The Changing Landscape of Milk and Milk Products – What's next?

Phillip S. Tong
Professor, Dairy Science
California Polytechnic State University
San Luis Obispo, CA

CAL POLY
DPTC
DAIRY PRODUCTS TECHNOLOGY CENTER

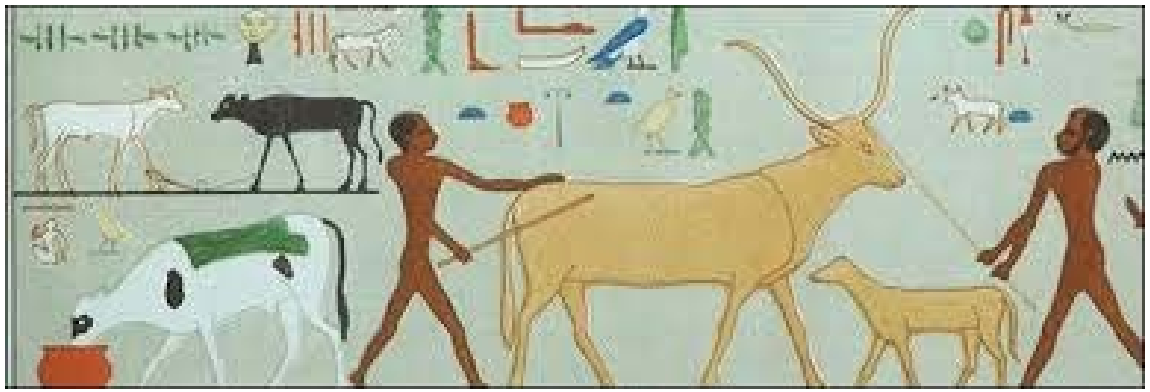
Neolithic times (9000 - 4000 BC – Domestication of animals

Initially hunter gatherers then Global warming

From Hunter/Gatherers, to Nomadic tribes to Settled Communities

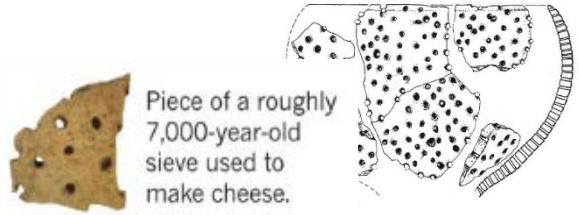
Domestication of animals in the Fertile Crescent

- Goats/sheep Middle East, nomadic pastoralists
- Meat
- Establishment of communities



Development of Lactase Persistence ~ 7,500 years ago

Gene-culture co-evolution

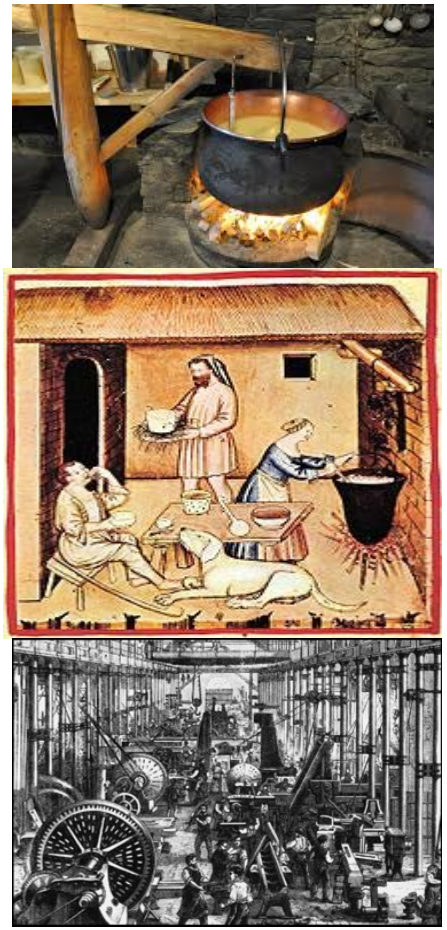


- Reduction of lactose through sieve straining of fermented milks
- Genetic mutation allowed for lactase persistence into adulthood
- Rapid spread of lactase persistence mutation

http://www.nature.com/news/archaeology-the-milk-revolution-1.13471

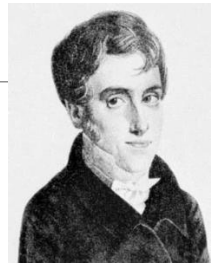
Post-Neolithic time (food preservation)

- Secondary Products Revolution - Bronze Age (3700 – 500 BC)
  - shifted their plant and animal exploitation
    - milk and blood could be used to make a variety of foods, some of which could be stored for long periods
    - Wool and plant fiber used to make cloth, netting, baskets and even structures.
- 3000 BC – 1500 AD – Widespread us of milk and milk products (artisanal approaches
- 1700's – 1800's Industrial revolution (mass production)

