



2018 SKILLS BUILDING PROGRAM

BIG DATA, ARTIFICIAL INTELLIGENCE AND DECISION SCIENCE IN HEALTH AND NUTRITION

Global issues in nutrition

Day 3 – Session 1

In partnership with





Global Targets (WHA/SDGs)



Low birth weight



Overweight

How much it will cost?

What will we buy with this investment?

- Nutrition
- Health/lives saved
- Economy

How can it be financed?

How can these analytics generate national political commitment? And how can we maximize the “bang for the buck”?

Using Economic Analysis to Support Nutrition Programs in Client Countries: 6 Years of Analytic Engagement



Analytic program in partnership with BMGF:

- Analyses in 14 countries
- 10 stand-alone HNP discussion papers
- Multiple policy briefs and other dissemination materials

Country	Year	Analysis completed	Discussion Paper	Policy Brief
Nigeria	2013/4	✓	✓	✓
Togo	2013/4	✓	✓	
Mali	2014/5	✓	✓	✓
DRC	2014/5	✓	✓	✓
Zambia	2015/6	✓	✓	
Uganda	2015/6	✓	✓	
Cameroon*	2015	✓		
Kenya	2015/6	✓	✓	✓
Tanzania*	2015	✓		
Cote d'Ivoire	2015/6	✓		
Guinea Bissau	2016	✓	✓	
Madagascar	2016	✓		
Bangladesh	2016	✓	✓	
Afghanistan	2016	✓	✓	

Analytic Products



COSTED PLAN FOR SCALING UP NUTRITION: NIGERIA

SEPTEMBER 2014

DISCUSSION PAPER

SCALING UP NUTRITION FOR A MORE RESILIENT MALI: NUTRITION DIAGNOSTICS AND COSTED PLAN FOR SCALING UP

FEBRUARY 2015

Knowledge Brief

Health, Nutrition and Population Global Practice

SCALING UP NUTRITION IN KENYA: WHAT WILL IT COST?

Meera Shekar, Jakub Kakietek, Wendy Karamba, Audrey Pereira, Julia Dayton Eberwein, Jonathan Kweku Akuoku and Priyanka Karthi



February 2016

KEY MESSAGES:

- Although the proportion of children under five in Kenya who are wasted recently declined to below 11 percent, allowing Kenya to meet the Sustainable Development Goal target for wasting, over one-fourth of all Kenyan children remained chronically malnourished (stunted) in 2014.
- Implementing 11 key nutrition-specific interventions in all regions of Kenya would cost \$76 million in public investments annually, produce tremendous health benefits (267,000 disability-adjusted life years averted, 6,600 lives saved, and 434,000 cases of stunting averted), and is highly cost-effective at \$317 per disability-adjusted life year averted.

SCALING UP NUTRITION IN THE DEMOCRATIC REPUBLIC OF CONGO: WHAT WILL IT COST?

A POLICY BRIEF

by Meera Shekar, Max Mattern, Luc Lavolette, Julia Dayton Eberwein, Wendy Karamba, and Jonathan Kweku Akuoku

Maternal & Child Nutrition

Maternal & Child Nutrition
DOI: 10.1111/mcn.1281

Original Article

The costs of stunting in South Asia and the benefits of public investments in nutrition

Meera Shekar, Julia Dayton Eberwein and Jakub Kakietek

Health, Nutrition and Population Global Practice, World Bank, Washington, District of Columbia, USA

Abstract

South Asia is home to the largest number of stunted children worldwide: 65 million or 37% of all South Asian children under 5 were stunted in 2014. The costs to society as a result of stunting during childhood are high and include increased mortality, increased morbidity (in childhood and later as adults), decreased cognitive ability, poor educational outcomes, lost earnings and losses to national economic productivity. Conversely, investing in nutrition provides many benefits for poverty reduction and economic growth. This article draws from analyses conducted in four sub-Saharan countries to demonstrate that investments in nutrition can also be very cost-effective in South Asian countries. Specifically, the analyses demonstrate that scaling up a set of 10 critical nutrition-specific interventions is highly cost-effective when considered as a package. Most of the interventions are also very cost-effective when considered individually. By modelling cost-effectiveness of different scale-up scenarios, the analysis offers insights into ways in which the impact of investing in nutrition interventions can be maximized under budget constraints. Rigorous estimations of the costs and benefits of nutrition investments, similar to those reported here for sub-Saharan countries, are an important next step for all South Asian countries in order to drive political commitment and action and to enhance allocative efficiency of nutrition resources.

Keywords: stunting, South Asia, cost-effectiveness, nutrition interventions, economic productivity

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For all publications see:
<http://www.worldbank.org/en/topic/nutrition>



Using Data Analytics To Mobilize Resources



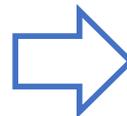
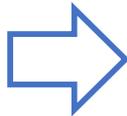
Types of analyses conducted



Estimating the costs

Cost effectiveness analysis

Benefit-cost analysis



Types of engagement with governments

Development of key policy documents

Prioritization of nutrition investments

Advocacy for increased resource – “investment cases”



Types of resource mobilized



IDA

Innovative financing (GFF, PoN)

Country budgets (DRM)

Using Data Analytics To Improve Efficiency

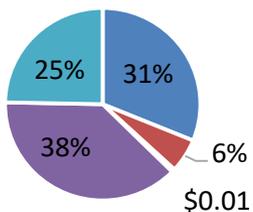
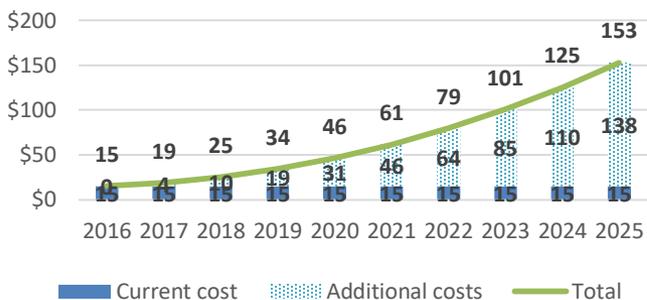


Estimating the costs

Cost effectiveness analyses

Benefit-cost analyses

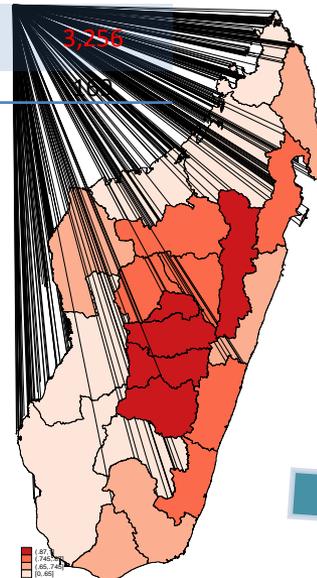
Annual Public Sector Cost of Scaling-up Nutrition-specific Interventions (USD million)



- Consumables
- Transport
- Program cost
- Other inputs
- Human resources

Intervention	Cost per DALY
IYCN	12
Vitamin A supplementation	29
Therapeutic Zinc suppl./ORS	216
Micronutrient powders	44
Deworming	264
Iron-folic acid supplementation	43
Iron fortification of staple foods	
Salt iodization	
Public provision of complementary food	3,256
CMAM for SAM	1,300

Cost-effectiveness map: Regions with the lowest cost per case of stunting averted



\$1 invested = \$22 returns



ANNUAL PUBLIC INVESTMENT

BENEFITS

Additional US\$79 million

US\$557 M in gains through productivity

Save 6.6 K lives

Save 302 K DALYs

Avert 434 K stunting cases

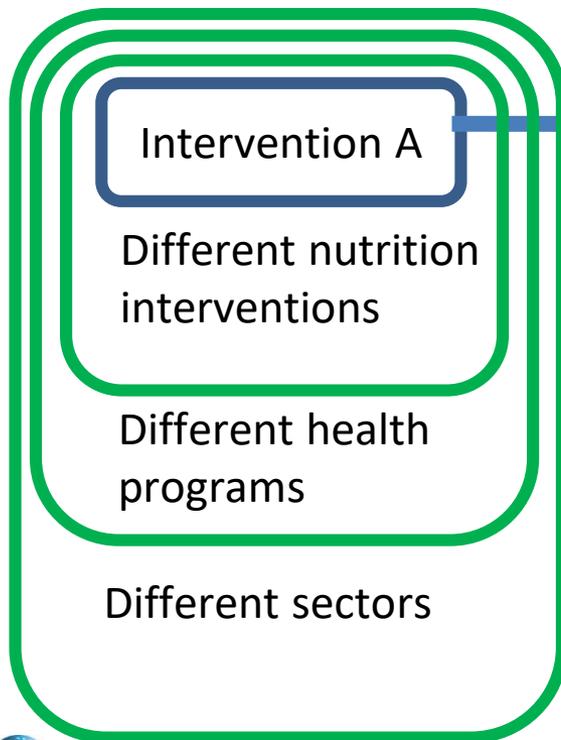
One key question we could not answer: what is

the optimal allocation of resources across interventions?

Using Data Analytics To Improve Efficiency



Technical efficiency – maximizing outputs at given **cost**.



Allocative efficiency – maximizing outputs by allocating resources across different **activities**



Better Nutrition





Why Efficiency?

- Allocation among different interventions and different regions.

