

NEBRASKA SORGHUM  
AT THE  
THIRD EUROPEAN SORGHUM CONGRESS:

*A Summary of Findings and Outcomes*

# REPRESENTING NEBRASKA

- Nebraska was the ONLY U.S. sorghum state checkoff in attendance
- Kira Everhart and Florentino Lopez also attended representing USCP
- Nebraska Sorghum displayed a poster in the main hall at the congress, and handed out Nebraska-specific promotional materials

# NEBRASKA SORGHUM POSTER



## New Markets. New Profit Opportunities. Ancient Grain.

### Functional Foods (Nutraceuticals)

Global Value:  
\$173.26 Billion

CAGR: 77%

Non-GMO  
Global Value:  
\$947.8 Million

CAGR: 16.5%

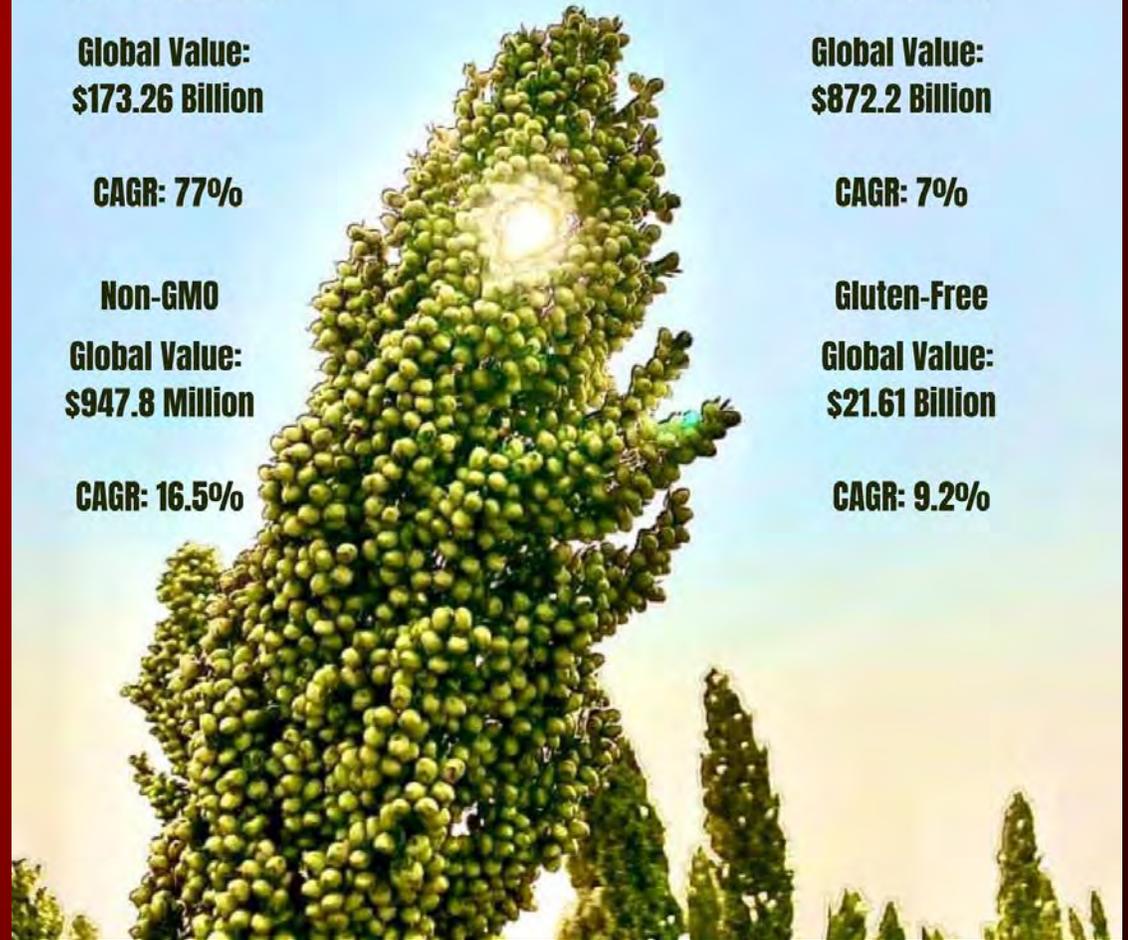
### Ethically-Labeled (Sustainable)

Global Value:  
\$872.2 Billion

CAGR: 7%

Gluten-Free  
Global Value:  
\$21.61 Billion

CAGR: 9.2%



# NEBRASKA SORGHUM

## New Markets. New Profit Opportunities.

### Nebraska Grain Sorghum Board

#### Our Vision:

As an ancient grain, sorghum is a fundamental part of our shared human history. At the Nebraska Grain Sorghum Board, we focus on developing innovative markets, while also celebrating our rich history. We are writing the next chapter in sorghum. One that increases economic opportunities for Nebraska farmers and provides a healthy alternative to consumers.

### Sorghum is:

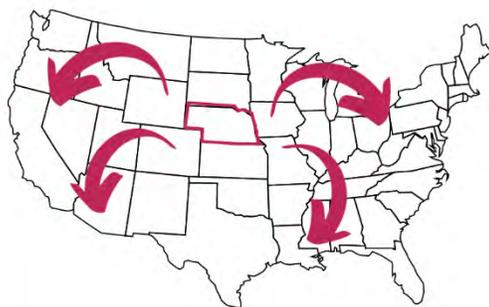
- Non-GMO (Global Value: \$947.8 million)
- Gluten-Free (Global Value: \$21.61 billion)
- Ethically Labeled (Global Value: \$872.2 billion)
- Nutraceutical (Global Value: \$173.26 billion)



### Nebraska's Strategic Location

Central location offers an integrated system of interstates, mainline railroads and airports.

Nebraska is 2.5 days by truck from anywhere in the continental United States.



# SELECT NEBRASKA

## Grow Your Business Here.



With a central location, skilled workforce and low business costs, it's no wonder some of the world's top Ag and manufacturing firms call Nebraska home. Here's why Nebraska is the best choice for your company.



### Our Pro-Business Environment ✓

- Well Educated & Productive Workforce
- Low cost of living and utility rates
- Safe, family-oriented communities
- Central U.S. location with access to interstate highway and rail transportation for effective product distribution
- Business-friendly regulatory environment

### Here's Where We Rank 📈

- 1st Most Investment projects per capita in 2016, '17, '18- *Site Selection*
- 2nd Best Regulatory Environment-*Forbes, 2019*
- 6th Best State - *US News & World Report, 2021*
- Top 10 in the US for Academic Bioscience R&D expenditures per capita
- Top 10 in the US for Power Reliability- *US News*

### Top 3 FDI Industries \$

- Advanced Manufacturing
- Food Processing
- Agricultural Machinery



### Top Trade Partners ↑↓

- Mexico
- Canada
- Japan
- South Korea
- China
- Germany

### What is made in Nebraska ⚙️

- Agricultural Equipment
- Chemicals & Plastics
- Food & Beverages
- Beef production

### Notable Nebraskan companies

- Union Pacific
- TD Ameritrade
- Berkshire Hathaway
- Kiewit
- Werner
- Mutual of Omaha

NEBRASKA  
SORGHUM  
PROMOTIONAL  
MATERIALS

# HEALTH BENEFITS OF SORGHUM IN HUMAN DIETS

- Dr. Stefano Bibbo presented results from a small study done on human patients at the Catholic University in Rome.
- The study included 40 patients. The findings reiterate what researchers are finding in the US in laboratory mice.
- Most notable effects include reduction of inflammatory disease symptoms, better diabetes management, and anticarcinogenic properties.
- I also met with Dr. Bibbo and his team in Rome. I am working to connect them with researchers in the US, and with private sector investors, to help fund a larger phase 2 trial.
- See slides from Dr. Bibbo's presentation in the following pages.