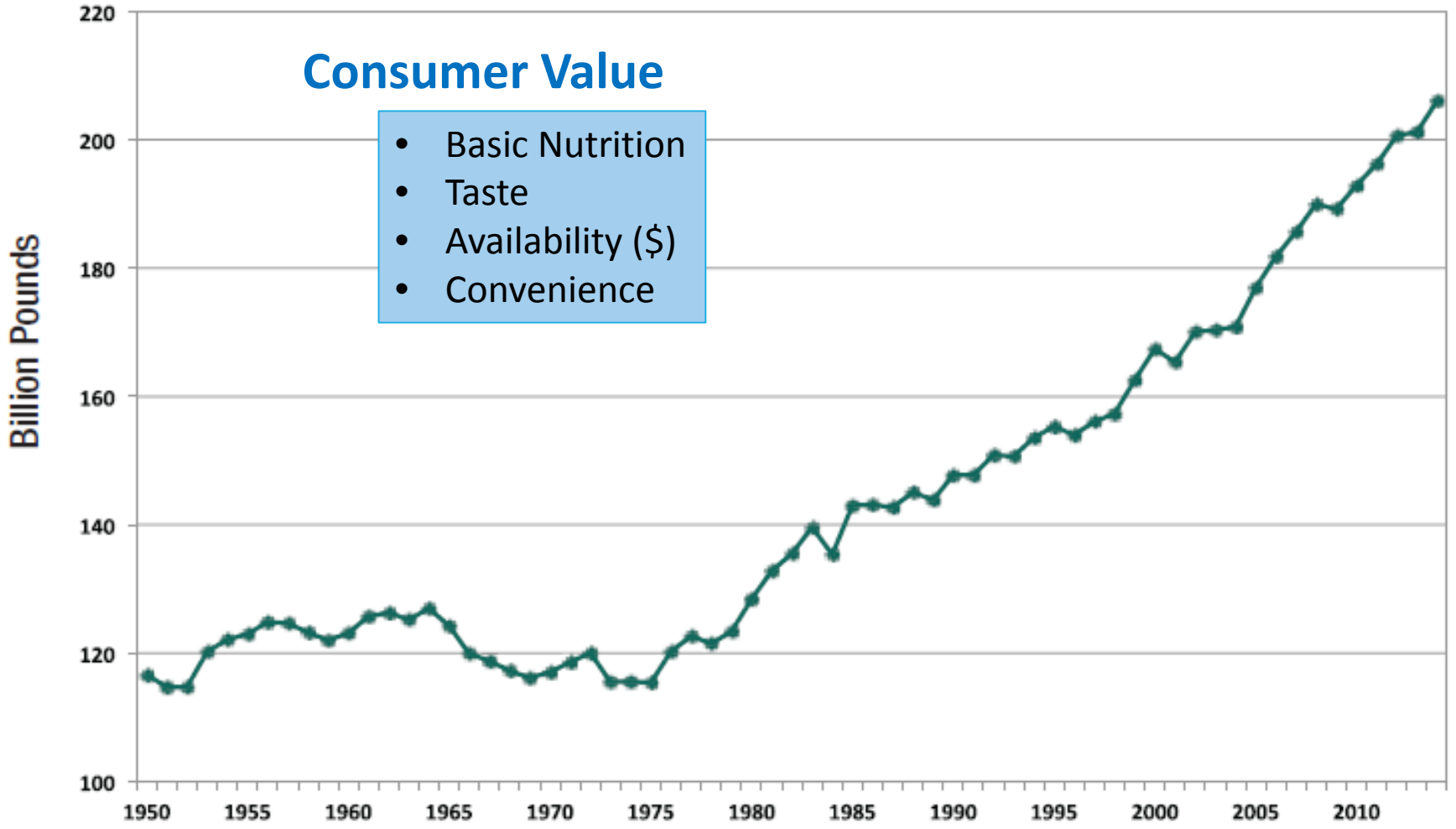


Dairy Technology Development

- 1795 Nicolas Appert – discovery of canning
- 1856 Pasteur experiments start, Gail Borden received first patent on condensed milk
- 1878 Continuous centrifugal cream separator invented by Dr. Gustav De Laval.
- 1884 Milk bottle invented by Dr. Hervey D. Thatcher, Potsdam, New York.
- 1890 Test for fat content of milk and cream perfected by Dr. S.M. Babcock.
- 1933 U.S. Public Health Service Milk Ordinance and Code (established pasteurization)
- 1948 UHT Processing introduced
- 1964 Plastic bottle introduced1976
- 1976 EPA ruling on pollution from cheese whey – applications of membrane technology
- 1990 Nutrition Labeling and Education Act requires mandatory nutrition labeling.



Total U.S. Milk Production, 1950-2014



Consumer Value

- Basic Nutrition
- Taste
- Availability ($)
- Convenience

Source: USDA, National Agricultural Statistics Service.

Milk – an amazing food material

Forming Food Structures with milk

spoon, slice, shred, spread, grate, melt, grate, foam . . .

