



### ***Importance of Animal Products In The Human Diet:***

***The experience of working in developing communities to improve livestock production***

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## **OUTLINE**

- Importance of livestock in developing countries
- Potential of ASF to address hidden hunger
- Effects of ASF on nutritional status, growth, and cognitive development
- Barriers to ASF consumption
- Conclusions

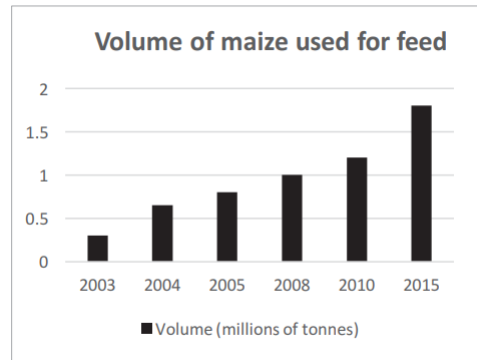
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## LIVESTOCK FOR LIFE IN LMICS

- Livestock support livelihoods of over 1 billion people
- Up to 80% of the population in some LMIC (1/3 of Africans) depend on livestock for livelihoods
- Livestock account for 40% of agricultural GDP on average
- As populations and incomes grow, demand for ASF grows

e.g., 600% poultry feed sector growth in Nigeria in 10 years due to growth in poultry production

Nigerian livestock sector



(GFC-UCDavis- FAO; AU-IBER, 2016; Liverpool-Tassie et al., 2016; LD4D, 2018; FAO, 2021; Berhanu, 2021)

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## SOCIOCULTURAL SIGNIFICANCE

- Status symbol
- Religious veneration
- Ceremonial gifts
- Conflicts/wars



(Swanepoel et al., 2010)

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## LIVESTOCK MANURE, A VERSATILE RESOURCE IN LMICS

- Manure is used as a fertilizer, cooking fuel and a building material in many parts of Asia and Africa
- Manure building blocks are being tested in The Netherlands; may reduce emissions by >30%.  
(Christiansen and Heltberg, 2012)



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## NUTRIENT UPCYCLING AND CROP PRODUCTIVITY

- Crop residues/ marginal pastures dominate ruminant diets in LMIC
- Livestock upcycle poor quality forage into nutrient-dense products and manure
- Rwanda **GIRINKA** Project
  - More than 130,000 cows distributed
  - Increased household income
  - Crop yields increased (by up to 100%)
  - Contributed to a decrease in stunting (44% in 2012 to 32% today)



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## DRAFT ANIMAL POWER

- Provided **traction** for ~ **50%** of the world's farmers in 2009 (World Bank)
- Accounted for 25% of the total energy requirement for farming
- May foster less GHG emissions and non-renewable energy use vs. machinery
- Ideal for marginal lands particularly in rural areas



(Mota Rojas et al., 2021; FAO 1982; Sims and O'Neil, 2003)

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## EMPOWERMENT OF WOMEN/YOUTH

- Are the only assets owned by many women in LMIC
- Determine if nourishing diets are fed
- Opportunity for youth employment

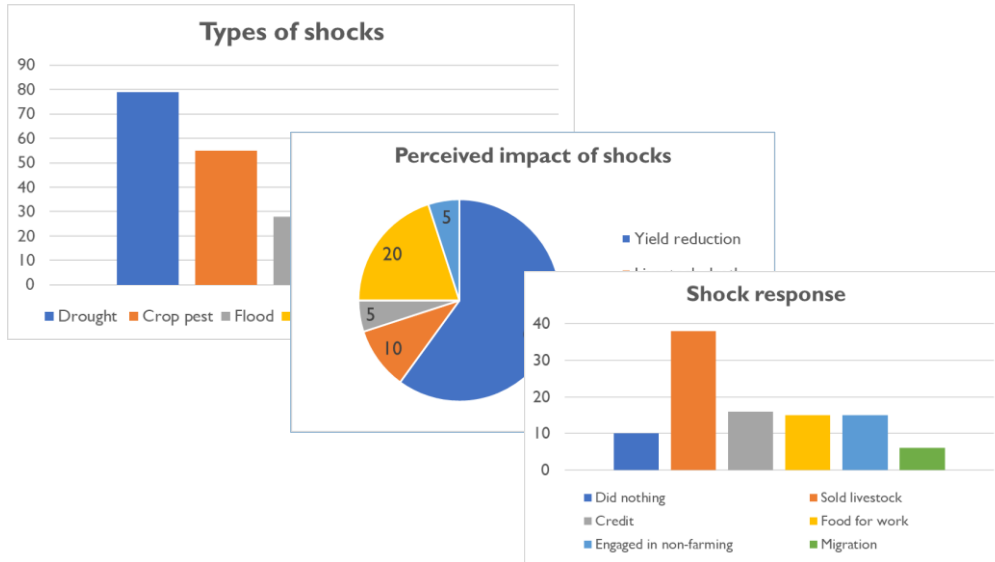


In Nepal: Distance learning increased community health worker training completion rate from by 80%

