

CURRENT AND POTENTIAL USAGE OF SOYBEAN PRODUCTS AS FOOD IN SOUTH AFRICA

VAN DER MERWE R¹, VAN BILJON A¹ & HUGO A²

¹*Department of Plant Sciences, Faculty of Natural and Agricultural Sciences, University of the Free State, PO Box 339, Bloemfontein, 9300, South Africa*

²*Department of Microbial Biochemical and Food Biotechnology, Faculty of Natural and Agricultural Sciences, University of the Free State, PO Box 339, Bloemfontein, 9300, South Africa*

E-mail: vandermerwer@ufs.ac.za

Soybean is the main vegetable oil crop in the world as it comprises more than 50% of the world's total oilseed production. South Africa is the third largest consumer of soybean in the world, but in terms of seed production, the country ranks thirteenth internationally. During the past 10 years local soybean seed production increased three fold and exceeded sunflower seed production. This increase in production may be attributed to several factors; however the high demand for oil cake may be the main reason. In addition, commercial farmers became aware of the benefits of soybean in crop rotation systems with maize. Consumers pursue alternative protein sources that are economical, healthy and of high quality. Although a steady increase in seed production was observed, the country continues to import large quantities of soybean products in order to meet the demand for both animal and human use. During the previous production season (2011/2012), 63% of the total production delivered was domestically processed, while 6% was exported. Only 5% of the production was processed for human consumption, while 36% was processed for oil and oil cake and 22% for seed and feed. Soybean is a valuable crop as a source of dietary protein and vegetable oil for millions of people. Soybean seeds that are processed into defatted flakes, lecithin and dietary fibres are used in the manufacturing of a variety of processed foods and other food products. Defatted flakes form the basis for the production of flours, isolates and concentrates. These products are used as ingredients in various food, meat and nutritional food industries. These include bakery, beverage, cereals, dairy alternatives, infant formulas, meat products, poultry and seafood products, meat analogs, vegetarian and snack products. Soybean oil as a by-product after processing is used in a variety of processed foods, vegetable oil blends and margarine. Whole soybeans, cooked, baked and roasted, serve as high protein and dietary fibre food sources. In South Africa, thousands of people live in poor and rural areas and face malnutrition due to rising food prices. The production of high-quality and health promoting soybean meals that are economical will contribute to reduce hunger and increase food security in these areas. In this review, the current and prospective production, use and demand for soybean and its products for human consumption in South Africa will be addressed. The domestic processing capacity and constraints in production, local processing and supply to the industries utilizing soybean products will be deliberated.

CURRENT AND POTENTIAL USAGE OF SOYBEAN PRODUCTS AS FOOD IN SOUTH AFRICA



R van der Merwe
A van Biljon
A Hugo

T: 051 401 9111 info@ufs.ac.za www.ufs.ac.za

© Copyright reserved
Kopiereg voorbehou

UNIVERSITY OF THE
FREE STATE
UNIVERSITEIT VAN DIE
VRYSTAAT
YUNIVESITHI YA
FREISTATA



UFS·UV
NATURAL AND
AGRICULTURAL SCIENCES
NATUUR- EN
LANDBOUWETENSAPPE

CONTENTS



- Background
- Aim
- Domestic production of soybean
- Total seed consumption and processing
- Application in human nutrition
- Soy human food market
- Breeding soybean for human food
- Conclusions
- Acknowledgements



BACKGROUND

- Numerous people in South Africa are poor, undernourished and many suffer from life-threatening diseases
- There is a need to increase production of wholesome food products that will combat poverty, malnutrition and ill health
- SA is food secure, but not household food secure
- Food insecurity is most severe in the rural areas where an estimated 70% of SA's poor reside



BACKGROUND

- A major concern is the continuously rising of food prices
- During the previous 4 years the following price increases of protein food sources (given in percentage) were observed:

Eggs	22% (1/2 dozen)
Fresh beef mince	19% per kg
Fresh whole chicken	11% per kg
Fresh full cream milk	2% (2 L)

(NAMC 2011)



BACKGROUND

- Rising food prices may contribute to food insecurity, insufficient protein consumption and undernourishment
- Poor people cannot afford the current meat prices and many especially those living in rural areas do not have the facilities to store raw meat
- These people will buy meat alternatives that are cheap, nutritious and can be stored without refrigeration



BACKGROUND

- Soybeans contribute to the production of meat alternatives and other food products that are economical, of high-quality and health promoting
- Generally soy ingredients are used in the manufacturing of numerous foodstuffs and health products
- Soy products form part of the daily food, nutrition and health supplement intake of practically all South Africans



BACKGROUND

- More and more people become aware of the health and nutritional benefits of soy products
- A wide range of soy foods and products are available to meet the needs of South Africans
- Vegetarians, lactose intolerant individuals include soy products as alternatives in their diets

BACKGROUND



- Although the SA market for soybean is huge, the human food sector is insignificant compared to the animal feed market
- The following could contribute to the low amount of soybeans being utilised in the human food market:



BACKGROUND



1. Insufficient seed/grain supply

The high demand of soybeans for animal feed production reduces the amount available for human consumption

2. Insufficient processing capacity

Infrastructure and technology dedicated to soy protein product processing is expensive and since the market for human consumption is small, little investment is being made in capacity expansion



BACKGROUND



3. Poor product quality of local soy protein products

Some soy-based food manufacturers feel that locally processed soy protein products are of poor quality and not on the standard required for their specific needs

Consequently processed soy protein products are essentially imported and consumers can acquire high quality products that satisfy their needs



BACKGROUND

- Approaches to increase local production of high quality soy protein products are pursued by:

- 1. Developing economical processing technologies**

- With reduced processing steps
- If some expensive processing steps can be removed, cost can be reduced

- 2. Development of soybean varieties** with advanced compositional properties that require less processing



BACKGROUND

- With this approach, extensive processing steps, to remove unwanted components can be reduced
 - could reduce processing demand and cost
- In addition, the quality of locally produced soy protein products can be improved through breeding and development of food grade varieties

The left side of the slide features three vertical panels, each showing a close-up of a soybean plant with green leaves and developing seed pods.