- 6 interventions:

- vitamin A supplementation,
- multiple micronutrient powder (MNP) supplementation,
- deworming,
- fortification of edible oil,
- fortification of bouillon cubes,
- biofortification of maize

- 3 Regions

- Analysis – comparison of 2 scenarios with the same cost/budget:

- Current coverage over 10 years (status quo),
- Most efficient (optimized) allocation.

- Findings: optimized allocation is **44% less expensive** than the current allocation

	Current coverage	Optimal allocation
Children reached*	13 million	13 million
Cost per child	\$2.93	\$1.63

*Children whose vitamin A deficiency was eliminated due to interventions



THANK YOU



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BIG DATA, ARTIFICIAL INTELLIGENCE AND DECISION SCIENCE IN HEALTH AND NUTRITION

Background on nutrition modelling

Day 3 – Session 2

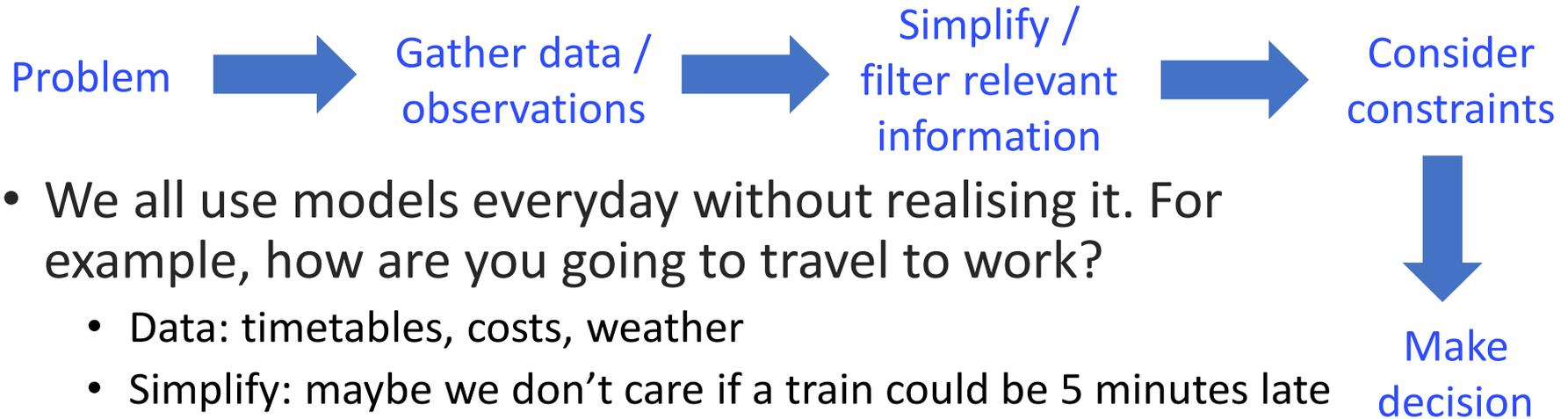
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What is a model

- Modelling is a process:



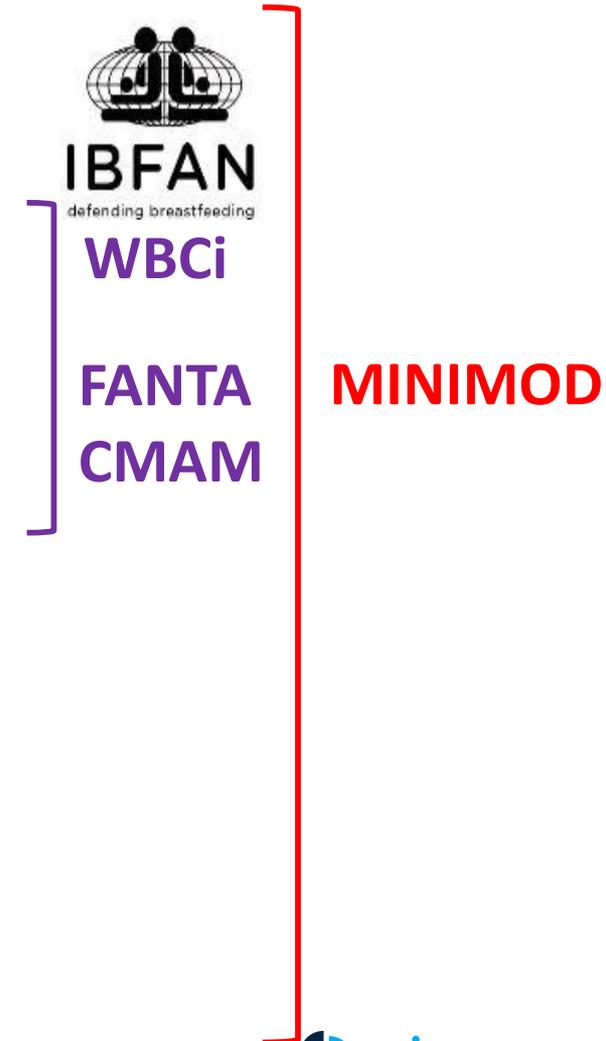
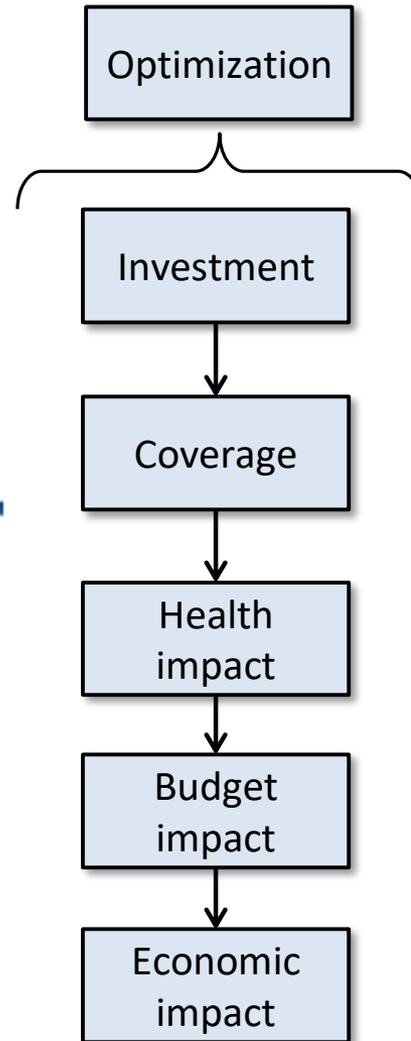
- We all use models everyday without realising it. For example, how are you going to travel to work?
 - Data: timetables, costs, weather
 - Simplify: maybe we don't care if a train could be 5 minutes late
 - Constraints: what are we prepared to pay and how fast do we need to get there?
- Sometimes there is too much information to consider, so we need to use a computer
- Models can help us to make decisions by organising all of the relevant data in a way that is useful for us

Existing tools for impact and economic analyses for nutrition



Multiple interventions:

Single intervention:



Where does Optima Nutrition fit in the mix

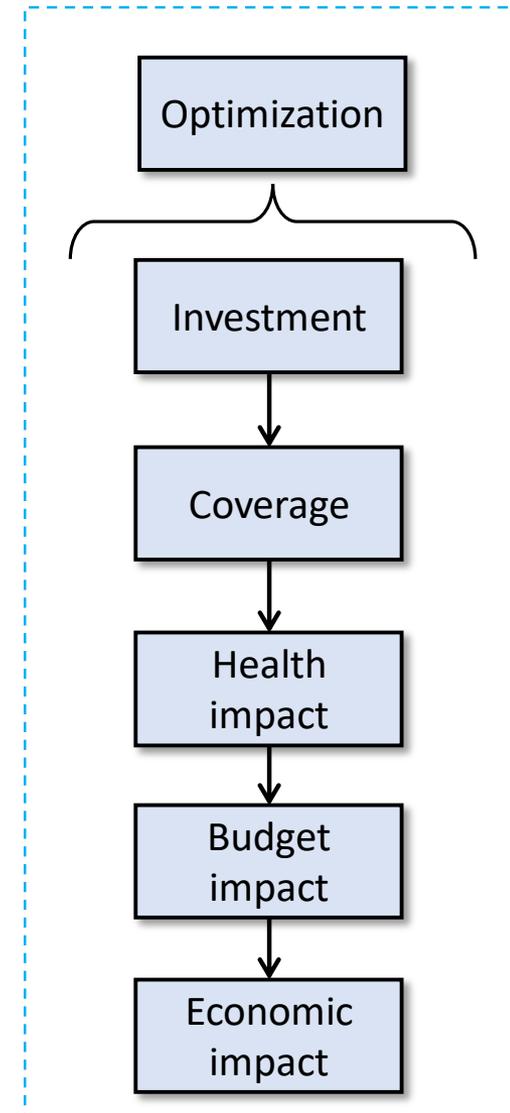


Optima Nutrition has two main uses:

- Optimising investment for best health and economic outcomes
- Projecting future scenarios: how will trends in malnutrition change under different funding scenarios?

The model has secondary uses for:

- Assessment of the impact of interventions on multiple malnutrition conditions:
 - Stunting in children
 - Wasting in children
 - Anaemia in children and women of reproductive age
 - Child and maternal mortality





How does work?