Milk

- Cheddar (sliceable)
- Yogurt(spoonable)
- Mozzarella (stretchable)
- Cream cheese (spreadable)
- Processed cheese(meltable)
- Parmesan cheese (grating)
- Cottage cheese (particulate)
- Whipped cream (foam)



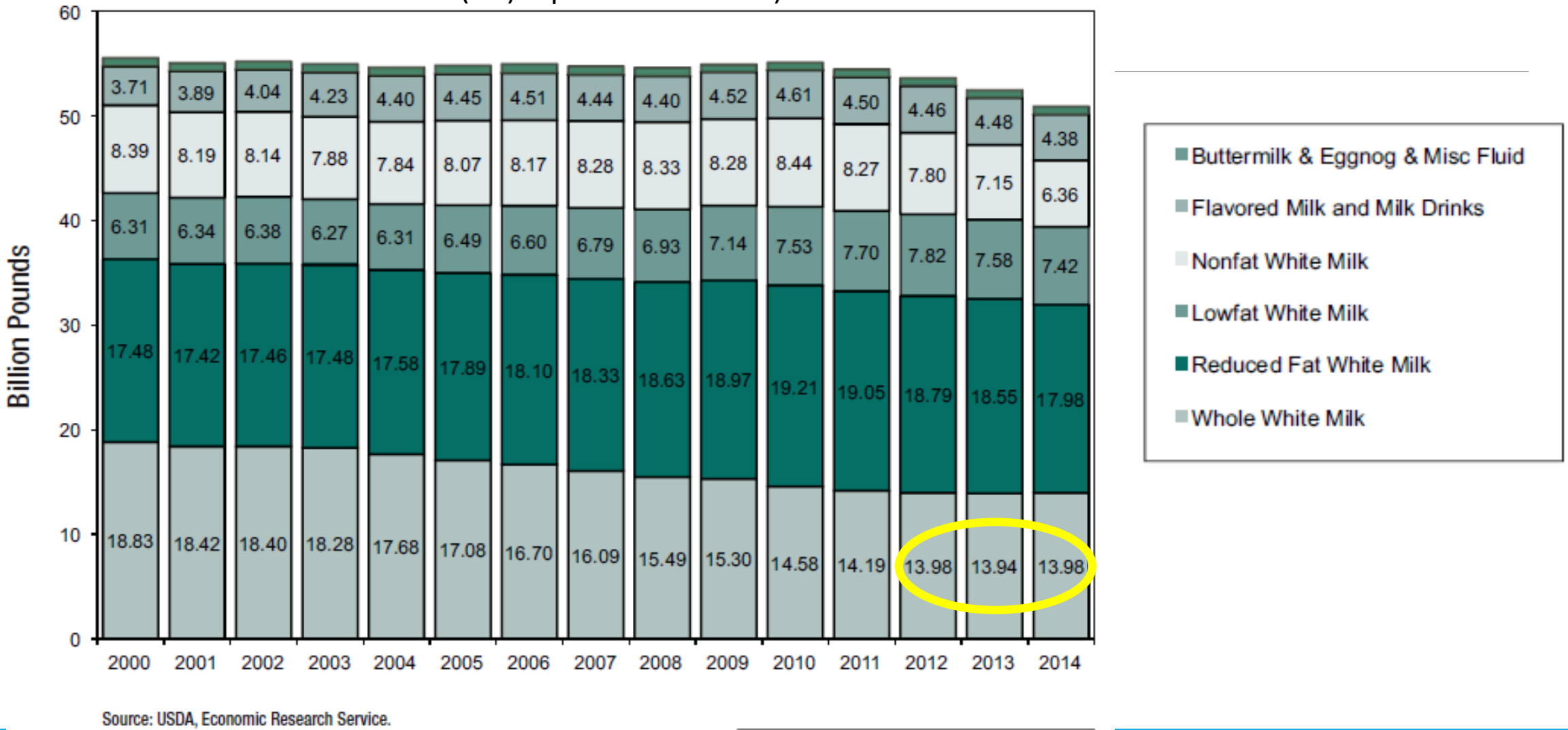





U.S. Fluid Milk Product Sales by Product and Total, 2000-2014

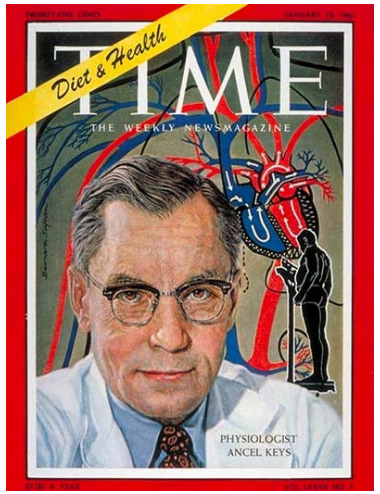
-3% in total milk sales from 2013

2014 total sales (lbs) equivalent to 1970)