AIM



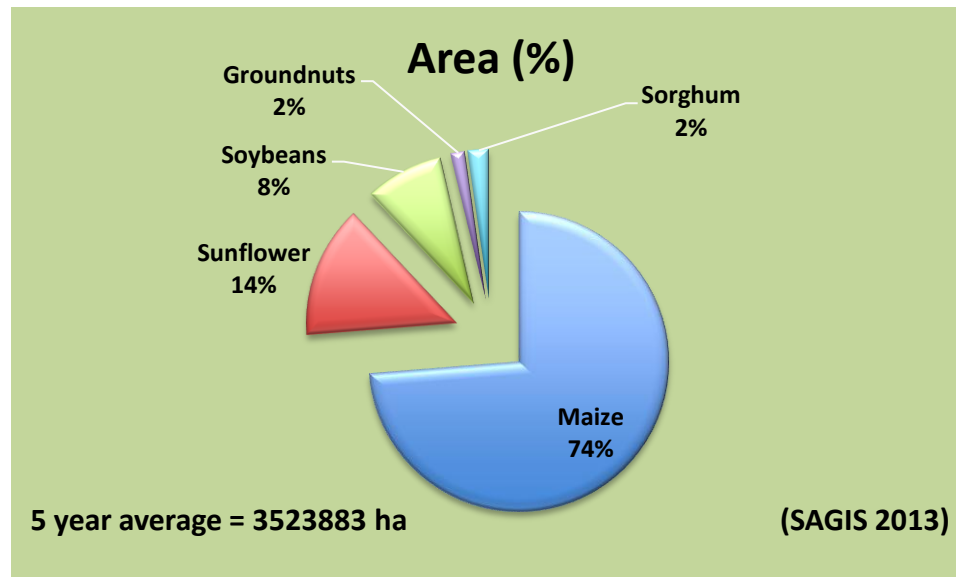
The aim of this survey was to analyse the local soy food market and to determine how plant breeding can contribute to the development of specific soybeans suitable for different food applications

DOMESTIC PRODUCTION OF SOYBEAN



Area planted

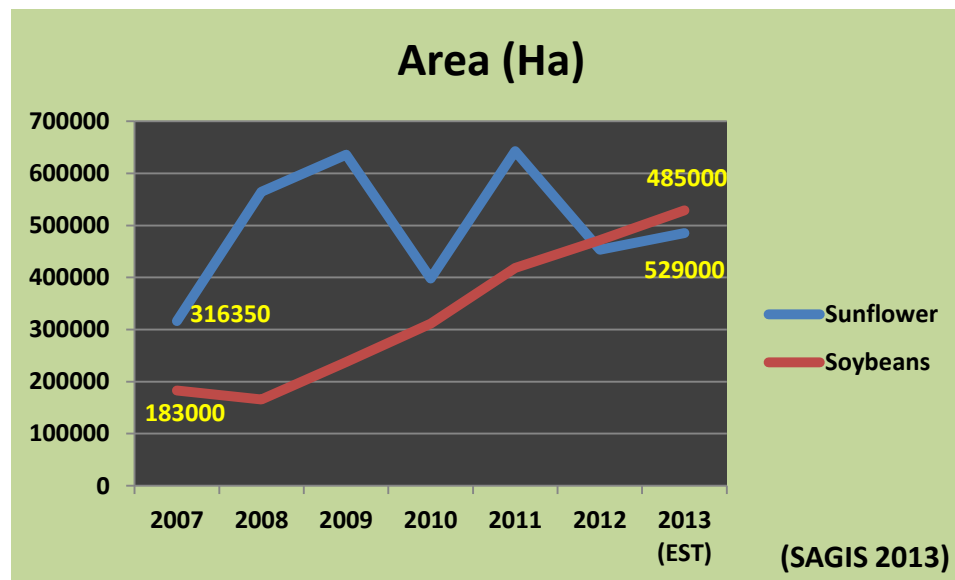
- Sunflower has always been regarded the major oil crop produced in SA
- Sunflower comprises 14% and soybean 8% of the area designated to summer crops



DOMESTIC PRODUCTION OF SOYBEAN



- During the last 5 years the area planted with soybeans has shown a steady increase
- During the previous season (2012), the area planted with soybean exceeded the area planted with sunflower