1. Burden of malnutrition

- Data synthesis
- Model projections

2. Programmatic responses

- Identify interventions & delivery modes
- Costs and effects

3. Objectives and constraints

- Strategic goals
- Ethical, logistic & economic constraints

4. Optimization algorithm

Key questions addressed by Optima Nutrition



- How can a fixed budget be allocated across interventions to minimise malnutrition and associated conditions?
- Which interventions should receive priority additional funding, if it were available?
 - In a sub-national analysis: which geographical regions should receive priority additional funding, if it were available?
- How might trends in undernutrition change under different funding scenarios?
- How close is a country likely to get to their nutrition targets:
 - with the current allocation of funding?
 - with the current volume of funding, but reallocated optimally?
- What is the minimum funding required, if allocated optimally, to meet the nutrition targets?



- For different funding levels, how should resources be allocated across a mix of nutrition interventions and what impact is achievable?
- Optimal outcomes can be measured as:
 - minimised stunting cases
 - minimised stunting prevalence
 - minimised wasting prevalence
 - minimised anaemia prevalence
 - minimised deaths or
 - A combination of the above, e.g. maximising the number of alive non-stunted children (“alive and thrive”).

Tour of the graphic user interface (GUI)





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BIG DATA, ARTIFICIAL INTELLIGENCE AND DECISION SCIENCE IN HEALTH AND NUTRITION

Modelling stunting using Optima Nutrition

Day 3 – Session 3

In partnership with



Objectives of session



- The objective of this module is to understand the underlying model framework, using the stunting model as an example
- We will start this module with a presentation and then do some exercises using the Optima Nutrition graphic user interface we showed you earlier this morning
- At the end of this module and exercises you should be able to:
 - Project status-quo / baseline scenarios
 - Estimate the impact of scaling up and down stunting interventions
 - Create and model different infant and young child feeding education packages



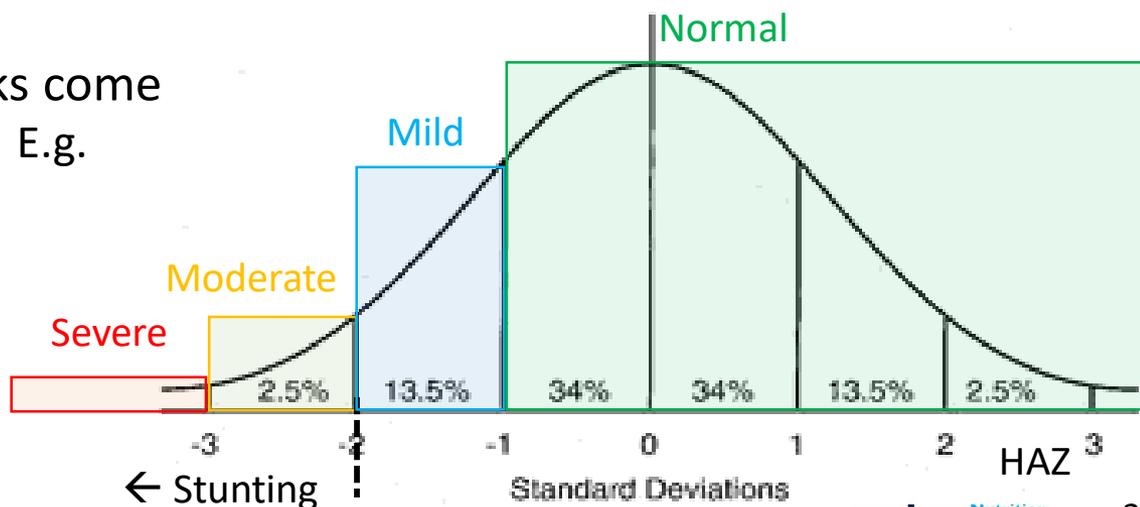
- The underlying model is a reproduction of the LiST framework
 - Tracks the under-5 population over a given period (e.g. 2018-2030)
- The model includes risk factors that contribute to stunting and mortality (among other things)
- The model includes a range of interventions
 - For example: balanced energy protein supplementation, multiple micronutrient supplementation, vitamin A supplementation, prophylactic zinc supplementation, infant and young child feeding education and public provision of complementary foods.
- Key outcomes for this session include the number of deaths and stunting cases, and the prevalence of stunting
- An optimisation algorithm is used to allocate a given budget across the nutrition interventions to minimise a chosen objective
 - For example, maximise the number of alive and non-stunted children



Definition of stunting in the model

- Height-for-age distribution is classified into four Z-score (HAZ) categories
- Risk factors for stunting are:
 - Birth outcomes OR =5 for term SGA; OR = 6.4 for pre-term AGA; OR = 46.5 for pre-term SGA [LiST]
 - Diarrhoea incidence OR =1.04 for every additional episode [LiST]
 - Past stunting OR = 45; 361.6; 174.7 and 174.7 for 1-6 month, 6-12 month, 12-23 month and 23-59 month categories respectively [LiST]
- Stunting increases the risk of mortality for children who have diarrhoea, pneumonia, measles and other illnesses:

- Odds ratios / relative risks come from available literature: E.g. OR for measles mortality = 6.01 if severely stunted *Olofin et al 2013, PLoS One*



Model populations and ageing process



Births



Risks of stunting include

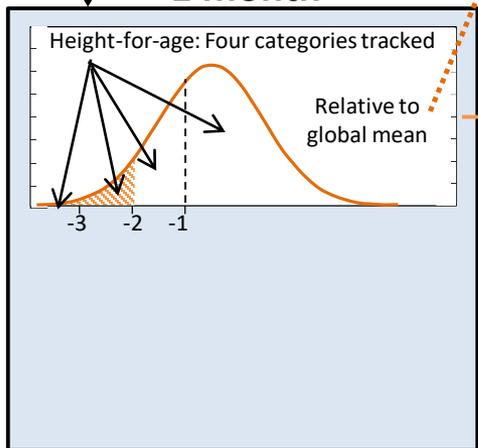
- breastfeeding practices
- past stunting
- diarrhoea incidence

SGA: Small for gestational age
AGA: Appropriate for gestational age

Key endpoints

- Stunting
- Deaths

<1 month



1-6 months

6-12 months

1-2 years

2-5 years

Stunted

Others not stunted by age 5 years

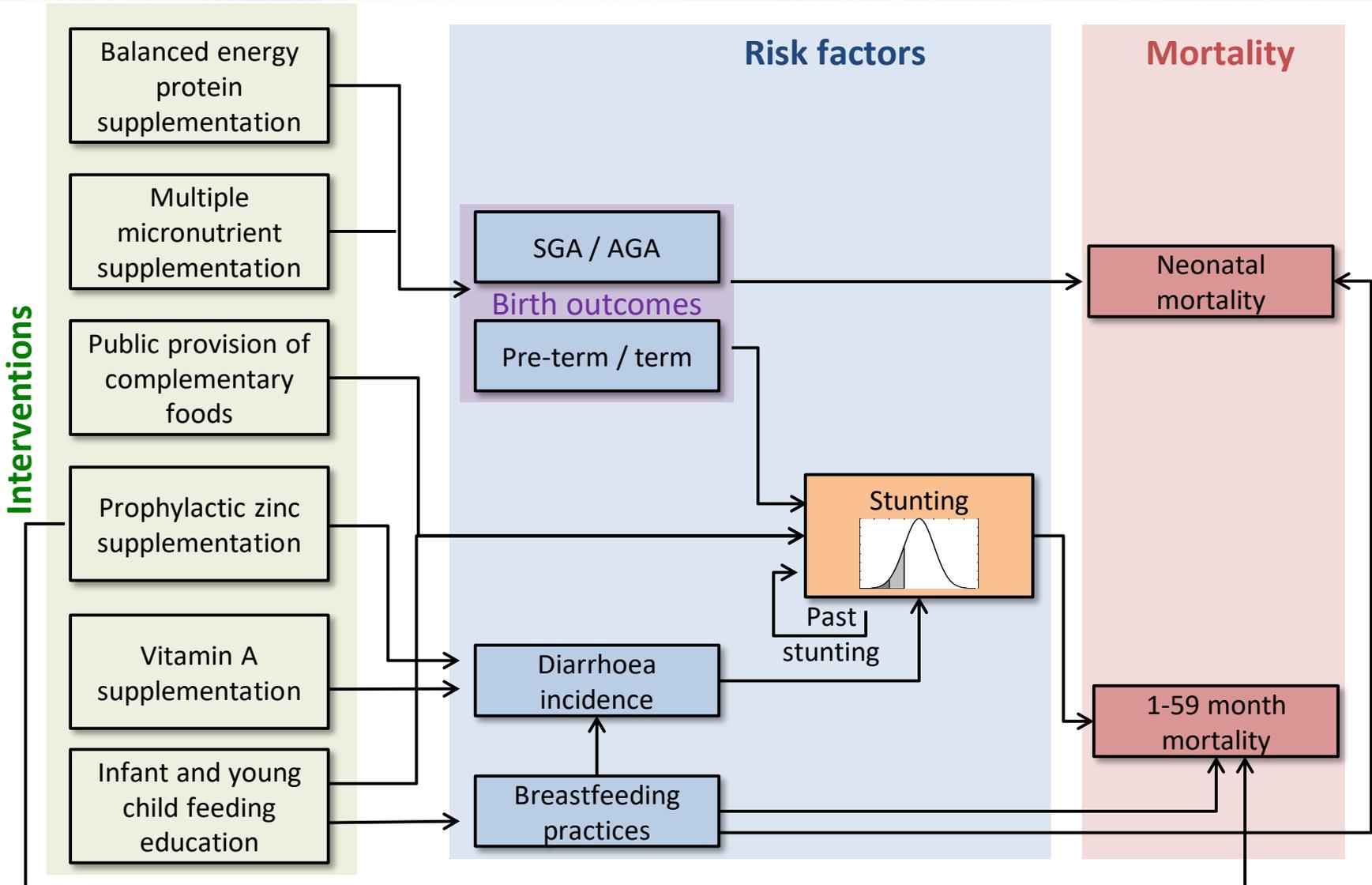
- Risk factors for mortality**
- Diarrhea
 - Pneumonia
 - Asphyxia
 - Sepsis
 - Prematurity
 - Other

