Session 3
Nutrition and Health
Chair: Prof Ian Macdonald

GLOBAL FOOD SECURITY FORUM
'Meeting Nutritional Needs'

7 - 8 July, 2014
Putrajaya Marriott Hotel, Malaysia

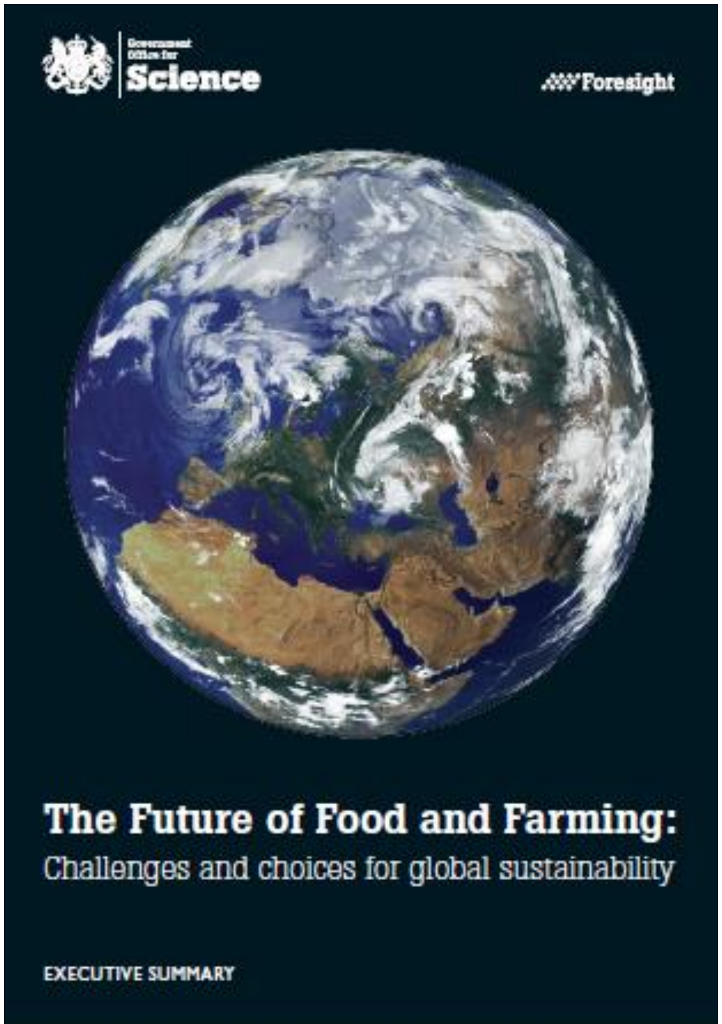
CONTENTS

Disease & Health Risk from Excess Meat Intake

Prof Andy Salter

Division of Nutritional Sciences, University of Nottingham

Impact of Livestock Production on Global Food Security & Health



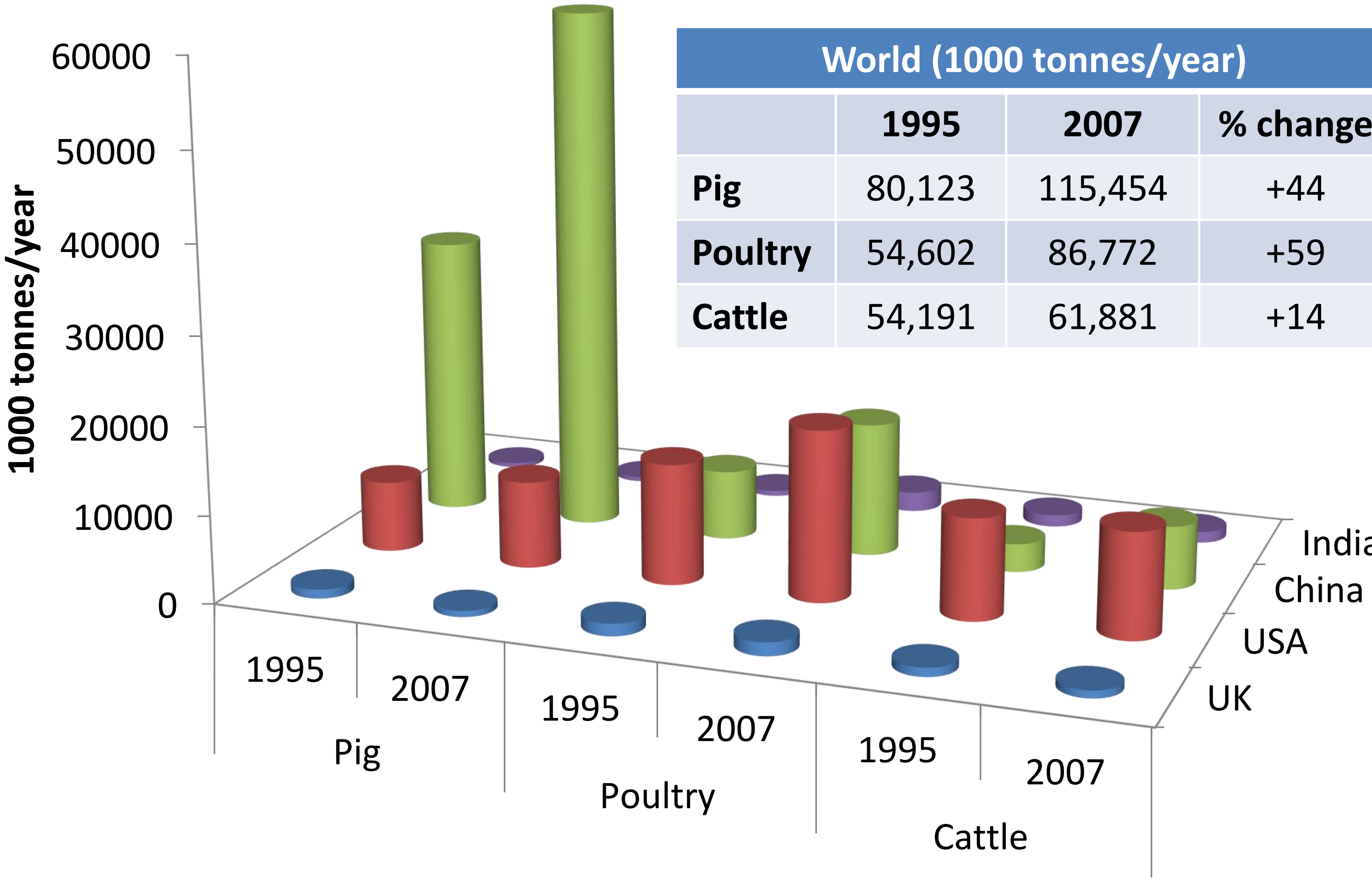
A reduction in the amount of meat consumed in high- and middle-income countries would have multiple benefits:

- A reduced demand for grain
- Lower greenhouse gas emissions
- **A positive effect on health**

Meat in the Human Diet

- Carnivory was present in the diet of early hominins more than 2 million year ago and is believed to have contributed to the success of the species
- Meat is an excellent, energy-dense source of high quality protein and a good source of a range of micronutrients (including thiamin, niacin, vitamin B_{12}, iron, zinc, potassium, and phosphorus)
- However, by selecting from a range of plant materials it is possible to remove meat from the diet without any significant nutritional consequences

Meat Production in Selected Countries 1995/2007



World (1000 tonnes/year)			
	1995	**2007**	**% change**
Pig	80,123	115,454	+44
Poultry	54,602	86,772	+59
Cattle	54,191	61,881	+14

Data from F AO. 2009. The state of food and agriculture. http://www.fao.org/publications/sofa/en/

Death from Non-Communicable Diseases (NCDs) and Animal Product Consumption in Selected Countries

Country	Sex	Life Expectancy (y)	Deaths from NCDs (1000s)	% under age of 70y	Age Standardized deaths per 100,000 of population		Livestock Product consumption (kcal/person/day)
					Cancer	CVD + Diabetes	
Brazil	M	70.0	474	52	136	304	603.2
	F	76.9	420	42	95	275	
China	M	72.2	4323	44	182	312	610.0
	F	75.8	3675	32	105	260	
India	M	63.1	2967	62	79	386	125.3
	F	66.1	2274	55	72	283	
Kenya	M	57.6	57	59	119	401	216.6
	F	62.1	47	52	113	326	
UK	M	78..0	244	29	155	166	850.5
	F	82.2	274	18	115	102	
USA	M	76.0	1055	37	141	190	900.0
	F	80.9	1150	24	103	122	

Modified from Salter AM (2013) Animal Frontiers 3(1) 20-27

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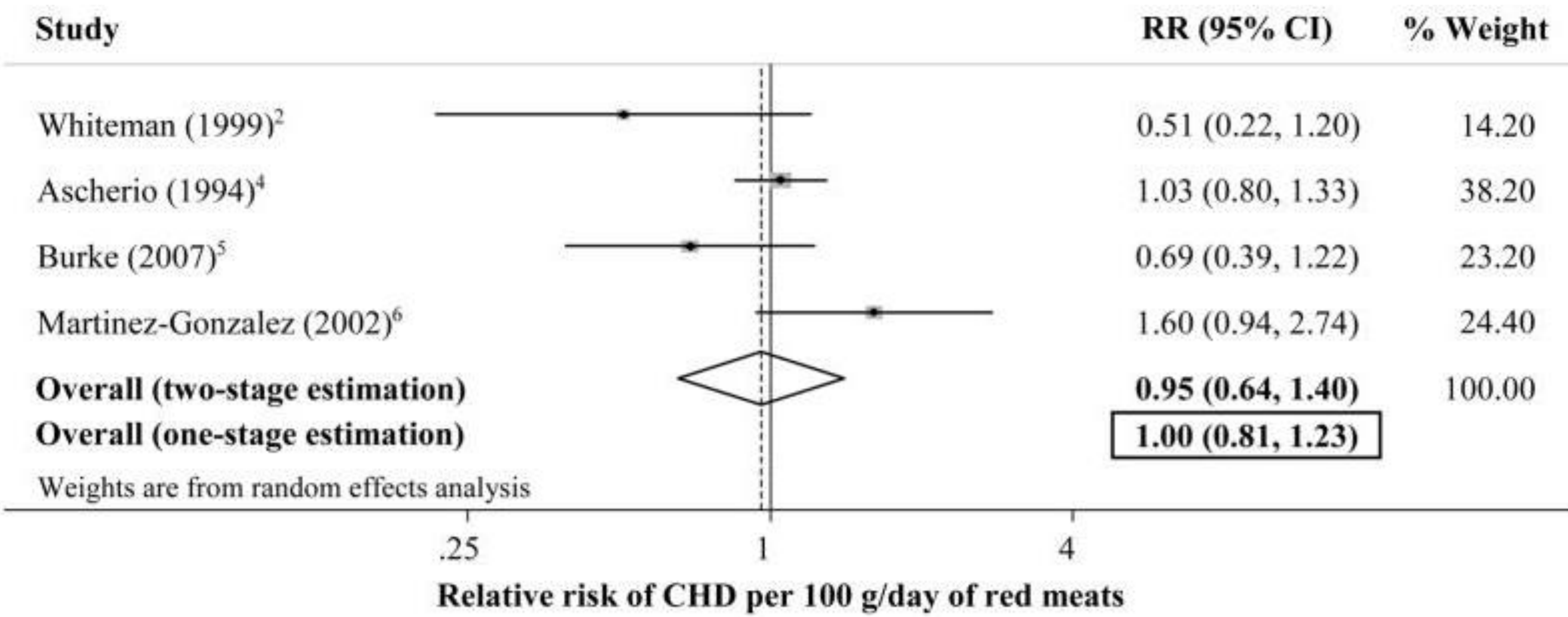
Modified from Salter AM (2013) Animal Frontiers 3(1) 20-27

Meat & Health

- Little evidence to suggest adverse effects of white meat (poultry), fish or seafood on health (apart from chemical/microbial contamination)
- Red meat consumption (pork, beef, lamb) has been associated with increased risk of a range on NCDs including Cardiovascular Disease, some Cancers (particularly Colorectal) and perhaps Type 2 diabetes
- Processed Red Meat (e.g. Bacon, Sausage) may have worse effects than Fresh Red Meat

Consumption of Red Meat and Coronary Heart Disease

(Meta-analysis of prospective studies)

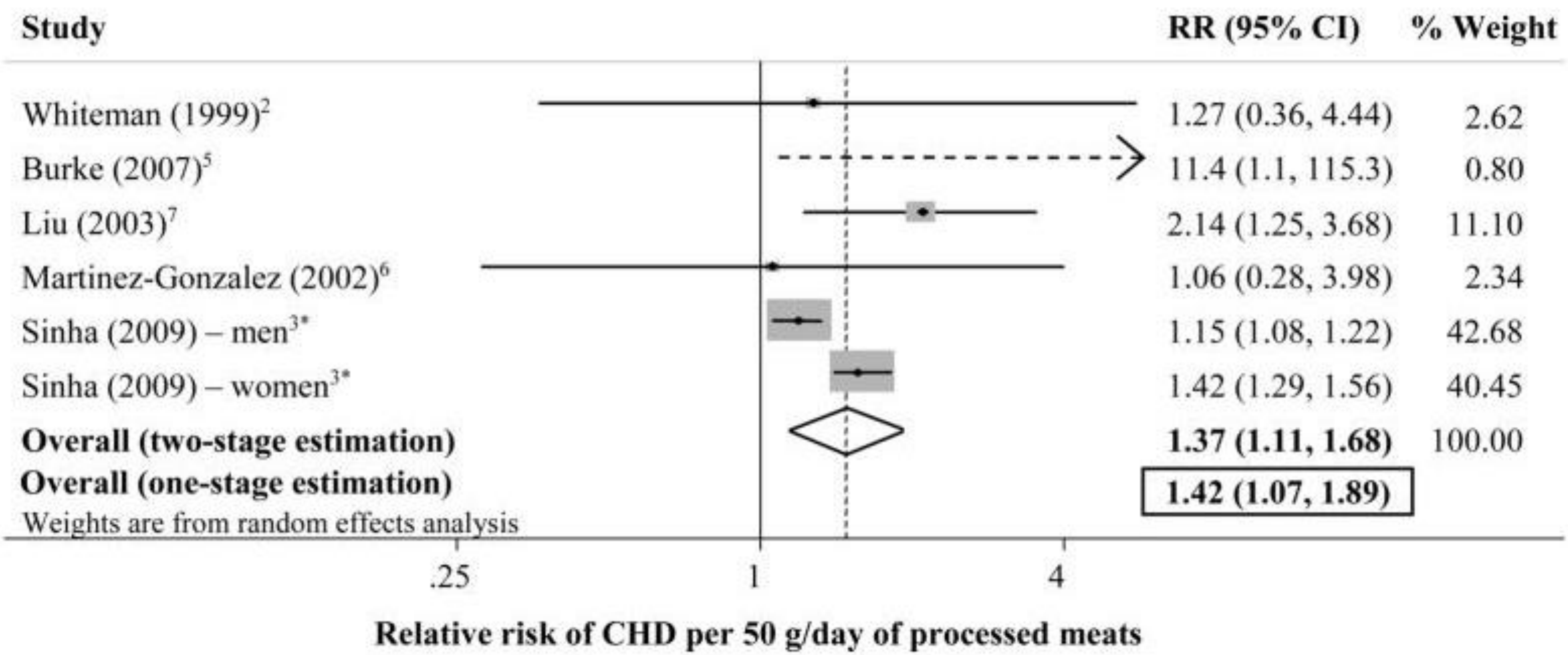


Also Showed similar outcome for Type 2 Diabetes

From: Micha et al (2010) Circulation 121(21):2271-83.

Consumption of Processed Meat and Coronary Heart Disease

(Meta-analysis of prospective studies)



Also Showed similar outcome for Type 2 Diabetes

From: Micha et al (2010) Circulation 121(21):2271-83.

Cardiovascular Mortality & Red Meat Intake

(Health Professionals Follow-up Study, n=51529 males, 40-75y)

	Q1	Q2	Q3	Q4	Q5
Red Meat Consumption (serving/d)	0.22	0.62	1.01	1.47	2.36
Physical Activity (Met-h/week)	27.5	22.7	20.2	18.8	17.2
Smokers (%)	5	7.3	9.8	11.3	14.5
Alcohol (g/day)	8.4	10.7	11.2	12.4	13.4
BMI (kg/m2)	24.7	25.3	25.5	25.7	26.0
CVD mortality risk*	1	1.05 (0.93-1.19)	1.15 (1.01-1.30)	1.15 (1.01-1.31)	1.25 (1.11-1.41)

*adjust for range of variables including the above

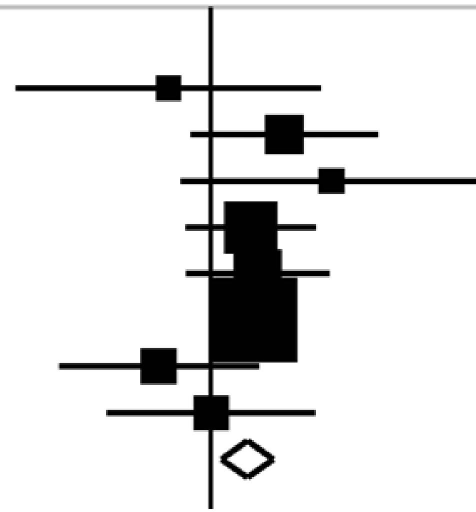
Similar results found for total & cancer mortality

Data from: Pan et al (2012) Arch Intern Med 172(7) 555-563

Red & Processed Meat and Colorectal Cancer

Meta-analysis of prospective studies

Author	Year	Subgroup	RR (95% CI) per 100g/day increase	% Weight
Colorectal cancer				
Pietinen	1999	Male	0.83 (0.43, 1.61)	2.92
Jarvinen	2001	Mixed	1.37 (0.92, 2.06)	7.74
Tiemersma	2002	Mixed	1.69 (0.88, 3.23)	2.98
English	2004	Mixed	1.19 (0.89, 1.58)	15.79
Larsson	2005	Female	1.23 (0.90, 1.67)	13.11
Norat	2005	Mixed	1.21 (1.02, 1.43)	44.43
Lee	2009	Female	0.80 (0.52, 1.23)	6.78
Nothlings	2009	Mixed	1.00 (0.64, 1.57)	6.25
Subtotal (I-squared = 0.0%, p = 0.483)			1.17 (1.05, 1.31)	100.00



Similar significant results found when fresh and processed meat analysed separately

From: Chan DSM, et al (2011) PLoS ONE 6(6): e20456

Conclusions

- Meat represents an energy-dense source of high quality protein and a range of micronutrients.
- Excessive Red (particularly processed) meat consumption may be associated with increased risk of developing cardiovascular disease (and possibly diabetes).
- Further research needed to ascertain what the components of processed meat are that exert such effects –fat, salt, nitrates?
- Excessive consumption of fresh and processed red meat associated with increased risk of colorectal cancer.

So what are the alternatives?

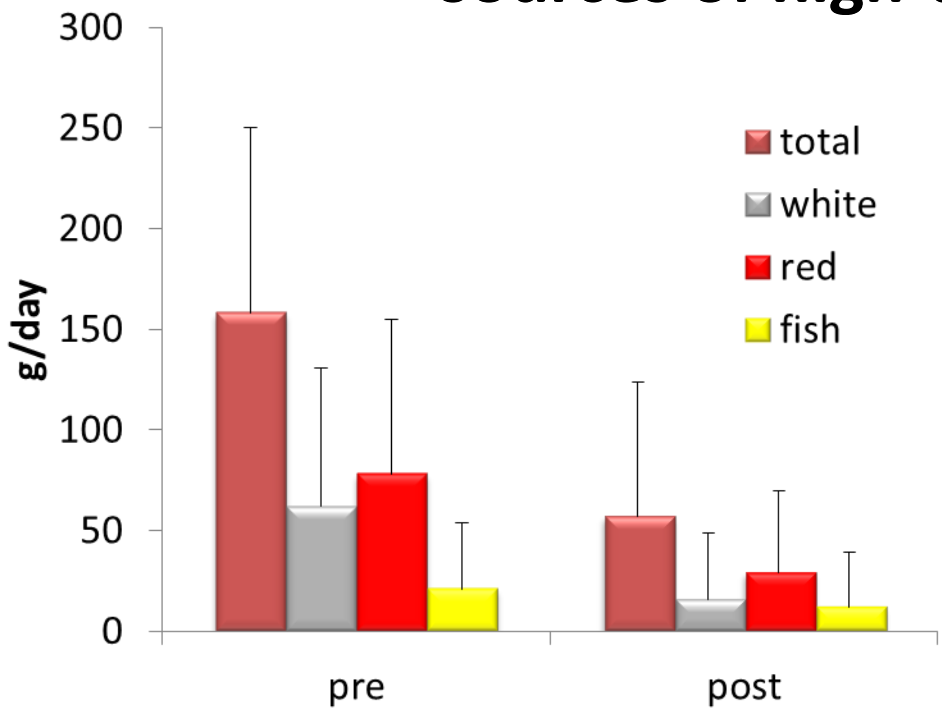
*'Compared with red meat, other dietary components such as fish, poultry, nuts, legumes, low-fat dairy products, and whole grains, were associated with lower risk'**

However many of these have significant sustainability issues associated with them and **PEOPLE LIKE MEAT**

Other alternatives include Meat Mimetics (e.g. Mycoprotein- deride from fungi) or **INSECTS**

*Pan et al (2012) Arch Intern Med 172(7) 555-563

Replacing meat with other more sustainable sources of high-quality protein



mMol/l	pre	post
Total cholesterol	4.45±0.53	4.05±0.66***
HDL cholesterol	1.53±0.39	1.50±0.38
LDL cholesterol	2.40± 0.36	2.15± 0.46**
Total triacylglycerol	1.14±0.53	0.88±0.31*

Technology Strategy Board

Consumer Insight driven development of ingredients and products to aid in the reduction of meat consumption
Marlow Foods/University of Nottingham + 4 other partners

Thank you

Present

Future?