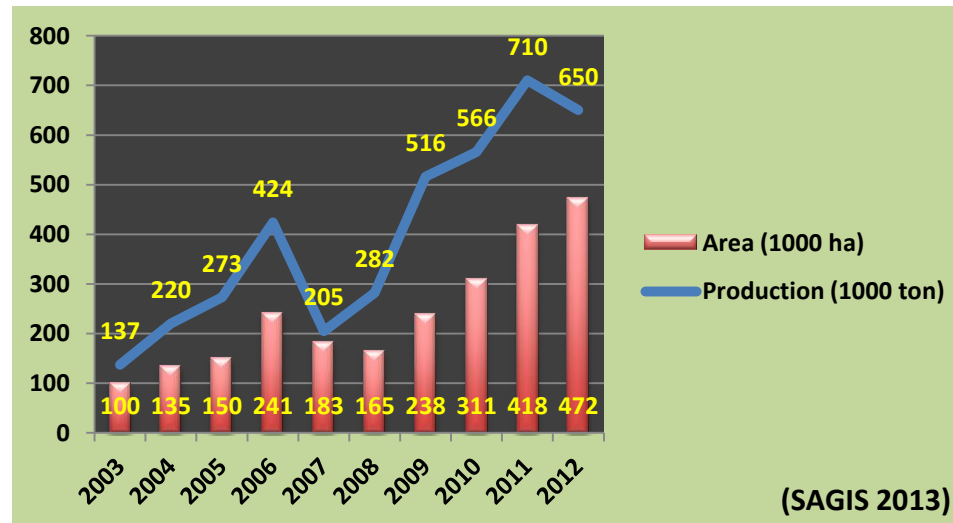


DOMESTIC PRODUCTION OF SOYBEAN



Production

- South Africa ranks 12th internationally for soybean seed production (FAO stats 2011)
- During the last 10 years domestic production increased almost five fold from 137000 ton (2003) to 650000 ton (2012) (SAGIS 2013)





DOMESTIC PRODUCTION OF SOYBEAN



The increase in local production is driven by several factors:

1. **Expanded area planted** – this area increased almost five fold during the last 10 years
2. **The growing demand for oil cake** by the animal feed industry (SA is a net importer of soybean meal and oil)



DOMESTIC PRODUCTION OF SOYBEAN



3. **Expansion and upgrading of local processing capacity** dedicated to soybean
4. **Maize-soybean crop rotation programmes**
– growers are recognising the benefits of using soybean in crop rotation with maize
5. **The development of local high yielding varieties** that are adapted to SA environments

TOTAL SEED CONSUMPTION AND PROCESSING



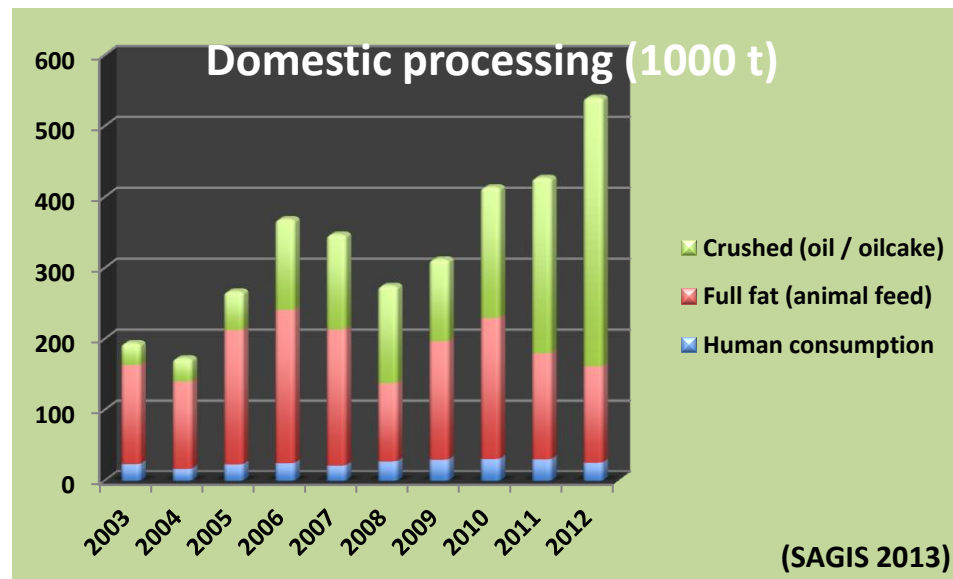
- A total of **553100 ton** of soybeans was locally consumed in 2012 (SAGIS 2013)
 - Includes the soybeans locally processed (98%)
 - Oil cake/oil
 - Full fat (animal feed)
 - Human consumption
 - Other applications (2%)
 - seed retained by farmers, seed released to end-consumers and seed for planting purposes





TOTAL SEED CONSUMPTION AND PROCESSING

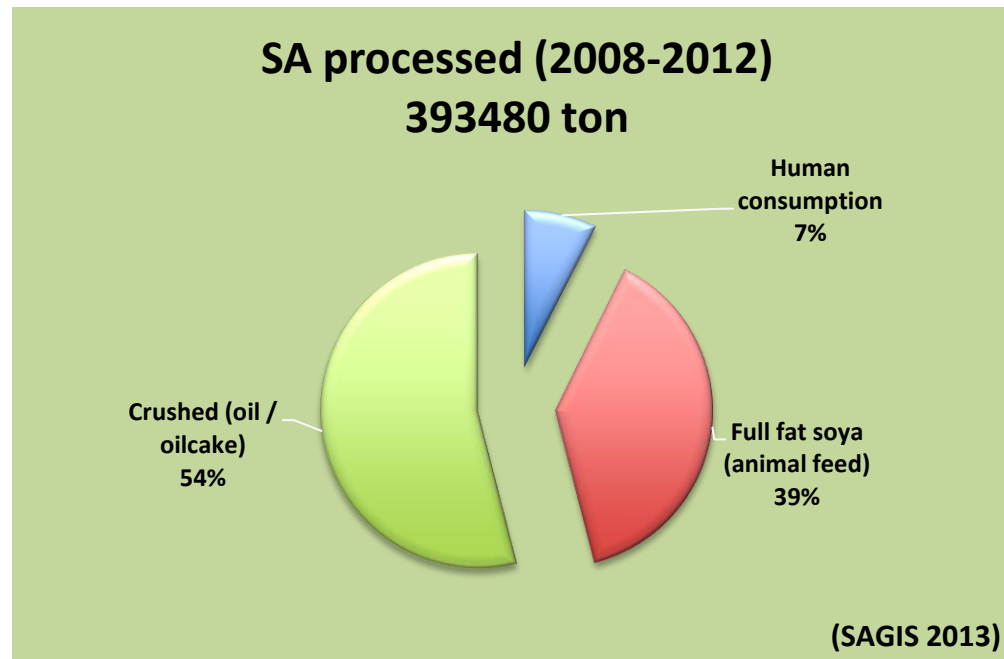
- During the last 10 years the domestic soybean processing increased in total from 194000 ton to 540200 ton