Neonatal death

Post-neonatal death

- Risk factors for mortality**
- Diarrhea
 - Pneumonia
 - Measles
 - Other

Relationship between interventions, risk factors, stunting and mortality



Summary of stunting-related interventions



16552

Intervention	Target population	Effects	Source / effect size
Balanced energy protein supplementation	Pregnant women below the poverty line	Reduces risk of SGA birth outcomes	RRR = 0.79 [Ota et al. 2015, The Cochrane Library]
Multiple micronutrient supplementation in pregnancy	Pregnant women	Reduces risk of SGA birth outcomes	RRR = 0.77 [LIST]
Public provision of complementary foods	Children 6-23 months below the poverty line	Reduces the odds of stunting	OR = 0.89 [Bhutta et al. 2008, The Lancet; Imdad et al. 2011, BMC Public Health]
Prophylactic zinc supplementation	Children 1-59 months	Reduces diarrhoea incidence Reduces diarrhoea and pneumonia mortality	Diarrhoea incidence RRR = 0.805 [Bhutta et al. 2013, The Lancet; Yakoob et al. 2011, BMC Public Health] Mortalities RRR = 0.85 [Bhutta et al. 2013, The Lancet; Yakoob et al. 2011, BMC Public Health]
Vitamin A supplementation	Children 6-59 months	Reduces diarrhoea incidence mortality	Incidence RRR = 0.87 [Imdad et al. 2011, BMC Public Health] Mortality RRR = 0.82 [Imdad et al. 2011, BMC Public Health]
Infant and young child feeding education (IYCF)	Children <23 months	See next slide	

Modelling feeding practices and their impact



- Correct (or incorrect) feeding practices have a different impact in the model depending on the age of the child
- Therefore the model allows the user to choose what ages their education packages cover, and accounts for the different impacts.

Age group			Effect size / sources
<p>< 6 months</p>	<p>Exclusive breastfeeding</p>	<p>Reduces diarrhoea</p> <p>Reduces mortality</p> <p>Indirectly reduces stunting and wasting (through decreased diarrhoea)</p>	<p>Diarrhoea incidence: compared to exclusive breastfeeding, OR = 1.26, 1.68, 2.65 for experiencing diarrhoea with predominant, partial or no breastfeeding^a</p> <p>Diarrhoea mortality: compared to exclusive breastfeeding, OR = 2.28, 4.62, 10.53 for diarrhoea mortality and 1.66, 2.50, 14.97 for other causes with predominant, partial or no breastfeeding^b</p> <p>Diarrhoea → stunting: OR for stunting = 1.04 for every additional diarrhoea episode compared to exclusively breastfed children^c</p>
<p>6-23 months</p>	<p>Partial breastfeeding</p>	<p>Reduces diarrhoea</p> <p>Reduces mortality</p>	<p>OR = 2.07 for no breastfeeding compared to partial breastfeeding^a</p>
	<p>Appropriate complementary feeding</p>	<p>Reduces odds of stunting</p>	<p>OR = 0.67^d</p>

^aLamberti et al. *BMC Public Health* 2011, **11**(Suppl 3):S15); ^bBlack et al. *The Lancet* 2008, **371**(9608):243-260; ^cLiST; ^dImdad et al. *BMC Public Health* 2011, **11**(Suppl 3):S25.

Combining education delivery in an infant and young child feeding (IYCF) package



- **Breastfeeding promotion and complementary feeding education interventions are combined in the model, as user-defined (IYCF) packages**
- An IYCF package can target one (or more) of: pregnant women, children 0-5 months or children 6-23 months
- An IYCF package can be delivered through one or more of:
 - Health facilities (GP, hospital): coverage is restricted by the fraction of the population who attend
 - Community health workers: reaches all women and can therefore have much higher coverage
 - Mass media: can cover all groups, depending on the message, with high coverage possible
 - If multiple delivery modes are selected, such as both health facility and community, then some parents will be exposed to multiple messages which can lead to greater impact.

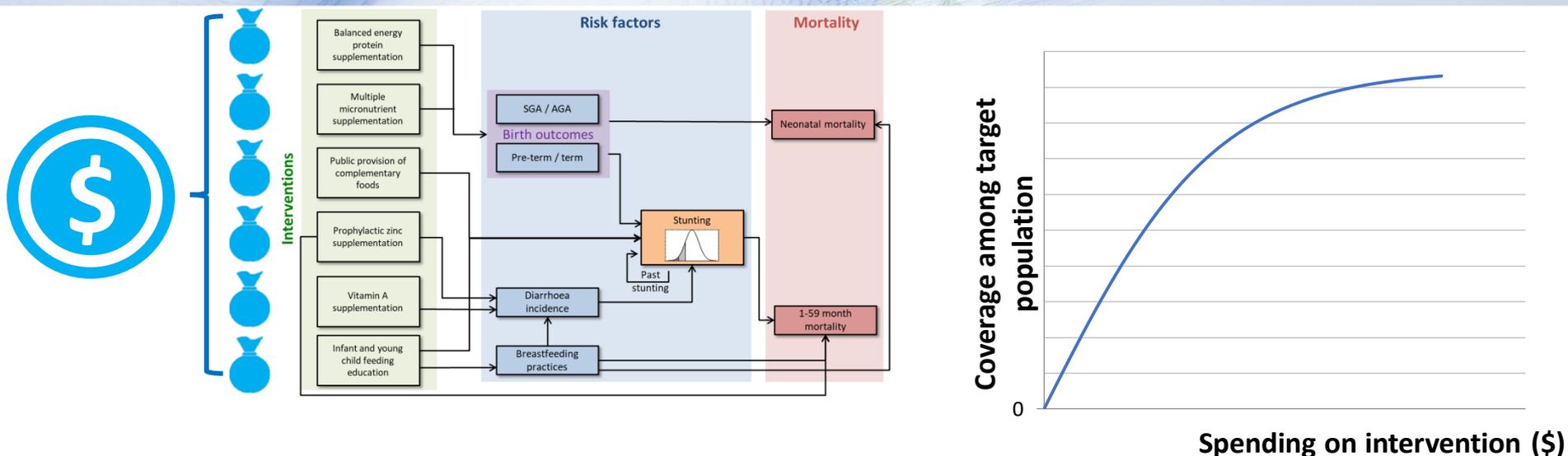
User defined IYCF packages and input sheet



- Users can design their own IYCF packages using the table below
- Multiple IYCF packages can be designed and used in an optimisation
- For example, below might reflect an IYCF package that includes:
 - **Pregnant women:** counseling for pregnant women attending health facilities
 - **<6 months:** visit from community health worker + counseling during facility child visits
 - **> 6 months:** community lectures + counseling during facility child visits
 - **Mass media messages** about advantages of exclusive breastfeeding 0-6 months

IYCF package	Target population	Health facility	Community	Mass media
IYCF 1	Pregnant women	x		
	<1 month	x	x	
	1-5 months	x	x	
	6-11 months	x	x	
	12-23 months	x	x	
	All			