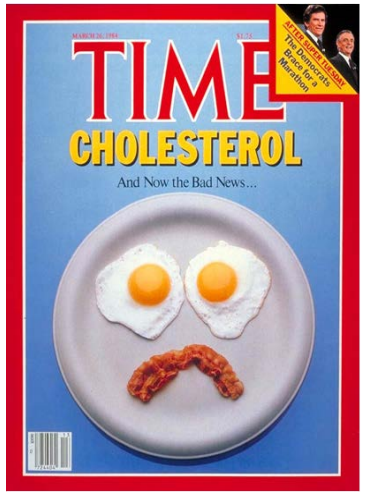


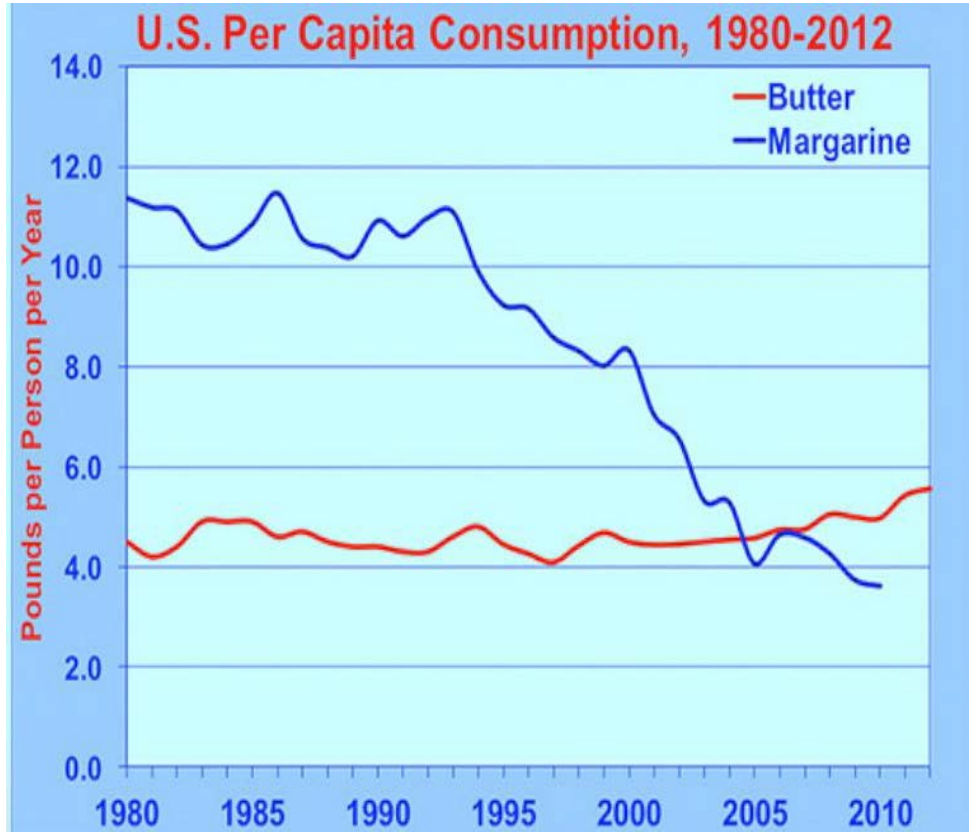
Source: USDA, Economic Research Service.

Jan 13, 1961



March 26, 1984





2014-15


8th
continent
soymilk
Low Fat
Excellent Source of Calcium
Chocolate


ONLY 40 CALORIES PER SERVING
CALIFIA FARMS
UNSWEETENED
Pure
ALMONDMILK
PASTEURIZED • HOMOGENIZED
50% MORE CALCIUM THAN MILK
48 FL OZ (1.4 L)


New
ORIGINAL
Silk
Cashewmilk
Irresistibly Creamy
60 CALORIES PER SERVING
Creamier than skim milk!
NON GMO Project VERIFIED
HALF GALLON (1.89 L)


KIRKLAND
Organic
RICEMILK
Original
12 1-QUART CARTONS (11.4 LITERS)


SO DELICIOUS
DAIRY FREE
USDA ORGANIC
COCONUT MILK
BEVERAGE
45 CALORIES PER SERVING
UNSWEETENED
SOY & DAIRY FREE
GOOD SOURCE OF CALCIUM
SERVING SUGGESTION
32 FLUID OZ (1 QT) 946 mL


UNSWEETENED
NEW!
CREAMY DELICIOUS GOOD FOR YOU!
Good Karma
Flax milk
DAIRY FREE
PROTEIN+
PLANT-BASED PROTEIN 5g
NO LACTOSE · GLUTEN FREE · TREE NUTS · SOY
OMEGA 3s PER SERVING 1200 mg
UNSWEETENED
Original
HALF GALLON (1.89L)


Rice
VEGAN
PEPPER JACK FLAVOR
Rice Vegan Slices
DAIRY & SOY FREE • CHOLESTEROL & LACTOSE FREE
MADE FOR MELTING • EXCELLENT SOURCE OF CALCIUM
10 slices
NET WT 5.7 OZ (190g)


daiya
deliciously dairy free
Dairy, lactose, and casein free
Sans lait, lactose et caséine
Gluten and soy free
Sans gluten et soya
mozzarella style shreds
copeaux à saveur de mozzarella
0
0g
0g
90
calories


