

THE COMING REVOLUTION OF CULTURED MEAT?

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Manufacturing Industry in Ontario

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Cozzarin: cultured meat



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OUTLINE

- Introduction
- Biological process
- Benefits, barriers
- Market size
 - » vegetarian, vegan
 - » general population
- Cost
- Diffusion
- Effect on Agriculture



CAVEAT

- Today -> meat substitutes that are real animal tissue

- Next time(?) -> plant-based (meat-less) meat substitutes
 - » Impossible Foods, Beyond Meat, Alpha Foods, Sunfed Meats (chicken-free chicken)
 - » Heme – iron containing molecule necessary for all- plant and animal life -



INTRODUCTION

- Synthetic meat -- invention related to / driven by regenerative medicine:
 - » “Cultured Meat”, “Cell Cultured Meat”, “In Vitro Meat”, “Clean Meat”, “Lab Grown Meat”, “Alt-Meat”, “Ethical Meat”
- What is it?
- Cultured Meat = muscle tissue grown in lab from living tissue (starter cells) in bioreactors using growth medium



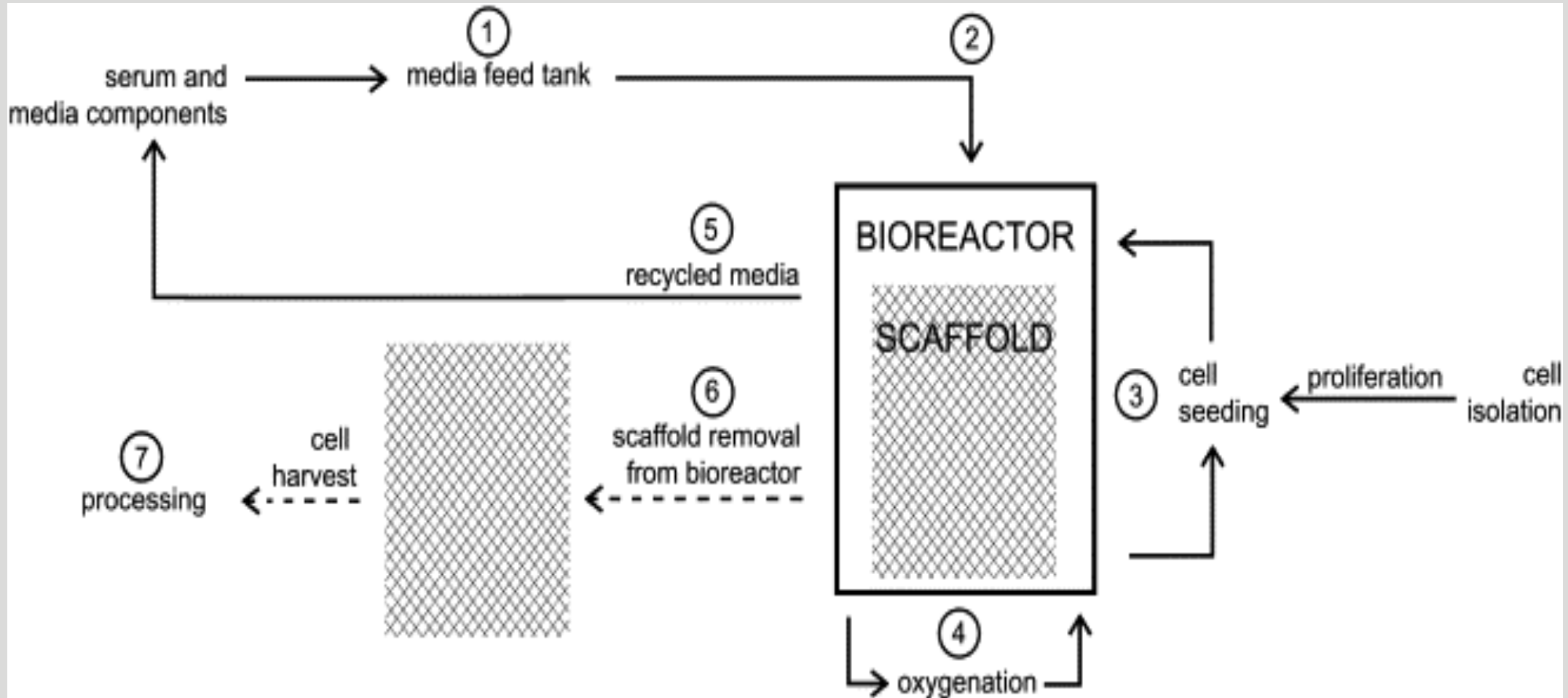
INTRODUCTION

- Research / commercialization:
- USA = Memphis Meats, Modern Meadow, JUST (Hampton Creek), Finless Foods (cultured fish)
- Netherlands = MosaMeat
- Israel = SuperMeat, Future Meat Technologies, Meat the Future
- Yuki Hanyu, Japan = Shojinmeat Project - DIY meat at home (high school kids)



BIOLOGICAL PROCESS

(pluripotent stem cell – endo / meso / ecto, iPSC)



» Datar, I., Betti, M., (2010) Possibilities for an in vitro meat production system, Innovative Food Science & Emerging Technologies, Volume 11, Issue 1, 13-22

BIOLOGICAL PROCESS

- Cell culture medium requires serum supplement:
 - » Bovine (calf) serum -- controversial
 - » Minimal-serum media: Essential 8 or TeSR-E8
 - » Essential 8 and TeSR-E8 formulated with DMEM/F-12 (ThermoFisher Scientific, 2018)
 - » DMEM/F-12 contains 3.151 g/L D-Glucose (dextrose)