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## Health benefits

- Absence of gluten (fundamental in gluten free-diet)
- Help in control of glycemic response (low glycemic index)
- Lower level of cholesterol absorption (policosanols)
- Rich in minerals (calcium, phosphorous) and vitamins
- Reduce chronic inflammation and oxidative stress
- Relevant in cancer and cardiovascular disease prevention
- Antimicrobial and anthelmintic activities



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## Anti-cancer activities of sorghum (Apoptosis)

Bioactive compounds	Cancer pathway	Anti-cancer mechanisms	Cancer type
<i>Hwanggeumchal</i> sorghum extracts	Apoptosis	↑ p53 ↓ Expression and phosphorylation of STAT5b/IGF-1R ↓ HIF-1 $\alpha$ , Bcl-2, Breast tumor kinase (Brk)	B <i>In vivo</i>
Apigeninidin		↓ Bcl-2 ↑ BAK, BAX, caspase-9, caspase-3, cleaved PARP, lamin B ↑ Release of mitochondrial cytochrome C and apoptosis-inducing factor	Leu
3-DXA extracted from red sorghum		↑ p53; ↓ Bcl-2	B
3-DXA (luteolinidin and apigeninidin)		p53-independent pro-apoptotic activity	C
Anthocyanin-rich plant extracts		↓ cIAP-2, survivin, XIAP, and Insulin-like growth factor binding proteins	C
Polyphenol extracts from bran		↑ ROS ↑ caspase 3, caspase 8, cleaved PARP1, cleaved caspase 3 ↓ IGF-1, IGF-2, and survivin, ↑ XIAP, ↓ SMAC	L
Sorghum extracts		↑ p53, caspase 3 and 7	C
Mixed cereal grain (MCG)		↓ Colonic neoplasia ↑ p53 and mRNA of CDKN1a and caspase 3	C <i>In vivo</i>
Sorghum extract		↑ Cleaved PARP and caspase-3 ↑ pH2AX, pERK, pJNK, ATF3	C

## Anti-cancer activities of sorghum (Angiogenesis and metastasis)

Procyanidin rich extract	Angiogenesis	↓ VEGF	L <i>In vivo</i>
<i>Hwanggeumchal</i> sorghum extracts		↓ p-STAT5, p-STAT3, VEGF, VEGF-R2 ↓ HIF-1 $\alpha$	B <i>In vivo</i>
<i>Hwanggeumchal</i> sorghum extracts	Metastasis	↓ Metastasis from breast to lung ↓ JAK/STAT pathways	B <i>In vivo</i>
Sorghum extract		↓ Migration and invasion ↓ $\beta$ -catenin, VEGF, MMP-9	C



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## Anti-diabetic activities of sorghum

Sorghum Fraction/ Bioactive Compound	Study Model	Anti-diabetic mechanism
Flavonoids Sorghum extract (ethanol based)	Enzyme assay STZ-induced diabetic rats	↓ $\alpha$ -amylase, $\alpha$ -glucosidase, AGEs ↑ p-AMPK/AMPK
Sorghum extract (methanol based)	High-fat-diet induced obese mice	↓ p38:p38, PEPCK, blood glucose level ↑ PPAR $\gamma$ and adiponectin ↓ TNF $\alpha$
Grain sorghum muffins	Healthy adult men Enzyme assay	↓ Plasma glucose and insulin ↑ Slowly-digestible and resistant starch ↓ Readily-digestible starch
Flavonoids Sorghum extract (ethanol based)	Enzyme assay Enzymatic assay	↓ $\alpha$ -amylase, $\alpha$ -glucosidase, AGEs ↓ $\alpha$ -amylase, $\alpha$ -glucosidase
Extruded Sorghum Drink	Healthy adults	↓ Postprandial glycemia
Flavonoids Sorghum extract	Enzyme assay STZ-induced diabetic rats	↓ $\alpha$ -amylase, $\alpha$ -glucosidase, AGEs ↓ pAMPK and macrophage infiltration

## Anti-diabetic and anti-atherogenic effect of phenolic extracts of sorghum grains

Sorghum Source	Bioactive Extracts	Anti-Diabetic and Anti-Atherogenic Effects
Brown sorghum varieties (SOR 01, SOR 03, SOR 08, SOR 11, SOR 17, SOR 21, SOR 24, SOR 33)	Gallic acid, chlorogenic acid, caffeic acid, ellagic acid, p-coumaric acid, quercetin, luteolin, apigenin.	Inhibitory effect on $\alpha$ -amylase and $\alpha$ -glucosidase activities.
Hwanggeumchal sorghum.	Phenolic extracts.	Reduced the serum glucose, total cholesterol, triglycerides, urea, uric acid, creatinine.
KNICS-579	Polyphenol extracts.	Reduced the concentration of triglycerides, total LDL-cholesterol and glucose.
Red sorghum	Total phenolic extracts.	Antioxidant activity against ABTS, DPPH, FRAP assays; Inhibitory effect on pancreatic lipase, $\alpha$ -amylase and $\alpha$ -glucosidase activities.



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## Anti-atherosclerotic activities of sorghum

Sorghum fraction/Bioactive compound	Study model	Anti-atherosclerotic mechanism
Sorghum Lipids	Enzyme assay	↓ HMG CoA Reductase
Whole Sorghum	Mice	↑ HDL cholesterol
Sorghum Lipids	Hamster	↓ Plasma non-HDL and cholesterol absorption
Sorghum Lipids	Hamster	↑ HDL cholesterol and <i>Bifidobacterium</i>
Sorghum Phenolics	HFD fed rats	↓ Plasma cholesterol and triglycerides
	STZ-induced diabetic rats	
Sorghum Phenolics	HUVECs	↑ HO1 and eNOS expression
		↓ ICAM1, MCP1, NOX4 and CD39 expression
Sorghum Phenolics	Human blood samples from healthy males and females after 8 h fasting	↓ Platelet aggregation and PMP release

## Antioxidant activities of phenolics extracts of sorghum grains

Sorghum Source	Bioactive Extracts	Antioxidant Activity
Hongyingzi, Hongzhenzhu, Dongbei sorghum, Jiangsu sorghum, Jiliang 2 sorghum, Longza 11, black grain sorghum, white Longmi sorghum.	Caffeic acid, <i>p</i> -coumaric acid, ferulic acid, protocatechuic acid, luteolindin, apigeninidin, luteolin, apigenin, taxifolin, naringenin.	Antioxidant activities against DPPH and FRAP assays.
Tannin-containing sorghum varieties (Sumac, Hi-Tannin, Seredo, CR 35:5 × 2), non-tannin varieties (white variety, KARI-Mtama, red variety, ICSV-III), Mizzou, Tx430.	Condensed tannins, 3-DXA, phenolics.	Induced phase II detoxifying enzymes; anti-proliferative effect on esophageal, OE33, colon cancer cells.
Liberty, Mr-Buster, Cracker, IS131C, Shawaya Short Black 1.	Phenolic extracts.	Antioxidant activities against DPPH and FRAP assays; Anti-proliferative effect on Caco-2 cells.
Tx3362, Shawaya Black, Black PI Tall, Hyb 107, Hyb 115, Hyb 116, Hyb 117, Hyb 118.	Total phenolics, condensed tannins, flavan-4-ols, 3-DXA.	Antioxidant activities against DPPH and ABTS assays.



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## Anti-proliferative effect of phenolic extracts of sorghum grains

Sorghum Source	Bioactive Extracts	Anti-Proliferative Effect
Black sorghum varieties (Macia, Sumac, PI152653, PI152687, PI193073, PI1329694, PI1559733, PI1559855, PI1568282, PI1570366, PI1570481, PI1570484, PI1570819, PI1570889, PI1570993).	Total phenolic extracts.	Anti-proliferative effect on HepG2 and Caco-2 cells: induction G1/S cell cycle arrest, activation of p53.
Red sorghum	3-DXA extracts.	Inhibitory effect on MCF7 cancer cells through up-regulating p53 and down-regulating Bcl-2 genes.
Dale, M81E	Vanillic acid, p-coumaric acid, ferulic acid, caffeic acid, apigeninidin, luteolinidin, malvidin-3-O-glucoside, apigenin, luteolin, trans-resveratrol, luteoferol.	Inhibitory effect on HCT116 and colon cancer stem cells through activating p53 gene.
Hwanggeumchal sorghum.	Total polyphenol extracts.	Anti-proliferative effect on MDA-MB 231 and MCF7 cells: down-regulating VEGF, VEGF-R2, cyclin D, cyclin E, pRb and up-regulating p53.
TX430, Sumac.	Total phenolic extracts.	Anti-proliferative effect on Hep G2 and HCT15 cells.