SO DELICIOUS
DAIRY FREE
Cashew Milk
NON-DAIRY FROZEN DESSERT
Salted Caramel Cluster


Tuna & Larry's
coconut
Bliss
non-dairy frozen dessert
Dark Chocolate
1 PINT (473mL)


THE ORIGINAL
Almond
Cheddar Style
The Good Health Cheese Alternative
NO Gluten
NO Cholesterol, GMO's, Lactose, Saturated Fats, or Preservatives!
Shreds, Melts, and Tastes Great!
Keep Refrigerated
Best within 7 days of opening
NET WT 8 OZ (226g)


Tofutti
SOUR CREAM
MILK FREE
Better than
SOUR CREAM
SOUR CREAM
SOUR CREAM


SO DELICIOUS
STRAWBERRY
Cultured
COCONUT
MILK
with Pre & Probiotics


SOY YOGURT
WholeSoy & Co.
BLUEBERRY
NET WT 6 OZ (170g)


daiya
deliciously dairy-free
BLUEBERRY
DAIRY & SOY FREE
GREEK YOGURT
STYLE


SO DELICIOUS
DAIRY FREE
6 Active Live Cultures
CULTURED
ALMOND MILK
PLAIN


SELL BY:
lucerne
PLUS PROTEIN
DAIRY BEVERAGE
REDUCED FAT
38% LESS FAT THAN WHOLE MILK
30% MORE PROTEIN
&
40% LESS SUGAR
THAN REDUCED FAT MILK†
NOT TREATED WITH GROWTH HORMONE rBST
NO ARTIFICIAL SWEETENERS
VITAMINS A & D
GRADE A, ULTRA-PASTEURIZED, HOMOGENIZED
HALF GALLON (1.89 L)


50% more protein
30% more calcium
*Compared to ordinary milk.
new!
2%
fairlife
believe in better milk.
reduced fat
ultra-filtered milk
from cows not treated with rBST†
52 FL OZ (1.5L)


70 Calories
milkwise™
turning milk on its head
original
milk beverage
33% less sugar
46% fewer calories
50% more calcium
Compared to reduced fat milk
40 Calories
milkwise™
turning milk on its head
reduced sugar
vanilla
milk beverage
67% less sugar
50% fewer calories
50% more calcium
Compared to skim milk

Why do we eat what we eat?

Physiological need

- Hunger/Satiety

Enjoyment

- Taste
- Entertainment (fun)
- Social acceptance

Health and Wellness

- Individuals
- Planet

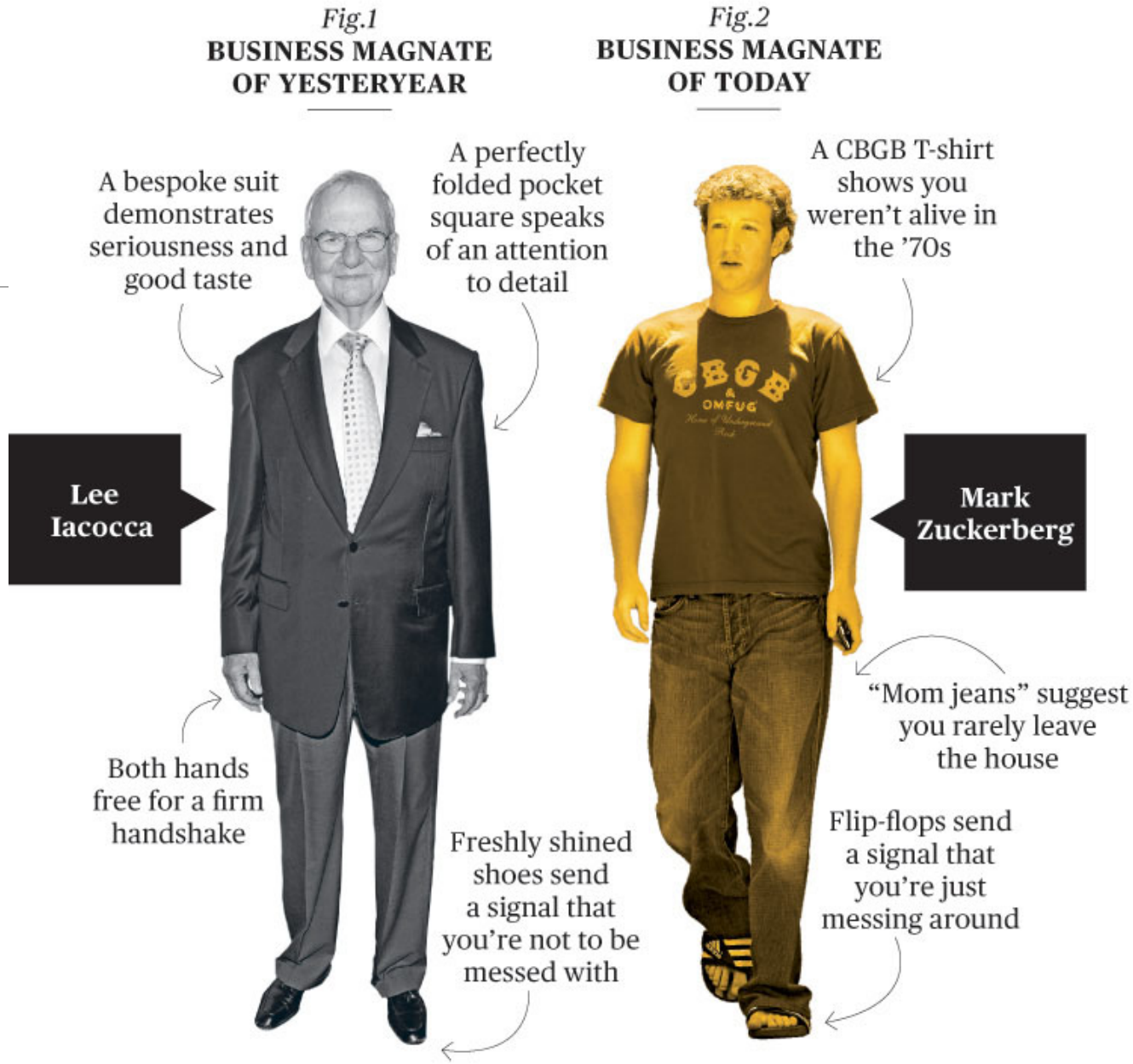
What does the future hold?

