

Cloned Cows and Biotech Beef: Does Animal Biotechnology have a Future? Alison Van Eenennaam, Ph.D. Cooperative Extension Specialist

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QUESTION: Is this a picture of a guinea pig?





Do you oppose the genetic modification of animals?

Yes
No









56% of Americans oppose scientific research into the genetic modification of animals http://pewagbiotech.org/research/2005update/2005summary.pdf







Unnatural genetic modification of animals..... like biotech beef





What is Biotechnology ?





Biotechnology Technology based on biology. The application of science and engineering to living organisms.



What isn't biotech beef?

- Selective breeding programs
- Artificial insemination
- Embryo transfer
- Genome-enabled or <u>genomic selection</u>
- Genetic engineering
- <u>Cloning</u>



Animal Biotechnology and Genomics Education



<u>Genomic Selection</u> (50,000 DNA marker-assisted selection !!)

Would you say your overall impression of genomic selection is....

- 1. Favorable
- 2. Unfavorable





<u>Genetic engineering</u> allows for traits to be moved precisely from one organism/animal to another

Would you say your overall impression of genetic engineering is....

- 1. Favorable
- 2. Unfavorable





66%



<u>Cloning</u> retains desirable genetics by producing an animal that is a genetically-identical copy.

Would you say your 54% overall impression of cloning is....

- 1. Favorable
- 2. Unfavorable





Public Attitudes Towards Specific "Animal Biotechnologies" (IFIC, 2005)



http://ific.org/research/upload/2005BiotechSurvey.pdf Animal Biotechnology and Genomics Education



Have you ever eaten a clone?

Yes
No





What is a clone ?



- <u>Cloning</u>, in horticulture and biology, any organism whose genetic information is identical to that of a "mother organism" from which it was created.
 - Food from clones has been a part of our diet for years. Many common fruits (e.g., pears, apples, oranges and lemons) and several vegetables (e.g., potatoes and truffles) are clones.





The public opposes the cloning of animals





Have you ever eaten milk or meat from a cloned animal?

1. Yes 2. No





Mechanical embryo splitting



unrelated surrogate mother

Pregnancy is monitored by ultrasound

Sheep gives birth to identical twins

The Holstein association of America has registered 2319 embryo split clones (ETS) through October 2002 – probably the most widely recognized were **DUPLICATE** and **DIVIDE**.



Cloning by embryo splitting





Have I ever eaten products from a cloned animal? YES!!

Therefore most of us have probably ingested meat and dairy products from livestock cloned by natural reproduction (monozygotic siblings), mechanical embryo-splitting, or even nuclear transfer from an embryonic donor cell into an enucleated oocyte.



Nuclear transfer from an <u>adult</u> donor cell into an enucleated oocyte.



Dolly (1996)











Clone Lamb of Ewe "A"



Dolly rapidly became entangled with the debate over human cloning



Ensuing discussion failed to elaborate on the reasons as to why cloning was developed

Dolly the cloned sheep kills a lamb - and EATS it!

By MIKE FOSTER / Weekly World News

EDINBURGH, Scotland - A frightened sei-doesn't seem to enjoy very entist says Dolly the cloned sheep has killed a young lamb - and eaten it!

What's more, the world's first cloned mammal has exhibited other strange be cyes full of hate," coung child, biting a keeper said a researcher inand staring menacingly at volved in the cloning

project. razzled scientists. Dolly's eerie antics "When you do something to - including the "cannger her, she looks at you nibalism"

two months ago. "A keeper was much," recalled the researcher. "When his back was turned, she bowled him over, then nipped his

face, drawing blood.

"Another time J brought my 8-yearold daughter to see Dolly in her pen. She was thrilled and was





Who's Buying?

\$20,000



Regancrest Emory Derry died unexpectedly.







Are the milk and meat from SCNT clones safe for human consumption?

On January 15th, 2008 the FDA published its final 968-page risk assessment on animal cloning. This report, which summarizes all available data on clones and their progeny are as safe to eat as food from conventionally bred animals



U.S. has a science-based regulatory system

YAG		PHOTO GALLERY	197 Bossler F	Rd, Elizabethtown, PA 17022	
Livestock Cloning and Genetic Preservation			Ph: 866.783.6226		
Beef Cattle	Dairy Cattle	Rodeo Stock	Swine Breeds	HOME	
"Paradise"		Cloning gives yo	u the ability to realize	the value of a truly	

"Paradise" A Supreme Champion

Cloning gives you the ability to realize the value of a truly great cow both from the breeding and merchandizing standpoint



Vandyk-K Integrity Paradise, the two time Supreme Champion at the World Dairy Expo, was an easy choice for her owners to clone. When you have an individual this good you need to have more copies of her to realize her true value. Cashing in on her value is just what they did when they sold a Paradise clone for \$50,000. The merchandising options you get from cloning are just fantastic, because you still have the genetic material to work with.