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## Our experience

clinical characteristics of patients and results after 1 month of GFD sorghum based.

patients	disease	Age	M/F	Symptoms during standard GFD	Results after 1 month of GFD sorghum based
1	NCGS	48	M	Glucose intolerance, overweight, deficiency anemia	Improved glucose intolerance, resolved anemia
2	NCGS	51	M	Megaloblastic anemia, chronic fatigue	Improved fatigue
3	NCGS	31	F	Iron deficiency anemia, vitamin D deficiency	Resolved anemia and vitamin D deficiency
4	NCGS	64	F	headache, osteoporosis, chronic fatigue	increased levels of vitamin D, improvement of pain related to osteoporosis
5	NCGS	36	F	Headache, chronic fatigue, vitamin D deficiency	Resolved all symptoms
6	NCGS	40	F	psoriasis, pruritus, vitamin D deficiency	Improved psoriasis
7	CD	32	M	Glucose intolerance, hypothyroidism	Improved glucose intolerance
8	CD	77	M	Pruritus, chronic fatigue	Resolved pruritus and fatigue
9	CD	49	M	Overweight, chronic fatigue	Resolved fatigue, lost weight
10	CD	15	M	Deficiency anemia, hyporexia	Resolved deficiency anemia, recovered appetite

GFD gluten-free diet; CD celiac disease; NCGS non-celiac gluten sensitivity.



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## Other clinical conditions

- GFD is a treatment option for many patients with irritable bowel syndrome
- Some cases of infertility can improve with GFD, even in the absence of obvious celiac disease
- Some condition of autoimmunity (as thyroiditis, hepatitis or enteropathies) could benefit from GFD
- Recent studies suggest a role for GFD in autism or psychiatric disorders

ENJOY



## Future perspectives?

- Well-designed clinical trials with a large sample of individuals are needed
- Longer follow-up patients to follow for many months or years
- Evaluation of the acceptance of the diet in the long term
- Evaluation of nutritional and biometric parameters (bioimpedence, magnetic resonance of muscle)
- Evaluation of the development of chronic diseases over time

## CONCLUSIONS

- Products made with sorghum flour represent a valid alternative in GFD
- Sorghum products has a good nutritional profile
- Studies in vitro or animal models suggested several implications in maintaining health or preventing chronic disease
- Preliminary experience on humans demonstrate encouraging results in promoting well-being
- High palatability and digestibility could favor the diffusion among consumers
- The high retail price could still represent a limitation for large-scale diffusion

# SORGHUM PRODUCTS

- Several product presentations by sorghum processors were offered.
- Products included pasta, cookies and cakes, vodka, rum, whiskey, pet food, animal feed, and ethanol.
- Bontasana (pasta) and Ori (cookies and cakes) offer the most promise in regard to locating processing in Nebraska.
- The ethanol findings, by a Moldovian entrepreneur, are worth sharing with Nebraska biofuels representatives.
- See slides on the ensuing pages.

# Ms. Monia Caramma and Bontasana Pasta



- Ms. Caramma has a long record of working to perfect sorghum-based pasta.
- She has patented chemistry to replace xanthan gum as the binder and uses a pure sorghum flour for her product.
- A resale company, which buys her product in Florida, sells the pasta for as much as \$23 per box.
- Bontasana pasta was used in the Catholic University study.
- Monia wants to expand her product into the US market.

# Why Sorghum pasta

A healthy choice



- 0 g of sugars ( detected by analysys on cooked pasta)
- No other cereal or emulsifier added
- High digestibility
- Traditional production technique
- Innovative gelatinization and milling process
- Nutty and delicate taste
- It doesn't overcook
- Porous texture
- Organic, Kosher Halal Certified
- Horeca and Consumers



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## Roadmap

# Sorghum pasta

Pasta can be produced with 100% of sorghum . Pasta has a high water absorption.

Its Glycemic index is low, below 65.

2015

**non-gelatinized flour**



The first pasta was a disaster. The dough, the extrusion and drying at 42 ° C were correct but as soon as pasta was boiled, it melted.

2017

**gelatinized flour**



The first test was carried out with a temperature between 60 and 67 °C. Result: consistent paste but easy to break

2019

**gelatinized flour**



We stabilized the gelatinization using variable temperatures in relation to the amount of amylose

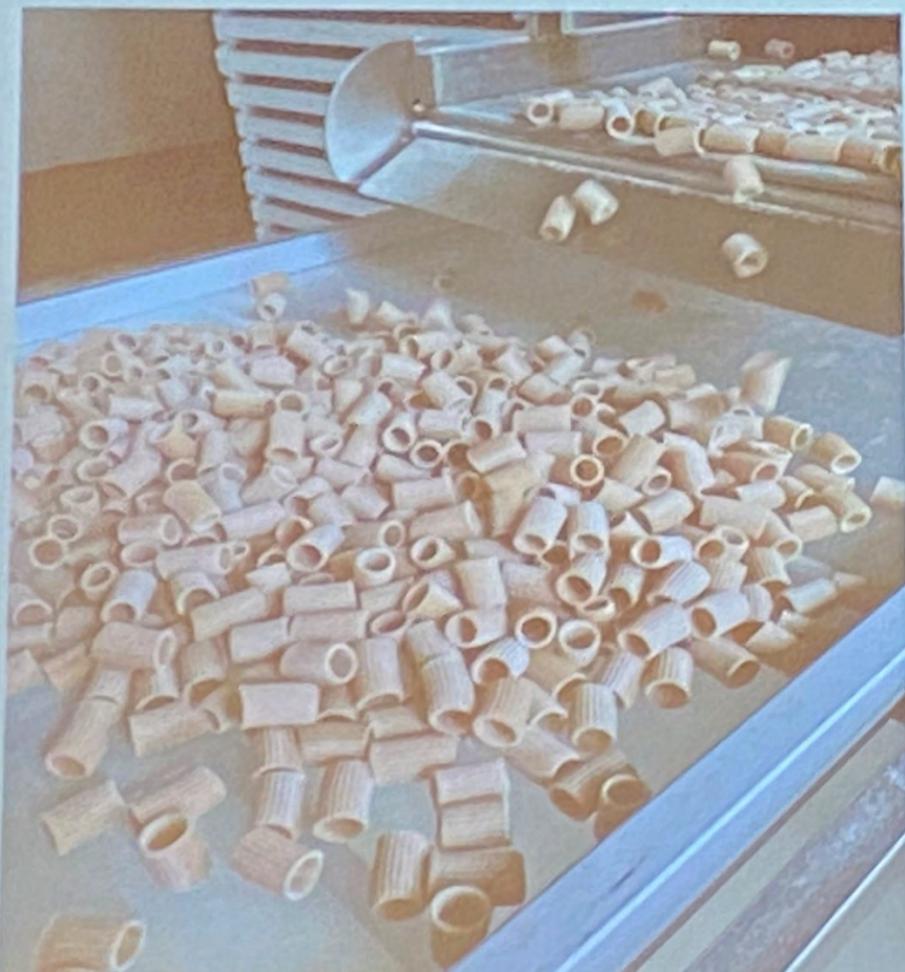
2020

**the result**



The pasta keeps cooking perfectly, supports bronze dies with traditional thickness





# Production

Sorghum grains are milled and transformed into flour with significant granulometry, which results in less water absorption. Molino e Riseria Martini in Castelbelforte, Mantova, Italy, is our trusted partner in transforming Sorghum into flour.

The result is a solid dough which, drawn in bronze, keeps the shape of the dough without breaking.

# Study

## A healthy choice

Sorghum flour samples were used to obtain pasta with high protein ( $\approx 170$  g  $\text{kg}^{-1}$ ), dietary fiber ( $\approx 80$  g  $\text{kg}^{-1}$ ), polyphenols (2.6 g GA kg pasta), and antioxidant activity. This sorghum pasta showed slower starch in vitro digestion than the other gluten-free pasta, with a high level of protein hydrolysis (76%). The highest eGI was observed in a rice sample (69.8) followed by a corn-based pasta (66.4). White and brown sorghum gluten-free pasta showed 2.9 and 2.4 times, respectively, higher potentially bioaccessible polyphenol content compared to that in cooked pasta. No significant variation in antioxidant activity was found in sorghum pasta after digestion and around 48% and 36% of activity was detected in dialysate.