What is the target?

	2011	2030
Boomers	47-65 yrs	66-84 yrs
	76 million	56 million
Millenials	16-34 yrs	35-53 yrs
	79 million	78 million

Boomers vs. Millenials

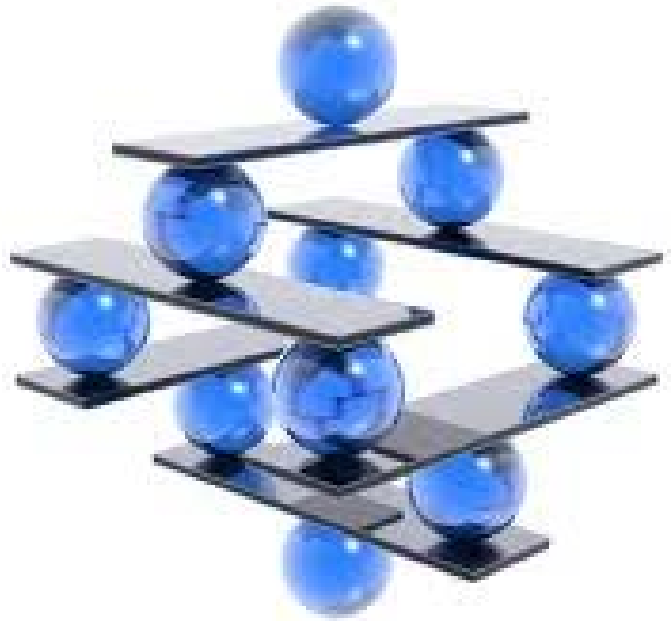
(customized i-phone/watch, $5 cup of coffee experience generation)



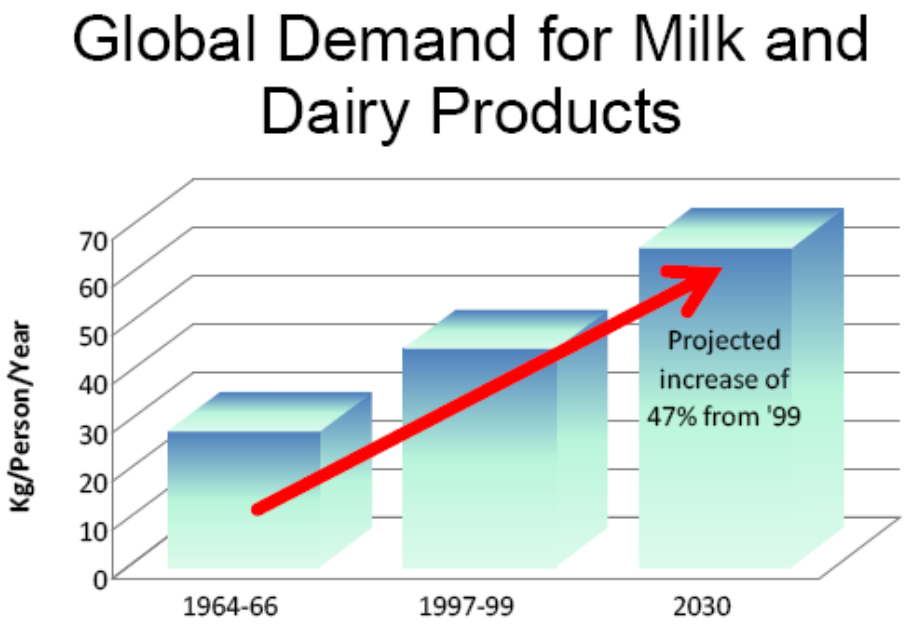
Dairy Foods & Dairy Ingredients

Striking the right balance . . . Public Good . . .Food Choice

- Price
- Convenience
- Sensory Quality
- Nutrition
- Environment
- Fairness/Justice
- Sustainability
- Manufacture
- Safety/traceability
- Wholesomeness, simplicity
- Retailing/Marketing