Nutritious leafy vegetables: underutilised but potentially important contributors to health and food security

Graham Lyons, School of Agriculture, Food & Wine,
University of Adelaide

THE UNIVERSITY OF ADELAIDE AUSTRALIA

Australian Government
Australian Centre for International Agricultural Research

FOODplus RESEARCH CENTRE

AVRDC
The World Vegetable Center

Contents

- Background
  - Food system approach
  - Orange sweetpotato program
  - Metabolic disease problem
- Nutritious leafy vegetables program
- Next leafy vegetables program: atolls

Nutritional value of leaves >> roots
Example: cassava

	Carotenoids mg/kg dry weight			Minerals		Protein %
	lutein	**zeaxanthin**	**b-carot**	**Fe**	**Zn**	
Root	0	0	0	5	6	2
Leaf	450	50	350	40	100	23

Leaves valuable but under-researched and underused

Alarming NCD rates

- Pre 1940s: traditional lifestyle
  - No or minimal diabetes, heart disease, etc
- Post 1940s: changes in diet, work, exercise
- Since 1960s: high incidence/prevalence of obesity, diabetes, heart disease, various cancers
- Need for a partial return to traditional/healthy diet and more exercise
- Important roles for nutritious leafy vegetables and education

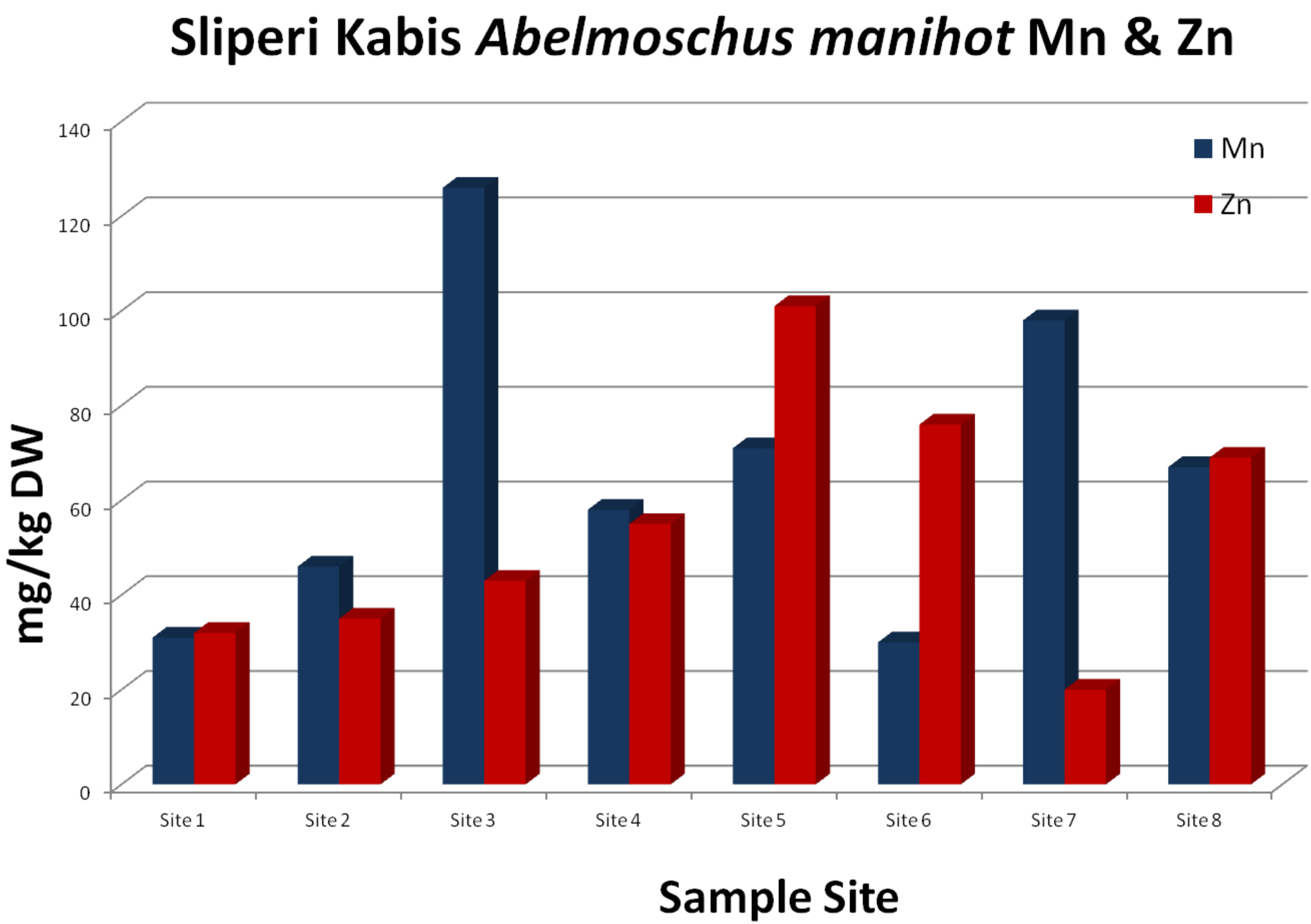
Nutritious leafy vegetables study

- May 2012-August 2013
- ACIAR funded
- Solomon Islands, Samoa, Tonga, Kiribati, Torres Strait Islands, Arnhem Land
- Mary Taylor, Roger Goebel, Pita Tikai, Takena Redfern, Tania Paul, Kalais-Jade Stanley, Graham Lyons et al
- Surveys (opinions/knowledge & leaf minerals/carotenoids), education/promotion (factsheets, media)

People survey

- Solomons: food gardens important; great variety of LGV & medicinals; good flavour and ease of growing; health knowledge low
- Samoa: LGV not a traditional food but taro leaf, pele popular; knowledge low; eager for recipes
- Tonga: fruit/vegs popular and education well advanced; professionals often lack time for cooking
- Northern Aust: little food garden activity: cash for buying shop food; long dry season; knowledge good in Sthn Torres Strait Is.

Nutrients: Genotype X Environment



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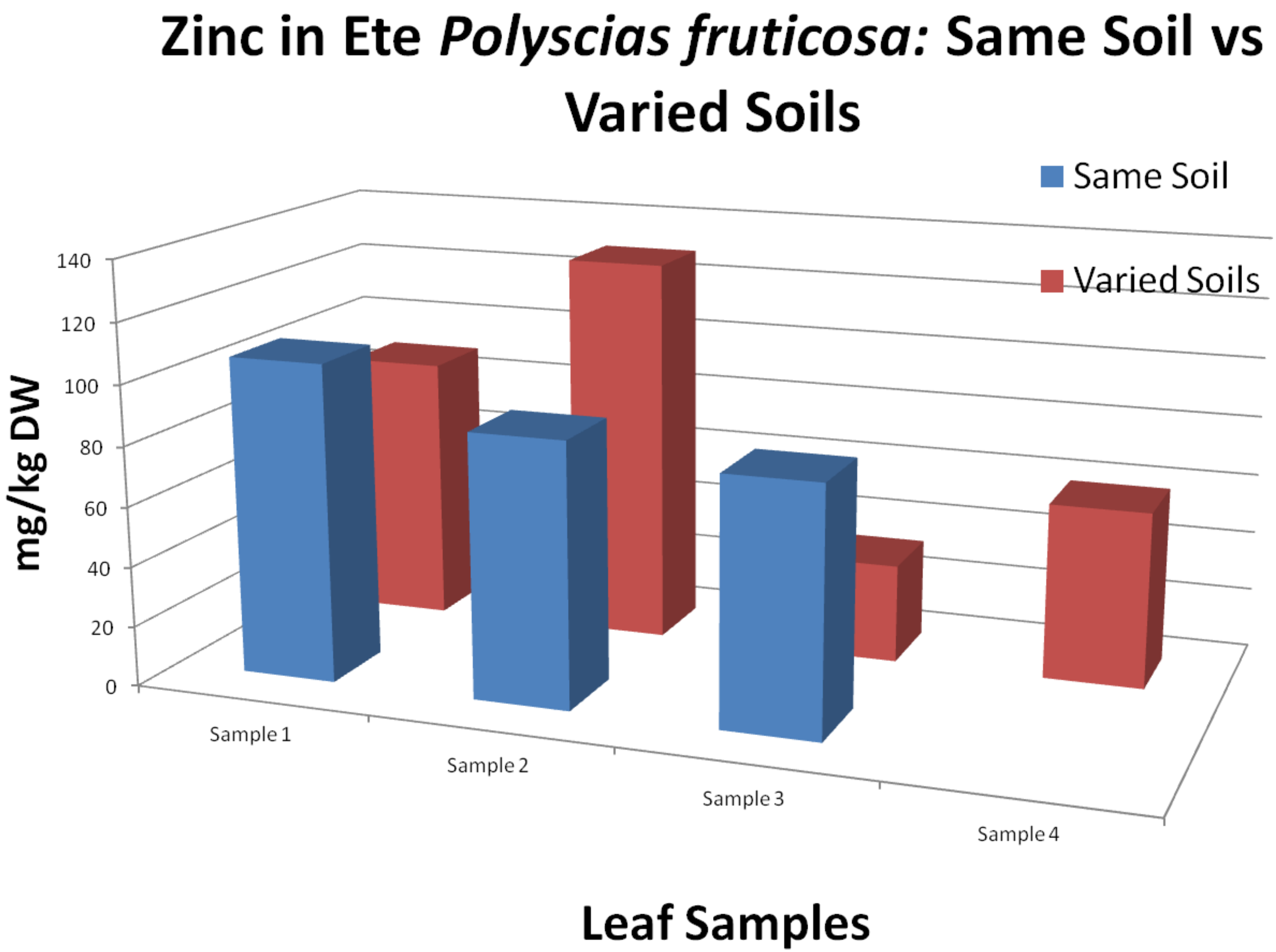


Nutrients: Genotype X Environment

Species	Mineral nutrient (mg/kg DW)	
	Zn	Mg
Lettuce	20	3300
Swpot	29	2400
Aibika	32	4700
Cassava	40	2300
Ofenga	46	16000
Sweetleaf	61	6500
Variation	3-fold	7-fold

Location: Burns Creek, Guadalcanal, Solomons

Ofenga (*Pseuderanthemum whartonium*)
a Mg & Ca accumulator

Mineral nutrients

Zinc: Ete (*Polyscias*), sweetleaf (*Sauropus*)

Sulphur: Drumstick (*Moringa*), watercress, cabbage

Magnesium: Ofenga (*Pseuderanthemum*)

Calcium: Ivy gourd (*Coccinia*), Ofenga

Selenium: Drumstick

Nitrogen/protein: Sweetleaf, Drumstick, cassava

Best all-rounders: Sweetleaf, Aibika/bele (*Abelmoschus manihot*), Ete, Drumstick

Carotenoids

Species	Carotenoid (mg/kg DW)		
	b-carotene	a-carotene	lutein
Drumstick	427	0	773
Aibika	356	38	1024
Sweetleaf	289	32	773
English cabbage	0	2	5

Mean levels for samples collected on Guadalcanal: top 3 compared with lowest

Ceylon spinach (*Basella alba*)

Promotion/education

- Factsheets: 500 x 12 = 6000
- Distribution included follow-up workshops at survey/sampling locations
- Online: www.aciar.gov.au/News2013July
- Samoan Women in Business Development workshop and pele propagation trial
  - Best planting material: 75cm sticks including plant tip, vertically cut at 35 degrees
- Media activity
- Capacity building, Masters studies at USP
- Thursday Island horticulture demonstration plots, Drumstick promotion, *Lift for Life* fitness/diet trial

Drumstick tree (*Moringa oleifera*)

Aibika/sliperi kabis (*Abelmoschus manihot*)

Drumstick & Aibika

	Fe	Zn	Mg	S	N	Se	lutein	b-car
	mg/kg DW, but N as %							
Drum	58	31	3700	12300	5.1	2.0	773	427
Aibika	73	44	7100	4500	4.9	0.17	1006	358
Cab	40	20	1450	3750	2.8	0.15	5	2

Drumstick tree & Aibika grown at Burns Creek, Solomons 2012, compared with English cabbage (mean of 3 market-bought samples)

Sweetleaf (*Sauropus androgynus*)

Marau, Solomons soil pH 9:

Ete (*Polyscias* sp)

Cassava deficient in Fe, K, P, N

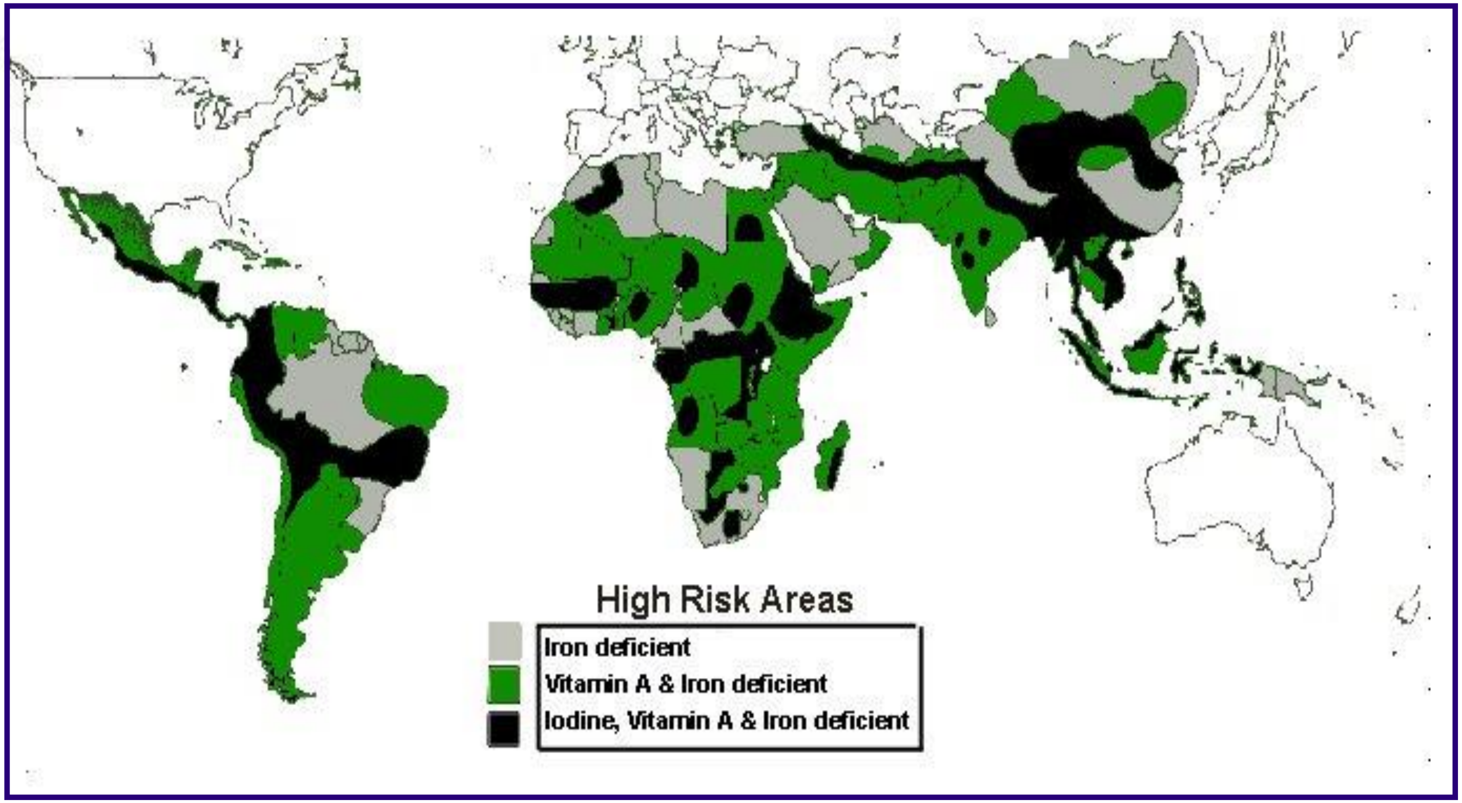

Community Nutrition
unicef
POHNPEI BANANAS
(UHT KAN EN POHNPEI):
CAROTENOID-RICH VARIETIES
Grow and eat orange- and yellow-fleshed varieties for your health
to help protect against diabetes, heart disease, certain cancers,
vitamin A deficiency, and anemia.
Padok oh sakan soangen uht kan me oangoahng pwehn sewese omwi roson:
soumwahu en suke, soumwahu en mohngiong, cancers,
seuitar en vitamin A, oh seuitar en nta.

Acknowledgement

- **Inspired by the late Dr Lois Englberger, founder of "Go Local"**
- **ACIAR funding**
- **Suppliers of samples, opinions**
- **Researchers:** Mary Taylor, Roger Goebel, Pita Tikai (AVRDC Honiara), Tania Paul, Kalais-Jade Stanley (WIBD Samoa), Takena Redfern (Kiribati), Graham Lyons et al
- **Analytical:** Waite Analytical Services (FOODplus) & Mares Laboratory, University of Adelaide; Dr Shahidul Islam et al (University of KwaZulu Natal, South Africa)

Pita Tikai, AVRDC, Solomons

Global micronutrient deficiencies



> 3 billion people afflicted

(Map from USAID)

Mexican sunflower (*Tithonia diversifolia*)

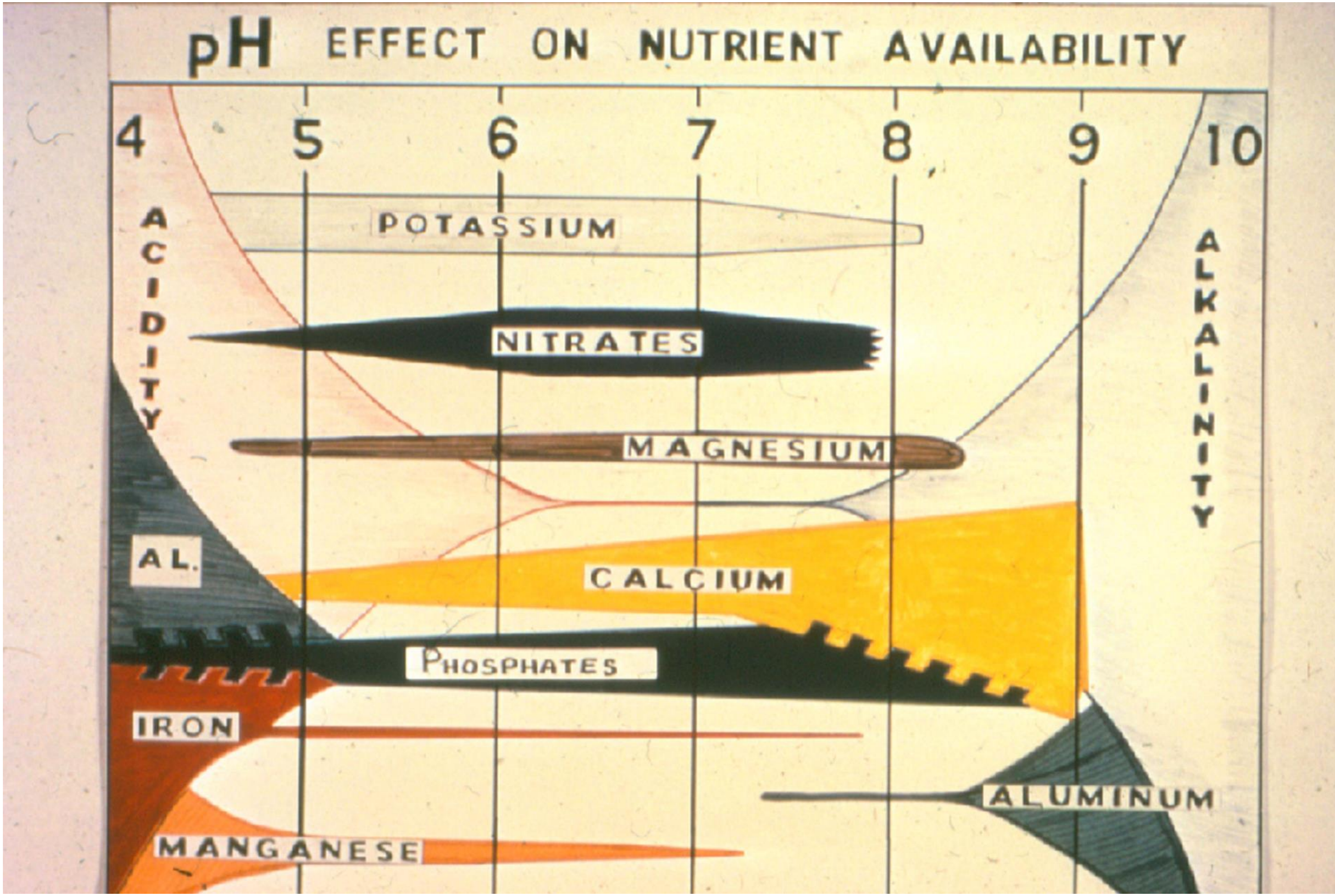
Dadap (*Erythrina*)