Linking investment in interventions to impact



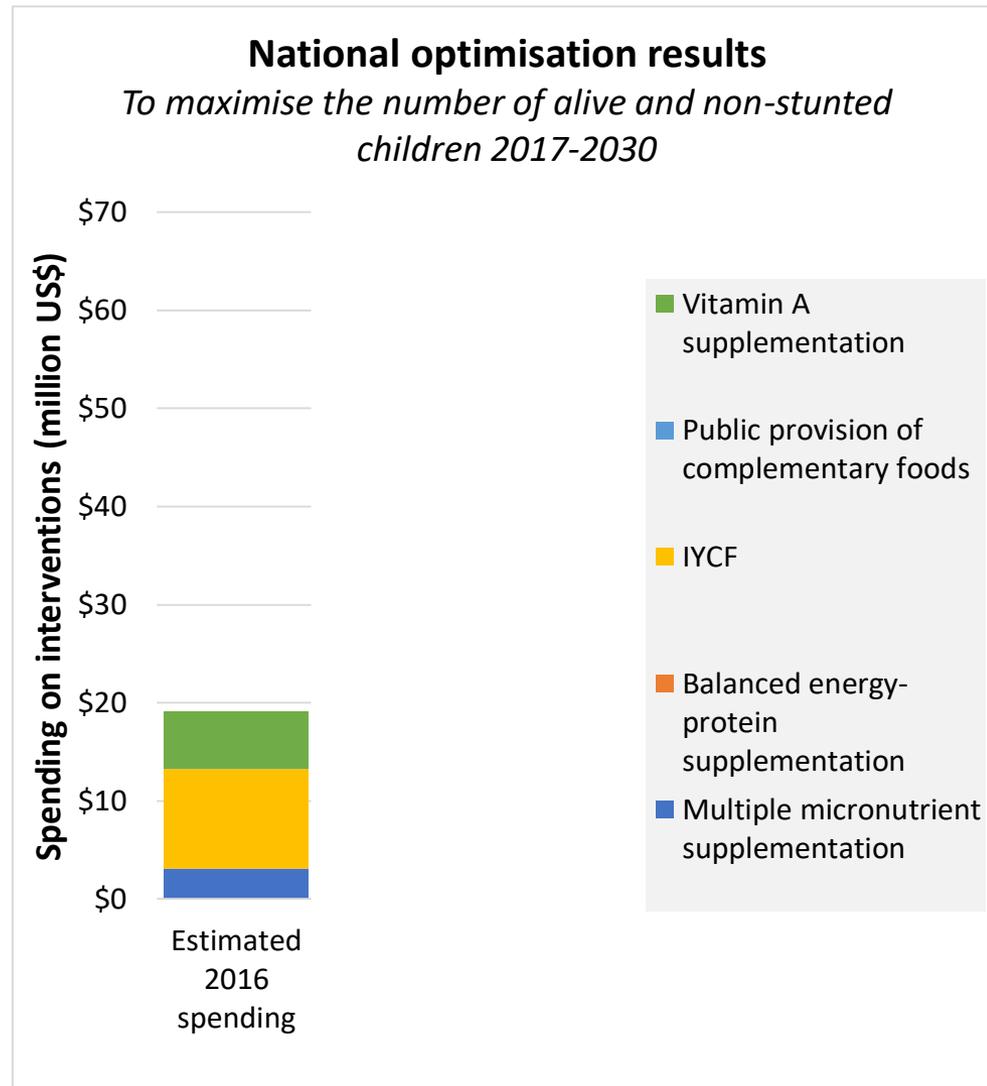
- The spending on interventions is linked to their coverage
- For each intervention, increasing investment:
 - Increases the number of people receiving the intervention
 - Leads to reductions in stunting and deaths according to estimated effectiveness
 - Has a saturation effect when scaling up interventions
- **The model is given inputs on how much to spend on each intervention, and produces estimates for stunting and mortality (among other things).**

Tanzania Example: National Spending in 2016



Tanzania's 2016 nutrition funding was estimated at US\$19.1 million^a:

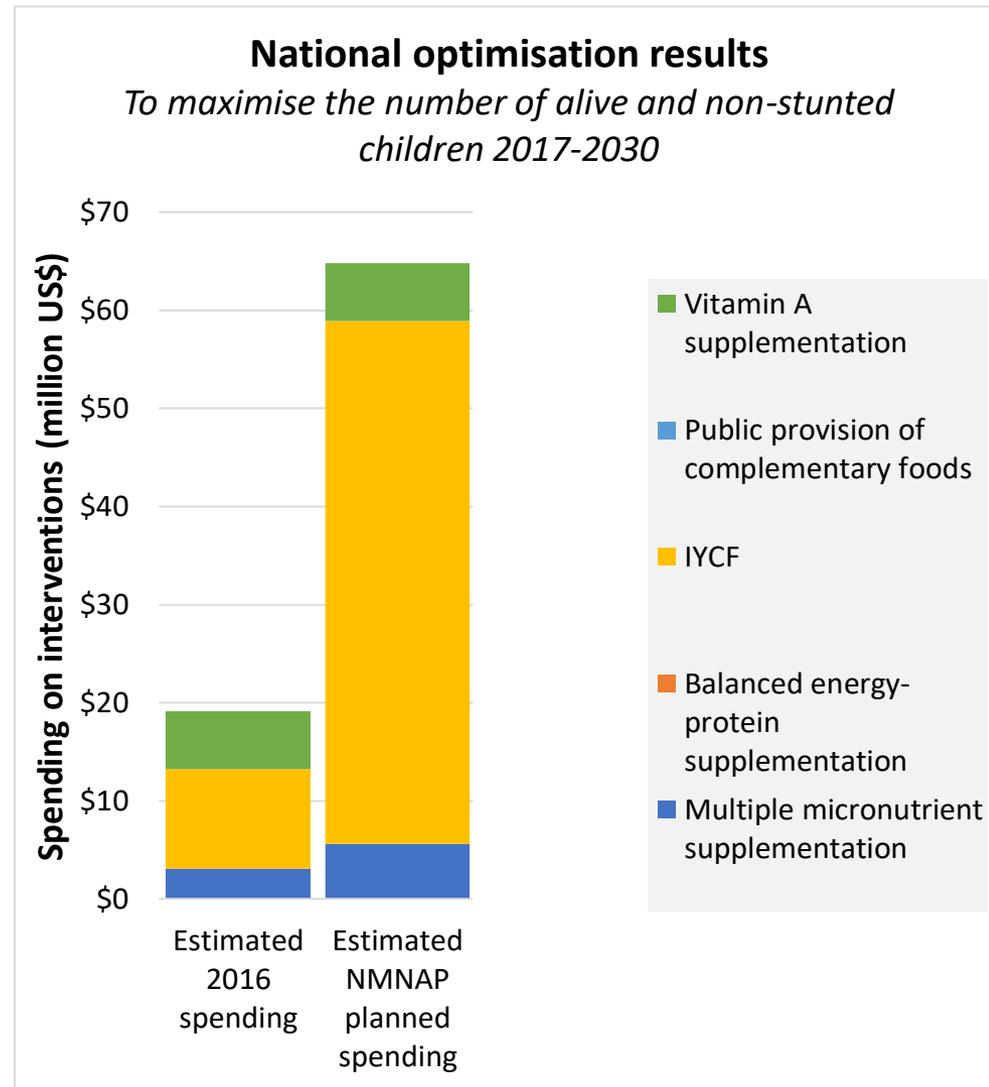
- IYCF (53%)
- Vitamin A supplementation (31%)
- Multiple micronutrient supplementation (pregnant women) (16%)



Tanzania's National Multisectoral Nutrition Action Plan (NMNAP)



- Tanzania's NMNAP includes 2021 national coverage targets:
 - 65% IYCF
 - 58% for micronutrient supplementation (pregnant women)
 - 90% for vitamin A supplementation
- Estimated to cost a total US\$64.8 million per annum
- If maintained to 2030 could result in a cumulative:
 - **949,000 (4.9%) additional alive and non-stunted children**, compared to continued estimated 2016 spending



Optimisation of estimated NMNAP budget

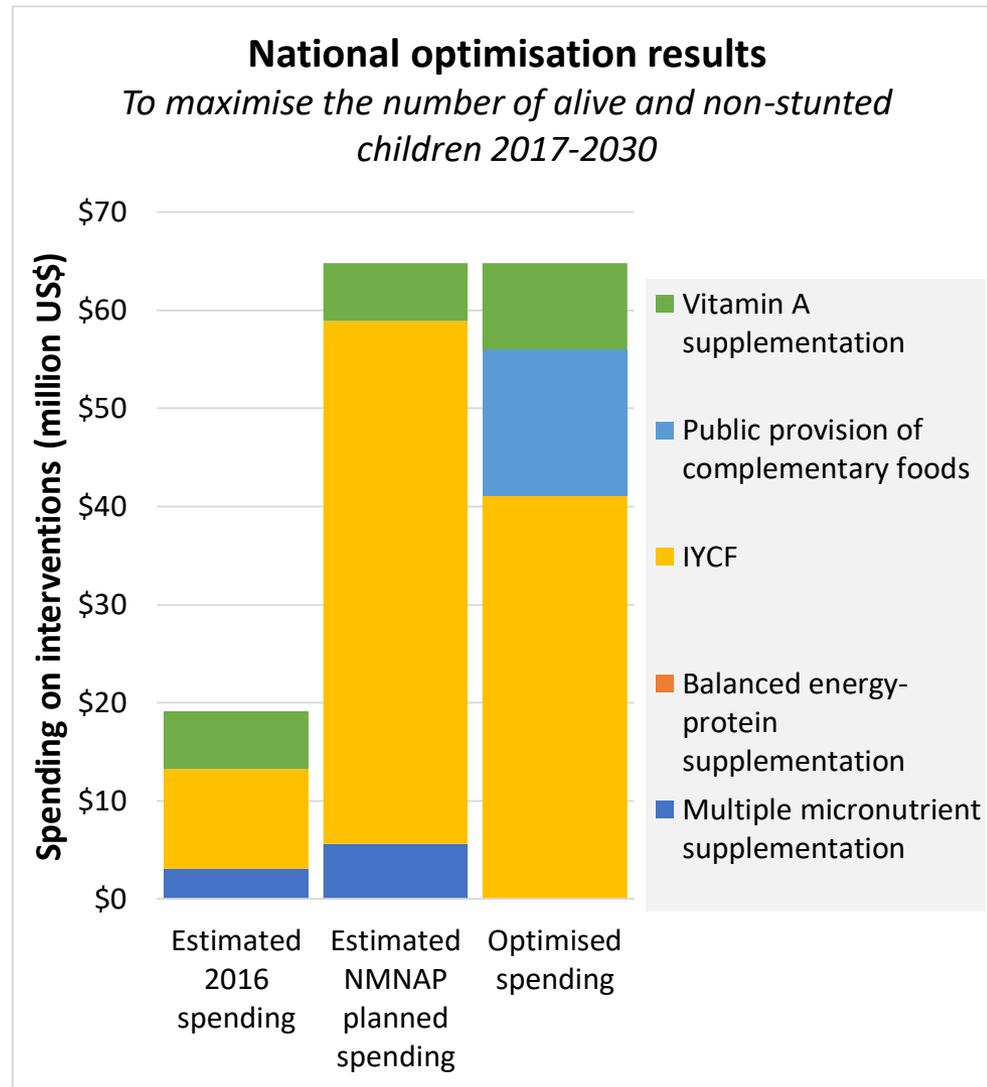


To maximise the number of alive and non-stunted children, funding should be optimally targeted towards:

- IYCF (63%);
- public provision of complementary foods (23%); and
- vitamin A supplementation (14%).