(Mullally et al., 2020)

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## IMPROVING RESILIENCE (HARARGE ZONE, ETHIOPIA)

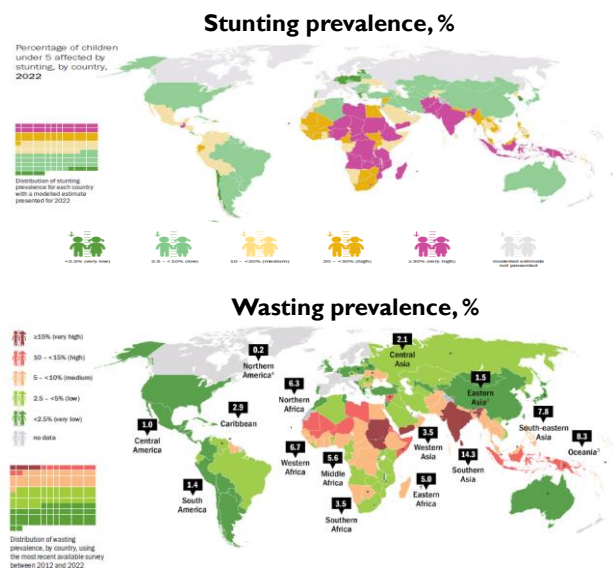


(Zeleeke et al., 2021)

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## GLOBAL PREVALENCE OF UNDERNUTRITION

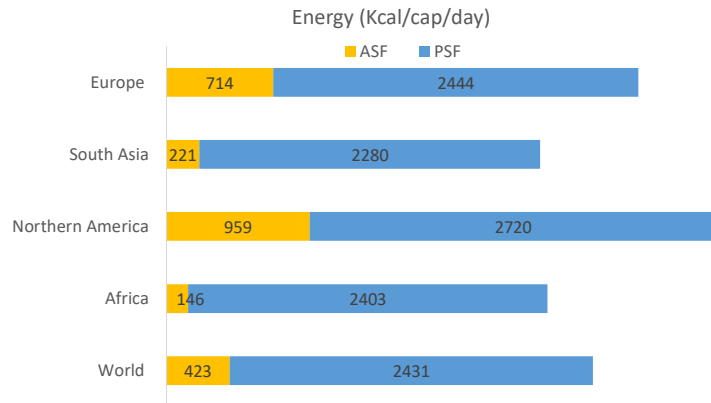
- Over 3 billion people cannot afford a healthy diet;
- 800 million are regularly hungry.
- 144 million children under 5 have stunted growth and cognition;
- 39 million are overweight.
- 45 million suffer from wasting, the deadliest form of malnutrition.



UNICEF/WHO/World Bank Group, 2023

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## GLOBAL PLANT (PSF) VS. ANIMAL (ASF)-SOURCED FOOD CONSUMPTION

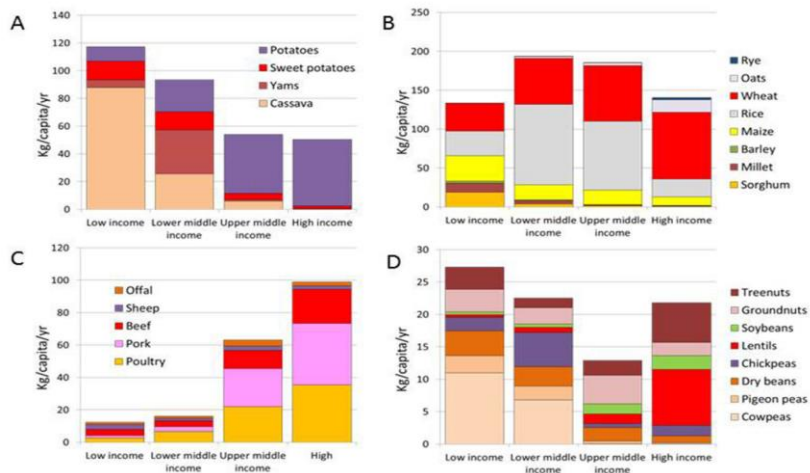


Hidden hunger is prevalent in the developing world, where most people are vegetarian (not by choice)

(FAO, 2021)

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## FOOD TYPES AVAILABLE FOR GLOBAL CONSUMPTION



**FIGURE 1.** Roots and tubers (A), cereals (B), meats (C), and beans, pulses, legumes, and nuts (D) in kg/capita/year available for global human consumption. Data are FAOSTAT 2019–2020 by World Bank country categories by gross domestic product (GDP).