Palavecino et altri: Gluten-free sorghum pasta: starch digestibility and antioxidant capacity compared with commercial products. J. Of Science food and Agriculture 9/08/18



# MR. MOHAMED ZELLAMA AND ORI

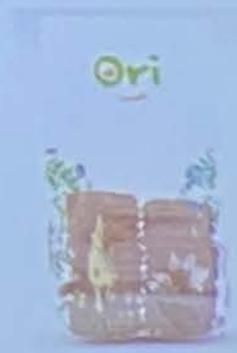
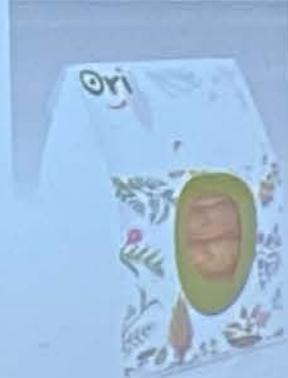
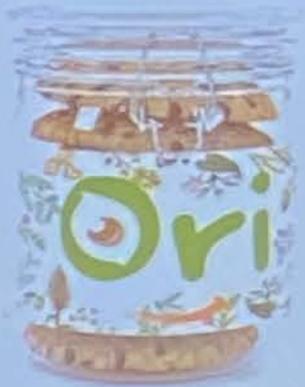
- Mr. Zellama was born in Tunisia, a country which relies heavily on sorghum as a staple in the local diet.
- Trained as an architect in France, Mr. Zellama left his practice to focus on creating sustainable and healthy foods.
- He was inspired by the 17 sustainable development goals presented by the United Nations, and operates his business on a socially responsible model which is appealing to many consumers.
- Mr. Zellama is interested in scaling up his operation and offering, perhaps, a franchise model in the US market.
- See Ori's slides on the ensuing pages.



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# Sorghum food, ORI solutions



**Ori**  
And More

Reason % of Consumers

Want to reduce inflammation

42%

Believe gluten-free products are healthier

37%

Want fewer artificial ingredients

35%

Seek more natural ingredients

31%

Want perceived weight-loss benefits

24%

Prefer not to eat wheat or grains

24%

# Why Sorghum

## A healthy choice

Consumers who are intolerant or allergic to gluten and those who are aware of it have specific reasons for choosing gluten-free products.

Given these characteristics, Sorghum is the best candidate to meet the demand for healthy products

### Sorghum

- does not cause inflammation,
- is rich in iron, and antioxidants,
- provides fiber
- is 100% sustainable even in crops.



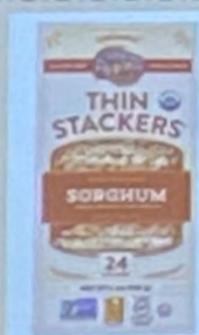
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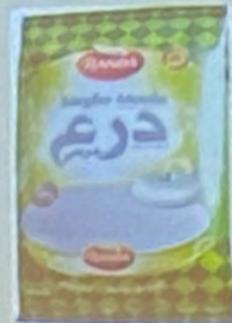
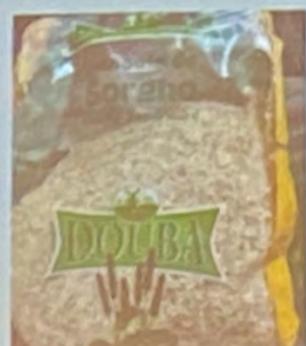
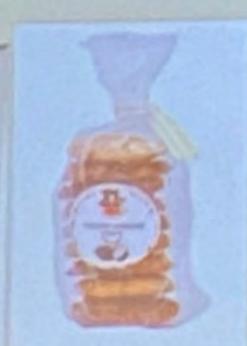
# Sorghum food, actual products



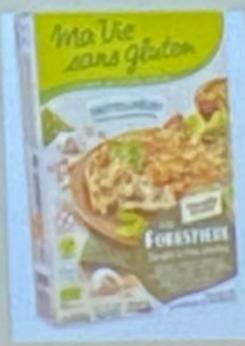
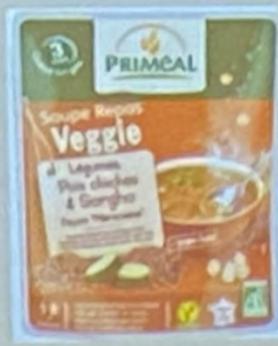
Asia



Canada / USA



Africa



# MR. SERGIU CATARAGAL AND THE DEPARTMENT OF AGRO-INDUSTRIAL GROUP F COMPANIES - MOLDOVIA

- Mr. Cataragal's group of companies focus on vodka and ethanol production from sorghum.
- The claimed efficiencies of sorghum over corn in ethanol production are notable, if true.
- More follow-up with Mr. Cataragal regarding the process and metrics of his ethanol findings is warranted.
- See Mr. Cataragal's slides on the ensuing pages.



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## Sorghum is the very CROP.

Ethanol is produced by breaking down the starch in the sorghum grain to create sugars, and then fermenting the sugars. 1 tonne of sorghum grain can produce up to 400 liters of ethanol.

CROP	Quantity	Ethanol yield
Wheat	1 tonne	340 – 360 litres
Corn	1 tonne	370 – 390 litres
Sorghum	1 tonne	<b>390 – 410 litres</b>

Dried Distillers Grains with Soluble, Sorghum DDGS a co-product of starch-based ethanol production, tend to be lower in fat and higher in protein than corn DDGS.

Parameter	Wheat	Corn	Sorghum
Crude Protein(Nx6.25), %	29.47	26.00	<b>29.92</b>
Crude fat content, %	5.71	10.62	<b>11.99</b>
Crude fiber content, %	7.81	5.64	5.24
Crude ash content, %	3.71	4.01	4.18

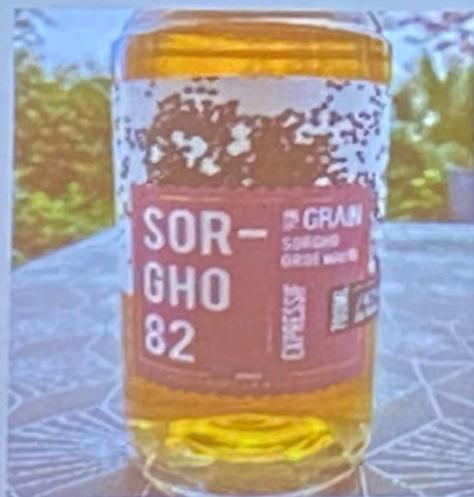
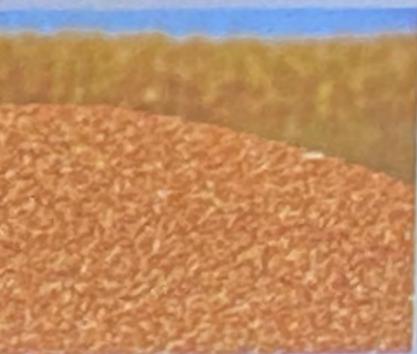
# BENOIT GARCIA AND BOWS DISTILLERY

- Mr. Garcia is making small-batch whiskey and rum in the south of France.
- His operation is a closed loop partnership with a local sorghum farmer.
- Biproduct from the production process is used for cattle feed.
- See Benoit's slides on the ensuing pages.

# GRAIN SORGHUM

**Objective: Produce drinking alcohol such as "Whiskey"**

- Cereal in future landscape and look for different taste
- **Barley makes bisphenols while sorghum does very little**
- Red grain variety used, with high starch content (76,2% in 2020 in France, +2%/maize)
- Raw grain, **grinding into flour, brewed with H2O like a beer**
- Fermentation and distillation
- **For one ton, 280 liters of pure alcohol, 7 ° of alcohol**
- Whiskey 70-72 °, then reduced, depending on the barrel setting 60-65 °
- Then again **reduced 40-50 ° at bottling**, with addition of malted barley to avoid the use of an enzyme banned in France
- **80% sorghum 20% malted barley.**





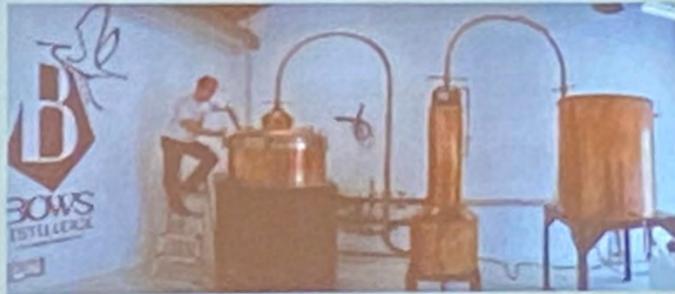
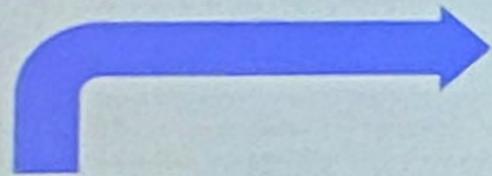
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# A circular economy!