Pawpaw with P & K deficiencies, Marau

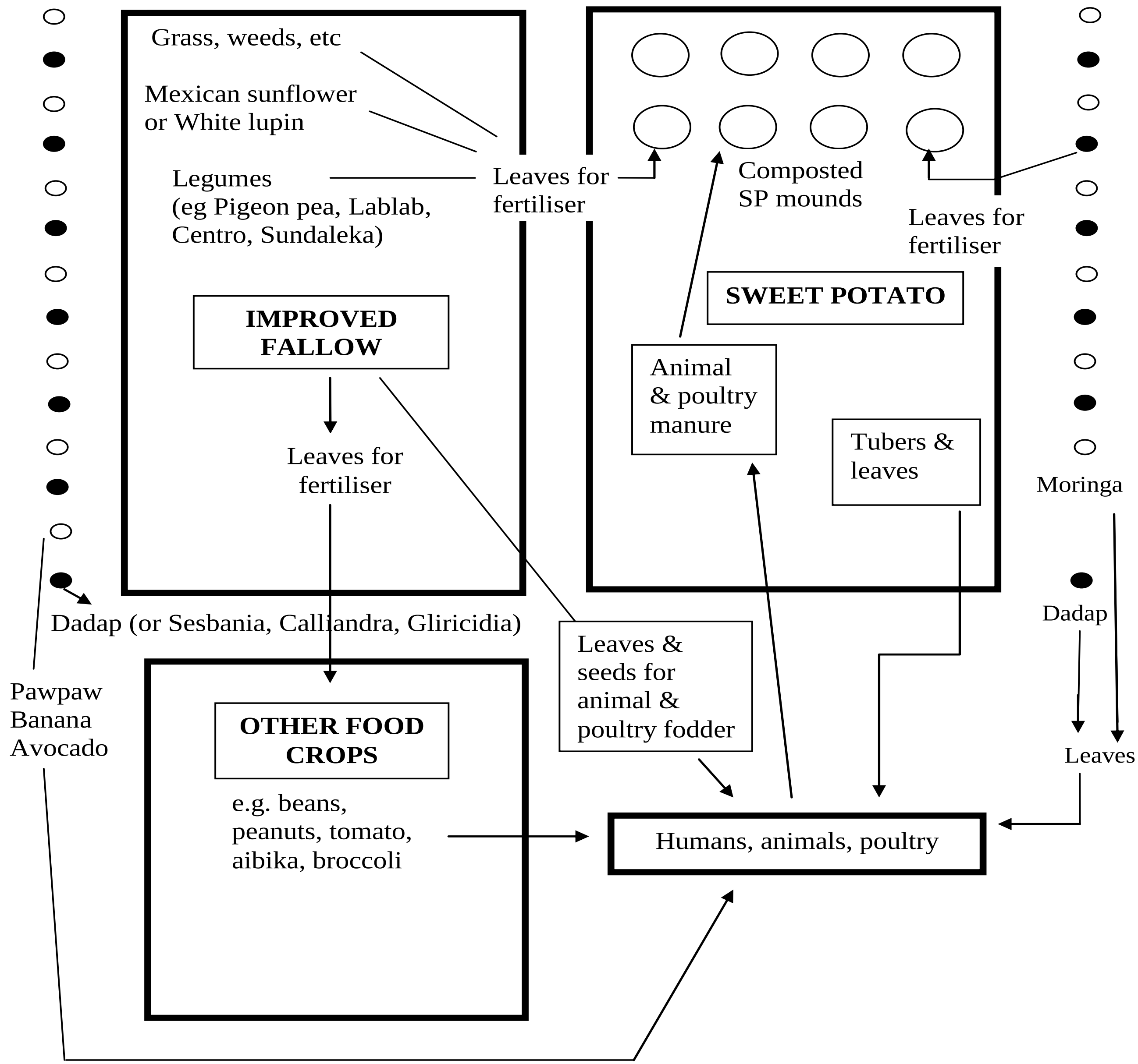
Ete (*Polyscias* sp), Marau, Solomons

Cassava deficient in Fe, K, N, P: Marau, Solomons

Influence of pH on Nutrient Availability

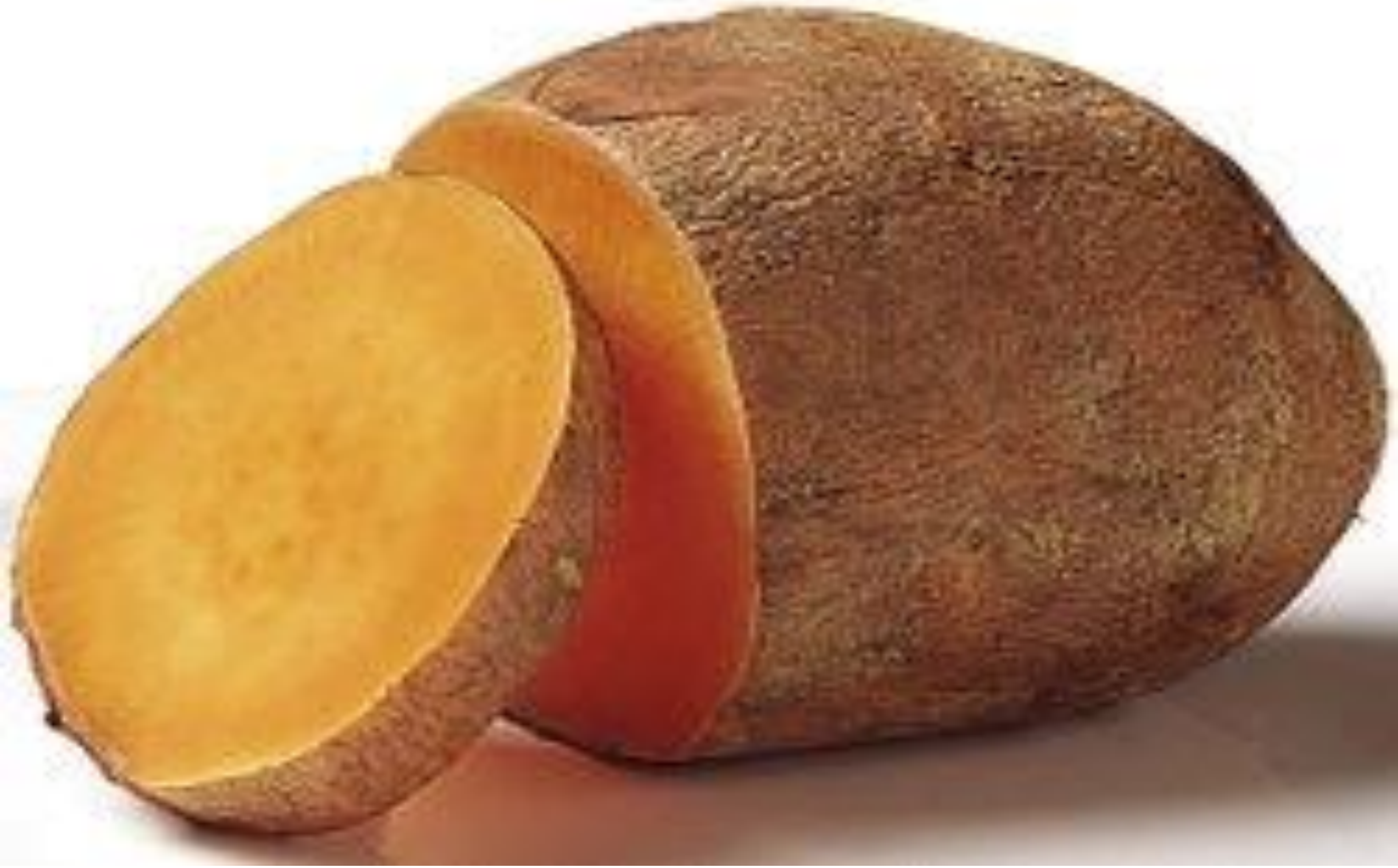


Model for a sustainable, low-input, sweet potato-based tropical subsistence food system (G Lyons)



Food systems and human nutrition

- Dietary diversity, education, biofortification, process fortification
- Linking agriculture with health
- Orange sweetpotato program
  - Solomon Is & PNG 2007-2010
  - To improve vitamin A status
  - Survey, imports, trials
  - Education: media, 28 nutrition workshops



Beauregard sweetpotato

RHS: 5/3 7401U
RHS: 9/3 7507U
RHS: 9/2 1355U
RHS: 9 137U
HarvestPlus standardized color strips, reflecting the total carotenoid content of cassava, maize and sweet-potato. Strips available from CIAT, CIMMYT, CIP, or HarvestPlus.
Cooked Suria
15
14
Yolk Color Fan
Dotterfarbfächer · Eventail colorimétrique
DSM

Other phytocompounds

Species	Total phenolics mg/g GE equiv	Antiox activity DPPH IC50
Ceylon spinach	76	42
Ofenga	26	688
Alternanthera	25	12
Cyathea fern	2	227
Butterfly tree	2	820

NB: Phenolics: ethanol extract (the higher the better)

Antioxidant activity: ethanol extract: DPPH radical scavenging activity, using half-maximal inhibitory conc, IC50 (the lower the better)

Alternanthera, Guadalcanal, Solomons

George Ernst, Thursday Island

Thursday Island horticultural demonstration plot

Cultural context important

We recommend that research and development be conducted within a framework which recognises the complex, diverse smallholder farming systems that exist in the Pacific. It is important that cash economies do not lead to unsustainable resource exploitation and the use of farming methods which are contrary to traditional values.

Role of sphingolipid metabolites in inhibiting Insulin resistance and Fatty Liver Disease.

Md Mobin Siddique, PhD

Associate Professor

School of Biosciences

FACULTY OF SCIENCE

University of Nottingham, Malaysia Campus

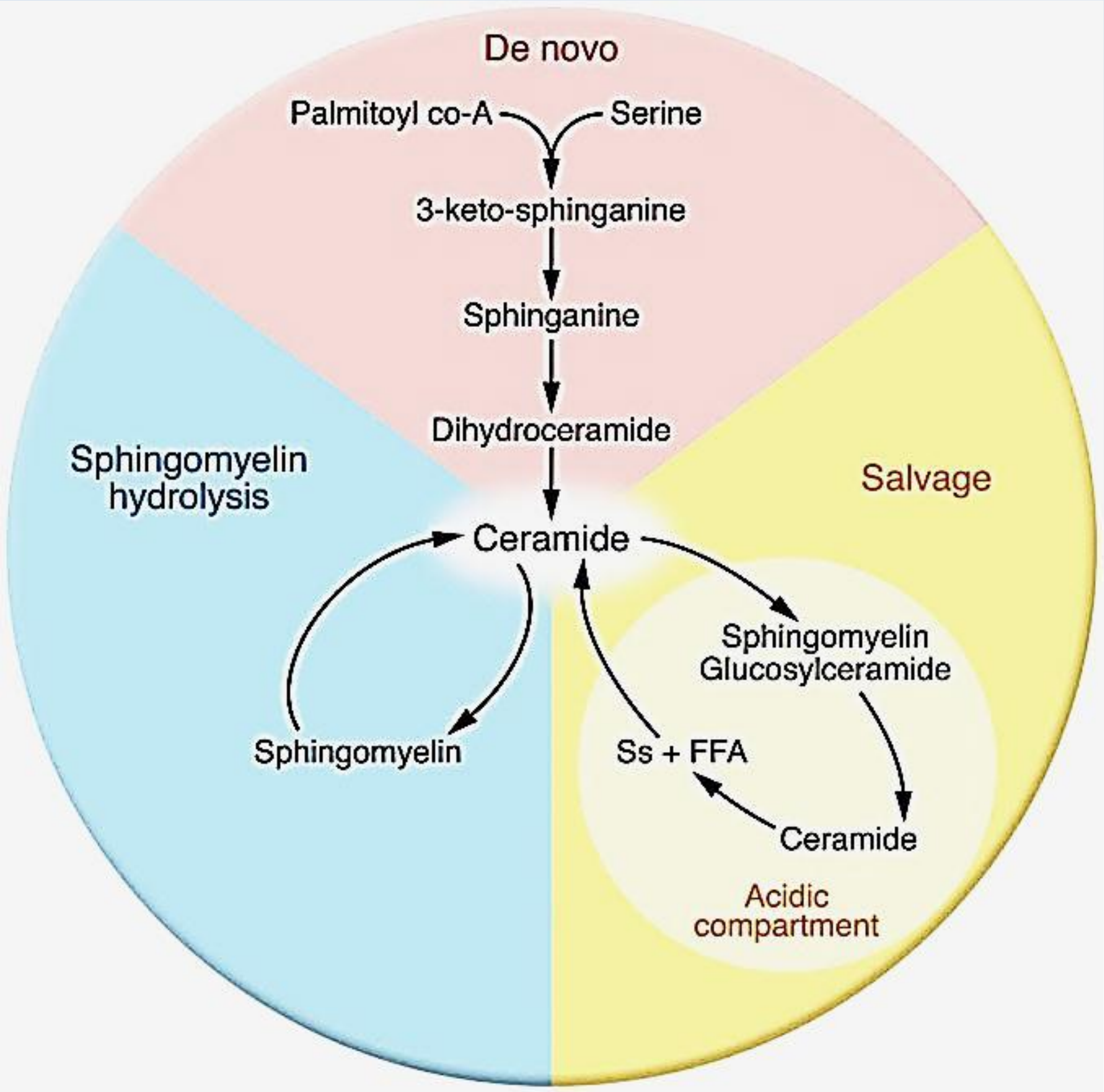
Sphingolipids

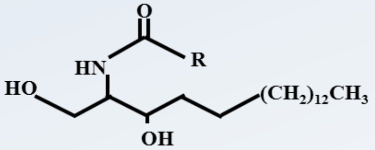
- Located in cellular membranes, lipoproteins (especially LDL) and other lipid-rich structures, such as skin.

- Sphingolipids are present in most of our diets.

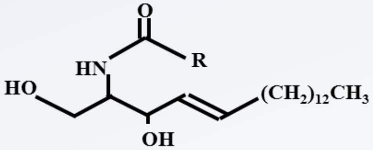
- Their amounts in foods are relatively small & there is no evidence that dietary sphingolipids are required for growth or survival.

Ceramide synthesis pathways:





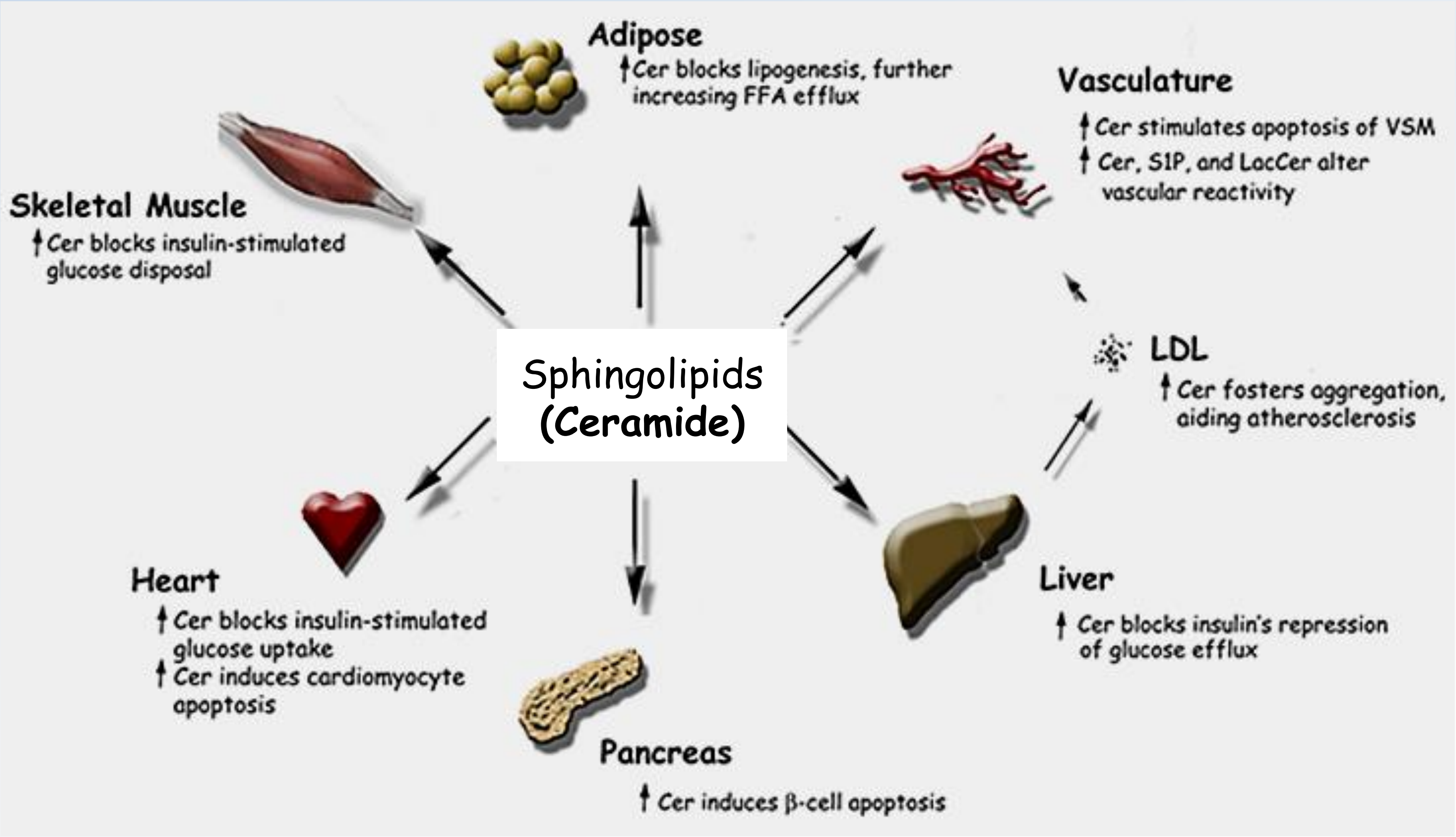
Dihydroceramide



Ceramide

Bikman and Summers (2011) . J Clinical Invest.