(Drewnoski, 2024; FAOSTAT, 2020, World bank)

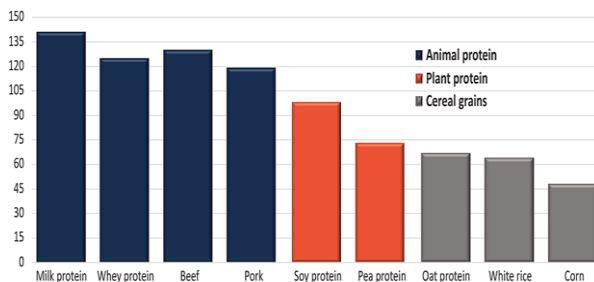
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## STARK DIFFERENCES IN GLOBAL MILK CONSUMPTION BY REGION/ COUNTRY (kg per person /year)

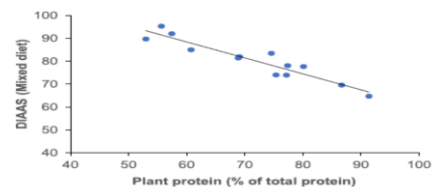
(Adapted from [FAO, 2019](#))

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## DIGESTIBLE AMINO ACID SCORE OF DIFFERENT FOOD ITEMS



**DIASS decreases as the proportion of plant protein in a diet increases**

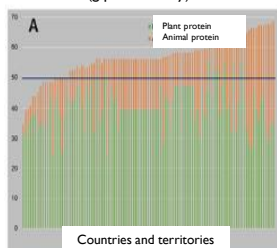


(Bailey and Stein, 2019; Moughan 2021)

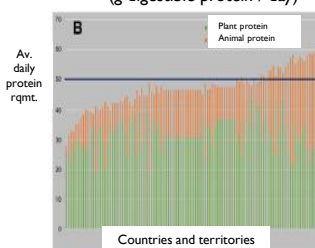
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## DEFFICIENCY OF QUALITY PROTEIN IN DIETS IN LMICS

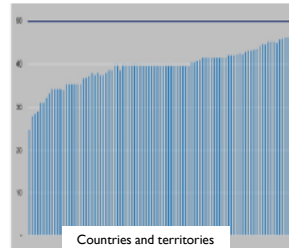
**Average per capita protein consumption in 103 LMICs**  
(g protein / day)



**Corrected for protein digestibility**  
(g digestible protein / day)



**Corrected for protein utilizability**  
(g utilizable protein / day)



Moughan (2021)

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## Animal-Source Foods: Bioavailable Nutrient Cluster and Undernutrition Solution

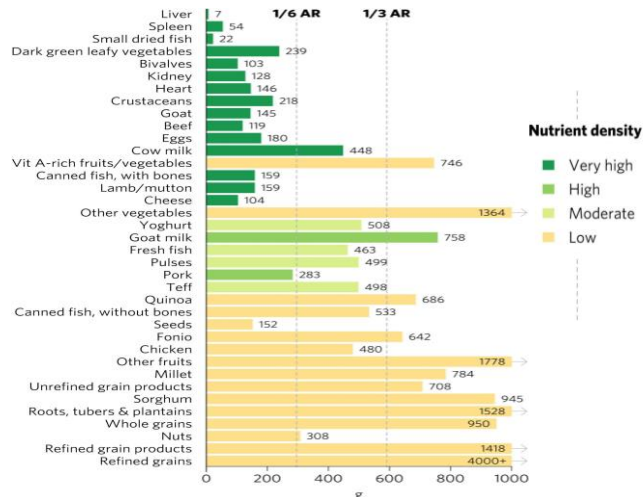
	Nutrient	Advantage vs. plant-source food
Superior-quality (ideal) protein	Protein	Higher quality/complete
Higher energy density	Iron	Only dietary source of bioavailable haem
Higher nutrient density and bioavailability	Zinc	More bioavailable
	Calcium	More bioavailable
	Vitamin B12	Only dietary source
	Vitamin A	Only preformed source (retinol); more bioavailable
	Vitamin D3	Only dietary source; more active and bioavailable than D2
	Choline	Main dietary source
	EPA and DHA	Main dietary source
	Thiamin, riboflavin, Vitamin B6	