Compared to the NMNAP scenario, optimisation is estimated to:

- **Increase the number of alive, non-stunted children by 192,000 (0.9%)** between 2017 and 2030
- **20% higher impact** than current NMNAP



Exercises



- See worksheet



2018 SKILLS BUILDING PROGRAM

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Modelling wasting using Optima Nutrition

Day 3 – Session 4

In partnership with



Objectives of session

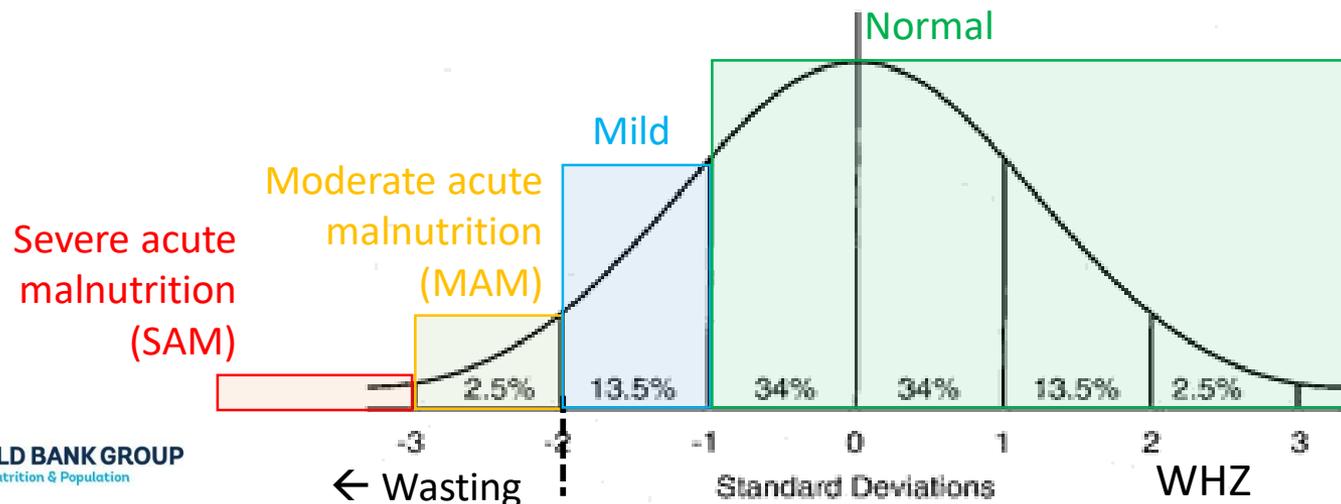


- Previously we covered stunting and stunting interventions in Optima Nutrition.
- This session will cover how wasting is incorporated in Optima Nutrition.
- We will start this module with a presentation and then do some exercises using the Optima Nutrition graphic user interface.
- At the end of this module and exercises you should be able to:
 - Understand the wasting component of the model, including prevention (incidence-reducing) interventions and treatment
 - Compare the impact of prevention and treatment interventions for reducing wasting
 - Understand how adding management of moderate acute malnutrition to a treatment intervention impacts its effects in the model
 - Be able to run budget scenarios in the model

Wasting implementation



- The weight-for-height distribution is tracked for children in each age band
- Split according to weight-for-height Z-scores (WHZ) as four categories (similar to stunting)
 - Categories: severe acute malnutrition [SAM], moderate acute malnutrition [MAM], mild acute malnutrition, normal
 - Wasting considered to be SAM + MAM categories
- Wasting is modelled as an incident (short-duration) condition
 - Independent distributions / burden is allowed for each age group

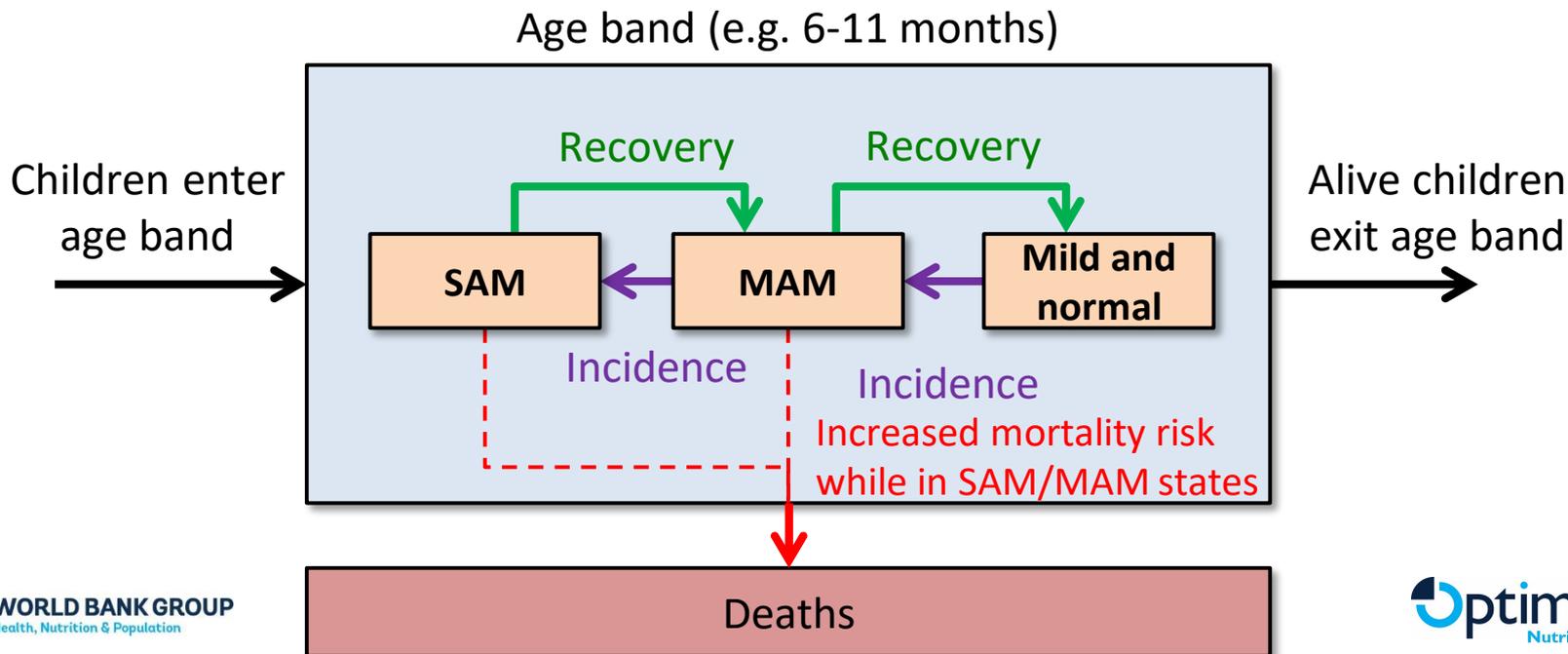


Dynamics of wasting in the model



Wasting is modelled as a short-duration condition

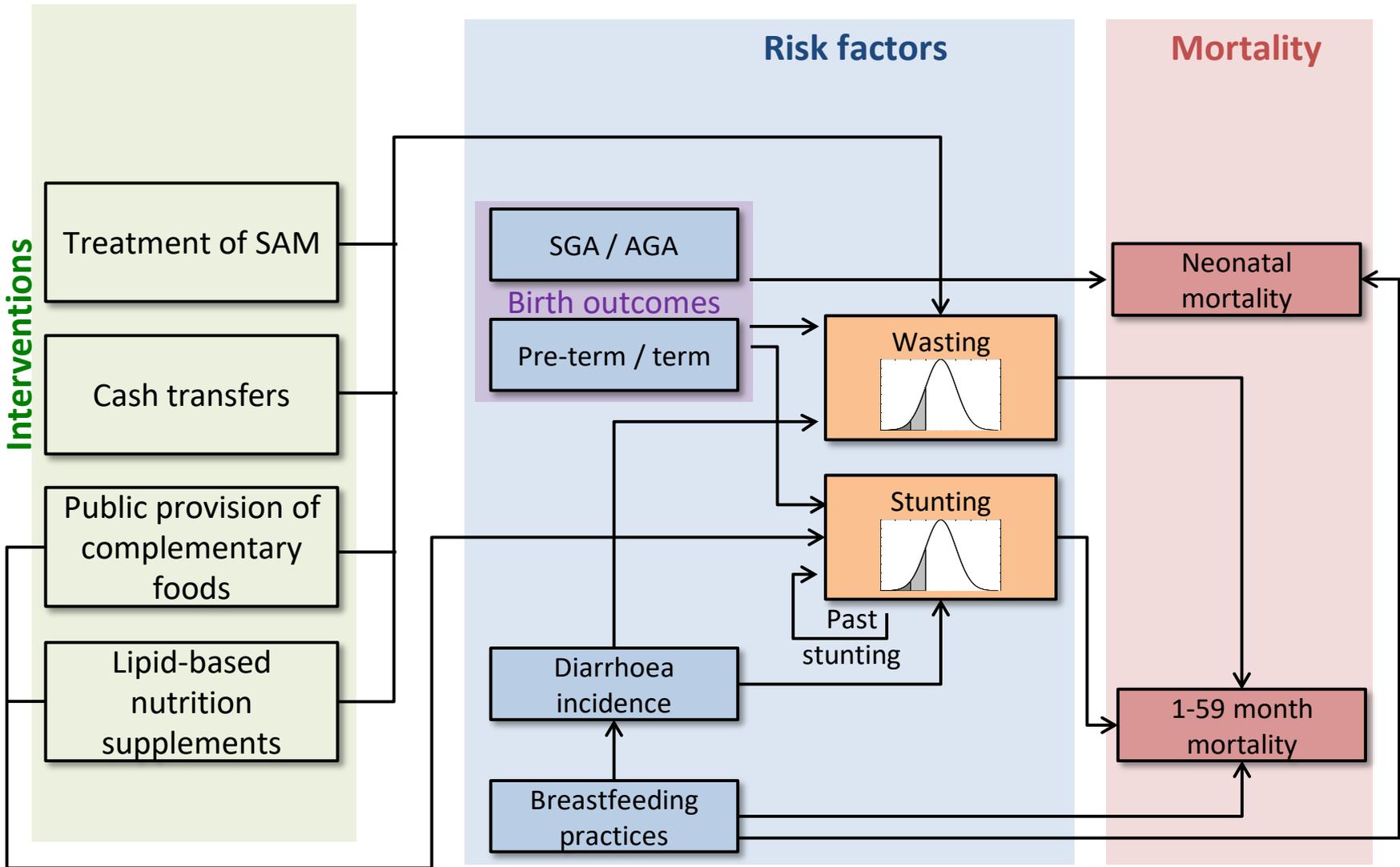
- **Incidence** (purple arrows): children develop SAM/MAM
- **Deaths** (red arrows): children are at greater risk of death while in the SAM/MAM compartments
- **Recovery** (green arrows): scale-up of SAM/MAM treatment reduces the duration spent in those compartments





