. Beitz<sup>1</sup>, Thomas Wheeler<sup>1</sup>, David Wenzel<sup>1</sup>, Peter Chubb<sup>1</sup>, and David Luby<sup>1</sup>

Published online 27 January 2013; doi:10.1073/pnas.1211111109

To enhance milk production and milk processing efficiency by increasing the protein concentration in milk, we have produced a transgenic cow with a higher level of  $\beta$ -casein and  $\kappa$ -casein. The milk of this cow contained 1.5-fold more  $\beta$ -casein and 1.5-fold more  $\kappa$ -casein than the milk of a nontransgenic cow. The milk of this cow also contained 1.5-fold more  $\beta$ -casein and 1.5-fold more  $\kappa$ -casein than the milk of a nontransgenic cow. The milk of this cow also contained 1.5-fold more  $\beta$ -casein and 1.5-fold more  $\kappa$ -casein than the milk of a nontransgenic cow.

ARTICLES

Genetically enhanced cows resist intramammary *Staphylococcus aureus* infection

Robert Hogg<sup>1</sup>, James R. Hogg<sup>1</sup>, David J. Hogg<sup>1</sup>, David R. Hogg<sup>1</sup>, Douglas D. Beaman<sup>1</sup>, Vernon G. Purcell<sup>1</sup>, Kevin D. Wells<sup>1</sup>, Neil Talbot<sup>1</sup>, & Harold W. Hogg<sup>1</sup>

10.1073/pnas.1211111109

Abstract: The most consequential disease in dairy cattle, mastitis, costs the US dairy industry billions of dollars annually. To test the feasibility of genetic control, we have produced a transgenic cow with a higher level of  $\beta$ -casein and  $\kappa$ -casein. The milk of this cow contained 1.5-fold more  $\beta$ -casein and 1.5-fold more  $\kappa$ -casein than the milk of a nontransgenic cow.

## Uses: (Niemann, 2012)

- identical production animals (e.g. meat)
- reproduce outstanding animals (e.g. horse)
- use in selection schemes
- reproduce transgenic animals



# Genetic breeding through cloning: drawbacks

## Low efficiency

	step	global
• oocyte enucleation:	60-92%	
• electro-fusion:	75-90%	
• activation:	60-80%	40%
• blastocyst:	20-40%	
• pregnancy:	20-30%	4%

## Postnatal mortality (Chavatte-Palmer 2004)

- Large offspring syndrome: 33%
- Thymus atrophy: 15%
- Kidney lysis: 11%
- Internal haemorrhage: 11%
- Sudden death: 7%

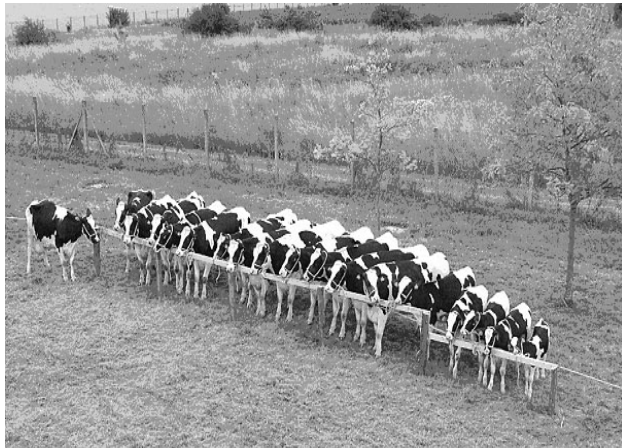
de Boer (1995)

Gjerris & Sandoe (2005, 2007)

Gonzales (2011)



# Genetic breeding through cloning



- identical production animals (e.g. meat)
- reproduce outstanding animals (e.g. horse)
- use in selection schemes
- reproduce transgenic animals

Welfare  
Autonomy  
Justice  
Intrinsic value  
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Caution  
Aesthetics

		W	A	J	IV	I	N	C	Ae
Cloning	meat cattle competition horses transgenic clones	x	x	x	x	x	x		