Allen et al., 2019; Beal et al., 2020

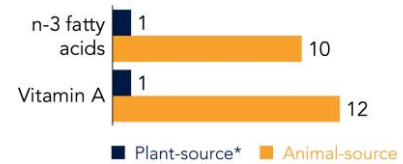
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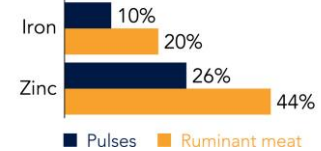
## FOOD AMOUNTS THAT GIVE 1/3 OF RECOMMENDED INTAKES (AR) OF KEY MICRONUTRIENTS IN WOMEN OF REPRODUCTIVE AGE (Vit. A, folate, vit. B12, Ca, Fe, Zn)



### Bioavailability (proportion of plant-source)



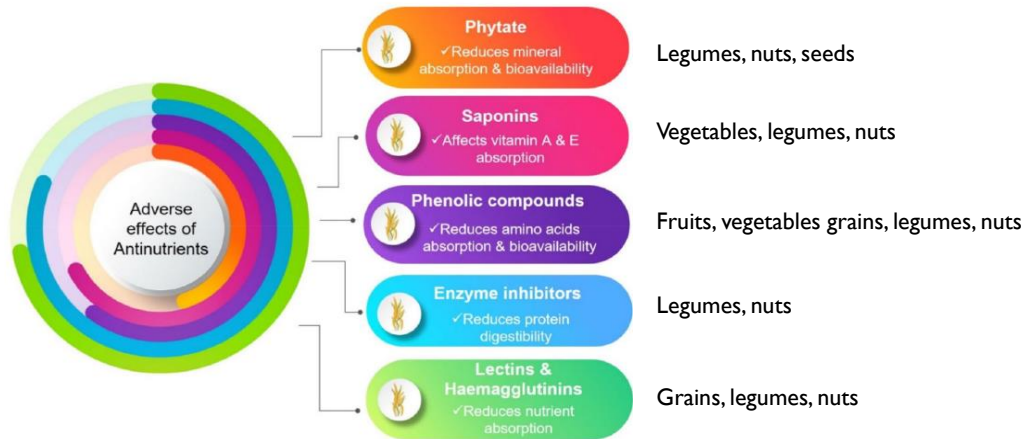
### Bioavailability (% absorbed)



(Beal T. and Ortenzi F. 2022)

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## PLANT ANTINUTRIENTS

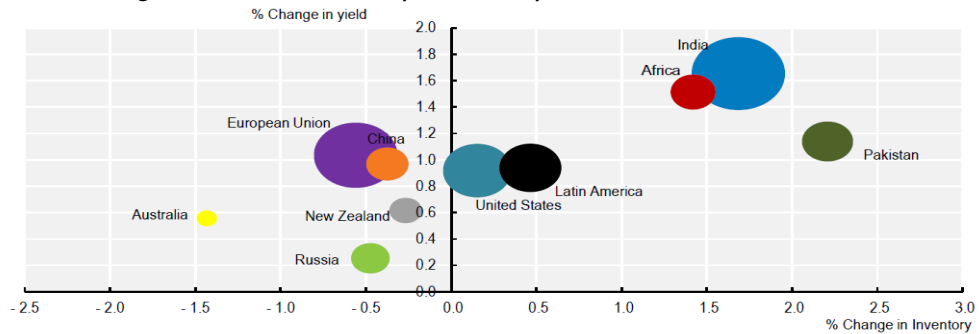


(Tharifikhan et al., 2021; Commerford et al., 2021)

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## GLOBAL MILK PRODUCTION GROWTH BY REGION

Annual changes in inventories of dairy herds and yields between 2021 and 2031



(Wyrzykowski et al., 2018)

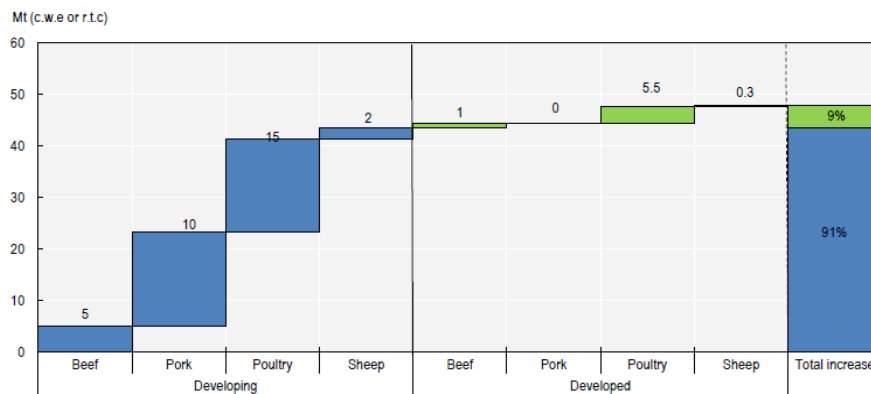
Bubble size indicates yield in the base period 2019-21.