TOTAL SEED CONSUMPTION AND PROCESSING

- The 5 year average for domestically processed soybeans is **393480** ton



TOTAL SEED CONSUMPTION AND PROCESSING



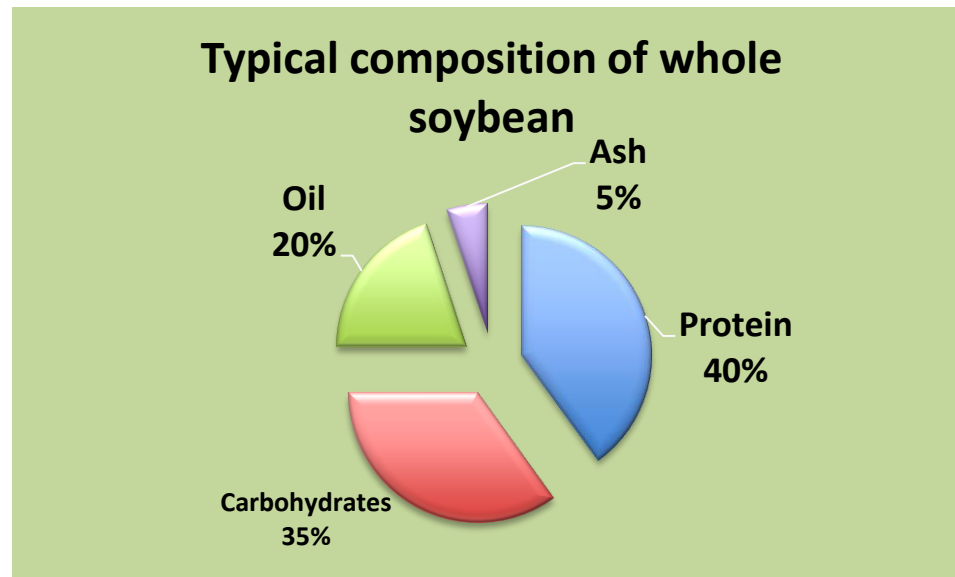
- Local production and processing does not meet the demand for both animal feed and human consumption
- Large quantities of processed products domestically consumed are imported
- Over a 5 year period (2005-2010)
 - 90% of soybean meal/oil cake - mainly from Argentina
 - 94% of soybean oil was imported - mainly from Argentina and Brazil (NAMC 2011)