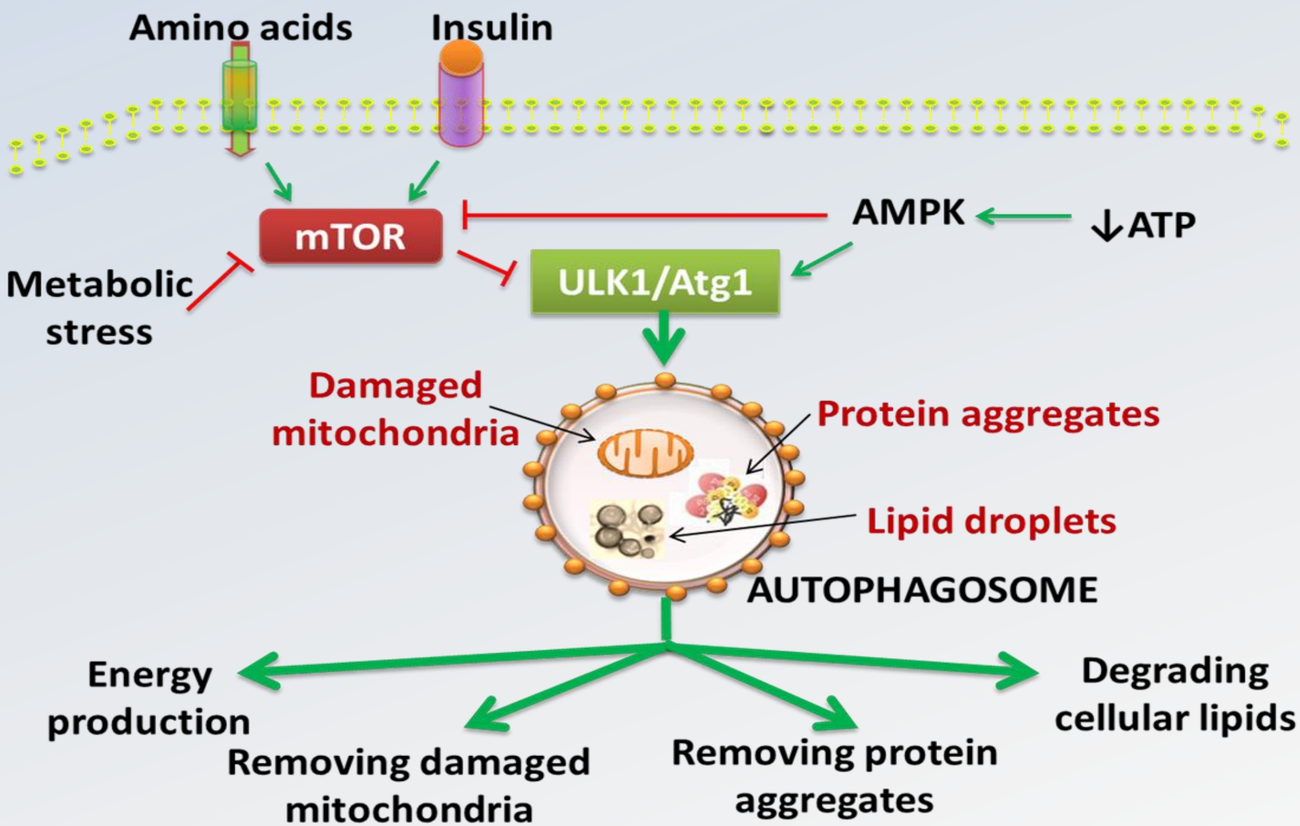
Sphingolipids and Metabolic Disease



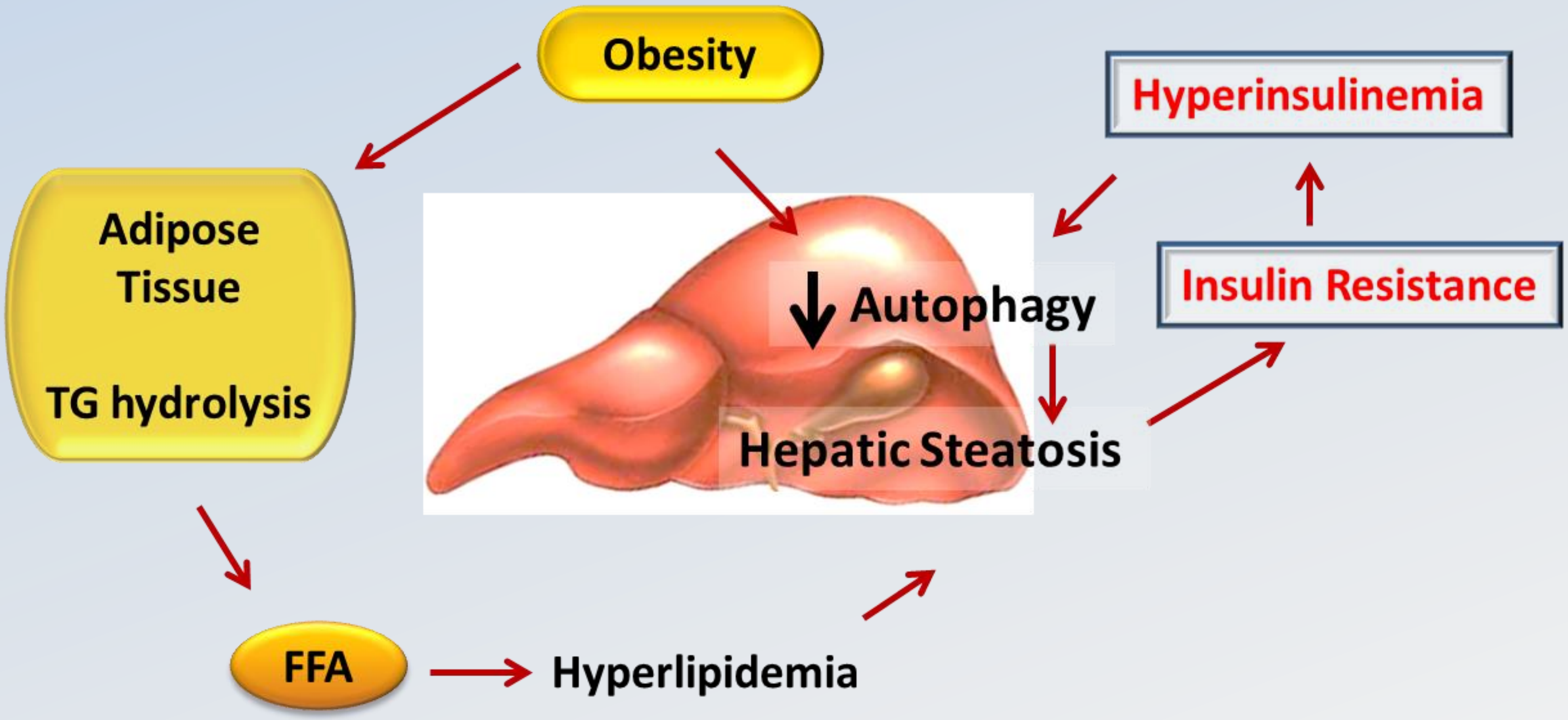
Summers and Nelson. 2005. Diabetes 54(3): 591-602

Autophagy or "self-degradation"

- Eliminates unwanted, misfolded or aggregated proteins, damaged organelles, and accumulated lipid droplets.
- Maintains energy balance during nutrient deprivation.



Lipid-mediated stress and Autophagy:



Caffeine stimulates hepatic lipid metabolism by the autophagy-lysosomal pathway in mice.
Sinha *et al*. 2014. *Hepatology*. 59(4):1366-80.

Thyroid hormone stimulates hepatic lipid catabolism via activation of autophagy.
Sinha *et al*. 2012. *J Clin Invest*. 122(7):2428-38.

Des1 knock out Mice in C57B/L6 background:

Palmitoyl-CoA

Serine → *SPT*

3-Ketosphinganine

↓ *3KR*

Sphinganine

Acyl-CoA → *CERS*

Dihydroceramide

↓ *DES -KO*

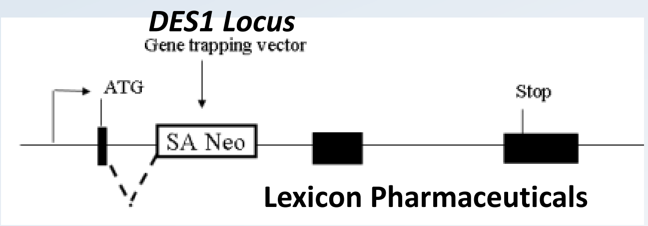
Ceramide

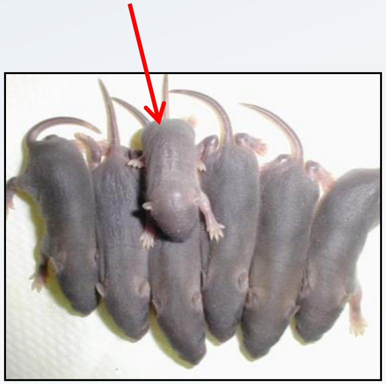
Ceramide -1 - phosphate

Glucosyl-ceramides

Sphingomyelin

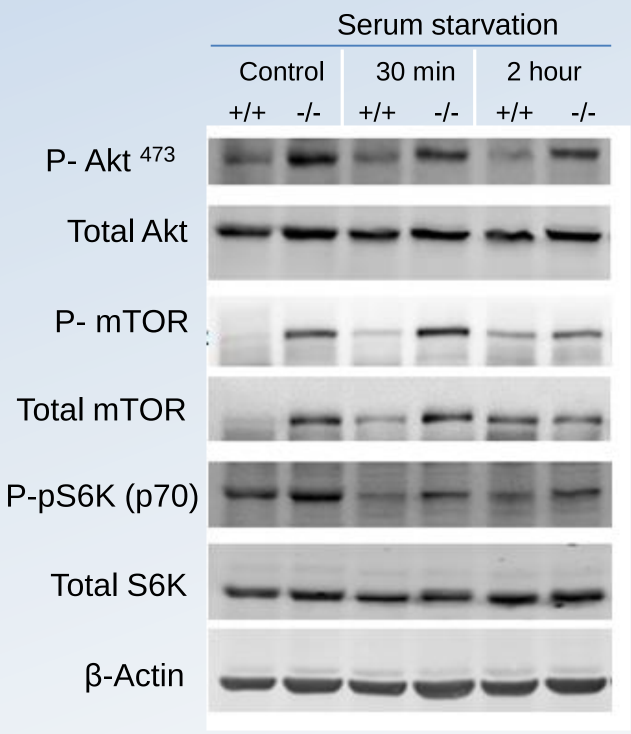
Sphingosine

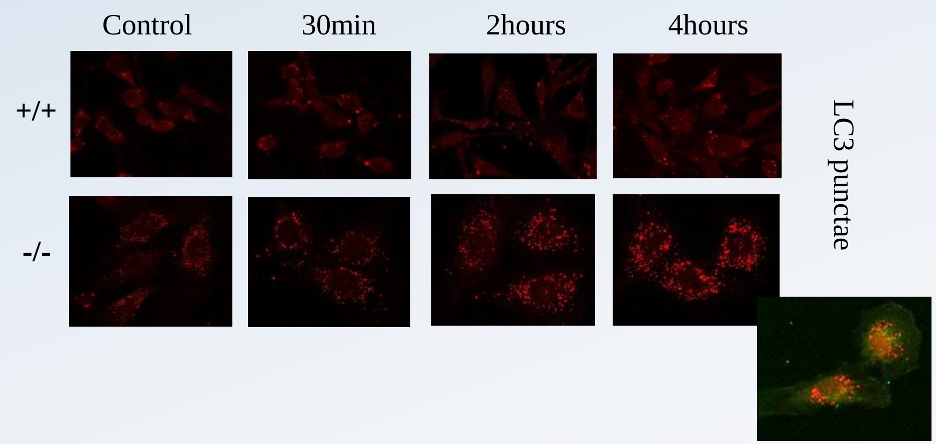


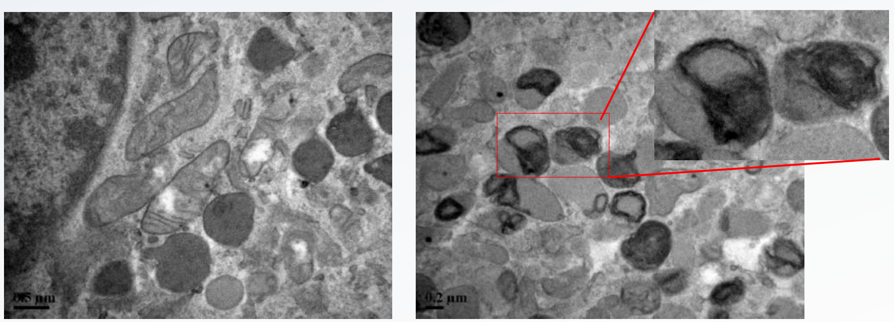


Holland *et al.* (2007). *Cell Metabolism.* 6:167

Des1 ablation induces pro-survival PI3K/Akt/mTOR pathway during starvation & increases autophagy.





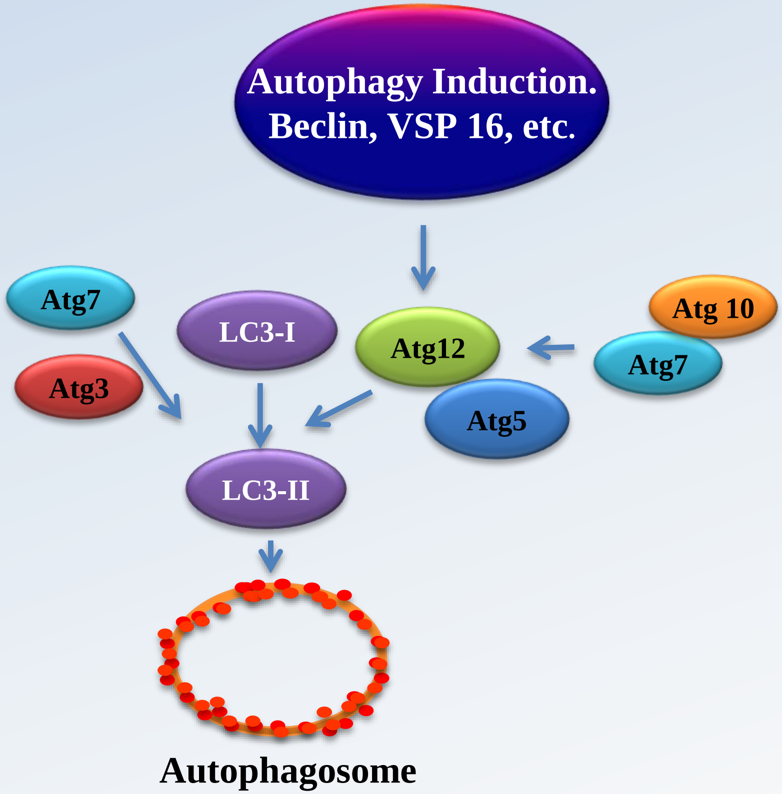


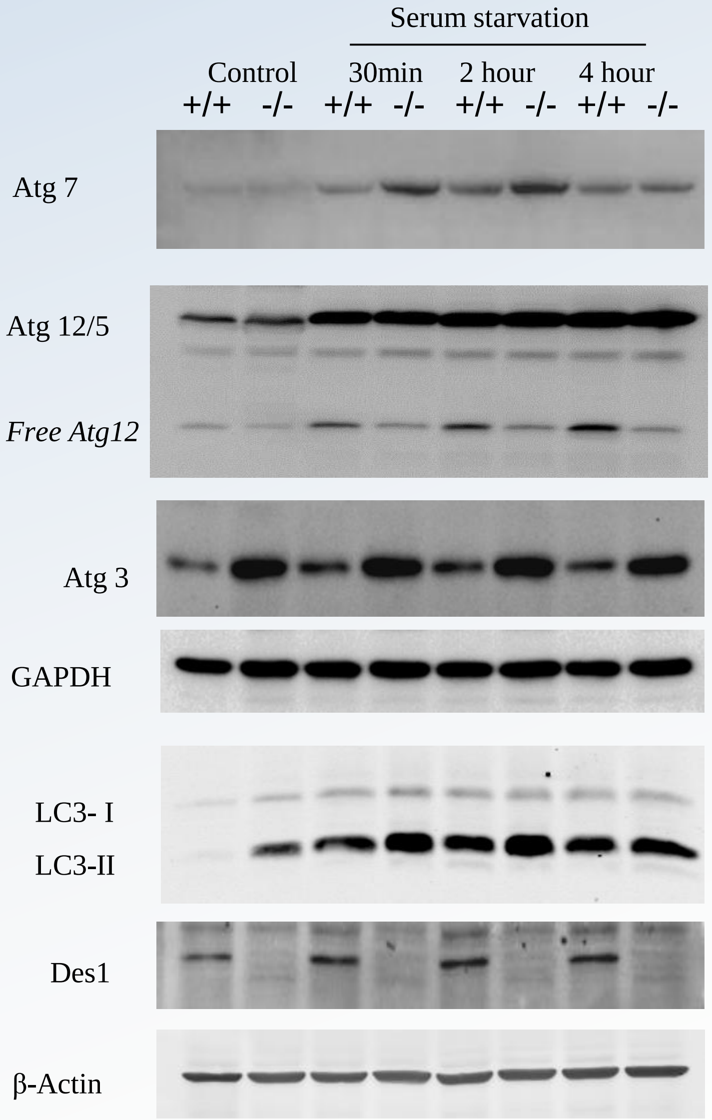
Des1 +/+

Des1 -/-

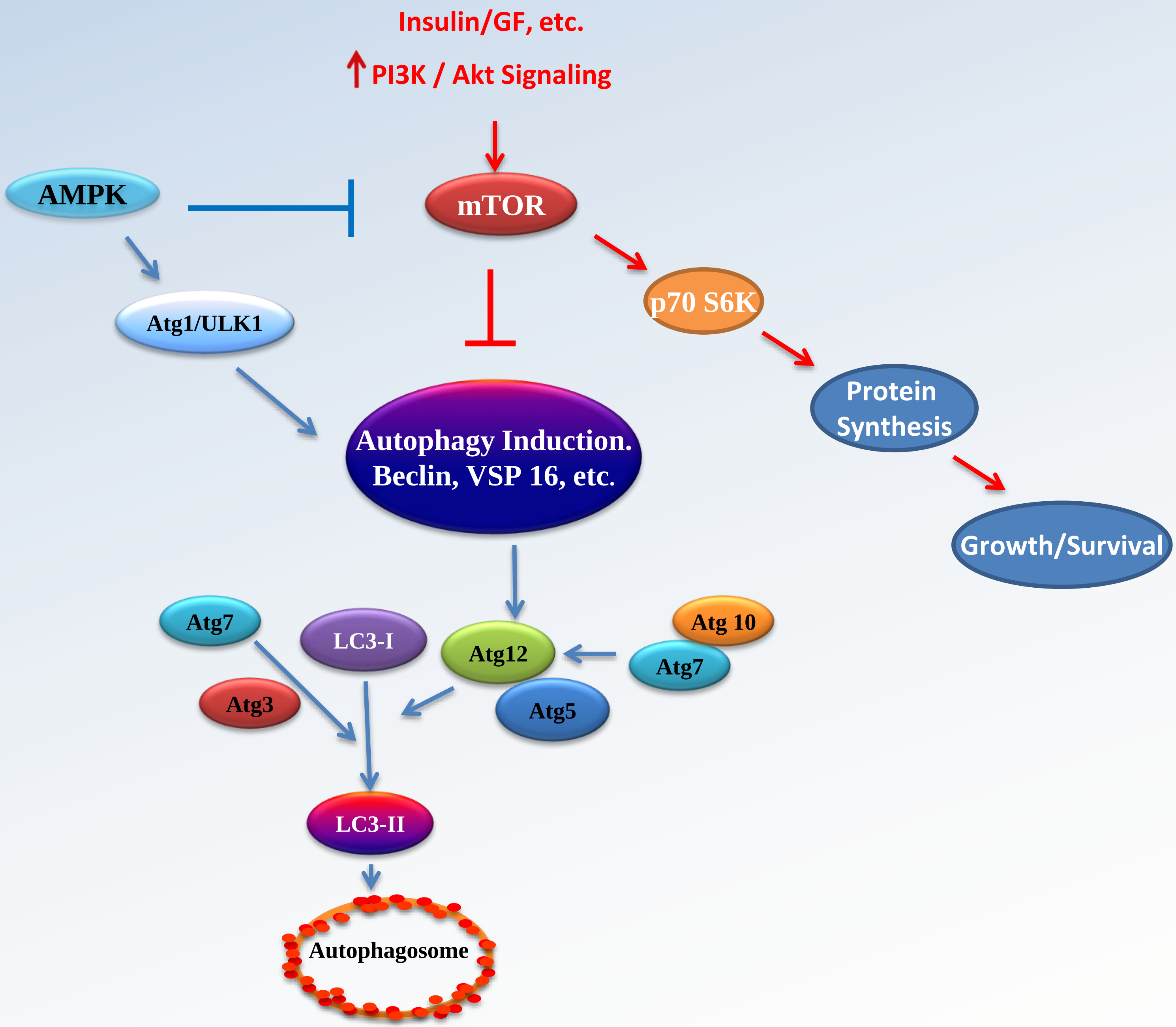
Siddique *et al.* (2013). *Mol Cell Biol*. 33(11):2353-69.

Des1 ablation increases autophagy in MEFs.