(OECD/FAO, 2022)

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## GROWTH OF MEAT PRODUCTION BY REGION AND TYPE

2031 vs 2019-21

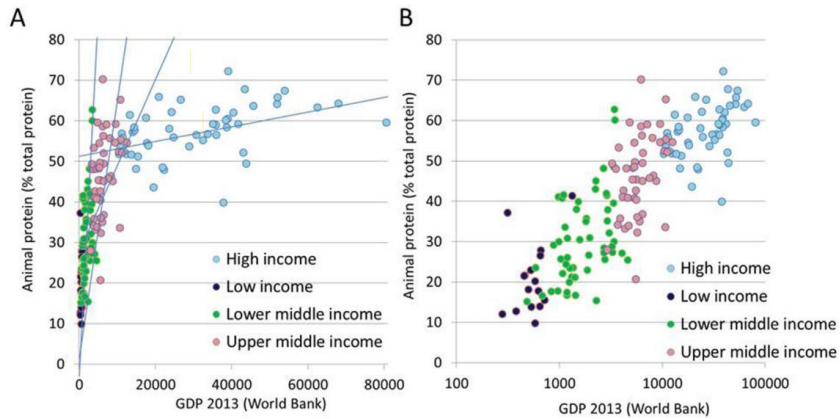


Note: c.w.e. is carcass weight equivalent, r.t.c. is ready to cook equivalent.

(OECD/FAO, 2022)

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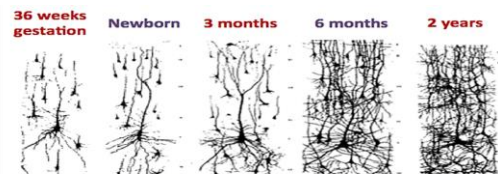
## ANIMAL PROTEIN CONSUMPTION RELATIVE TO GDP ACROSS COUNTRY INCOME LEVELS



(Drewnoski, 2024; FAOSTAT, 2013, World bank)

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## BRAIN DEVELOPMENT EVENTS

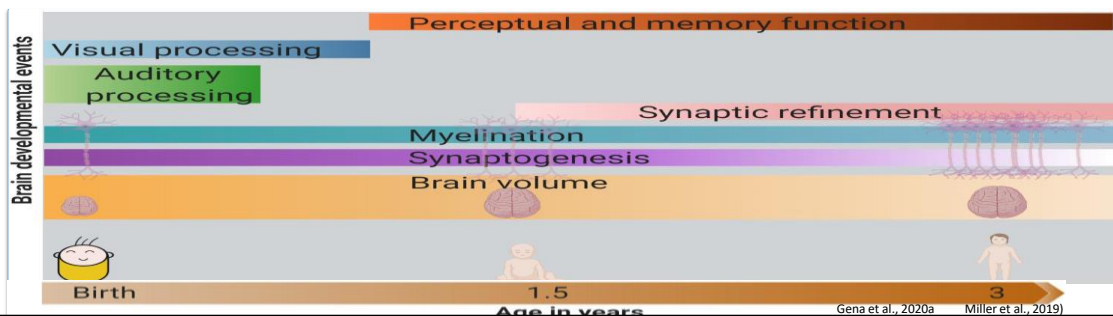


Synapse formation

2/3 of brain

DNA formed

Brain growth ~ 90% complete



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## NUTRIENTS AFFECTING BRAIN DEVELOPMENT

### Macro

Protein  
Glucose  
Fats (Long chain PUFA)

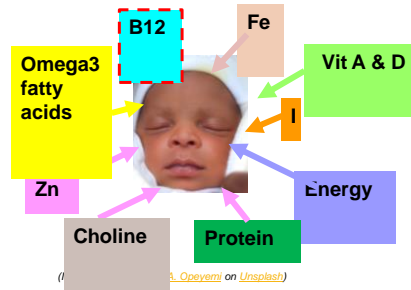
### Micro

Iron  
Iodine  
Zinc  
Copper

### Vitamins/Cofactors

B vitamins (B6, B12)  
Vitamin A  
Vitamin K  
Choline

If I, Zn and Fe deficiencies are eliminated, global IQ will increase by 10 points



Animal-source foods (ASF) are the best source of high-quality, nutrient-rich foods for children aged between 6 and 23 months (WHO, 2017).