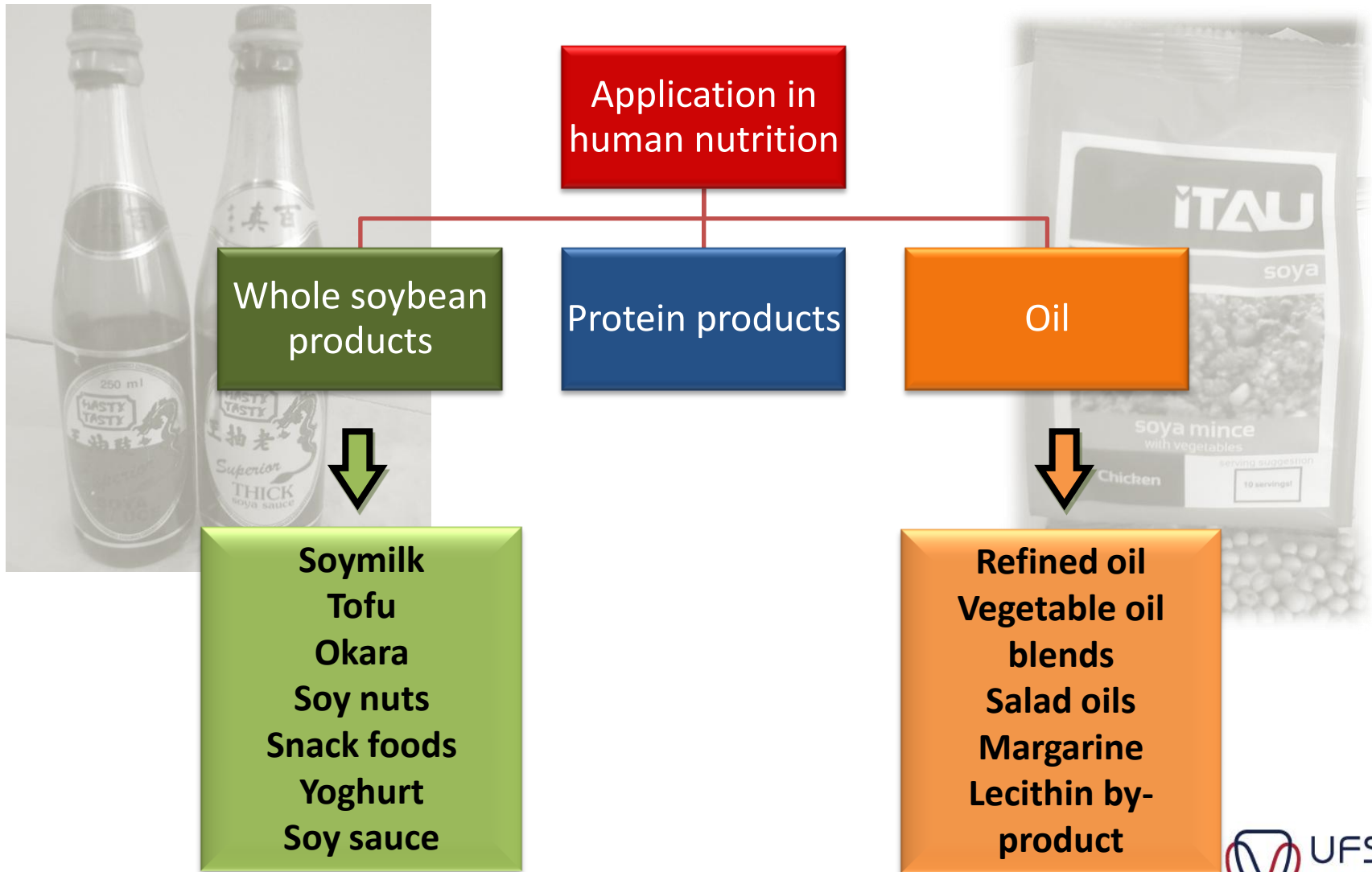
APPLICATION IN HUMAN NUTRITION



- There is a growing interest in soybean production because of the nutritional value and health benefits of soy products
- Soybeans have the following nutritional components:



APPLICATION IN HUMAN NUTRITION



APPLICATION IN HUMAN NUTRITION



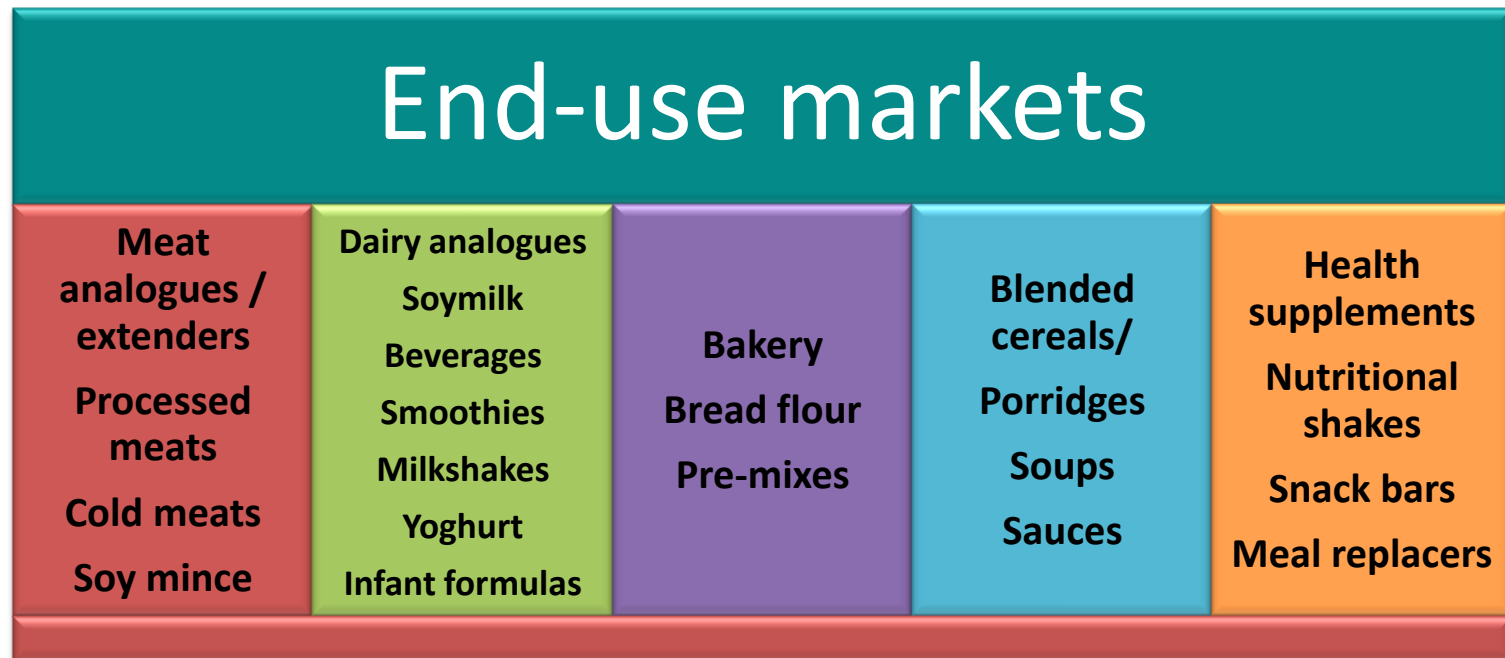
- Soybeans are processed into different soy protein products in order to be used in different foodstuffs and health products
- Four major categories are classified according to their protein content:

Soy protein products			
SOY FLOUR FULL FAT	SOY FLOUR DEFATTED	SOY PROTEIN CONCENTRATE	SOY PROTEIN ISOLATES
40-42% protein	50-54% protein	65-70% protein	90-92% protein
20% oil	1% oil	1% oil	1% oil

APPLICATION IN HUMAN NUTRITION



- Soy protein products are texturised by various processes to produce TSPs that are used in a variety of end-products that have different applications





SOY HUMAN FOOD MARKET

- On a 5 year average, **28640** ton of soybeans was locally processed for human consumption (SAGIS 2013)
- However, this volume does not satisfy the total demand needed in the human food sector
- More than half of the soy market for human consumption relies on imports

SOY HUMAN FOOD MARKET



- In 2005, **34050** ton of soy, excluding oil cake, was imported (value R235 Million)