http://tools.thermofisher.com/content/sfs/manuals/FAQ_Essen8_Medium_vitronectin_man.pdf



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BENEFITS

1. Meat safety (salmonella, listeria, e-coli, campylobacter)
2. Health benefits due to low saturated fat / infused with Omega 3
3. Resource usage < Traditional Ag (?) – Memphis Meat 3 calories to 1 calorie of bovine meat vs 23 to 1 conventional
4. = 13% energy use compared to conventional [no grazing land required, no cereals for finishing required]



BENEFITS

5. Actual meat without slaughter (PETA, vegetarians)
6. Little waste(?) – where does the used growth medium go – is it recycled (yes)
7. Less rendering / animal waste (nasty)
8. Potential to 'grow' any premium or rare meat: elk, buffalo, deer, ostrich, bear etc.



BENEFITS

9. Time to market:

- » Cattle – 9.4 mo. gestation; 36 months to market =
45.4 months
- » Pig – 3.8 mo. gestation; 10 months to market =
13.8 months
- » Chicken – 21 day incubation; 56 days to market =
2.6 months
- » **Vs. 6 weeks for cultured beef**

BARRIERS

- Consumer:
 - » appearance, color, taste, texture, price(!)
 - » no bones, no steak, no roast (Johnson et al. 2018)
 - » strong aversion to GMOs (Europe, Japan)
 - » Frankenfood
- Conventional Ag:
 - » US Cattlemen's Association does not want “meat” in the name of the product



<https://www.cnn.com/2018/09/17/consumers-arent-necessarily-sold-on-eating-cultured-meat-from-a-lab.html> <https://gmo.geneticliteracyproject.org/FAQ/where-are-gmos-grown-and-banned/>

BARRIERS

- Legal / regulatory issues: USDA wants regulatory oversight
- FDA wants oversight because there is no carcass and thus USDA inspection is unwarranted
- Better for Ag if USDA 'wins'

POTENTIAL MARKET SIZE

- “From an investment standpoint, this is potentially a trillion-dollar market opportunity,” – venture capitalist
- Vegetarians / those interested in animal welfare: *could be* earliest adopters – would they eat “ethical meat”?