Paradise's Clone Wins!!!

Paradise 2 Selected All-American <u>Sr. 2 Year Old</u>







not milk?

TELL THE FDA: KEEP ANIMAL CLONES OUT OF OUR FOOD



Cloned Food is Coming. But YOU Can Stop It!

URGENT ACTION: FDA is poised to approve milk and meat from animal clones. Send your comments to FDA today.



www.centerforfoodsafety.org



Of the Americans who are uncomfortable or unsure about animal cloning; their primary concern is:



http://pewagbiotech.org/research/2005update/2005summary.pdfAnimal Biotechnology and Genomics Education





- 1. Government regulators <u>should include ethical and moral</u> <u>considerations</u>, in addition to scientific evaluation of risks and benefits, when making regulatory decisions about cloning or genetically modifying animals.
- 2. Though ethical and moral considerations are important, government regulators <u>should consider only scientific</u> <u>evaluation of risks and benefits</u> when making regulatory decisions about cloning and genetically modifying animals.



http://pewagbiotech.org/research/2005update/2005summary.pdf



Animal cloning regulations in Denmark and Norway prohibit cloning for food and agricultural purposes.

"Alicia"



An International Star

Winner at the prestigious International Dairy Show in Madison, WI and at the Royal Winter Fair in Canada, Shoremar S Alicia was cloned in 2001. The clone calf, born in winter of 2002, was one of the favorites when she was at Cyagra. Using the merchandising options that cloning creates, Alicia's owners sold Alicia's Clone before it was born for \$100,000 in October of 2002.

Shoremar S Alicia 3E-97 6-10 2x 365d 35,760 4.3 1541 3.2 1147 All-American Age Cow 2003 All-American & All-Canadian 5-Year Old 2000 All-American People's Choice Winner 2000 Holstien International Cow of the Year 2000 All-Canadian 4-Year Old 1999 All-Canadian Jr. 2 Year Old 1997 Nominated for QII – Queen of the Breed 2004



January 2007: The European Food Standards Agency is seeking urgent legal advice after farmers announced the <u>birth of a calf whose genetic mother</u> is the clone of an American prizewinning dairy cow.



Which clones will be labeled?

- Legislative bills calling for the mandatory labeling of products derived from clones <u>and their offspring</u> have been introduced
- Is the intent of such labels food safety or ethical misgivings?
- If it is ethical, then unclear why all clones are not subject to these labeling requirements?



CASE STUDY

Should we genetically engineer animals improved health and welfare? If we can genetically enhance disease resistance – are we obligated to do so – and if not why not?





Transgenic cows expressing an antibacterial endopeptidase in their mammary glands show enhanced resistance to mastitis.



Wall,R.J. *et al.* 2005. Genetically enhanced cows resist intramammary Staphylococcus aureus infection. *Nature Biotechnology* 23, 445-451. Animal Biotechnology and Genomics Education



CASE STUDY

Dog evolved from a common wolf like ancestor. Breeds have been developed for work and "companionship"



Is this more "natural" or more acceptable than genetic engineering?



Is animal biotechnology risky?

Excessive caution does not necessarily remove the risk of future catastrophes. It is possible that "playing it safe" by abandoning research and development in all forms of animal biotechnology might deny us a technique or products which could prevent an environmental disaster in fifty years time, or could prove invaluable in the treatment of some disease.

Would there be general acceptance of transgenic technology if it could be applied to engineering resistance to influenza in poultry and therefore lessen the risk of an influenza epidemic, such as the one in 1918 that killed more than 20 million people? Clark,J. & Whitelaw,B. 2003. A future for transgenic livestock. *Nat. Rev. Genet.* 4, 825-833





Hematech

Cloned transchromosomic calves producing human immunoglobulin

Yoshimi Kuroiwa¹, Poothappillai Kasinathan², Yoon J. Choi³, Rizwan Naeem⁴, Kazuma Tomizuka¹, Eddie J. Sullivan², Jason G. Knott², Anae Duteau³, Richard A. Goldsby³, Barbara A. Osborne⁵, Isao Ishida^{1*}, and James M. Robl^{2*}