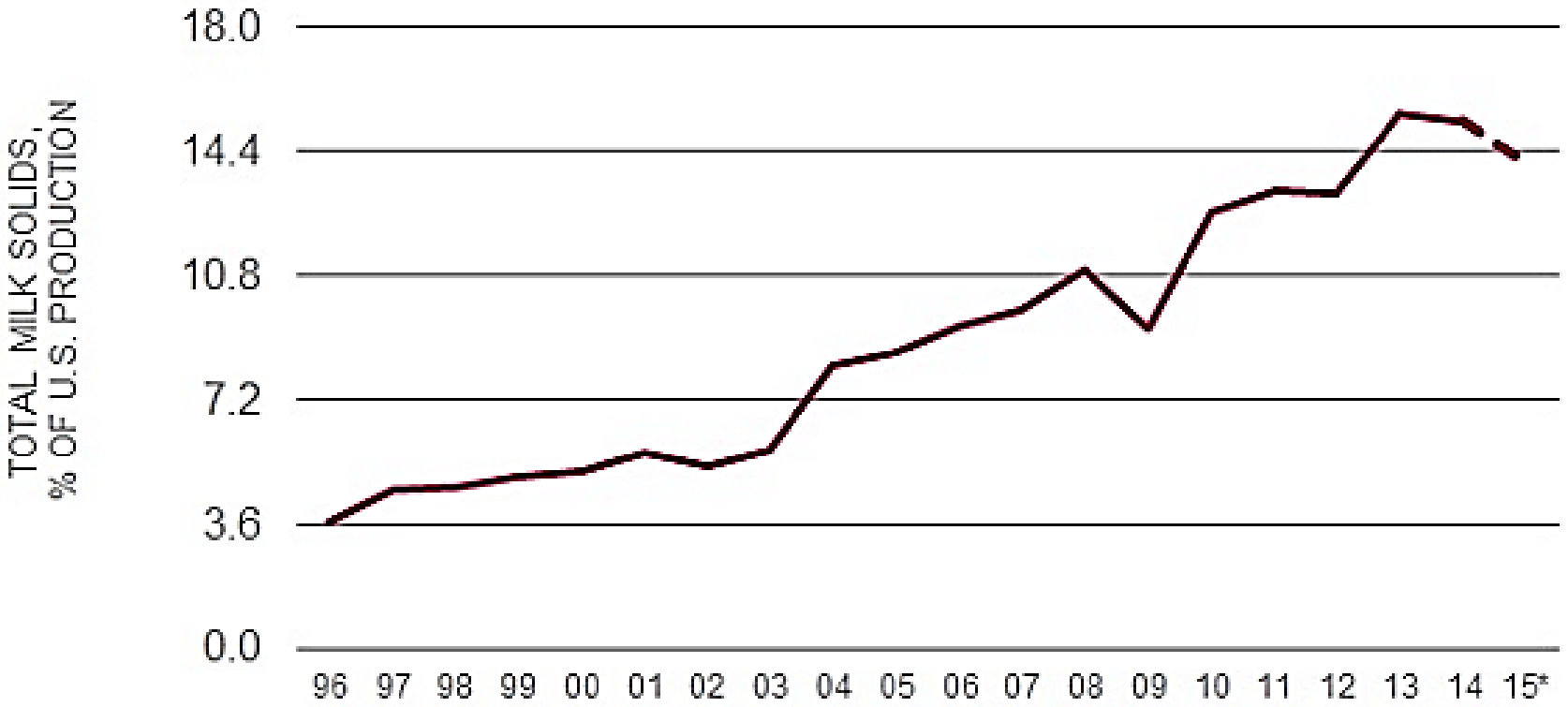
Where are dairy products needed/desired around the world and how will they obtain them?



Source: FAO, 2002; World agriculture toward 2015/2030

National Dairy Research Program

U.S. Dairy Exports - Percent of Production 1996-2015



* 2015 year-to-date through November. Source: U.S. Dairy Export Council, USDA.

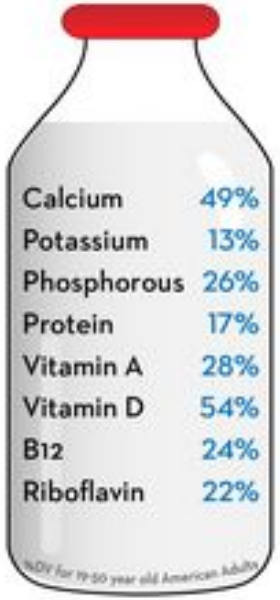
Will next generation of scientists and technologists bring new game changing discoveries and innovations?

Milk

Natures Perfect Food ??

9

ESSENTIAL NUTRIENTS IN MILK



Research Questions?