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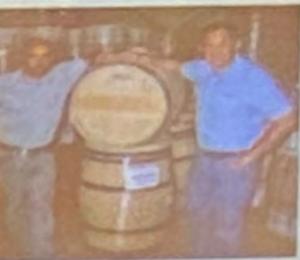
## Project's holder

grain cereal supply  
< 1 km

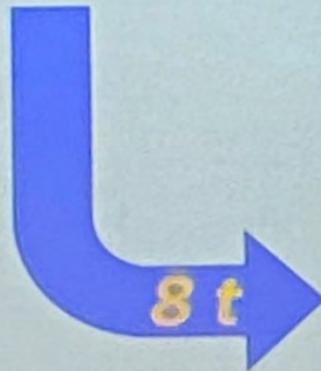


200 hL

agricultural  
spreading of  
stillage, plots  
< 3 km



barrel making  
< 10 km



8 t



valorization of DDGS in bovine feed  
600 meters from the distillery



BOWS  
DISTILLERIE



# MARKET OVERVIEW: PET FOOD

- Sorghum's use in pet food is rapidly growing worldwide.
- Interestingly, the number of multi-national companies buying pet food brands and getting into processing of pet food is growing as well.
- This is because of the tremendous value to be found in the pet food market, which competed with Chinese buyers on price in 2020.
- Also in 2020, Americans for the first time spent more on pets than they did on children.
- See slides on the ensuing pages.

Population: More than 900 million dogs, 600 million cats worldwide.

**Top 10 Dog Populations By Country**

COUNTRY	POPULATION
USA	69,929,000
China	27,400,000
Russia	12,520,000
Japan	12,000,000
Philippines	11,600,000
India	10,200,000
Argentina	9,200,000
United Kingdom	9,000,000
France	7,570,000
South Africa	7,400,000

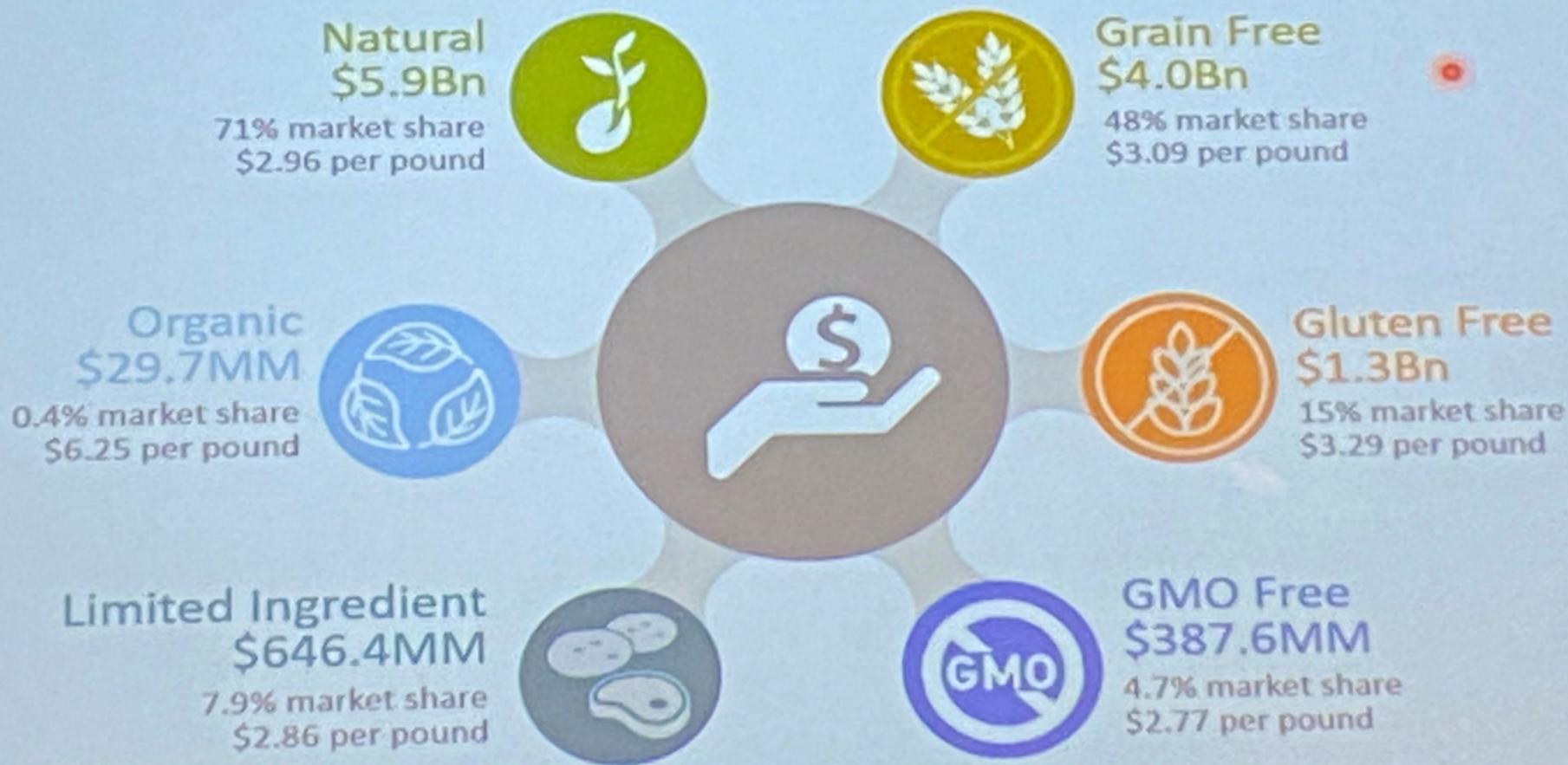
**Top 10 Cat Populations By Country**

COUNTRY	POPULATION
USA	74,059,000
China	53,100,000
Russia	17,800,000
Brazil	12,466,000
France	11,480,000
Germany	8,200,000
United Kingdom	8,000,000
Italy	7,400,000
Ukraine	7,350,000
Japan	7,300,000

[How Many Pets Are In The World & The US?](#)  
[71+ Pet Stats \(simplyinsurance.com\)](#)

# miumization of Pet Food in US Pet Retail

Categories – L52W w/e 10/05/19



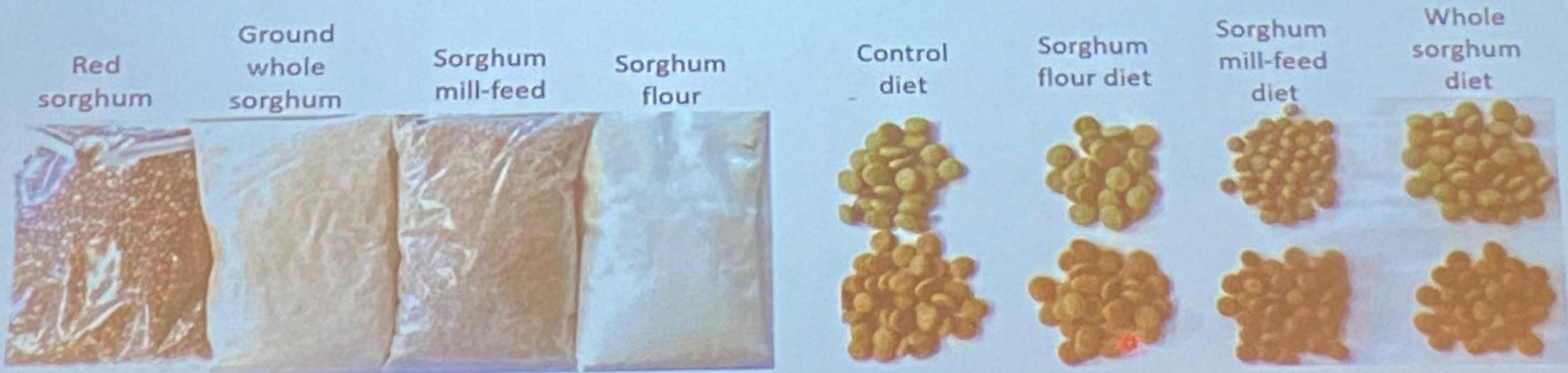
Natasha Davis, Strategic Client Partner  
October 16, 2019