- **Wasting is a risk factor for several causes of death in children > 1 month:** [Olofin et al. 2013, PLoS One]
 - **Diarrhoea** RRR = 1.60, 3.41, 12.33 for mild, moderate and severe WHZ categories compared to normal
 - **Pneumonia** RRR = 1.92, 4.66, 9.68 for mild, moderate and severe WHZ categories compared to normal
 - **Measles** RRR = 2.58, 9.63 for moderate and severe WHZ categories compared to normal
 - **Other** RRR = 1.65, 2.73, 11.21 for mild, moderate and severe WHZ categories compared to normal
- **Risk factors for wasting are:**
 - **Diarrhoea incidence** OR = 1.025 for every additional episode; assumed the same OR as for stunting, from LiST
 - **Preterm / term and SGA / AGA birth outcomes** OR for wasting =1.65 for pre-term AGA, 2.58 for term SGA, 3.50 for pre-term SGA [Christian et al. 2013, International Journal of Epidemiology]
- **Wasting and stunting modelled as independent**
 - This is the approach taken in LiST

Wasting: risk factors, outcomes and interventions

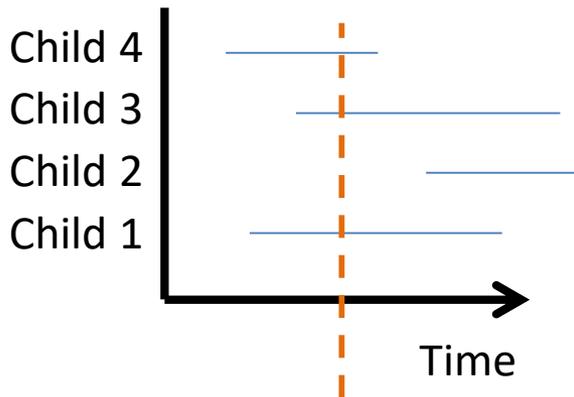


Treatment of wasting reduces episode duration



SAM episodes

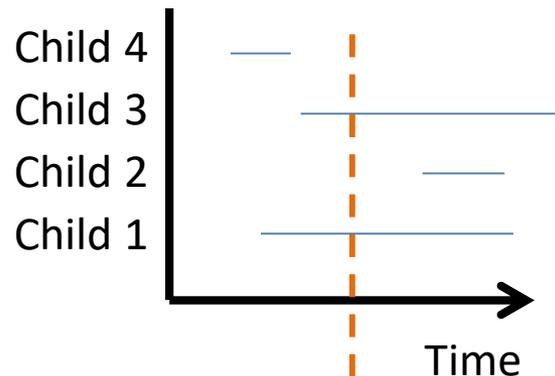
No treatment



Cross-sectional
prevalence
estimate = **75%**

SAM episodes

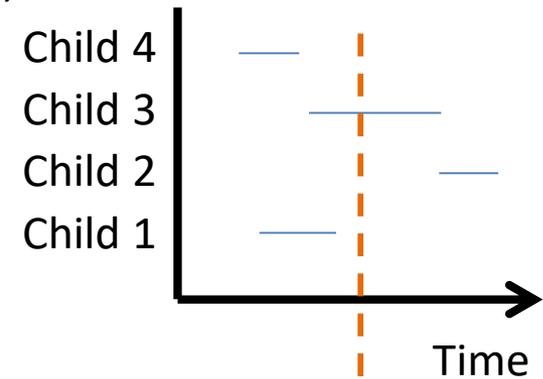
Some treatment (child 2 and 4)



Cross-sectional
prevalence
estimate = **50%**

SAM episodes

All treated



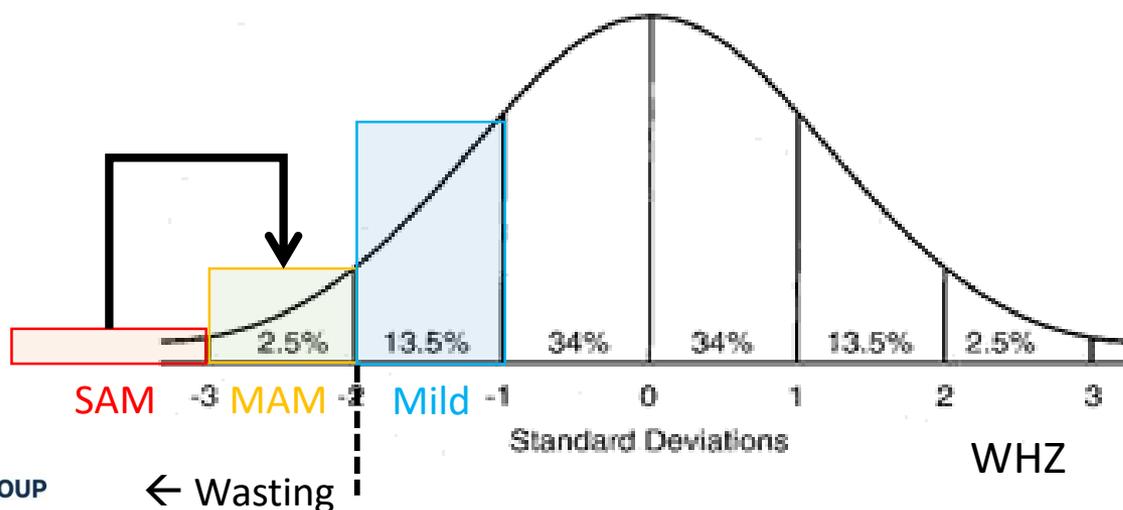
Cross-sectional
prevalence
estimate = **25%**

- Treatment of SAM reduces the duration of the condition Effectiveness = 0.78 for SAM if covered, OR = 0.84 for MAM [Lenters et al. 2013]
- This translates to a reduction in cross-sectional prevalence estimates



Interventions: treatment of SAM

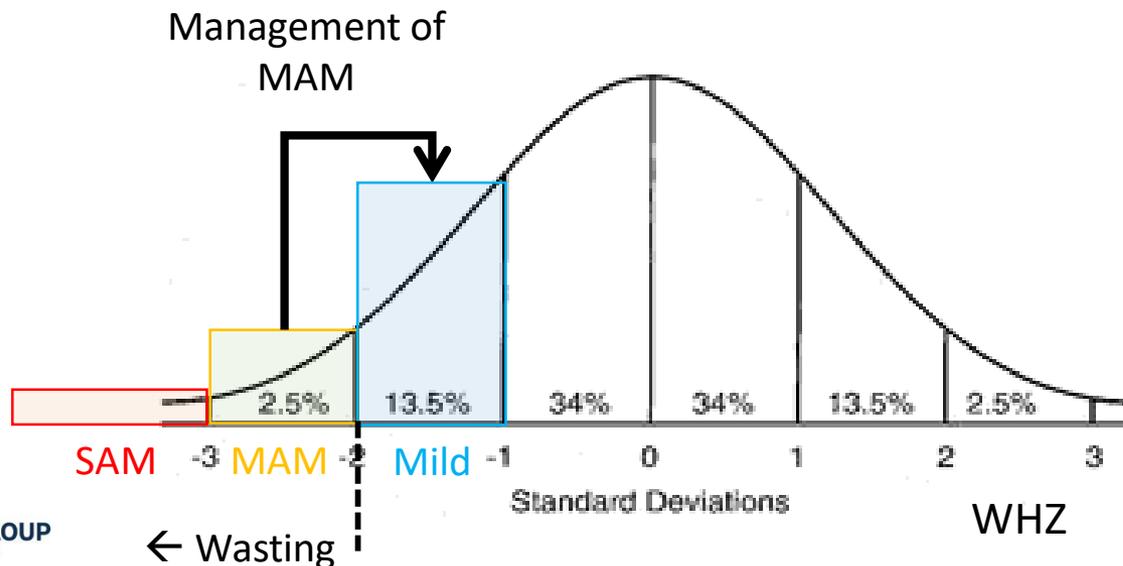
- Treatment of severe acute malnutrition (SAM)
 - Target population is all children experiencing SAM
 - Treated children are moved to the MAM category
- Scaling up treatment of SAM:
 - Increases recovery from SAM Effectiveness on recovery rate = 0.78 [Lenters et al. 2013]
 - Therefore reduces the prevalence of SAM (i.e. RRR= 0.22)
 - Reduces mortality
 - **Increases the prevalence of MAM** (indirectly increases mortality from MAM and incidence of SAM)