- What is optimal for dairy product composition?
- How is this “best” achieved?
  - Dairy farm practices (pre-harvest)
  - Dairy/food plant practices (post-harvest)
    - Mammary/lactation physiology and dairy cattle nutrition
    - Product and Process Science and Technology

Customized Milk

Pre-Harvest Approaches To Improve value

Scientists develop genetically modified dairy cows

A GM breakthrough that can be tolerated: Scientists develop genetically modified cows that produce low-lactose milk

By TOM GOODENOUGH

PUBLISHED: 03:12 EST, 17 June 2012 | **UPDATED:** 19:46 EST, 17 June 2012

- Chinese scientists have genetically modifying dairy cows to produce milk with different properties, the U.K.'s Daily Mail reports. Their accomplishments so far include:
  - Creating a cow with milk rich in omega-3 fats by inserting bacteria genes into her DNA.
  - Creating a calf that will give low-lactose milk.
  - Creating 300 dairy cattle that produce milk with the same nutrients and fat content as human breast milk, with the hopes that the cows could provide an alternative to formula.

% Hypolactasia (lactose intolerance)

http://nutrigenomics.ucdavis.edu/?page=Information/Concepts_in_Nutrigenomics/Lactose_Intolerance

65%

World's population has reduced efficiency to digest lactose after infancy (they are the non-mutants)

http://ghr.nlm.nih.gov/condition/lactose-intolerance

Table 1
% Hypolactasia (lactose intolerance)*

Race, Ethnicity, Country of Origin	Hypolactasia
Southeast Asians	98%
Asian Americans	90%
Alaskan Eskimo	80%
African-American Adults	79%
Mexicans (rural communities)	74%
North American Jews	69%
Greek Cypriots	66%
Cretans	56%
Mexican American Males	55%
Indian Adults	50%
African American Children	45%
Indian Children	20%
Descendents of N. Europeans	5%

* Assembeled by R. Rodriguez from various sources

Customized Milk and Milk Products

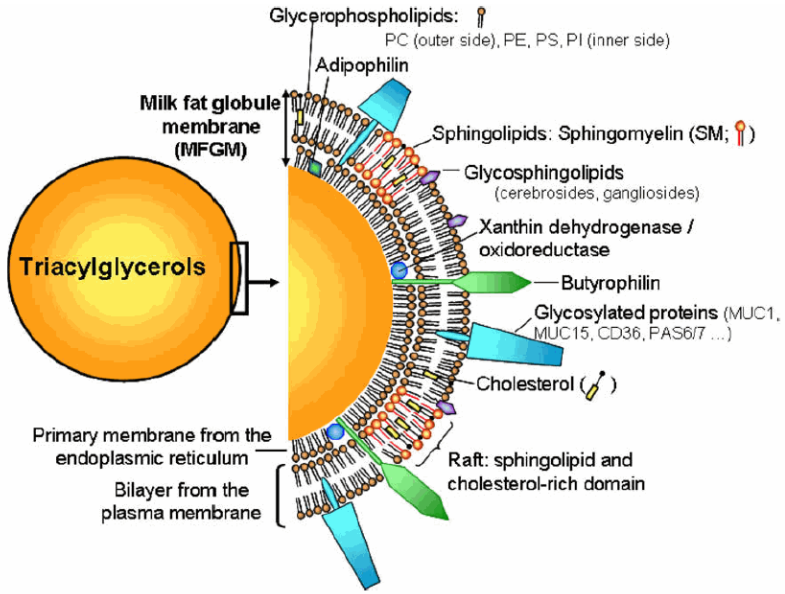
Post-Harvest Approaches to improve value

- Quality and Efficiency
  - Purification/isolation/concentration technologies
    - Whey & casein streams w/o cheesemaking and their application
    - Improving shelf-life and food safety
    - Gallon of milk in a third or less of its volume
  - Lactose hydrolysis/removal/replacement/utilization
- Non-thermal process technologies
    - Safety with high bioactivity?

Customized Milk and Milk Products

Post-Harvest Approaches to improve value

- Restructuring milk and dairy systems
  - Milkfat globule size separation, composition and use
  - Whey/casein optimization
  - Milkfat globule membrane components health benefits and utilization
  - Non-protein nitrogen fraction (in milk permeate)



The Washington Post

Search

Innovations

Man-made cow's milk may soon be a reality

Impossible Foods is developing a new generation of meats and cheeses made entirely from plants. Our mission is to give people the great taste and nutritional benefits of foods that come from animals without the negative health and environmental impact.

NEW HARVEST

Muufri

Cellular Agriculture Brewing Milk using Yeast

"If you have all the right ingredients, making milk by hand can actually be surprisingly easy," Ryan Pandya says. (Muufri)

MNIFT

CAL POLY DPTC DAIRY PRODUCTS TECHNOLOGY CENTER

Innovation capitalizes on natural variation of milk composition:

Anxiety, Insomnia : Night Milk

PHOTO: RACHAEL SAUNDERS FOR THE WALL STREET JOURNAL

- Melatonin
- Tryptophan

What will this mean for you through 2025?

. . . Change or stay the same?

Thanks for your attention!