Published online: 12 August 2002, doi:10.1038/nbt727

Human polyclonal antibodies (hPABs) are useful therapeutics, but because they are available only from human donors, their supply and application is limited. To address this need, we prepared a human artificial chromosome (HAC) vector containing the entire unrearranged sequences of the human immunoglobulin (h/g) heavy-chain (H) and lambda (λ) light-chain loci. The HAC vector was introduced into bovine primary fetal fibroblasts using a microcell-mediated chromosome transfer (MMCT) approach. Primary selection was carried out, and the cells were used to produce cloned bovine fetuses. Secondary selection was done on the regenerated fetal cell lines, which were then used to produce four heatthy transchromosomic (Tc) calves. The HAC was retained at a high rate (78–100% of cells) in calves and the h/g loci underwent rearrangement and expressed diversified transcripts. Human immunoglobulin proteirs were detected in the blood of newborn calves. The production of Tc calves is an important step in the development of a system for producing therapeutic hPABs.

TRANS OVA

JOINT VENTURE

RESEARCH DEVELOPMENT CENTER

http://www.hematech.com





Plasmapheresis to extract polyclonal antibodies from the blood of cloned, transchromosomic, knockout cattle carrying human immunoglobulin



Animal Genomics and Biotechnology Education



"Biotechnology must be used within ethical constraints. It is the task of bioethics to help society develop those constraints"

- American consumers (75%) and scientists (70%) agree that cloning and genetic engineering of animals raise some moral and ethical issues
- However public is much less likely to approve (21-25%) of these technologies than scientists (60-68%)

Keystone Research Center (2004) – Biotechnology and ethics: a national survey of consumers and scientists. Report to the Biotechnology Industry Organization. KRC Research, Washington DC, 29pp.



"Biotechnology must be used within ethical constraints. It is the task of bioethics to help society develop those constraints "

- American consumers (75%) and scientists (70%) agree that cloning and genetic engineering of animals raise some moral and ethical issues
- However public is much less likely to approve (21-25%) of these technologies than scientists (60-68%)
- Animal scientists must become conversant and willing participants in the consideration of ethical issues and concerns surrounding the implementation of their work if they wish to be involved in reaching the societal consensus as to *which ethical constraints* will ultimately be applied in determining acceptable uses of animal biotechnology











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1. Conventional: Antibiotic therapy









2. Natural: alternative therapy



"An infected cow should be given an extra tablespoon of dolomite night and morning until the infection clears. Hydrogen peroxide; 10 ml squirted straight into the affected quarter has cured black mastitis in hours."



3. <u>Genomic Selection</u> (DNA-informed selective breeding on a grand scale)



The use of 50,000 SNP markers across the entire genome enables an estimation of genetic merit

Can be used to predict genetic merit for mastitis resistance





4. <u>Genetic Engineering</u>: Transgenic cows show resistance to mastitis.

Usba United States Department Of Agriculture Agricultural Research Service





Transgenic Cows Resist Mastitis-Causing Bacteria

By <u>Rosalie Marion Bliss</u> April 4, 2005

WASHINGTON, April 4--U.S. Department of Agriculture researchers have used gene-transfer to called mastitis.

"This research is an important first step in understanding how genes can be used to protect anima Research Service (ARS).

This scientific discovery, published in the current edition of <u>Nature Biotechnology</u>, demonstrates t Currently, vaccines, antibiotics and a cow's own immune system cannot effectively fight the bacter

A scientific team led by <u>Robert J. Wall</u>, an animal physiologist with the ARS <u>Biotechnology and Ge</u> produced using recombinant DNA technology--that includes the genetic code for producing a natu

While all milk contains several naturally occurring antimicrobial proteins, such as lysozyme and la

Wall,R.J. *et al.* Genetically enhanced cows resist intramammary Staphylococcus aureus infection. *Nature Biotechnology* 23, 445-451 (2005).



5. <u>Clone</u> a bull whose daughters are very mastitis resistant and use these bulls to breed for mastitis resistance.





Which Animal Biotechnology would you use?

- 1. Conventional Treatment
- 2. Natural Therapy
- 3. Genomic Selection
- 4. Genetic Engineering
- 5. Clone a Resistant Bull







"We have recently advanced our knowledge of genetics to the point where we can manipulate life in a way never intended by nature. We must proceed with the utmost caution in the application of this new found knowledge."

LUTHER BURBANK, 1906

Creator of over 800 new plant varieties through plant breeding.