Soybeans	43%
Isolates	35%
TSP	13%
Concentrates	3%
Soy blends	5%
Flours	1%

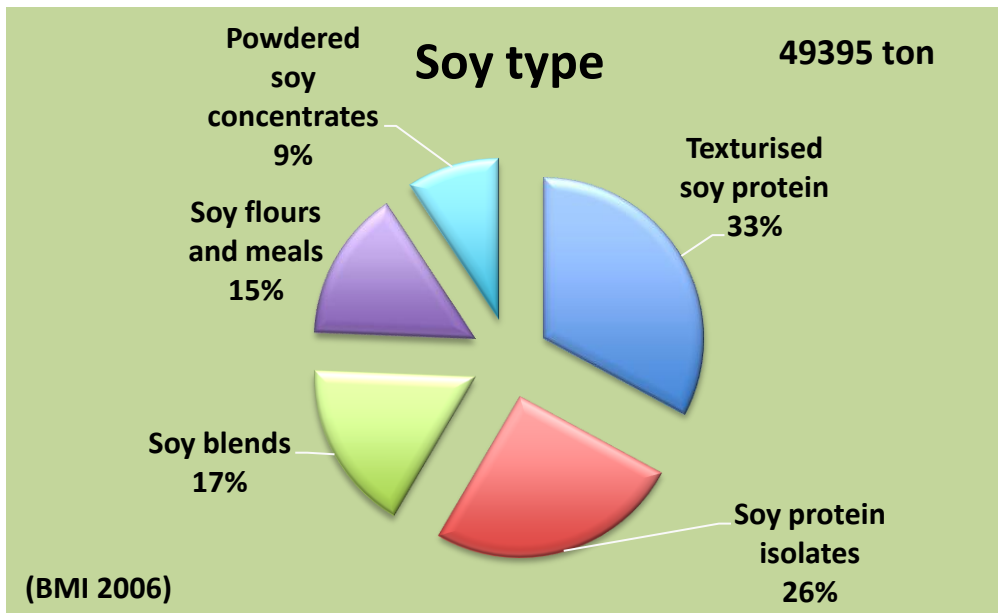
(BMI 2006)

- Soy protein products are generally imported from South America, North America, the Far East and Europe

SOY HUMAN FOOD MARKET



- In 2005 the total market for human sector was **49395 ton**
- An overview of the soy market for human consumption by soy type for 2005





SOY HUMAN FOOD MARKET

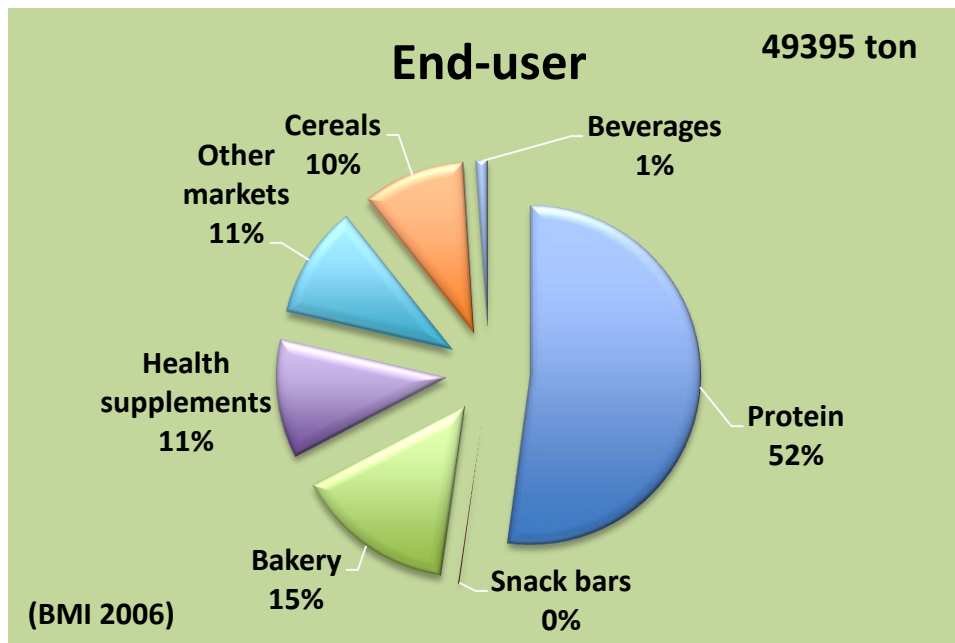
- TSP and soy protein isolates together accounted for approximately 60% to the total market
- TSP, isolates and concentrates are generally used in the meat industry
- Isolates are also used for the manufacturing of soy-based foods
 - for the beverage, health food, soy-fortified porridges and cereal industries



SOY HUMAN FOOD MARKET



- An overview of the soy market for human consumption by end-user for 2005



SOY HUMAN FOOD MARKET



- **The protein market (52%)**
 - Processed meat products, especially emulsion meat products like polony and viennas
 - Soy meat analogues consumed by vegetarians and low income population
- **The bakery market (15%)**
 - Mostly baked goods such as bread and bread rolls
 - Pre-mixes also contributed a small amount
 - Mainly full fat flour were used

(BMI 2006)



SOY HUMAN FOOD MARKET

- **Health supplements (11%)**
 - Diet shakes, health and nutritional supplements
 - Mainly consumed by body builders, people who want to lose weight and those recovering from hospital operations
- **Soy-blended cereals (10%)**
 - Consisted mostly of maize- and wheat-blended cereal products
 - Hot and cold cereals

(BMI 2006)



SOY HUMAN FOOD MARKET

- **The beverages market (1.0%)**
 - Included mostly soymilk, flavoured milk yoghurt, and powdered beverages
 - Soymilk is the most established soy analogue and shows good growth with increased consumer demand
- **Snack bar market (0.1%)**
 - Niche market and needs development