<https://www.wired.com/story/the-high-cost-of-lab-to-table-meat/>

POTENTIAL MARKET SIZE

- From 3.3% (Harris Poll, 2016) – 5.3% (OSU, 2018) are vegetarian or vegan in US
- Thus vegetarian/vegan market: 10.7 – 17.3 million
- Half vegetarians are vegan (Harris Poll, 2016)
- Vegan market: 5.4 – 8.6 million



POTENTIAL MARKET SIZE

1. 60% vegans said they would 'try it'
2. US general population:
 - 33% (MSU, 2018) to 40% (Ingredient Communications, 2018) would eat it
3. 107.5 – 130.3 million potential
4. Tyson invest\$-> Memphis Meats & Beyond Meat
5. Cargill invest\$-> Memphis Meats

<https://www.datasmoothie.com/@surveygoo/nearly-one-in-three-consumers-willing-to-eat-lab-g/>

» https://www.vrg.org/nutshell/Polls/2016_adults_veg.htm
<https://www.cnbc.com/2018/09/17/consumers-arent-necessarily-sold-on-eating-cultured-meat-from-a-lab.html>

COST (AVC \$/LB)

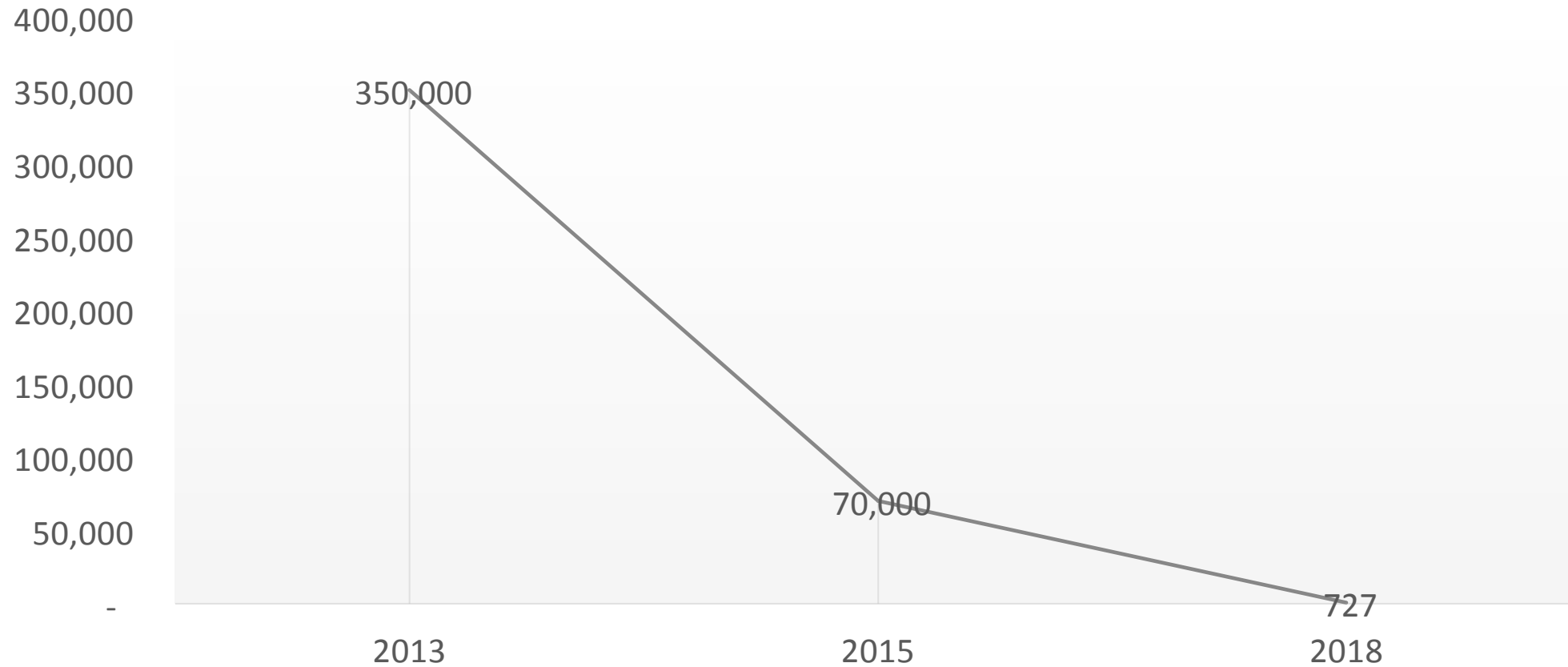
- Mark Post (Maastricht U, 2013) -> \$350,000 for 0.303lb patty (\$1,155,116/lb)
- Mark Post (Maastricht U, 2015) -> \$70,000 for 0.303lb patty (\$231,023/lb)
- Memphis Meats 2018 -> \$2,400/lb
- MM goal \$5/lb (scaling up, learning-by-doing)