### Nutrient deficiency impacts

- Reduced brain size
- Impaired neuronal growth
- Altered synapses
- Cognitive delays
- Reduced neurotransmitter production
- Altered myelination
- Growth failure
- Chronic illness
- Lower IQ

(Georgieff, 2022)

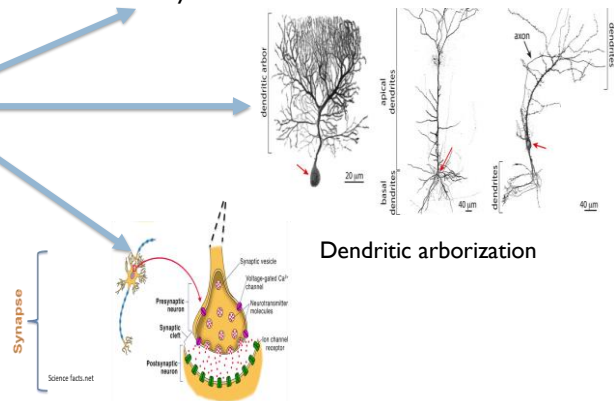
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## HOW ASF ENHANCES COGNITIVE DEVELOPMENT

**ASF**

**Bioavailable micronutrients:  
Iron, zinc, iodine, and B vitamins  
(B12, B6, folate, and riboflavin)**

Enhanced myelination -



Synaptic connectivity

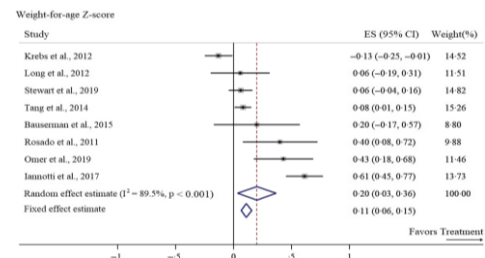
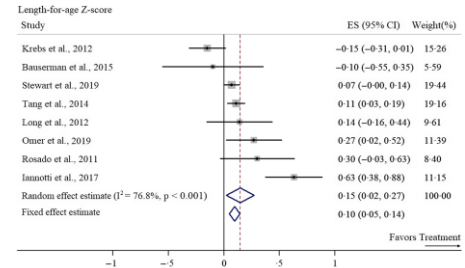
(Löfblad et al., 1997; Lanouie et al. 2019; Sheffield, 2022).

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## ASF IMPROVED NUTRITION AND PHYSICAL GROWTH

- Meta analysis of 8 studies (Randomized controlled trials)
- Studies had 42 to 1471, 5 to 24 month-old children from rural parts of Africa and Asia
- Background diets contained little or no ASF
- ASF supplementation resulted in lower stunting and wasting

(Asare et al., 2022)

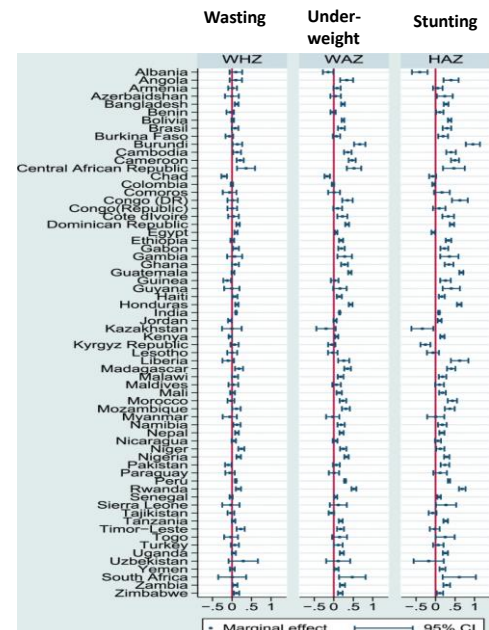


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## MILK CONSUMPTION REDUCES UNDERNUTRITION

- Monitored milk consumption based on 24 h recall by mothers from 67 LMIC
- Measured child stunting (HAZ), underweight (WAZ) and wasting (HAZ)
- Approx. 668,000 children aged 6 to 59 months per measure
- Milk consumption was associated with reduced stunting (HAZ) and underweight (WAZ)

(Herber et al., 2020)



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## LULUN EGG PROJECT, ECUADOR

- Giving one egg per day to 6–9-month-olds in Ecuador for six months
- Reduced stunting (low height or length for age) by **47%**
- Reduced wasting (low weight for age) by **74%**