(BMI 2006)



SOY HUMAN FOOD MARKET

- The soy market for human consumption is growing due to the local demand for healthy and nutritious soy food products
- Between 2004 and 2009 the soy product market in SA showed an annual compound growth rate of 15.8% (Market Research.com)
- There is a concerted effort of numerous local and international manufacturers to bring soy ingredients and soy foods to the consumer



SOY HUMAN FOOD MARKET

- The following data for 2012 was obtained from an independent company that is an importer and distributor of soy products in SA

Soy protein product type	Import (ton)	Value (Rand)
Soy concentrate and TSP (<65% protein)	3168	28 million
Soy concentrate and TSP (>65% protein)	3 390	45 million
Soy isolates	11774	242 million
Lecithin	1698	29 million
Total	20030	344 million



SOY HUMAN FOOD MARKET

- The following data was obtained from local companies involved in manufacturing and retail of several soy products

Food market	Soy type	Source	End-product/ application	Total annual demand (ton)
Meat (Meat analogues)	Defatted white flakes Processed locally in TSP	Imported • India	Soy mince meals	550
Meat (Butchery Meat analogues)	Isolates Concentrates TSP	Imported • North America • Brazil	Cold meats Polony Russians Viennas Meat sausages	960

SOY HUMAN FOOD MARKET



Food market	Soy type	Source	End-product/ application	Annual demand (ton)
Beverages	Full fat flour	Imported • North America • Brazil	Soymilk Smoothies Shakes Ice-cream	Not available
Cereal/ Instant porridge (Milling and soy product development)	Full fat flour	Locally produced soybeans	Food products fortified with soy protein: Instant maize porridge Soup powders Sauce powders	2880

SOY FOOD MARKET



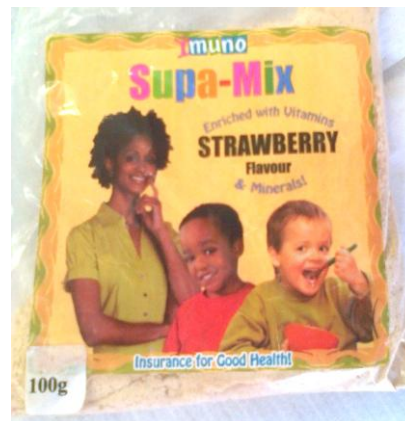
Food market	Soy type	Source	End-product/ application	Annual demand (ton)
Bakery (Milling and soy product development)	Full fat flour	Locally produced soybeans	BREAD SOY • full fat enzyme active soy flour INFRASOY • roasted full fat soy flour INFRAGRAN • roasted full fat grits Supply to • Bakery • Meat • Milk replacement • Health food • Snack • Convenience food • And other industries	10000



SOY FOOD MARKET

It appears that

- From domestically produced soybeans mainly full fat soy flours and TSPs are manufactured
- Isolates, concentrates, different classes of soy flours and flakes and defatted variants are imported



BREEDING SOYBEAN FOR HUMAN FOOD



- Need for the development of soybean varieties for the human food market that will answer to both the demand of growers as well as consumers
- 80% of SA soybean production is GMO varieties (Roundup Ready)
- For some human food markets high yielding conventional (non-GMO) varieties that can meet the performance of GMO varieties are sought after
- Different soy food processors have different requirements with regard to the nutritional composition or functional properties of soy ingredients

BREEDING SOYBEAN FOR HUMAN FOOD



Key breeding targets include:

- Breeding for important agronomical traits
- Breeding for improved nutritional and functional value
- Breeding for reduced negative compounds that cause undesirable flavours and “beany flavour”, flatulence and poor digestibility

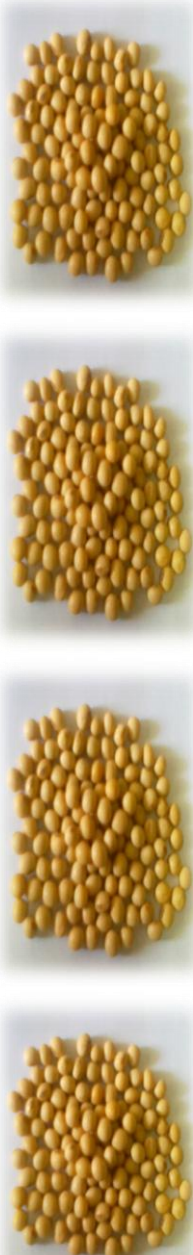




BREEDING SOYBEAN FOR HUMAN FOOD

- Agronomical traits play a role when growers make cultivar choices and should be considered in breeding food grade soybeans:
 - Yield potential
 - Growth habit
 - Maturity group type
 - Shattering resistance
 - Pod height
 - Lodging resistance
 - Resistance to pests, diseases and chemicals





BREEDING SOYBEAN FOR HUMAN FOOD



- Breeding of food grade soybeans are classified into the following categories:

1. Seed size

- Large-seeded soybeans are most preferred for the production of soymilk, dairy alternatives and tofu

2. Seed appearance

- Clear hilum
- Yellow seed coat and cotyledon
- Thin, strong seed coat
- Preferred for the production of soymilk, dairy alternatives and tofu

BREEDING SOYBEAN FOR HUMAN FOOD



3. Seeds with unique composition

- **Protein content and composition**

- High protein (content $\geq 43\%$)
- Increased protein/oil ratio
- Eliminating/reducing unfavourable components
 - Lipoxygenase (reduce “beany” flavour during oxidation with lipids)
 - Trypsin inhibitor

- **Carbohydrates**

- High sucrose
- Sucrose content increased with 40%
- Reduction in flatulence causing raffinose and stachyose to $<1\%$