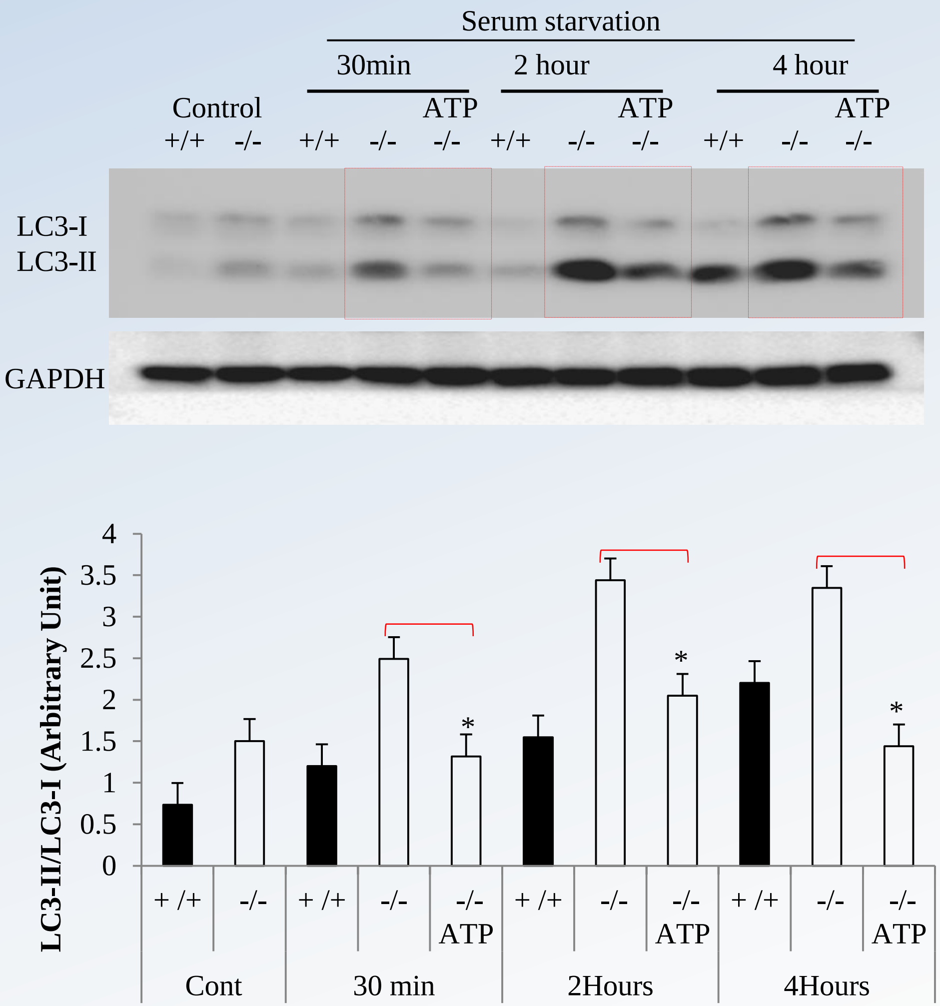


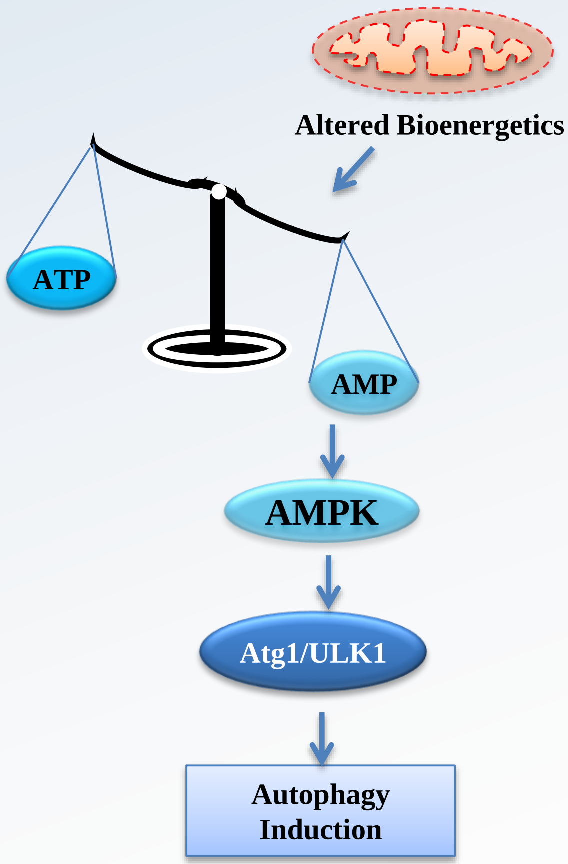


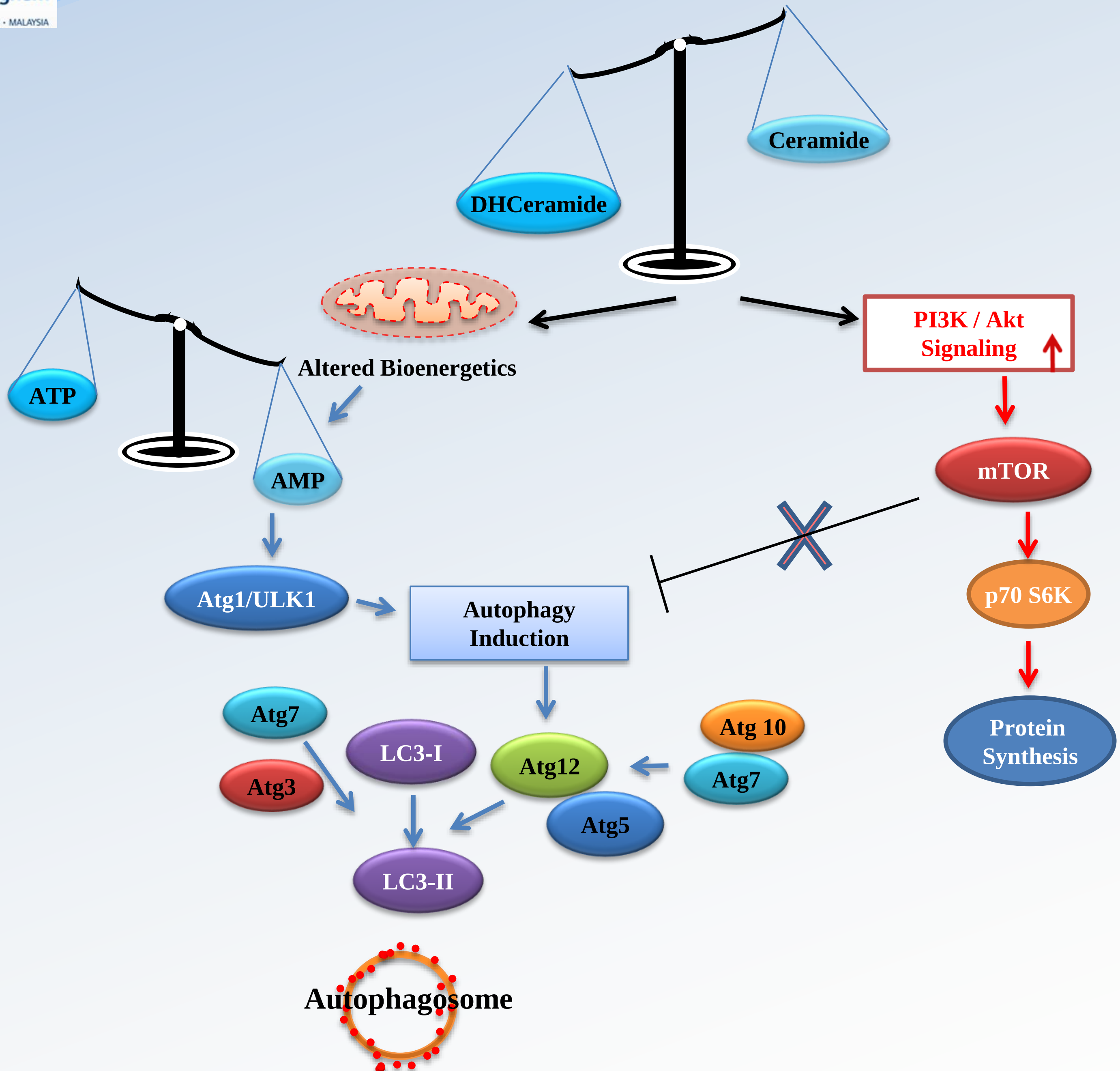
Siddique *et al.* (2013). *Mol Cell Biol*. 33(11):2353-69.


Insulin/GF, etc.
↑ PI3K / Akt Signaling
AMPK
mTOR
Atg1/ULK1
p70 S6K
Protein Synthesis
Autophagy Induction.
Beclin, VSP 16, etc.
Growth/Survival
Atg7
LC3-I
Atg12
Atg 10
Atg7
Atg3
Atg5
LC3-II
Autophagosome

Addition of ATP prevents autophagy caused by Des1 ablation.

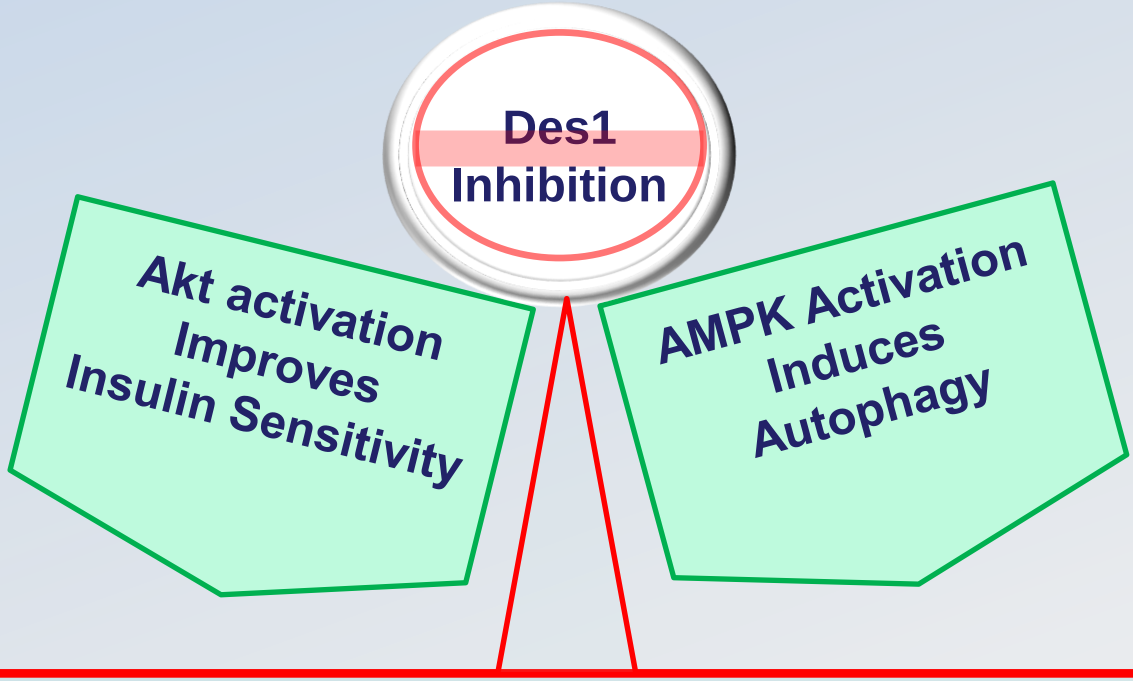






Siddique *et al.* (2013). *Mol Cell Biol*. 33(11):2353-69.

Des1 inhibition could be a promising tool !

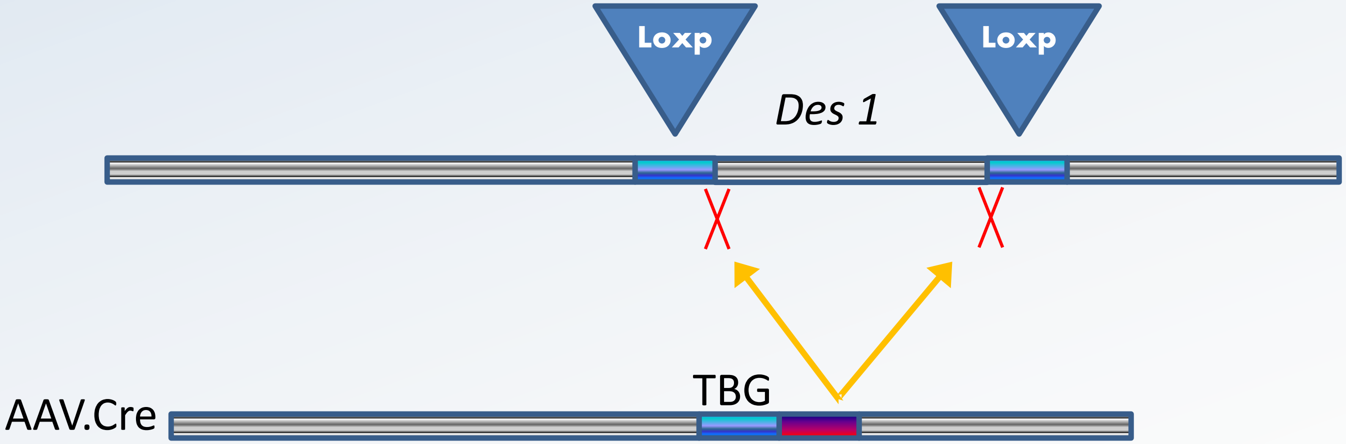


Does pharmacological inhibition or genetic ablation of *Des1* induces similar phenotypes *in vivo* ?

On going research:

Validating our *in vitro* data using Tissue specific Des1 knock out mice.

-depletion of *Des1* only in liver
-drug free trial, no unknown side effects



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Prof Asgar Ali

Prof Festo Massawe

School of Biosciences

University of Nottingham, Malaysia Campus

Plant Cell Walls
ARC Centre of Excellence

THE UNIVERSITY of ADELAIDE

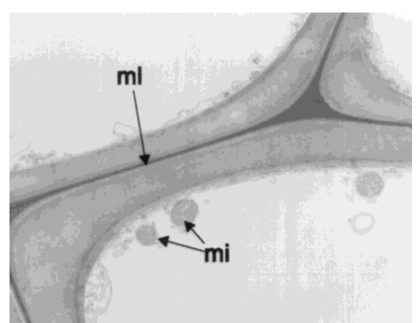
The impact of cell walls on plant fitness, human health and biofuels

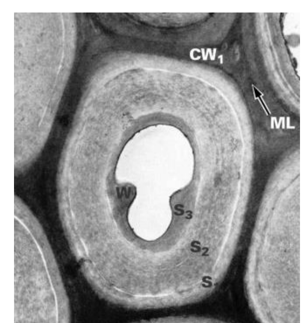
Rachel Burton

Australian Plant Phenomics Facility
The Plant Accelerator

Functions of Plant Cell Walls

- strength to support plants
- flexibility
- sometimes porous
- sometimes water-proof
- physical barrier to invasion
- change during growth and stress.





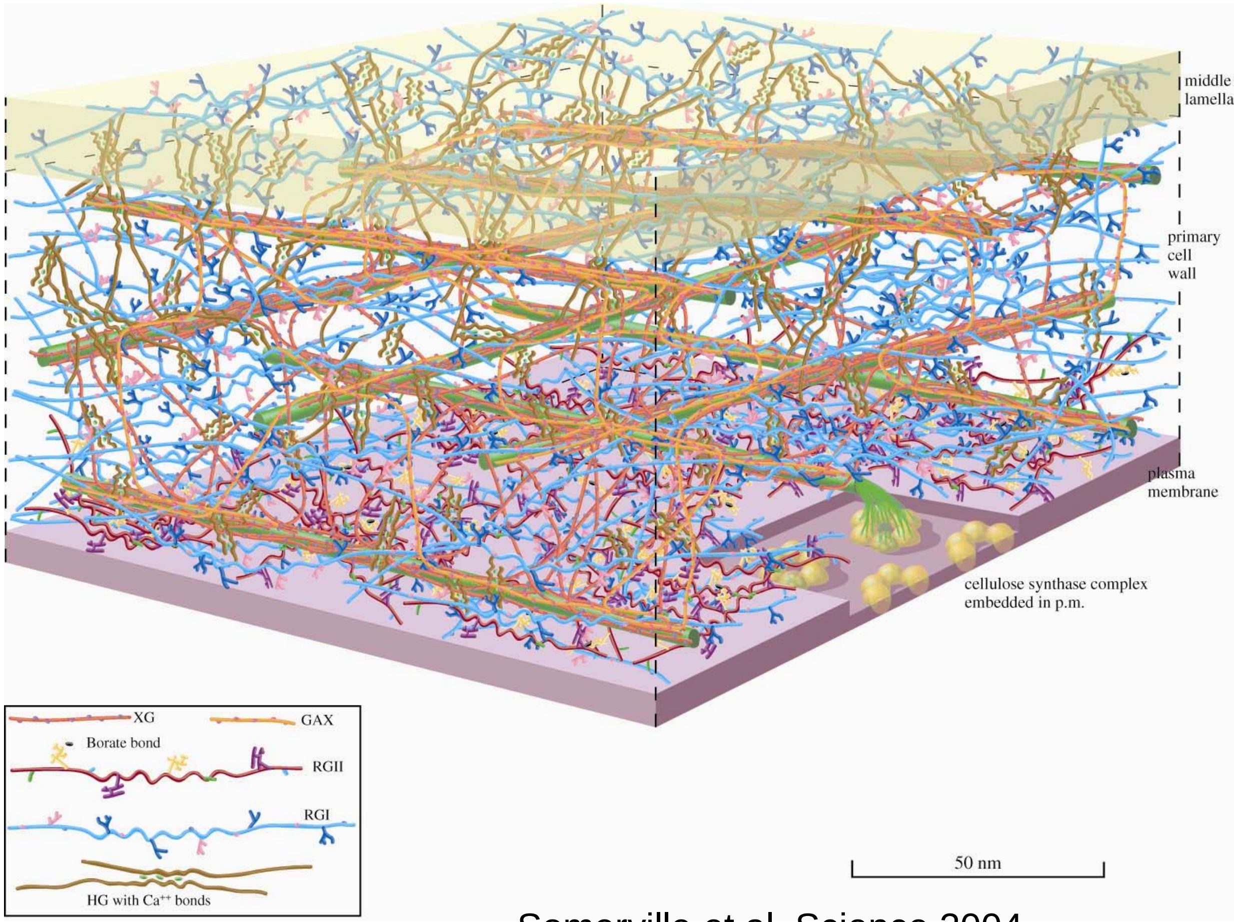
Cell Wall Components

Cellulose microfibrils

Complex matrix phase between microfibrils

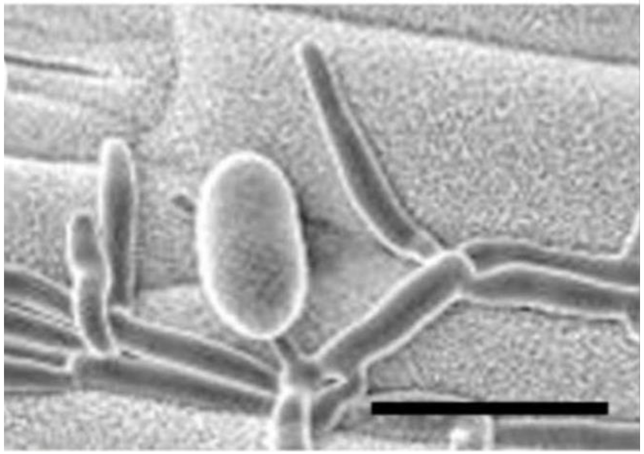
Mostly polysaccharide (90%+), some protein

Polysaccharide association mostly non-covalent?



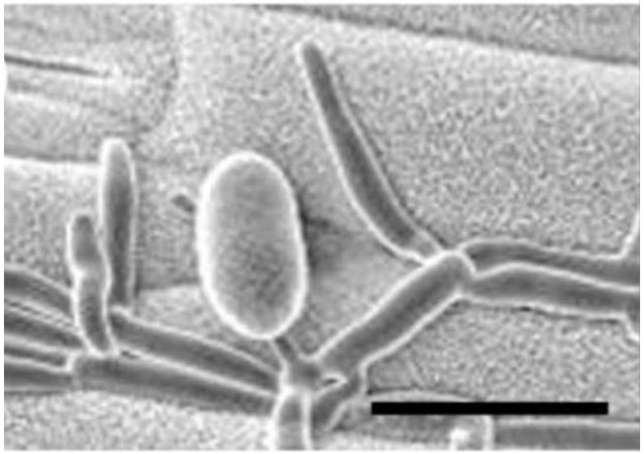
Somerville et al. Science 2004

Pathogen attack



Yield losses

Pathogen attack

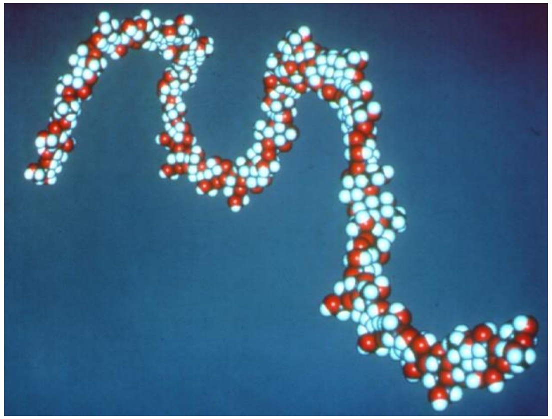


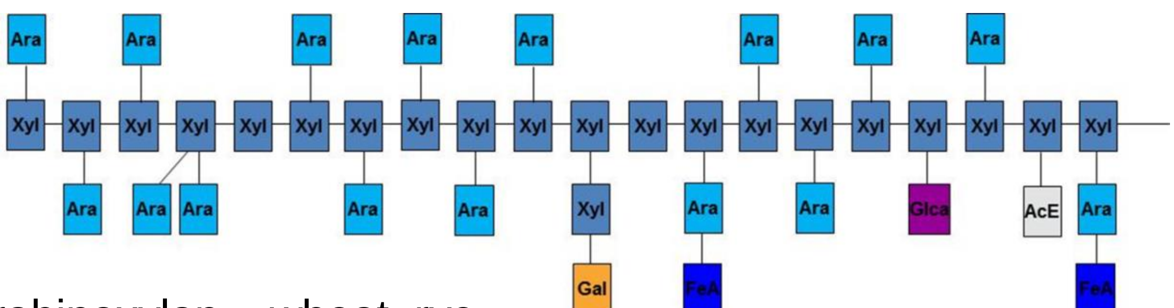
Yield losses

Wall Polysaccharides and Nutrition

- Cell wall polysaccharides usually have an asymmetrical shape
- Polysaccharides with an asymmetric shape usually form aqueous solutions of high viscosity
- High viscosity limits diffusion rates and slows filtration
- Animals have no digestive enzymes for these polysaccharides.