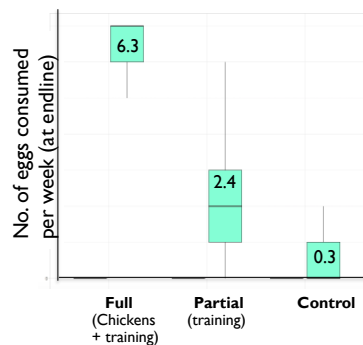
(lanotti et al, 2017)

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## ONE EGG PROJECT, BURKINA FASO

Our culturally tailored behavior change intervention

- Increased egg intake in children with and without gifting chickens
- Reduced wasting and underweight
- Increased women's decision-making power



Baseline egg consumption was zero.



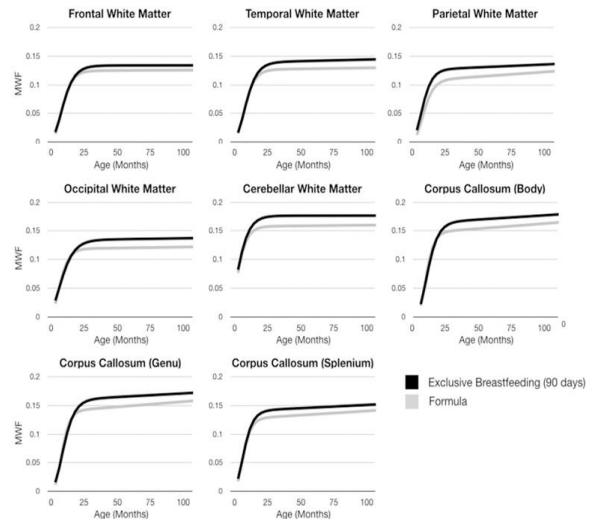
(McKune et al., 2020)

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## GROWTH OF BRAIN REGIONS IN BREAST VS. FORMULA-FED INFANTS

Breastfed children had:

- improved overall myelination
- increased general, verbal, and non-verbal cognitive abilities
- long-chain PUFA, iron, choline, sphingomyelin and folic acid are significantly associated with early myelination



(Deoni et al., 2018)

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## ASF INCREASED CHILDREN'S COGNITION IN KENYA

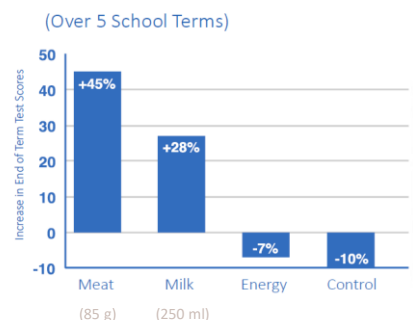
Embu Kenya, 2 years; 7–10-year-olds; n=554

Meat improved:

- Cognitive performance (Raven's score, math)
- School test scores
- Physical activity, initiative and leadership
- Arm muscle mass, B12 status

Milk improved:

- Linear growth if stunted
- B12 status



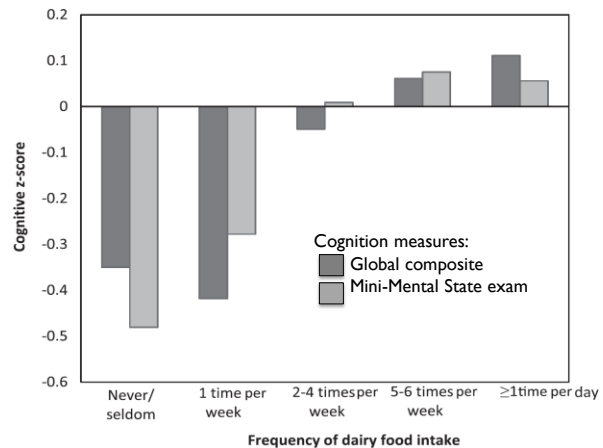
(Neumann et al., 2007; Hullet et al., 2014)

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## DAIRY INTAKE ASSOCIATED WITH INCREASED COGNITION IN ADULTS

- Cross-sectional analyses
- 399 males and 573 females, aged 23–98 years
- Monitored self-reported frequency of dairy consumption
- Measured cognition in different ways.
- Increased dairy consumption frequency was associated with increased cognition



(Crichton et al. 2016)

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## ASSOCIATION BETWEEN MEAT CONSUMPTION AND HEIGHT OR COGNITION

(20,086 Chinese men and women that were >50)