BREEDING SOYBEAN FOR HUMAN FOOD

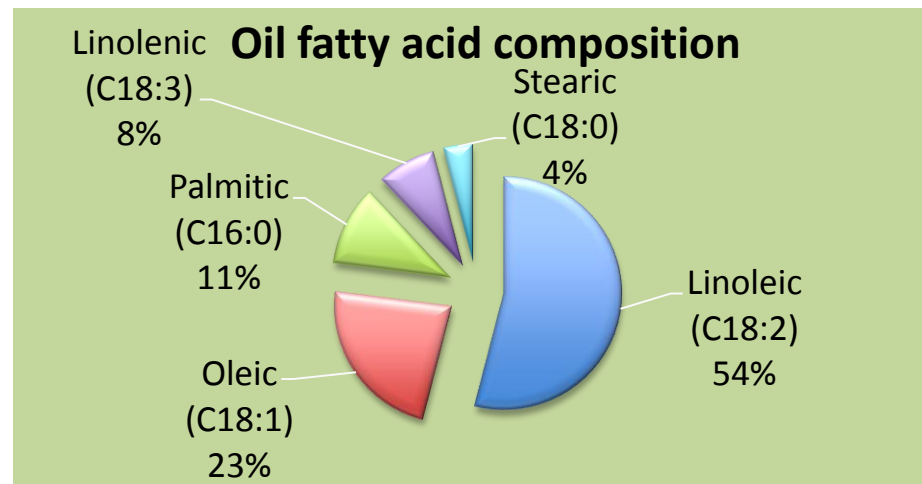


- Conventional high protein and high sucrose varieties are preferred for producing
 - Whole soybeans
 - Full fat and low fat flours
 - Soymilk powder
 - Soymilk
 - Dairy analogues
 - Meat analogues
 - Baked goods

BREEDING SOYBEAN FOR HUMAN FOOD



- **Oil quality**
 - Increased/reduced oil content
 - Oil content negatively correlated to protein content
 - Altering fatty acid composition
- Commodity soybean oil is composed of five major fatty acids:





BREEDING SOYBEAN FOR HUMAN FOOD

- Reduced polyunsaturated fatty acid content
 - Improves oxidative stability
 - Low linolenic acid (C18:3) soybean oil
 - High oleic acid (C18:1) soybean oil
 - High oleic and elevated stearic acid (C18:0) soybean oil

4. Breeding seeds high in functional components

- High-isoflavone (>0.4%)
- Enhanced tocopherol content and composition



CONCLUSIONS

- Although the soybean market for human consumption may be regarded insignificant compared to the animal feed market
- **There is a huge demand for soybeans** in the human food sector and the demand is increasing
- **Substituting soy product imports with locally produced products** as millions of rand are spent on acquiring those products from foreign countries



CONCLUSIONS

- **Local processing capacity** dedicated to manufacturing of soy protein products should be expanded/upgraded to meet demand for the production of soy based foods
 - There is a need to develop processing technology that is less expensive
- **Niche markets** for soy-based foods are established and will continue to grow
- **Small holder farmers** may provide an opportunity for producing soybeans for the food market and especially niche markets



CONCLUSIONS

- **Farmers may be contracted by soy processors** and negotiate for premiums when delivering high quality, non-GMO food grade soybeans
- **Breeding of conventional varieties** with special compositional traits
- Food grade varieties can contribute to:
 - 1. Reduction in soybean processing cost**
Some additional processing steps, could be omitted when using lipoxygenase free or reduced raffinose and stachyose varieties



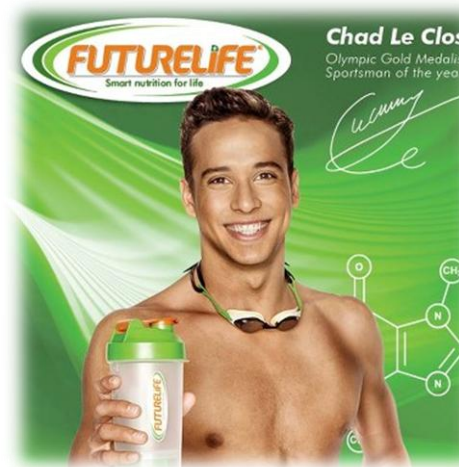
CONCLUSIONS

2. **Production of high quality soy protein products** that comply with the needs of the food manufacturers
3. **Producing better tasting soy products** that will be more pleasing for the consumer
4. **Ultimately contribute to production of less expensive soy-based foods and products** that satisfy the needs of all consumers





- There is however one big hurdle to overcome and that is to inform the man on the street about the good properties of soybean and to change the perception of Tom, Dick and Harry that think soy tastes “bad”
- Hopefully with the help of Olympic Hero's such as Ryk Neethling, Chad Le Clos and rugby hero Pat Lambie this can change...



ACKNOWLEDGEMENTS



- Danie Botha
- Cobus Crous
- Henry Davies
- Antony Jarvie
- Aalwyn de Lange
- Annetjie de Lange
- Tian du Toit
- Aalwyn Labuschagne
- Theuns Scheepers
- Dirk Strydom
- Fritz Teseling
- Francois van Schalkwyk
- Louis Verhoef



Thank You Dankie

T: 051 401 9111 info@ufs.ac.za www.ufs.ac.za

© Copyright reserved
Kopiereg voorbehou

UNIVERSITY OF THE
FREE STATE
UNIVERSITEIT VAN DIE
VRYSTAAT
YUNIVESITHI YA
FREISTATA



UFS·UV
NATURAL AND
AGRICULTURAL SCIENCES
NATUUR- EN
LANDBOUWETENSAPPE