## The World's Top 10 Pet Food Companies

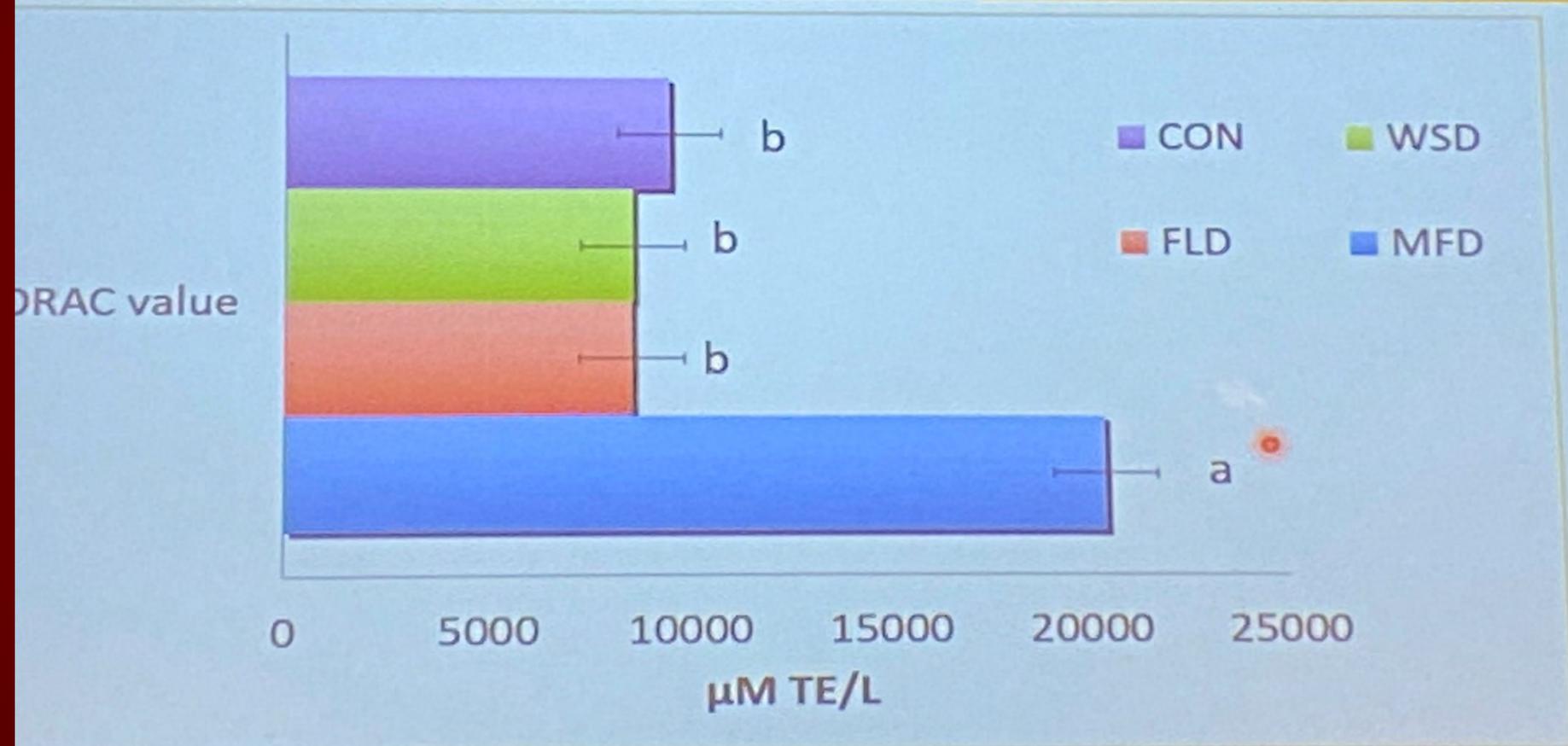
Company	Country	Annual Revenue
<u>Mars Petcare Inc.</u>	United States	\$18,085,000,000
<u>Nestlé Purina PetCare</u>	United States	\$15,422,000,000
<u>J.M. Smucker</u>	United States	\$2,937,500,000
<u>Hill's Pet Nutrition</u>	United States	\$2,525,000,000
<u>General Mills</u>	United States	\$1,694,600,000
<u>Diamond Pet Foods</u>	United States	\$1,500,000,000
<u>Spectrum Brands / United Pet Group</u>	United States	\$951,000,000
<u>Agrolimen SA</u>	Spain	\$900,000,000
<u>Unicharm Corp.</u>	Japan	\$822,000,000
<u>Simmons Pet Food</u>	United States	\$1,000,000,000

# Processing

- Red sorghum locally sourced then milled at the Hal Ross Flour mill
- Yield of flour 70%, bran, tailings, and germ collected into “mill feed” fraction



Oxygen radical absorbance capacity (ORAC) of plasma collected from dogs at the end of each period fed diets based on various sorghum fractions



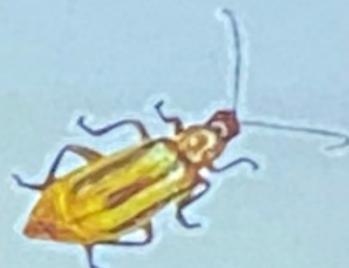
# SORGHUM IN SWINE AND POULTRY FEED

- Sorghum's utility in swine and poultry diets is well documented.
- The ensuing following slides were presented by European and Russian swine and poultry feeders respectively.
- The results shown reinforce findings amongst US producers feeding sorghum.



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# Sorghum in fattening pigs (2013)

Puntigam et al.

Experimental Group

Stage of fattening	Corn		Sorghum	
	31-73 kg	73-119 kg	31-73 kg	73-119 kg
Whole grain corn fermented	50.4	52.1	51.4	53.0
Corn, dried	20.0	20.0	0	0
Sorghum, dried	0	0	<b>20.0</b>	<b>20.0</b>
Soybean meal, 44% CP	24.0	22.0	23.1	21.2
Fibre	2.5	3.0	2.0	2.5
Canola oil	0	0	0.4	0.4
Premix for Sorghum	0	0	3.1	2.9
Premix for Corn	3.1	2.9	0	0
MJ ME/kg	11.72	11.69	11.71	11.68



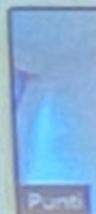
**NO** difference in zootechnical performance (ADG; ADFI; F:G ratio)

**NO** difference in slaughter performance (lean [%], Fat thickness, mm; Muscle thickness, mm)



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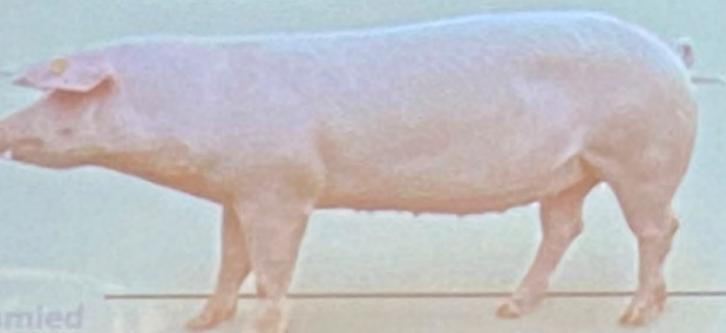
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# Sorghum in diets of sows

Ingredient	DM, g	Corn/Sorghum, %		Corn/Sorghum (wet), %						
		pregnant	lactation	pregnant	lactation					
Corn fermented (whole or ground), 32 % H <sub>2</sub> O, 7 % CP (88 % DM)	680	-	-	-	-	33.0	-	40.0	-	
Sorghum fermented 28 % H <sub>2</sub> O, 9 % CP (88 % DM)	720	-	-	-	-	-	33.0	-	40.0	
Corn dried, 7 % CP	880	25.0	-	30.0	-	-	-	-	-	
Sorghum dried, 9 % CP	880	-	25.0	-	30.0	-	-	-	-	
Wheat, 12 % CP	880	-	-	15.0	15.0	-	-	10.0	10.0	
Barley, 10.5 % CP	880	50.0	51.0	26.5	28.0	43.5	44.0	23.5	24.5	
Soybean meal 44 % CP	880	9.0	8.0	19.0	17.5	8.5	8.0	18.0	17.0	
Fibre concentrate 30 % CF	880	13.0	13.0	4.0	4.0	12.3	12.3	3.5	3.5	
Canola oil/Soy oil	999	-	-	1.5	1.5	-	-	1.5	1.5	
Premix sow	950	3.0	3.0	4.0	4.0	2.7	2.7	3.5	3.5	
		100	100	100	100	100	100	100	100	
		Content in % / kg Premix								
		Lysine	4.0	5.0	7.0	8.0	4.0	5.0	7.0	8.4
		Methionine	-	-	2.5	2.5	-	-	2.5	2.6
		Threonine	-	-	2.5	2.7	-	-	2.5	2.8
		Tryptophan	-	-	0.4	0.3	-	-	0.4	0.3