# Cases and values

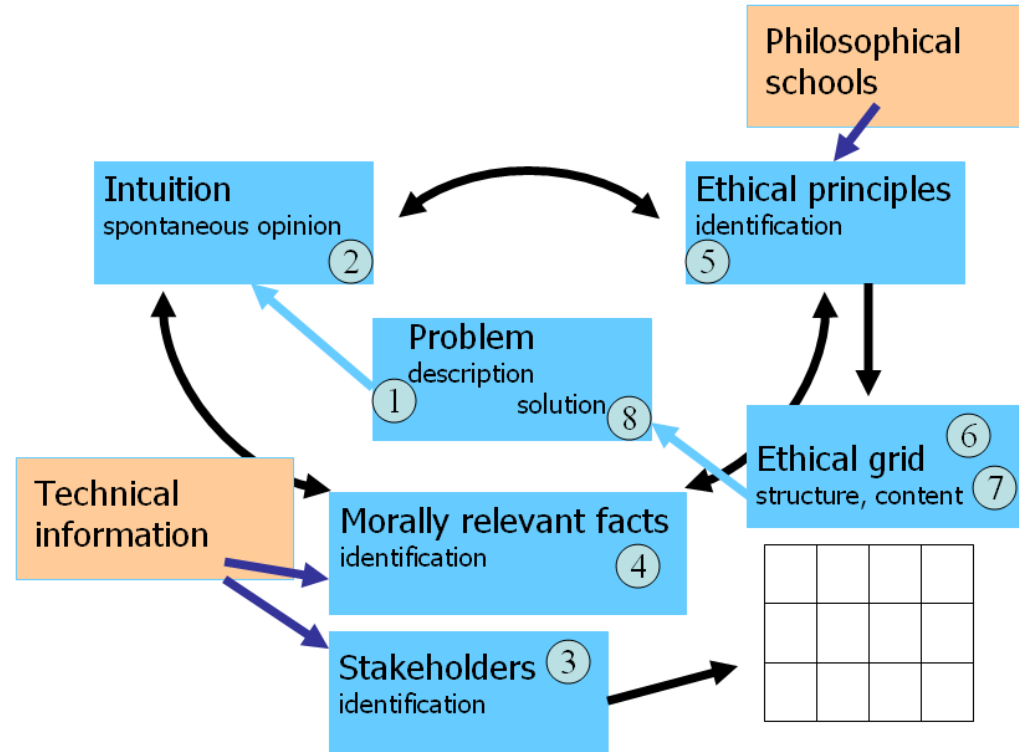
		Welfare	Autonomy	Justice	Intrinsic value	Integrity	Naturalness	Caution	Aesthetics
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Genetic selection	breeding goals, blind hens,	x	x	x				x	
	featherless chicken, polled ruminants	x	x	x	x	x	x		x
	artificial insemination	x	x	x				x	
	embryo transfer	x	x	x		x	x	x	
	in vitro fertilization	x	x	x		x	x		
Sex selection	calves, chicken	x	x	x			x		
Genomic selection	breeding goals	x	x	x		x	x	x	
Transgenesis	production animals, transplantation,	x	x	x	x	x	x	x	
	bio-pharmaceuticals								
Cloning	meat cattle								
	competition horses	x	x	x	x	x	x	x	
	transgenic clones								



# Ethical tools

		Well-Being	Autonomy	Justice
Cows	H	Welfare	Freedom of behaviour	Equity of conditions of life
	D			
	P			
Farmers	H	Income, Working conditions, Risks	Freedom of action	Commercial equity
	D			
	P			
Society	H	Security, Quality of life	Informed choice	Affordability
	D			
	P			
Environment	H	Conservation	Biodiversity	Sustainability
	D			
	P			

The Ethical Matrix  
B. Mepham (2000, 2004, 2005)



The Reflexive Equilibrium Method  
W. Van der Burg, T. Van Willigenburg (1998)  
B. Rutgers (2006)



# Conclusions