Mixed link beta-glucan – barley, oats





Arabinoxylan – wheat, rye

Fermentable polysaccharides are beneficial in human nutrition!

- Faecal bulk and laxation
- Reduction in plasma cholesterol
- Reduced glycaemic index (GI) and insulin levels, hence non-insulin-dependent type II diabetes
- Reduction in risk of colo-rectal and other cancers
- Reduction in risk of coronary heart disease, diabetes, obesity.

Cereal Grains as a Major Source

Short Chain Fatty Acids

- Three acids are produced – acetate (2C), propionate (3C) and butyrate (4C).

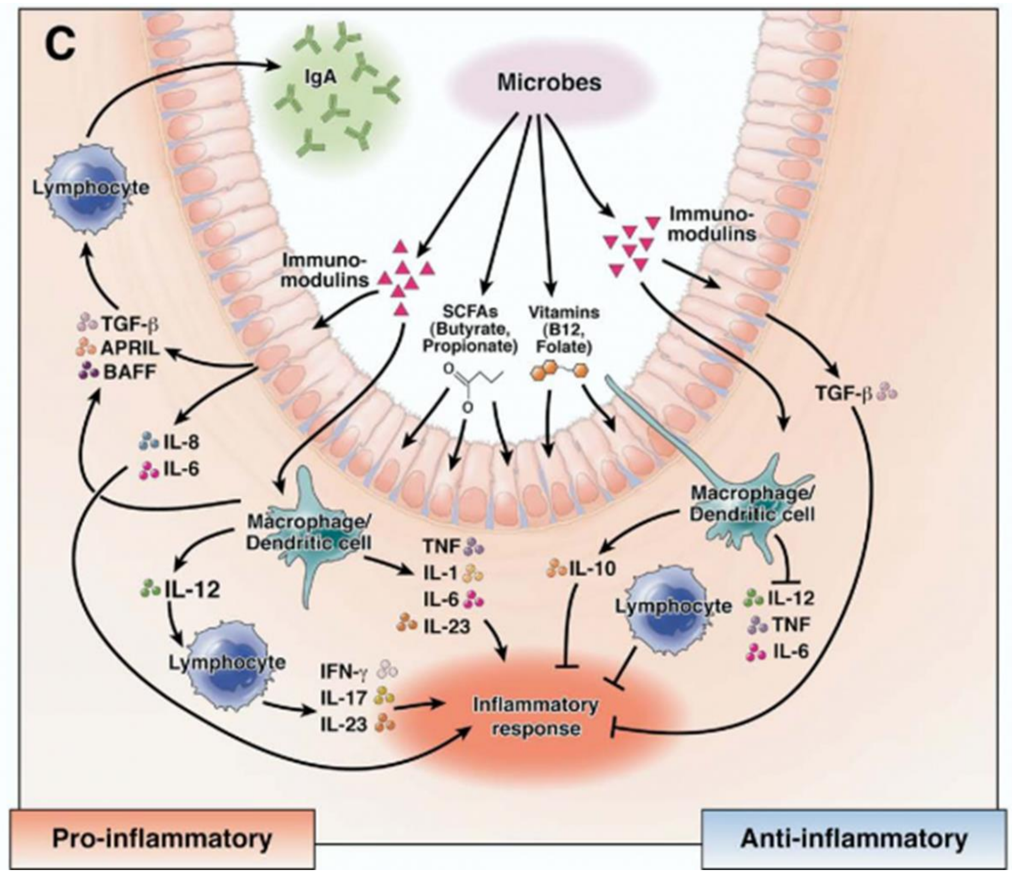
- Main effects are:
  - Lowering of colonic pH leading to ionisation of toxic amines which cannot be absorbed when protonated.
  - Inhibition of growth of pathogenic bacteria due to pH change
  - Energy supply for colonocytes

The Microbiome Links to Many Diseases….

- Cardiovascular disease
- Type II diabetes
- Obesity
- Irritable bowel syndrome
- Colon cancer

- Asthma
- Rheumatoid arthritis
- Emphysema

- Parkinsons?
- Others…..?



Sekirov et al. Physiol Revs 2010

Biofuel Feedstocks – non food!

- grasses and cereals, which form the monocotyledon family Poaceae

- grain-milling residues
  - wheat bran
  - spent grain from breweries

- crop residues
  - wheat straw
  - maize stover
  - sugarcane bagasse
  - grape marc

- perennial grasses
  - Miscanthus sp.
  - switchgrass (*Panicum* spp.)
  - other prairie grasses (USA)

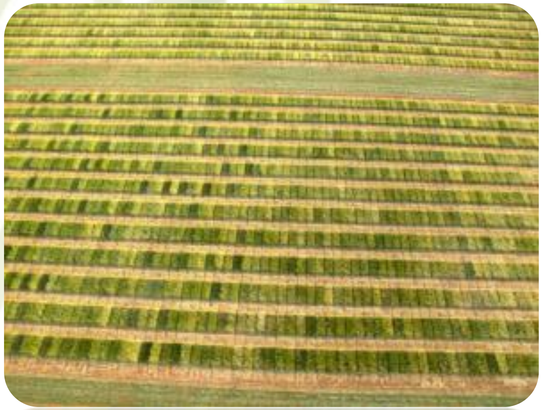
- saltbush on salty country?

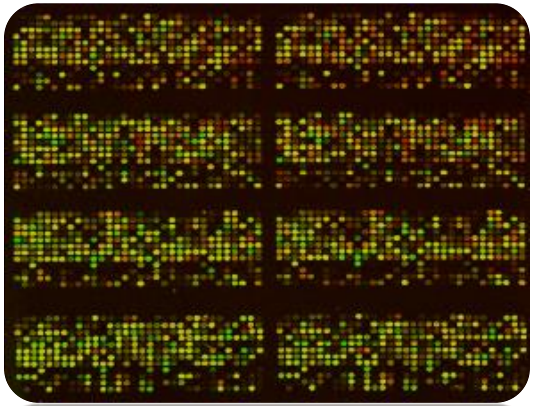
- *Agave*

- Algae

Phenotyping – the new bottleneck in plant science

- Genomics is accelerating gene discovery
- Physiological characterization of plants is still time consuming and labor intensive

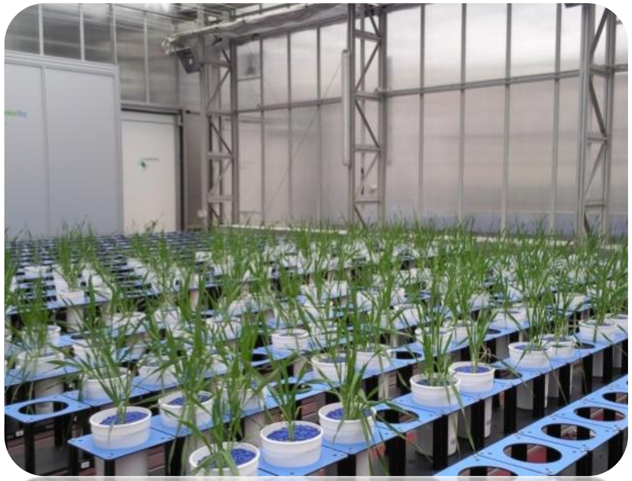




High-throughput phenotyping

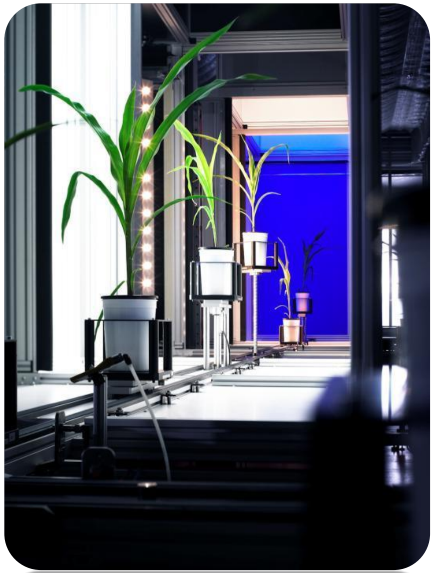
- Phenotyping is essential for
  - functional analysis of specific genes
  - forward and reverse genetic analyses
  - production of new plants with beneficial characteristics

- High throughput is essential for phenotyping
  - in different growth conditions
    (e.g. watering regimes, nutrient supply)
  - of many different lines
    - mutant populations
    - mapping populations
    - breeding populations
    - germplasm collections



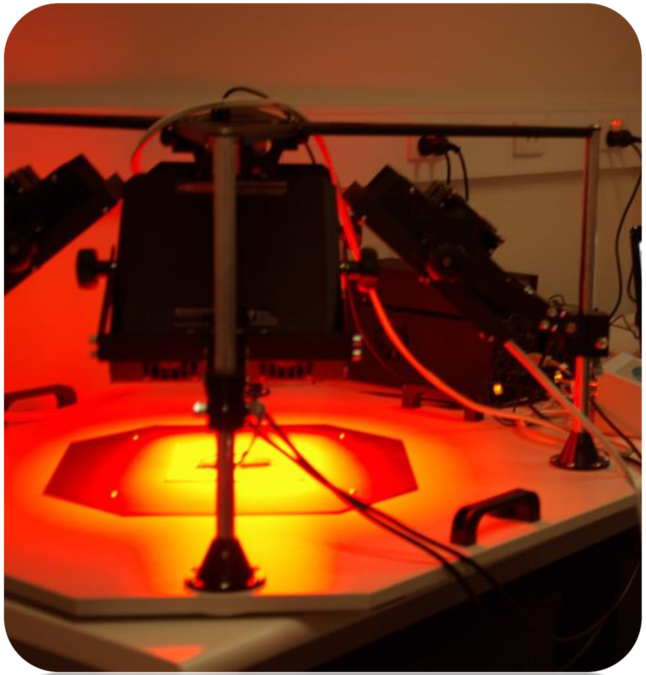
The technological opportunity

- Relieve phenotyping bottleneck with robotics, non-invasive imaging and analysis using powerful computing
- Provide “whole of lifecycle”, quantitative measurements of plant performance from the growth cabinet to the field
    - bring together physiology and genetics



The applications

- Candidate gene identification for quantitative traits
  - Mapping populations, association studies
- Gene function analysis
  - Transgenic populations
- Trait dissection
  - Detailed biology behind complex traits
- Novel productivity associations
  - Identification of new yield-influencing traits
- Multi-parameter experiments
  - High levels of GxE, ExE



The Plant Accelerator

- 4,485 m^2 building, 2,340 m^2 of greenhouses
- 4 x 140 m^2 fully automated 'Smarthouses'
- ~2,400 plant capacity in Smarthouses

- First public sector facility of this type and scale

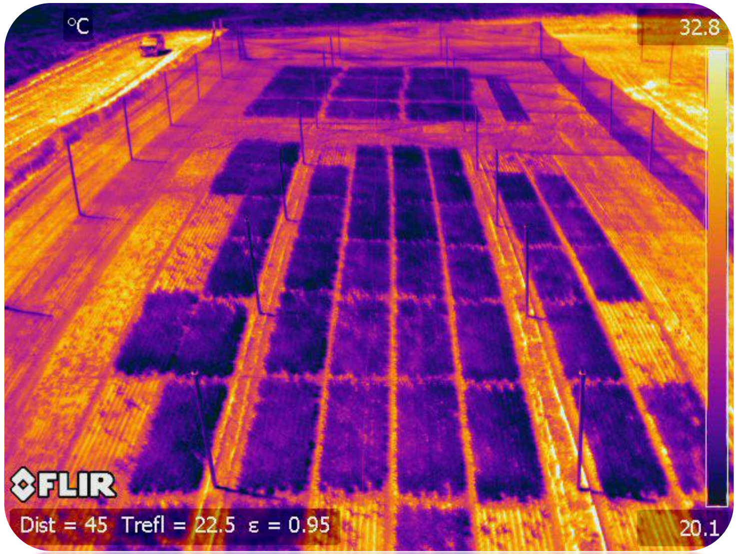
Commercial scale phenotyping

The challenges

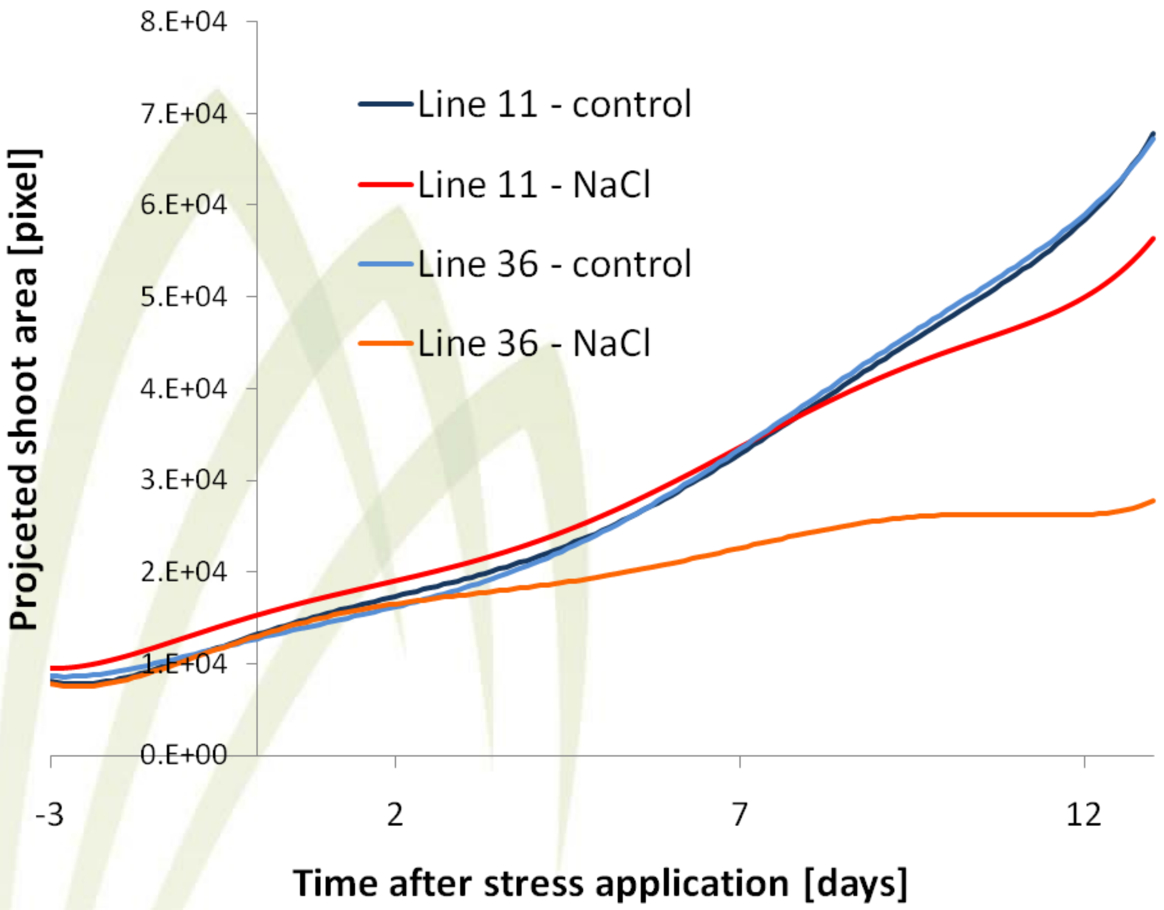
- Image analysis
  - Identification of specific features, 2D/3D imaging
- Database design and maintenance
  - Phenotyping ontologies, image storage requirements, metadata
- Statistical analysis
  - Limited literature in plant growth analysis techniques

Example projects

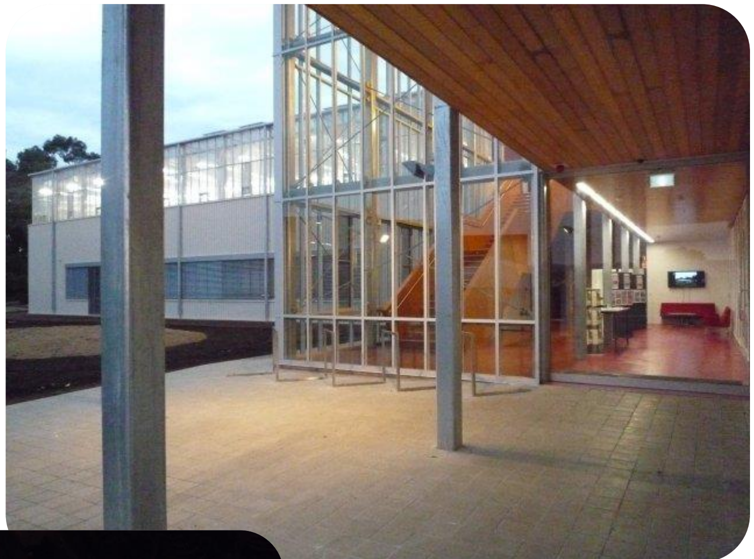
- QTL mapping for osmotic tolerance in wheat
  - >500 plants, three weeks of imaging
- Growth analysis of transgenic barley
  - ~160 plants, five weeks of imaging

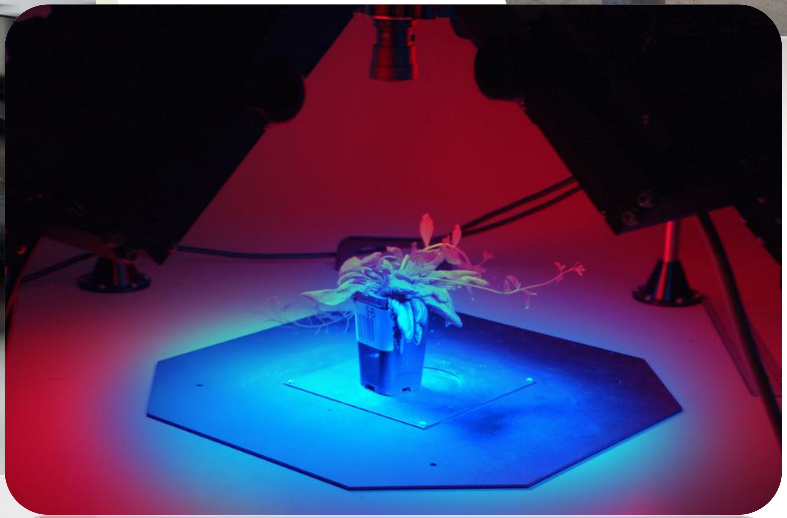


Osmotic tolerance in soil



Nawar Shamaya, ACPFG





Micronutrient Deficiencies in Southeast Asia

Dr. Umi Fahmida

Southeast Asian Minister of Education Organization
Regional Center for Food and Nutrition
(SEAMEO RECFON), Indonesia

Global Food Security Forum 2014
Kuala Lumpur, 7-8 July 2014

Presentation Outline*

1. Consequences of micronutrient deficiencies for health and developmental outcomes
2. Magnitude of micronutrient deficiencies in Southeast Asian (SEA) countries
3. Where do SEA populations get their micronutrients?

