





Breeding Objective



"A breeding objective need not be economic. For example, in many companion animal species it is tempting to believe that the breeding objective must be the maintenance of a ridiculous appearance and congenital abnormalities!"

(John Gibson, UNE)

The 8-week old body weight of broiler (meat) chickens has increased from 0.81 kg to 3.14 kg over the period 1957 to 2001, and approximately 80% of this four-fold increase has been the result of genetic selection.
 1957 vs. 2001 chickens 1957</l

































	Traits that might be if interest to edit in Beef cattle			
5	Polled/Horned			
	Myostatin			
	Recessive Genetic Conditions			
S	Tenderness loci (calpastatin/calpain)			
	Disease resistance (e.g. BRD)			
	SCD (stearoyl-CoA desaturase)			
No.	Editing would synergistically accelerate conventional breeding programs (not replace them!) by precisely bringing in discrete desired genetic variation as needed			









Will gene editing be a trigger for regulatory oversight? Yes/No/Maybe The Cartagena Protocol defines "Living modified organism" to mean any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology "Modern biotechnology" means the application of: a. In vitro nucleic acid techniques, including recombinant deoxyribonucleic acid (DNA) and direct injection of nucleic acid into cells or organelles, or

b. Fusion of cells beyond the taxonomic family,

that overcome natural physiological reproductive or recombination barriers and that are not techniques used in traditional breeding and selection







	Fast growing salmon The founder female was generated in 1989 – 28 years ago Nature Biotechnology 10:176 – 181. 1992
CALIFORNIA	0 1992 Nature Publishing Group http://www.nature.com/naturebiotechnology
	GROWTH ENHANCEMENT IN TRANSGENIC ATLANTIC SALMON BY THE USE OF AN "ALL FISH" CHIMERIC GROWTH HORMONE GENE CONSTRUCT. Shao Jun Du, Zhiyuan Gong, Garth L. Fletcher', Margaret A. Shears', Madonna J. King', David R. Idler' and Choy L. Hew' Rement Institute, The Monging for Sid, Children and Departments of Children Binder Mention of Markowski (Univ. Rement Institute, The Monging for Sid, Children and Departments of Children Binder Mention, University of Networkshot, Children and Alexies. "Comparison of the Monging of Children Binder Mention of Monging Children Binder Mention of Monging Children Binder Mention of Children Binder Mention of Children Binder Mention of Monging Children Binder Binder Mention of Monging Children Binder Bi
X	We have developed an "all fish" growth hormone (GH) chimeric gene construct by using an antifreeze protein gene (AFP) promoter from ocean pout linked to a chinook salmon GH cDNA clone. After microinjection into fertilized, nonacti- vated Atlantic salmon eggs via the micro- pyle, transgenic Atlantic salmon eyes vas
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	Use of gene editing to introduce a naturally-occurring polled allele into Holstein cattle versus selective breeding				
	Attribute	Polled Holstein through gene editing	Polled Holstein through introgression		
	Phenotype: No horns	YES	YES		
	Mutation uniquely detectable	NO – polled allele	NO – polled allele		
	Food safety concerns associated with phenotype	NO	NO		
	# generations taken to achieve polled >15/16 Holstein	ONE (FAST)	MANY (SLOW)		
	Linkage drag?	NO	YES		
	Improved animal welfare	YES	YES		
	Regulated?	Yes because of human intention???	NO		
	Likely to happen	Not if takes years and costs millions of dollars	NO		
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Many animal breeding goals, including gene edited animals, have the potential to address sustainability goals including improved animal well-being, efficiency and reduced environmental footprint





Breeding programs increasingly utilize a combination of advanced reproductive technologies and genomic tools to accelerate the rate of genetic gain.

There are a number of biotechnologies that involve the use of *in vitro* processes, and many result in genetic modifications that are indistinguishable from the naturally-occurring variation that is the driver of both traditional breeding programs and evolution.

A number of useful traits including disease resistance and animal welfare traits have been successfully introduced into various livestock species using both genetic engineering and gene editing techniques.

Ultimately these biotechnologies complement the genetic improvement that can be accomplished using traditional selection techniques and, if judged acceptable, offer an opportunity to synergistically accelerate genetic improvement in food animal species.