https://www.washingtonpost.com/news/wonk/wp/2015/05/20/meet-the-future-of-meat-a-10-lab-grown-hamburger-that-tastes-as-good-as-the-real-thing/?noredirect=on&utm_term=.4a6ba82b9caa

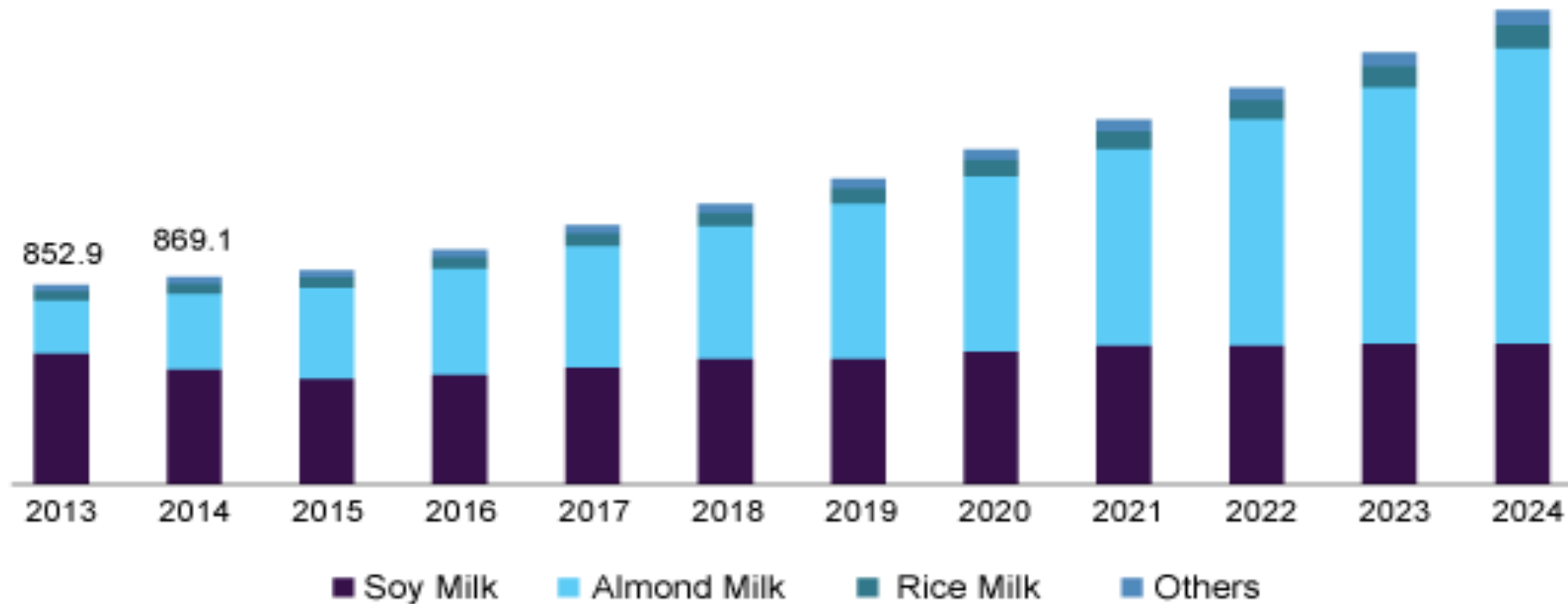
COST – LEARNING BY DOING (CULTURED MEAT)