	CHILDHOOD MEAT EATING <sup>a</sup>				Trend <i>P</i> value
	Yearly/Never	About once a month	About once a week	Almost daily	
Height (cm) <sup>b</sup>	—	0.24*	0.54***	0.76***	< 0.001
Cognition (delayed 10 word recall)		0.12**	0.32***	0.57***	< 0.001
Cognition (Immediate 10 word recall)		0.72***	1.47***	1.77***	< 0.001

<sup>a</sup> Adjusted for age and sex; \*\*\*  $P < 0.001$ ; \*\*  $P < 0.01$ ; \*  $P < 0.05$

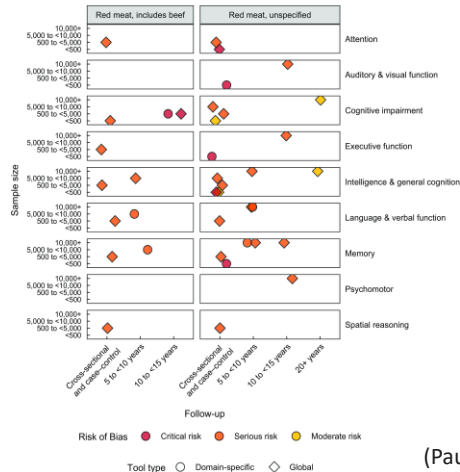
(Heys et al., 2010)

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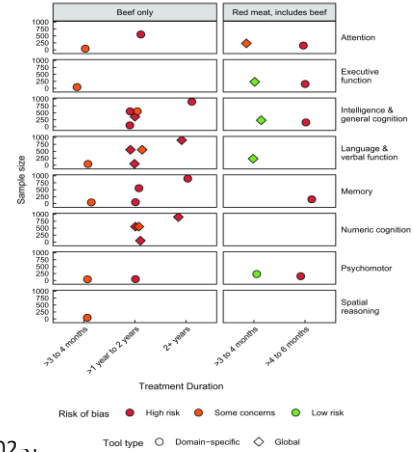


## FACTORS DIFFERING AMONG STUDIES ON MEAT CONSUMPTION AND COGNITION

### Observational studies (n=13)



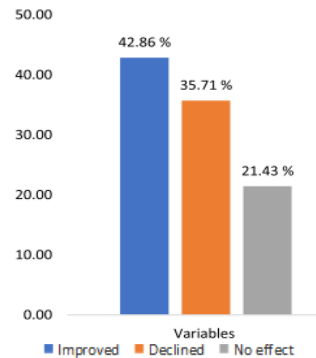
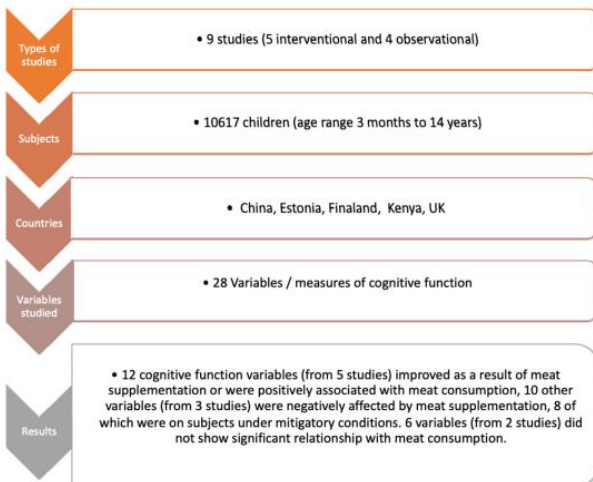
### Intervention studies (n=9)



(Paul and Fleming, 2023)

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## MEAT CONSUMPTION ASSOCIATED WITH IMPROVED COGNITION



If the 8 studies with confounding HIV effects are removed, **meat consumption increased cognition in 71% of variables**

(Balehgn et al., 2022)

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## BARRIERS TO ASF CONSUMPTION

- Sociocultural factors
  - Gender
  - Caste
  - Religion
  - Cultural taboos
  - Fads
- Biases (crops, fortificants)
- Availability (low livestock productivity)
- Affordability
- Accessibility



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## TAKE HOME MESSAGES

- Livestock play a vital role in social status, conflict, religion, equity, incomes, educations and livelihoods in the developing world
- Stunting affects 144 million children under five, constraining their growth, health, education, and future productivity
- ASF are at superior for preventing stunting and enhances cognitive development and growth
- ASF are inadequately consumed in LMIC due to socio-cultural factors, and lack of affordability, accessibility and availability.
- Multisectoral approaches are needed to improve supply of and demand for ASF in developing countries.

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### Disclaimer

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