** Focus on maternal and child nutrition*

Consequences of Micronutrient deficiencies

- Iodine deficiency: impaired cognitive function
- Vitamin A deficiency: xerophthalmia, increased morbidity and mortality
- Iron deficiency: impaired health, growth, mental and motor development, productivity, maternal mortality
- Zinc deficiency: impaired growth and immune function
- Folate deficiency: NTD

Micronutrient deficiency - DNA damage with health effects

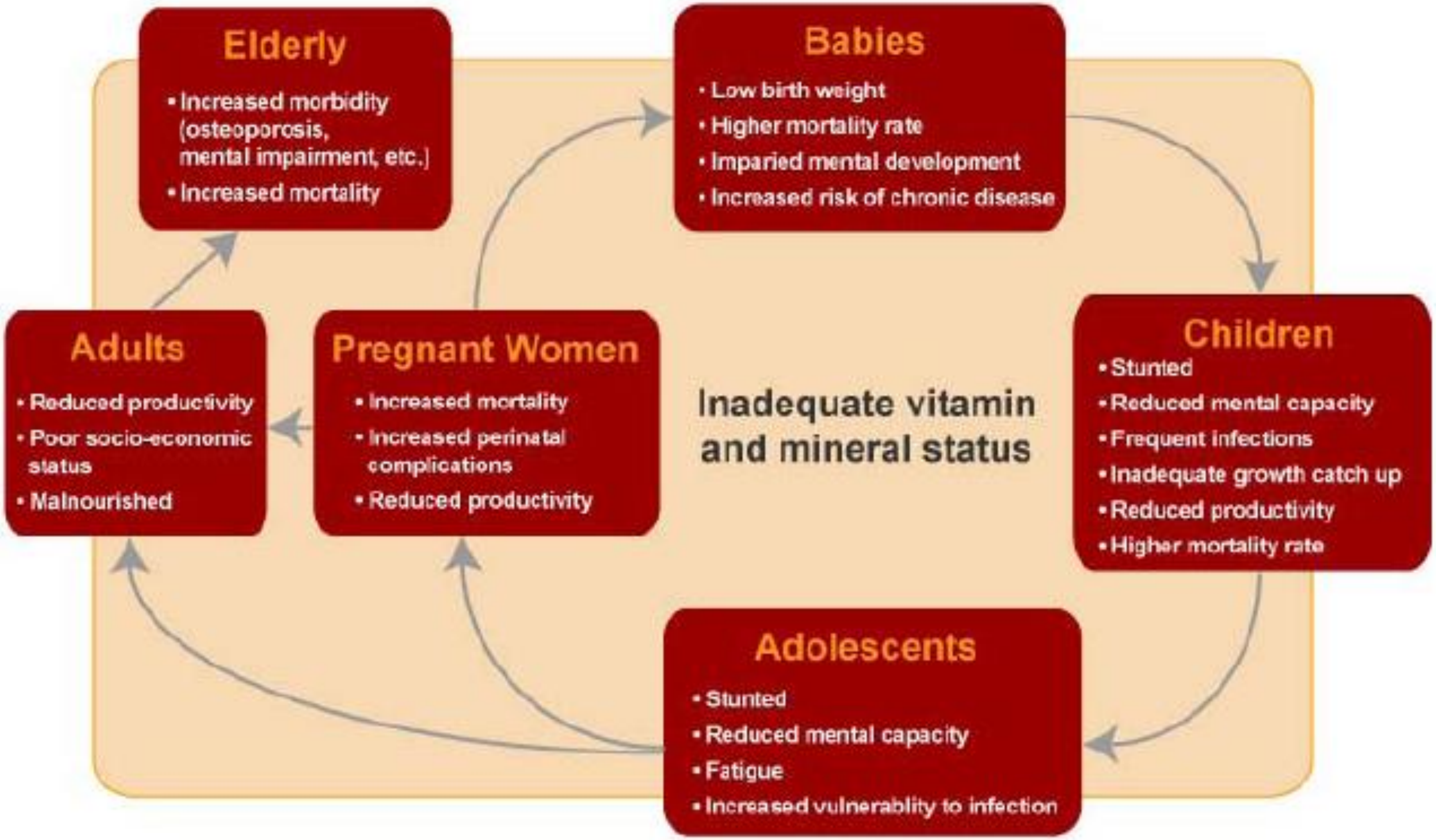
Table 3. *Micronutrient deficiency and DNA damage*

Micronutrient	Percent of US Population	DNA Damage	Health Effects
Folic acid	10%	Chromosome breaks	Colon cancer; heart disease; brian dysfunction
Vitamin B_{12}	4% (<half RDA)	Uncharacterized	Same as folic acid; neuronal damage
Vitamin B_6	10% (<half RDA)	Uncharacterized	Same as folic acid
Vitamin C	15% (<half RDA)	Radiation mimic (DNA oxidation)	Cataracts (4×); cancer
Vitamin E	20% (<half RDA)	Radiation mimic (DNA oxidation)	Colon cancer (2×); heart disease (1.5×); immune dysfunction
Iron	7% (<half RDA) 19% women 12–50 yr old	DNA breaks; radiation mimic	Brain and immune dysfunction; cancer
Zinc	18% (<half RDA)	Chromosome breaks; radiation mimic	Brain and immune dysfunction; cancer
Niacin	2% (<half RDA)	Disables DNA repair (polyADP ribose)	Neurological symptoms; memory loss

This information is adapted from Ref. 2. RDA, recommended dietary allowance. Numbers in parentheses for "Health Effects" indicate increased risk for condition/disease.

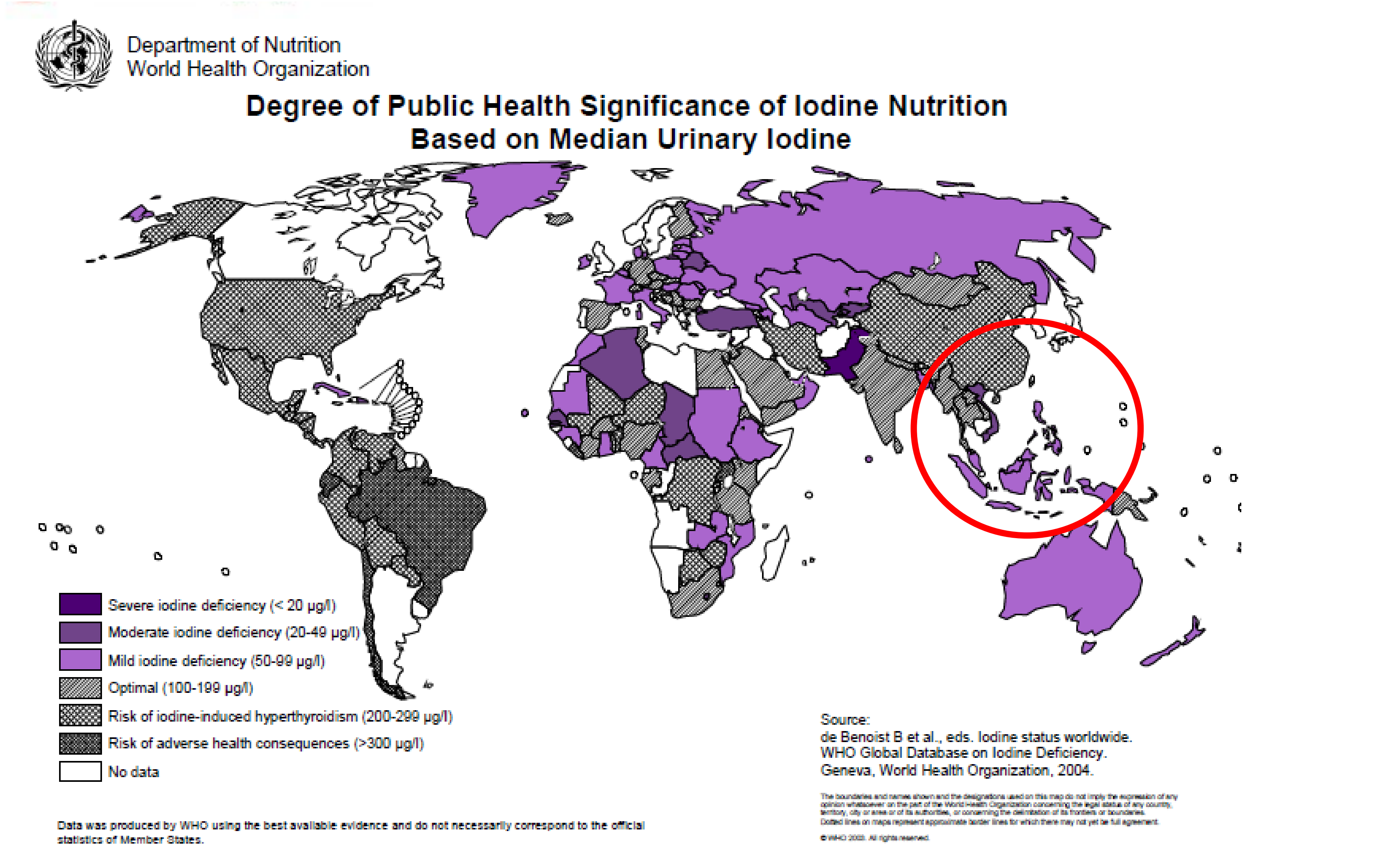
Source: Kaput J: Physiol Genomics 2004   Ref 2: Ames, Toxicol Lett 1998

Effects of inadequate vitamins and minerals during the life cycle



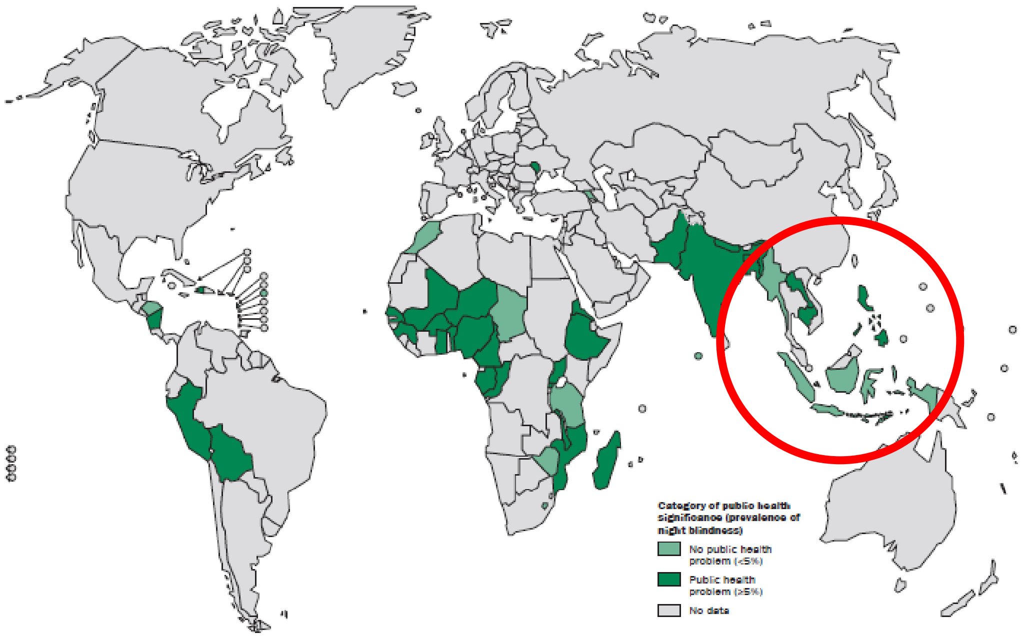
Source: Micronutrient Initiative (2013) as adapted from UN SCC/ACN (2000)

Iodine Deficiency

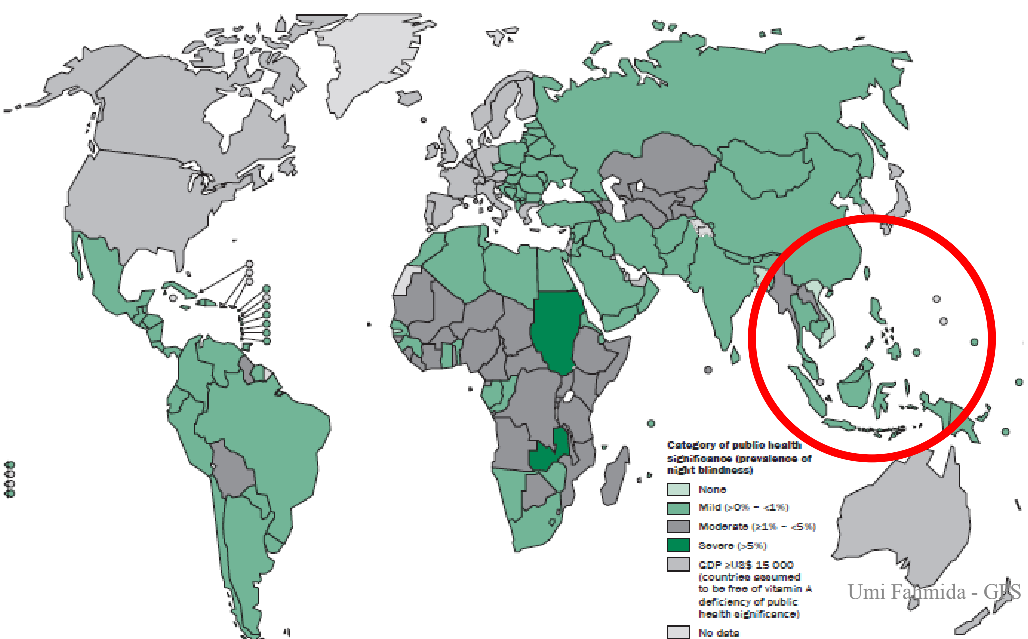


Vitamin A deficiency

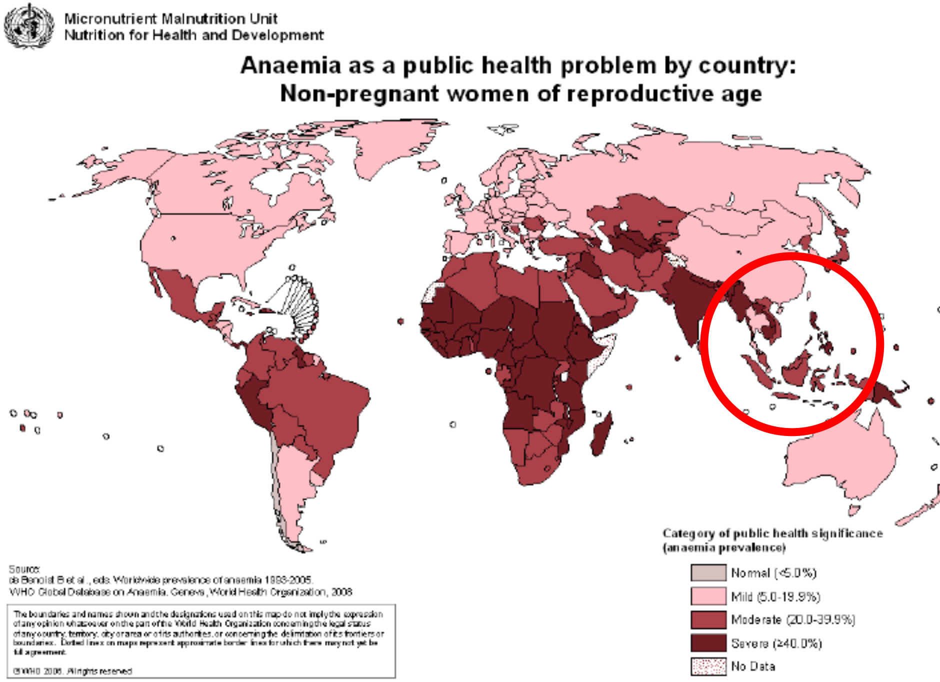
Countries and areas with survey data: Pregnant women

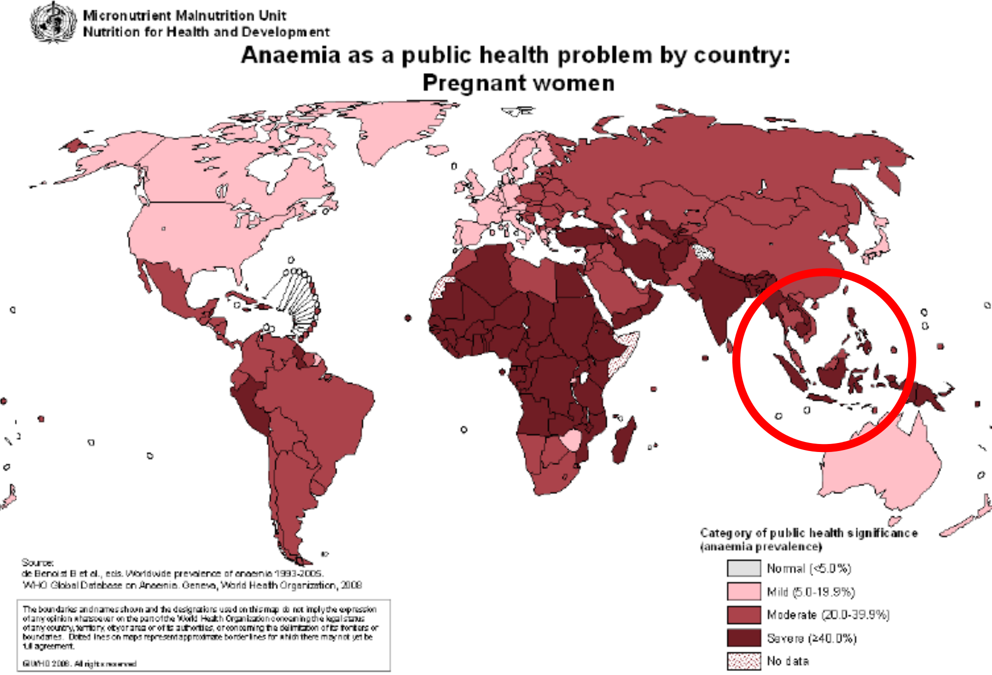


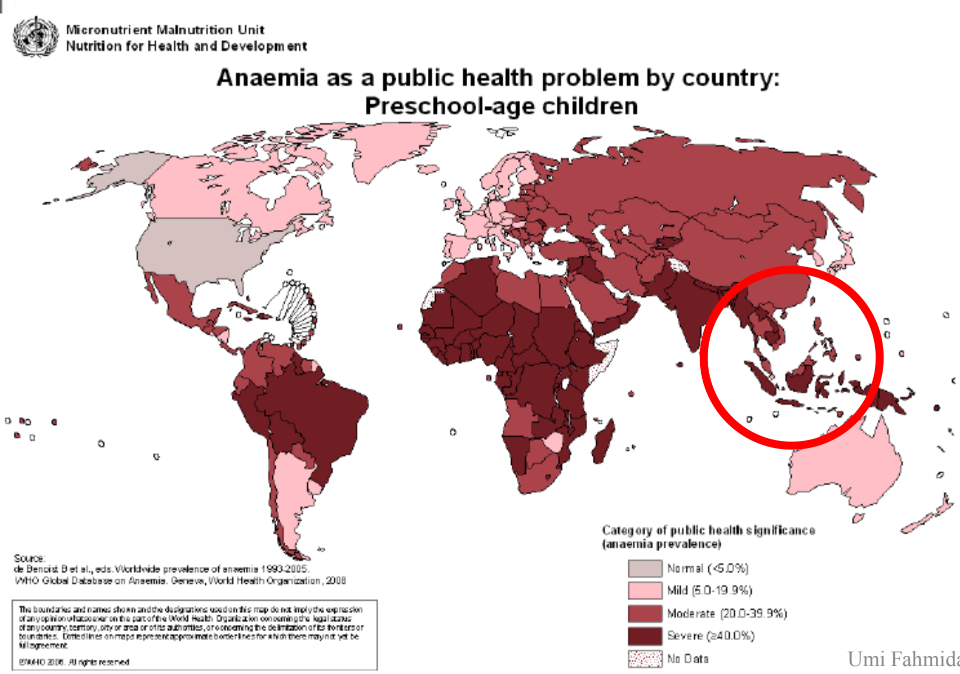
Countries and areas with survey data and regression-based estimates: Preschool-age children



- **Night blindness**: mostly of no public health significance (<5%) in pregnant women; mild (<1%) to moderate (1-<5%) in preschool-age children
- **Serum retinol** < 0.70 µmol/L: mild (2-10%) to severe (≥20%) for pregnant women and preschool-age children





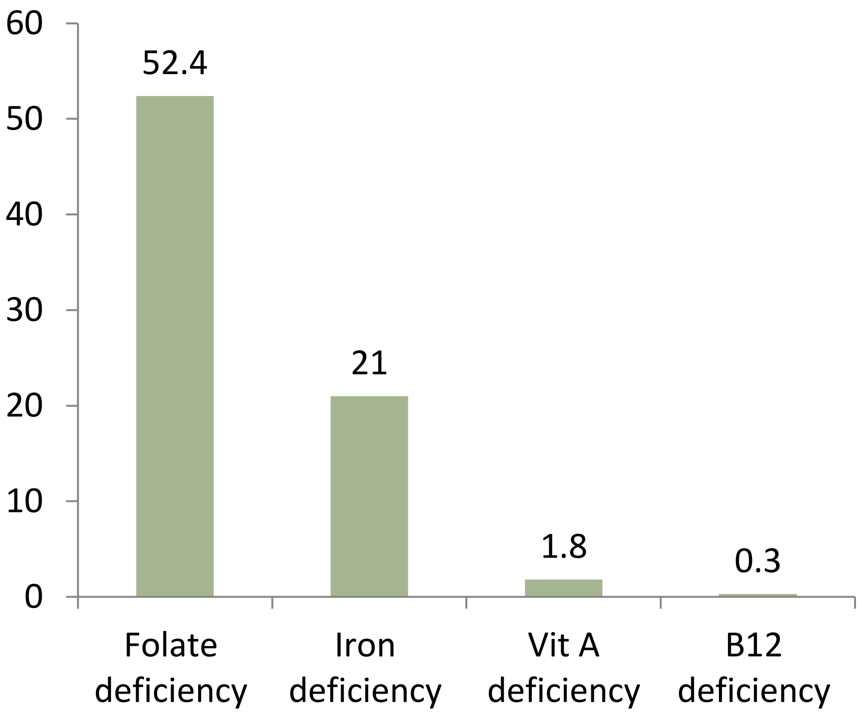


Anemia as public health problem

- Mild to severe for non-pregnant women
- Moderate to severe for pregnant women and preschool-age children