\$/patty



DIFFUSION / MKT PENETRATION

U.S. dairy alternatives market size, by product, 2013 - 2024 (USD Million)



DIFFUSION

1. If surveys correct -> 108 – 130 million Americans will 'try' cultured meat
2. What proportion will substitute for ground beef / pork / chicken permanently?
3. Right now – *only* ground beef/pork/chicken
4. But(!): hamburgers, hotdogs, sausage, nuggets – at home / away from home



DIFFUSION

- 18 Sep, 2018 White Castle, national rollout – Impossible Slider (Impossible Foods)
- Applebee's, Bareburger, Wahlburgers using Impossible Food burger 'meat'
- A&W (Canada) now selling Beyond Meat burger



EFFECT ON AGRICULTURE

- Memphis Meats claim -- 1% of land, 1% of water compared to traditional ag
- Memphis Meats 3-to-1 calories vs 23-to-1 conventional for beef
- 40-45% of US beef consumption is ground beef
- “The average American will eat the equivalent of 800 hamburgers in 2018” (Purdy, 2018)



<http://beef2live.com/story-ground-beef-united-states-128-104332>

<https://qz.com/1171669/the-average-american-will-eat-the-equivalent-of-800-hamburgers-in-2018/>

EFFECT ON AGRICULTURE

- Let's agree 40% US beef cons is ground beef
- If 30% consumers eat/adopt cultured meat—
12% of beef market will be 'lost'
- 12% fewer cattle (at 2017 cons = 3.9 million)
- 12% less cropland for feed(?)



2017: 32.2 million head cattle slaughtered (USDA, 2018)

EFFECT ON AGRICULTURE

- For Canada same assumptions (total cattle slaughter 2017 = 2.98 million)
- 12% reduction in cattle demand ~ 360,000 fewer head

EFFECT ON AGRICULTURE

- What growth rates in adoption can we expect?
- Alt-dairy projected to have 10.8% annual growth rate 2018-2023
- Using 10% CAGR in cultured meat consumption -- reduction in Cdn cattle slaughter could drop by 19% (577k head) within 5 years of first market introduction

EFFECT ON AGRICULTURE

Potential Offsetting Mechanism:

State of art – 20,000L tank + 63kg D-glucose → 3500kg of meat per batch

One tank ~ 15.75 steers (1200lb steer → 490lb boneless trimmed meat)

EFFECT ON AGRICULTURE

- Growth medium – composed of amino acids and D-glucose
- D-glucose could come from corn syrup
- 247,664 US vats = 3.9 million head plus
22,861 Cda vats = 360,000 head
- → require 17,043MT of corn syrup (<0.005% US corn production) – Uh oh...





THANK YOU



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POTENTIAL MARKET SIZE (SURVEYS)

- Oklahoma State U. survey (FoodS Survey, 2013-2018, N>62,000)
- Q44 Are you a vegetarian or a vegan?
 μ Yes μ No
- 5.3% answered 'Yes' = 17.3 million consumers
- Harris Poll in 2016 (N=2,015) found 3.3% of US are vegetarian (half of vegetarians are vegan)



Dairy Substitutes	
Califia Farms	NotCo (Chile)
Good Karma	Perfect Day
Heidi Ho Veganics	Ripple
Kite Hill	Snow Monkey
Malk	WayFare Foods
Melt	Willow Cup
Miyokos	Wink



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