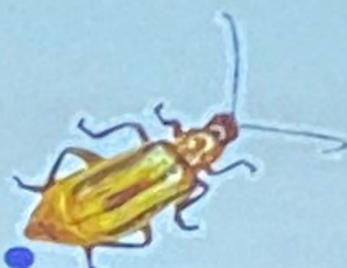
Premix-Amino acids:





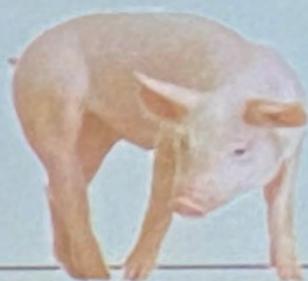
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# Sorghum in weaning pigs (12-32 kg)

Ingredient	DM g	Corn/Sorghum, %			Corn/Sorghum, %		
Corn fermented (whole or ground), 32% H <sub>2</sub> O, 7 % CP (88% DM)	680	-	-	-	50.0	25.0	-
Sorghum fermented, 28% H <sub>2</sub> O, 9 % CP (88 % DM)	720	-	-	-	-	25.0	50.0
Corn dried, 7 % CP	880	50.0	25.0	-	-	-	-
Sorghum dried, 9% CP	880	-	25.0	50.0	-	-	-
Barley, 10.5 % CP	880	19.0	20.0	22.0	23.0	24.0	25.0
Soybean meal, 44 % CP	880	23.0	22.0	21.0	20.5	19.5	18.5
Fibre concentrate, 30 % CF	880	4.0	4.0	3.0	3.0	3.0	3.0
Premix	950	4.0	4.0	4.0	3.5	3.5	3.5
	100	100	100	100	100	100	100



Premix-Amino acids:

	Content in %/ kg Premix						
Lysine	10.0	10.6	11.3	9.2	10.5	11.8	
Methionine	3.5	3.4	3.3	3.0	3.2	3.4	
Threonine	4.5	4.5	4.6	4.0	4.4	4.9	
Tryptophan	0.7	0.5	0.4	0.5	0.4	0.4	



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Игорь Зарубный est entré dans la salle d'attente

Admettre

Voir

✕

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# Sorghum in diets of fattening pigs

Ingredient	TM g	Grower (32 - 70 kg), %			Finisher (70 - 120 kg), %		
Corn fermented (whole or ground), 32 % H <sub>2</sub> O, 7 % CP (88 % DM)	680	60.0	30.0	-	60.0	30.0	-
Sorghum fermented, 28 % H <sub>2</sub> O, 9 % CP (88 % DM)	720	-	30.0	60.0	-	30.0	60.0
Barley, 12 % CP	880	14.5	15.2	16.0	17.5	18.2	19.3
Soybean meal, 44 % CP	880	20.5	19.5	18.5	16.8	15.8	14.5
Fibre concentrate, 30 % CF	880	2.0	2.3	2.5	3.0	3.3	3.5
Premix	950	3.0	3.0	3.0	2.7	2.7	2.7
		100	100	100	100	100	100



Premix-Amino acids:

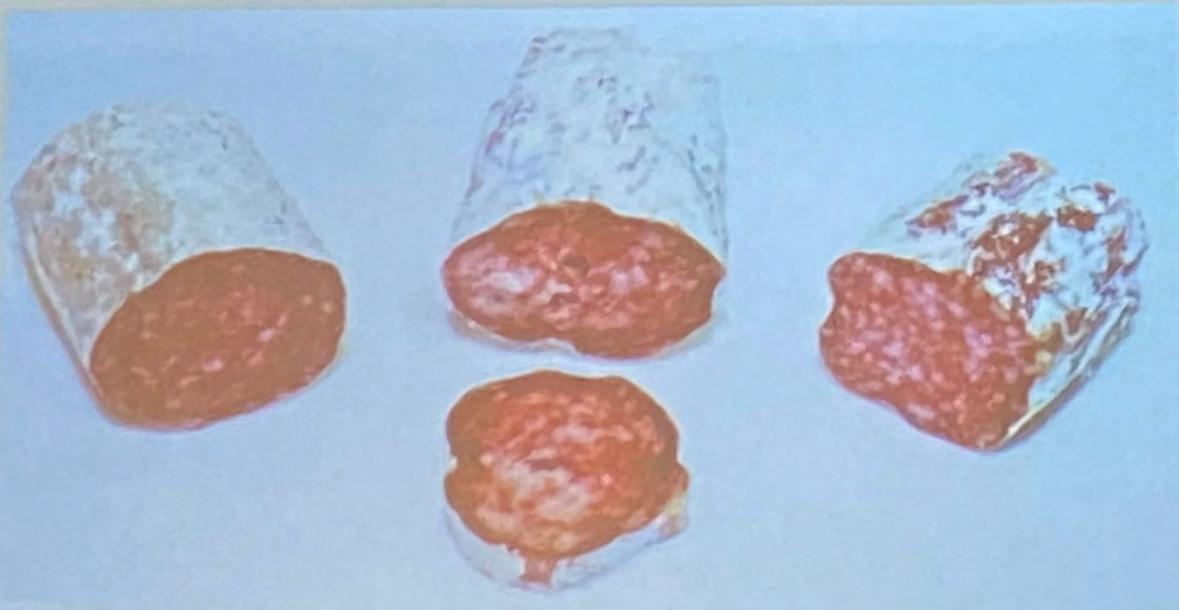
	Content in % / kg Premix						
Lysine	8.5	10.0	11.6	8.5	10.0	11.6	
Methionine	2.0	2.1	2.3	2.0	2.1	2.3	
Threonine	3.0	3.5	4.0	3.0	3.5	4.0	
Tryptophan	0.2	0.1	0.0	0.2	0.1	0.0	



# Sorghum – product quality



The **higher the content of PUFA** in the diet, the higher it is **in the body fat** – the lower its **quality!**





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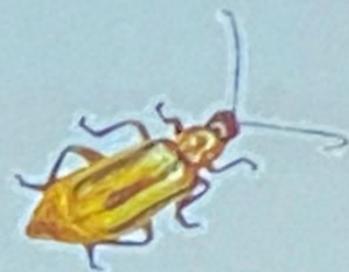
# Sorghum to lower PUFA in

Ingredient	TM g	PS g	Diet – fattening pigs											
Corn fermented, 33% H <sub>2</sub> O	670	15,2	75,5	74,2	75,2		75,7		50,0		50,0			
Sorghum fermented, 28% H <sub>2</sub> O	720	12,3				75,5		77,0		50,0		50,0		
Wheat, Barley, Triticale	870	9-10							26,0	26,8	26,5	28,3	76,5	79,5
Soybean meal, 44% CP	870	8	21,7	20,0	21,0	18,1	20,0	13,5	18,0	15,5	14,5	9,0	13,0	2,0
Soybeans full fat, 19% EE	935	120				1,0	3,5			3,0	4,5			7,0
Soybean expeller, 10% EE	945	64						1,5	6,5			6,0	9,5	15,
Canola meal, 31% CP, 12% EE	900	38		3,0										
Premix	950	0	2,8	2,8	2,8	2,9	2,8	3,0	3,0	3,2	3,0	3,2	3,5	3,5
Content of PUFA, g/kg DM (88%)		ca	16,2	17,1	17,5	17,2	17,2	17,0	17,2	16,9	17,1	17,0	16,7	17,