Concurrent micronutrient deficiencies

Myanmar anemic adolescent girls (13-<18 yr)



Source: Htet MK et al (2012)

Odds ratio (95% CI) of Indonesian vitamin A deficient infants and mothers of having deficiencies of other micronutrients

Micronutrient deficiency	VAD infants	VAD mothers
Anemia	2.5 (1.3-5.0)	3.8 (1.4-10.0)
Iron deficiency	2.4 (1.0-6.0)	4.8 (2.0-11.6)
Zinc deficiency	2.9 (1.1-7.8)	1.9 (0.7-4.6)
Iron, Zinc deficiency, or both	2.6 (1.2-5.5)	2.8 (1.2-6.8)
Anemia, Zinc deficiency, or both	2.6 (1.3-5.3)	3.1 (1.1-8.9)

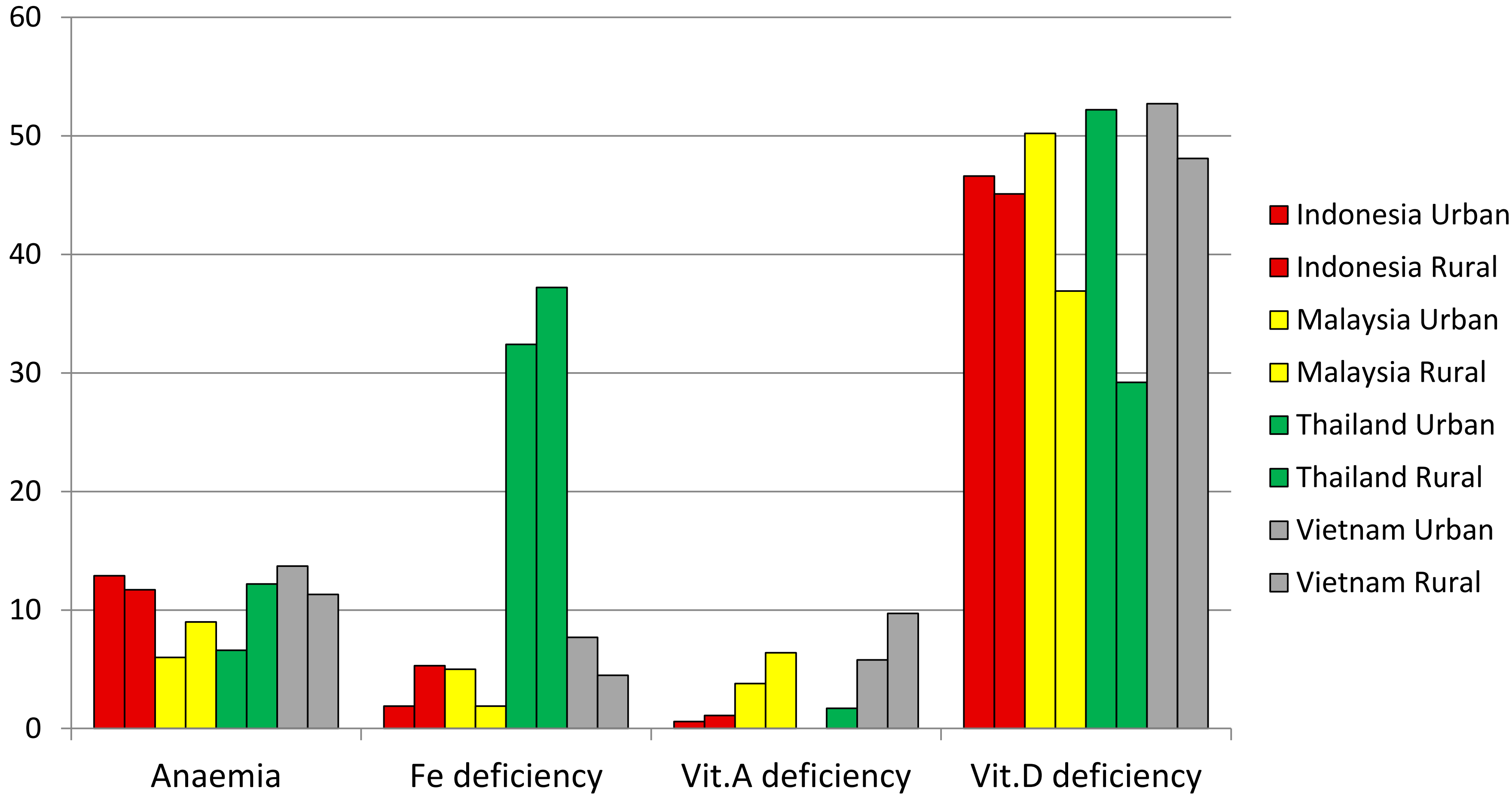
Source: Dijkhuizen et al (2001)

Risk of zinc deficiency in SEA countries*

Country	%population at risk of inadequate Zn intake	%stunting	Risk category
Brunei	12.8		
Cambodia	43.6	53.3	High
Indonesia	34.4	42.2	High
Laos	35.7	47.3	High
Malaysia	14.1	26.6	Medium
Myanmar	34.6	41.6	High
Philippines	31.9	32.7	High
Thailand	41.6	16.0	Medium
Vietnam	27.8	38.7	High

* Based on combined information i.e. prevalence of childhood stunting and percentage of individuals at risk of inadequate zinc intake *(Source: IZiNCG, 2004)*

South East Asian Nutrition Survey (SEANUTS), children*



*Age: 4-12yr (Mal), 5-12yr (INA), 6-12yr (Thai, Viet)

Source: Rojroongwasinkul N et al (2013); Poh BK et al (2013); Nguyen BKL et al (2013)

Folate deficiency in women of child bearing age

- Myanmar: 54.2% (plasma folate < 6.8 nmol/L)
- Thailand: 18.2% (serum folate ≤ 6 ng/ml)
- Malaysia: 15.1% (plasma folate < 6.8 nmol/L)
  - Malay 16.8%, Chinese 7.1%, Indian 21.5%
  - Higher plasma folate amongst users of suplement in Malaysia: users 17.6 nmol/L, non-users 12.8 nmol/L

- Indonesia/Jakarta: 0% (RBC folate <305 nmol/L)
  - Other centers: China/Beijing 18%, Malaysia/KL 8%
  - Mandatory folic acid fortification in wheat flour (2mg/kg) in Indonesia

Role of fortification and supplements

Source: Htet MK (2011); Sirikulchayanonta C et al (2004); Kor GL et al (2006); Green TJ et al (2007)

Dietary folate intakes in women of child bearing age

Country	Folate intake (µg/d)	%RNI [1]	Correlation b/t intake and serum folate
Malaysia	202	50.5	0.315**
Thailand	172	50.6	0.680**

[1] RNI = 400 µg/d

Food items most frequently consumed by women of child-bearing age in Thailand and their folate contents

Food items	Folate (μg/100m)	Average frequency score (times/week/person)
Rice, cooked	2.9	15.1
Egg	36.9	2.8
Orange	12.2	2.8
Rice noodle	7.2	2.7
Bread, white, slice	12.2	2.7
Guava	9.5	2.5
Soy milk	1.95	2.5
Drinking yoghurt	2.2	2.5
Yard long beans, fresh	105.0	2.2
Kale Chinese, cooked	80.2	2.1

Source: Sirikulchayanonta C et al (2004); Kor GL et al (2006)

'Problem nutrients' amongst the under-two year-old children

(Cambodia, Indonesia, Laos, Thailand, Vietnam)

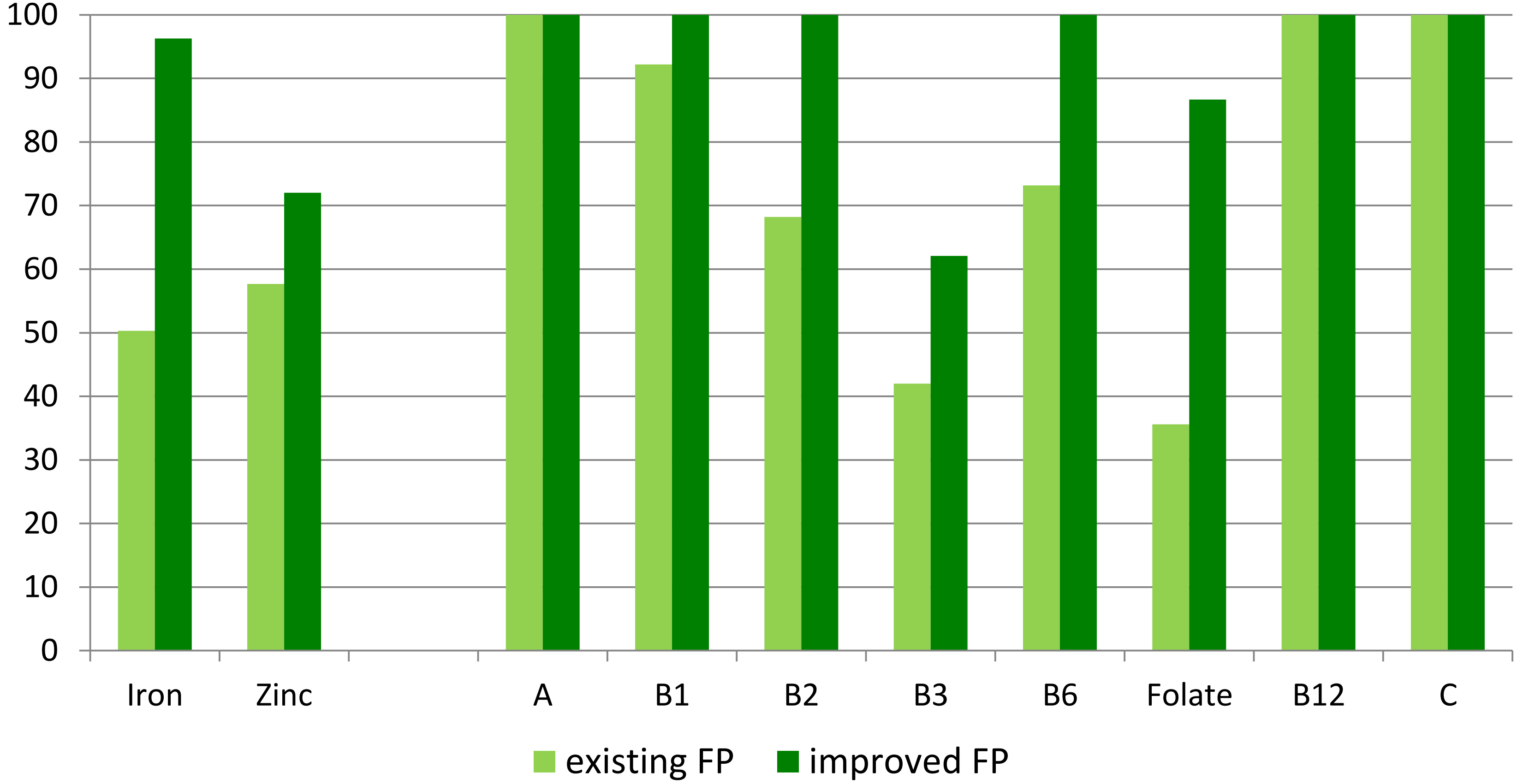
S**MILING* (S**ustainable **M**icronutrient **I**nterventions to ControL Definciencies and **I**mprove **N**utritional Status and **G**eneral Health in Asia)*

6 – 8 months		9-11 months		12-23 months*	
'Problem' nutrients	Number of countries	*'Problem'* nutrients	Number of countries	*'Problem'* nutrients	Number of countries
Iron	5	Iron	4	Thiamine	3
Zinc	3	Zinc	2	Niacin	3
Thiamine	2	Niacin	2	Iron	2
Niacin	2	Folate	2	Zinc	2
Riboflavin	1	Thiamine	1	B12	2
B12	1	Riboflavin	1	Folate	2
Folate	1	B12	1	Riboflavin	1
B6	1				

Source: SMILING Project WP4 (Linear programming for setting up food-based recommendations)

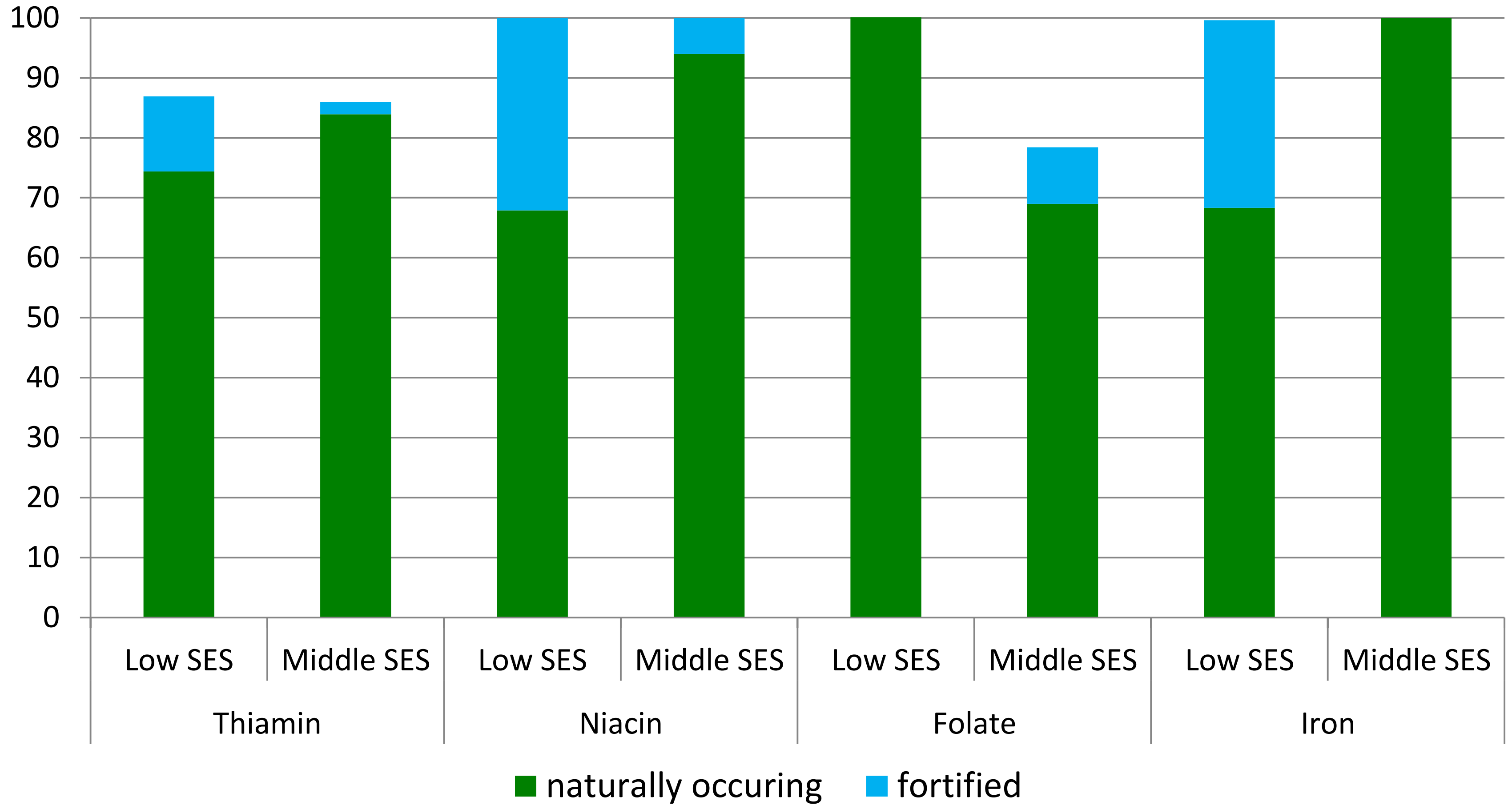
*Data for this age group is missing one country, so relates to 4 not 5 countries

How much does micronutrient intakes is affected by food pattern?



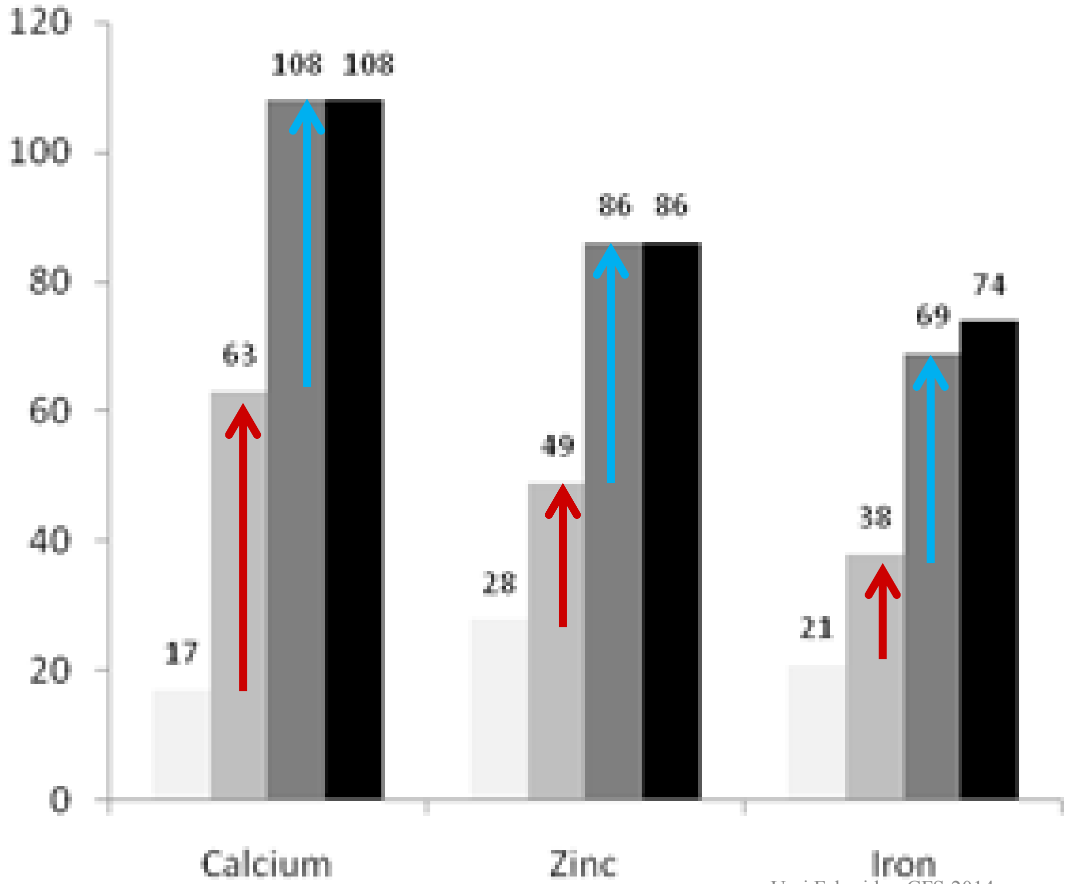
Percentage RNI which can be achieved when diet is optimized with the existing food pattern (existing FP) and when food pattern is improved (improved FP) in Myanmar under-two-year old children. *Source: Hlaing LM (2014)*

Problem nutrients by socioeconomic (SES) in 12-23mo children in Bandung city, Indonesia



Simulation: Intakes of problem nutrients as percentage of estimated nutrient needs

Source: Fahmida U (2013). Use of fortified foods for Indonesian infants. In: Preedy VR (ed). Handbook of Food Fortification and Health: From Concepts to Public Health Applications, Volume 2, Nutrition and Health, pp. 383-93. Springer Science+Business Media, New York



Animal source foods

Fortified foods

NDF=nutrient-dense foods,
FF=fortified foods ,
Fe-rice= rice fortified with iron and other nutrients (zinc, vitamin A, B2, B3, folate).

Summary

1. Micronutrient deficiencies has short-term and long-term negative consequences on health and developmental outcomes
2. While commonly recognized problems were not yet fully resolved, more nutrient deficiencies were identified in the region. Concurrent deficiencies are common.
3. Improving food pattern can improve nutrient adequacy. However for some nutrients, naturally occuring foods cannot fulfil the nutrient requirements and enriched/ fortified foods are needed.

Thank You – Terima Kasih

ufahmida@seameo-recfon.org / umifahmida@gmail.com