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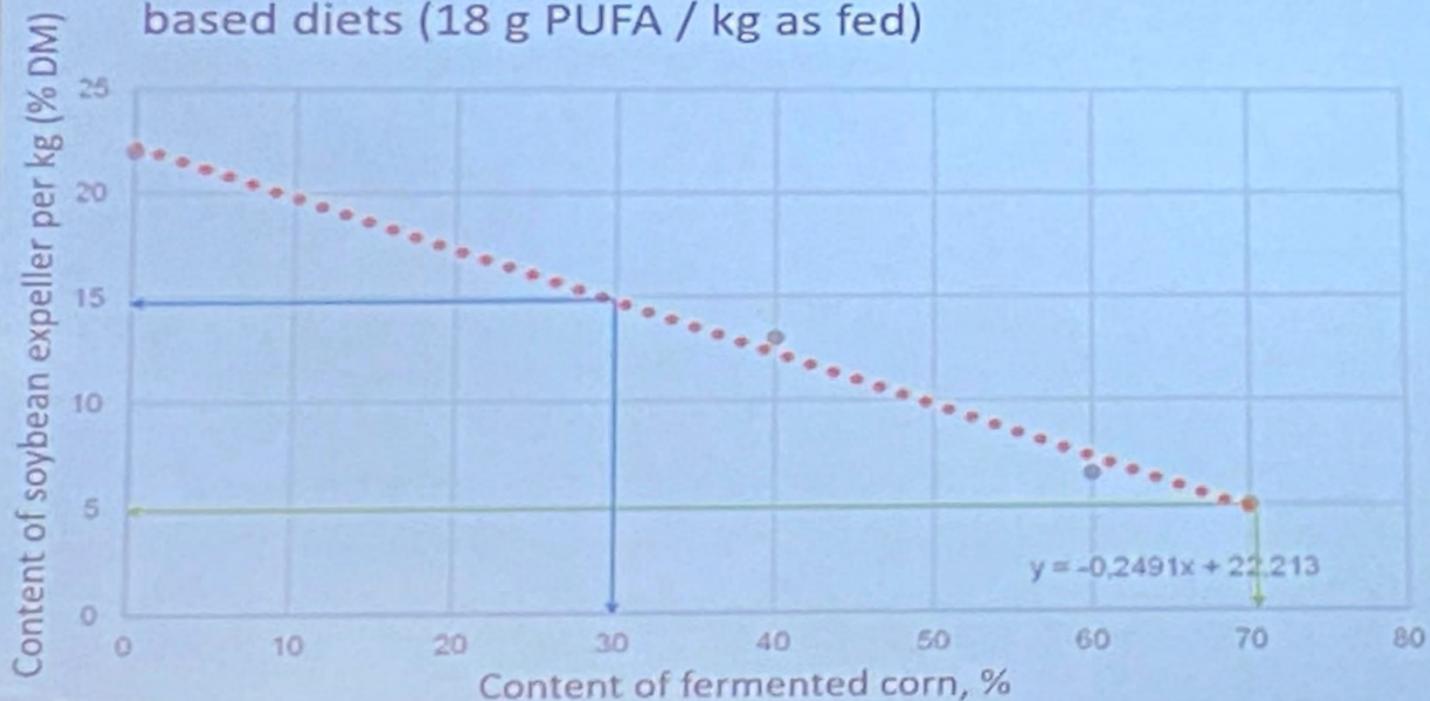
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# Sorghum to lower PUFA in diet



Maximum content of soybean expeller in corn (fermented) based diets (18 g PUFA / kg as fed)



A higher level of sorghum in diets of fattening pigs allows the incorporation of higher levels of soybean cake (nonGMO).



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## Use of sorghum on the farm

- Sorghum is included in the diet of laying hens, 7% of the total ration
- For laying hens feed the sorghum is twice passed through roller crusher. It ensures better digestibility as hens have shorter gastrointestinal tract.
- The main part of the production is sent for export to the European Union.
- Drying and processing of sorghum grain is adapted to the crop's specific characteristics.
- The technology is adapted to the farm conditions with the optimisation of costs and the final result

## Why sorghum?

- Cost effectiveness compare to corn
- Replacement of corn in a diet because of sorghum is identical in its composition and performance to corn
- Productivity increase **+0,3%**
- Egg weight increase **+0,2 g**
- Egg yolk color is more intense

# SUPPLEMENTAL MEETINGS: ZURICH, MILAN, AND ROME

- Qualysense Ag (Zurich):
  - I met with the Qualysense team in Zurich. Their seed-sorting technology goes beyond visible physical characteristic measurement to include infrared readings of protein content.
  - This technology could be of value to producers who are directly marketing their product to high-value end users in that it could provide qualitative metrics used to negotiate higher prices through ensured quality.
  - The technology could also be of value to high-end processors for the same reasons of quality control.
  - Unfortunately, the technology is not cheap. A small machine costs around a million dollars, with a \$200-\$300 per metric ton service fee.

- Machine capacity per hour: 300 kg
- Daily capacity: 16 hours (conservative number) x 300 kg = 4,800 kg per day
- Monthly capacity: 27 days a month x 16 hours x 300 kg/hour = 129,600 kg / month = 129.6 MT per month
- Yearly Capacity: Running 8 months >>  $129.6 \times 8 = 1036$  MT
- Would need to create a premium product that will sell (like a premium popcorn product for example):
- Value created for a premium product should be about 5 times more than paying a service fee (About 1000-1500 USD) at minimum (There is a farmer and brand owner who will want to make extra. logistics, processor (cleaning) & packaging cost won't change.
- Qualysense does have a machine near Chicago and has offered to host board members/processors to tour that facility.

- Bontasana (Milan):
  - I met with Ms. Monia Caramma for lunch at Linfa.
  - We tasted her sorghum-based pasta. Without exaggeration, I can say it was the best I've ever eaten. I could not tell the difference between this product and a traditional wheat-based pasta.
  - Monia indicated that she would need two dedicated production lines initially, if she were to begin production in Nebraska.
  - Monia indicated that Europe does not grow enough sorghum at present to allow her to scale up her business.
  - This was a good relationship-building meeting. I have invited Ms. Caramma to attend the Sorghum Symposium in Kearney in January 2022.

- Catholic University Team (Rome):
  - I met with Dr. Gallabrini and Dr. Bibbo to follow-up on their findings presented in Toulouse.
  - The initial study was small. It included only forty patients. What is notable is that this was a human trial, rather than a laboratory specimen.
  - The Catholic University team wants to plan a phase two trial that is larger in scope.

# ADDITIONAL OUTCOMES

- International Working Group
  - The European (and global) sorghum industry faces the same challenges that we are subject to in the US. Namely, lack of consumer awareness, value-added markets development, and volatility caused by the large Sino presence in international sorghum purchases.
  - Additionally, the industry is nascent worldwide. It is my conclusion that sorghum is too small, and opposing commodity forces are too great, to operate parochially.
  - I have begun building an international working group to focus narrowly on uniform consumer messaging/imagery that can be broadly appealing to consumers and consistently impart the message of sorghum's healthy, non-gmo, gluten-free and #sustainable traits. Confirmed team members thus far include representation from Europe, Brazil, Canada, and Australia. I would like to include representation from Japan and Africa as well.

# NEBRASKA VISITS

- Invitations have been extended to Ori and Bontasana to attend the 2022 Sorghum Symposium.
- Both companies have indicated their desire to access the US market and are keen on Nebraska's role in meeting their processing needs.

# PHASE TWO SORGHUM DIETARY TRIAL IN HUMANS

- Dr. Bibbo is preparing a phase two proposal.
- I have agreed to share with private industry and USCP to fund the phase two trial.
- The funder of the trial will own the data collected.

# OVERALL SUMMARY:

Processing of consumer-ready high value products using sorghm is nascent internationally. The US is likely ten years ahead of Europe in this regard. However, progress is being made, and research is consistent in supporting the benefits of sorghum for human consumption.

It is incumbent upon Nebraska Sorghum to take a leadership role in promoting value-added markets development around sorghum's non-gmo, gluten-free, healthy, and sustainable traits internationally. This must be done in a spirit of respectful cooperation with our counterparts abroad, rather than in a spirit of competition. The challenges facing the sorghum industry are similar regardless of geography.

Sorghum is on the rise. Foreign populations who are ideologically opposed to technology in food products offer a substantial opportunity for sorghum farmers across the globe. Further, resource and climate sustainability are increasingly on the minds of consumers. Sorghum is uniquely positioned to leverage these markets.