Extending treatment of SAM to include MAM



- Scaling up treatment of SAM does not directly reduce wasting prevalence, since children recover to MAM
- The treatment of SAM intervention has an option to include management of MAM.
 - If selected, the treatment intervention will also shift children from MAM to mild
- Note that this will make the cost of the treatment intervention more expensive (by a user defined amount)



Extending treatment of SAM to include multiple delivery modes



- It is also possible to deliver treatment interventions through health facilities only, or health facilities + community.
 - The coverage of health facility delivery is restricted by the fraction of the population who attend health clinics
 - The cost of each delivery mode can be different, based on setting-specific data

	Default	Extension	Add extension
Program	Treatment of SAM	Management of MAM	<input type="text"/>
Delivery mode	Health facility	Community-based	<input type="text"/>

[Save changes](#) [Revert](#) [↓](#) [↑](#)

Wasting prevention interventions



16552

Intervention	Target population	Effects	Source / effect size
Public provision of complementary foods (PPCF)	Children 6-23 months below the poverty line	Reduces the odds of stunting Reduces the incidence of SAM Reduces the incidence of MAM <i>Indirectly reduces SAM mortality</i> <i>Indirectly reduces MAM mortality</i>	Stunting: OR = 0.89 [Bhutta et al. 2008, The Lancet; Imdad et al. 2011, BMC Public Health] SAM / MAM incidence RRR = 0.913 [LiST]
Lipid-based nutrition supplements (LNS)	Children 6-23 months below the poverty line	Similar to PPCF but also impacts anaemia (see next session)	
Cash transfers	All children below the poverty line	Reduces the incidence of SAM Reduces the incidence of MAM <i>Indirectly reduces SAM mortality</i> <i>Indirectly reduces MAM mortality</i>	SAM incidence: RRR = 0.766 for 6-23 months, RRR = 0.792 for 24-59 months [Langendorf et al. 2014, PLoS Med] MAM incidence: RRR = 0.719 for 6-23 months, RRR = 0.792 for 24-59 months [Langendorf et al. 2014, PLoS Med]

Exercises



- See worksheet



2018 SKILLS BUILDING PROGRAM

BIG DATA, ARTIFICIAL INTELLIGENCE AND DECISION SCIENCE IN HEALTH AND NUTRITION

Modelling anaemia using Optima Nutrition Day 3 – Session 5

In partnership with



Objectives of session



- The previous sessions covered how stunting and wasting are modelled in Optima Nutrition.
- This session will cover how anaemia is incorporated in Optima Nutrition.
- We will start this module with a presentation and then do some exercises using the Optima Nutrition graphic user interface.
- At the end of this module and exercises you should be able to:
 - Understand the anaemia component of the model, including additional population groups (women of reproductive age, by age category).
 - Understand different delivery modalities for iron and folic acid supplementation interventions, and different food fortification vehicles
 - Understand the two kinds of intervention dependencies, threshold and exclusion.

Model populations: overview of stratifications



Non-pregnant
women of
Reproductive
Age (WRA)

15 - 19 years	Not anaemic	Anaemic
20 - 24 years	Not anaemic	Anaemic
25 - 29 years	Not anaemic	Anaemic
30 - 39 years	Not anaemic	Anaemic
40 - 49 years	Not anaemic	Anaemic

Pregnant
women

15 - 19 years	Not anaemic	Anaemic
20 - 29 years	Not anaemic	Anaemic
30 - 39 years	Not anaemic	Anaemic
40 - 49 years	Not anaemic	Anaemic

Children

Also stratified by:

- Stunting
- Wasting
- Breastfeeding

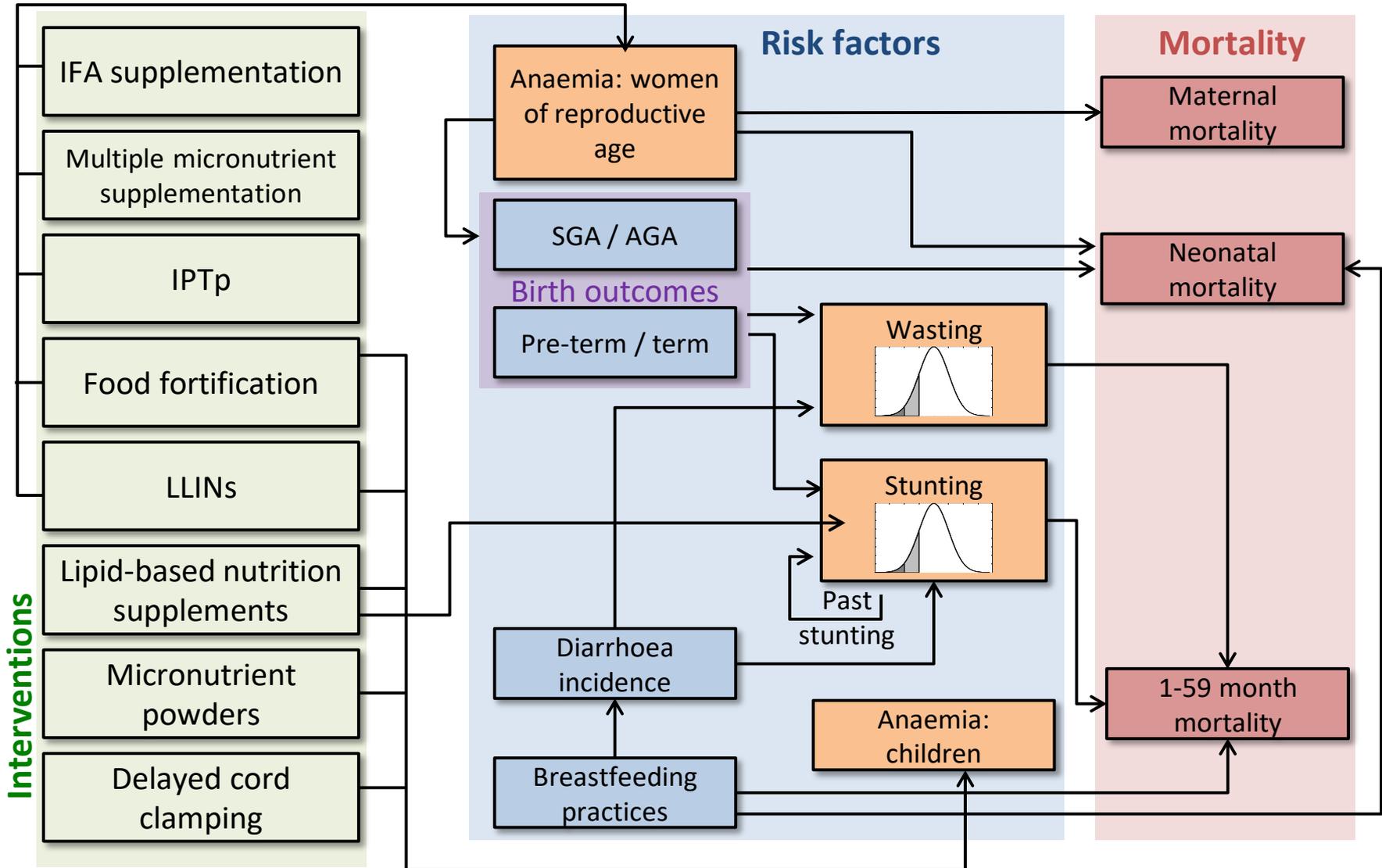
0 - 1 months	Not anaemic	Anaemic
1 - 6 months	Not anaemic	Anaemic
6 - 11 months	Not anaemic	Anaemic
12 - 23 months	Not anaemic	Anaemic
24 - 59 months	Not anaemic	Anaemic

Anaemia: risk factors and effects



- Anaemia in pregnant women is modelled as a risk factor for maternal mortality (haemorrhage)
 - Anaemia increases relative risk of death due to haemorrhage $RRR = 10.675$ antepartum; intrapartum; and postpartum for the estimated fraction who are severely anaemic [LiST]
- Anaemia in pregnant women is modelled to be a risk factor for suboptimal birth outcomes $OR = 1.32$ for pre-term AGA [Xiong et al. 2000, Am J Perinatology]; $OR = 1.53$ for term SGA; $OR = 1.53$ for pre-term SGA [Kozuki et al. 2012, J. Nutrition]
 - This can affect stunting, which in turn can affect mortality in children

Anaemia: risk factors, outcomes and interventions



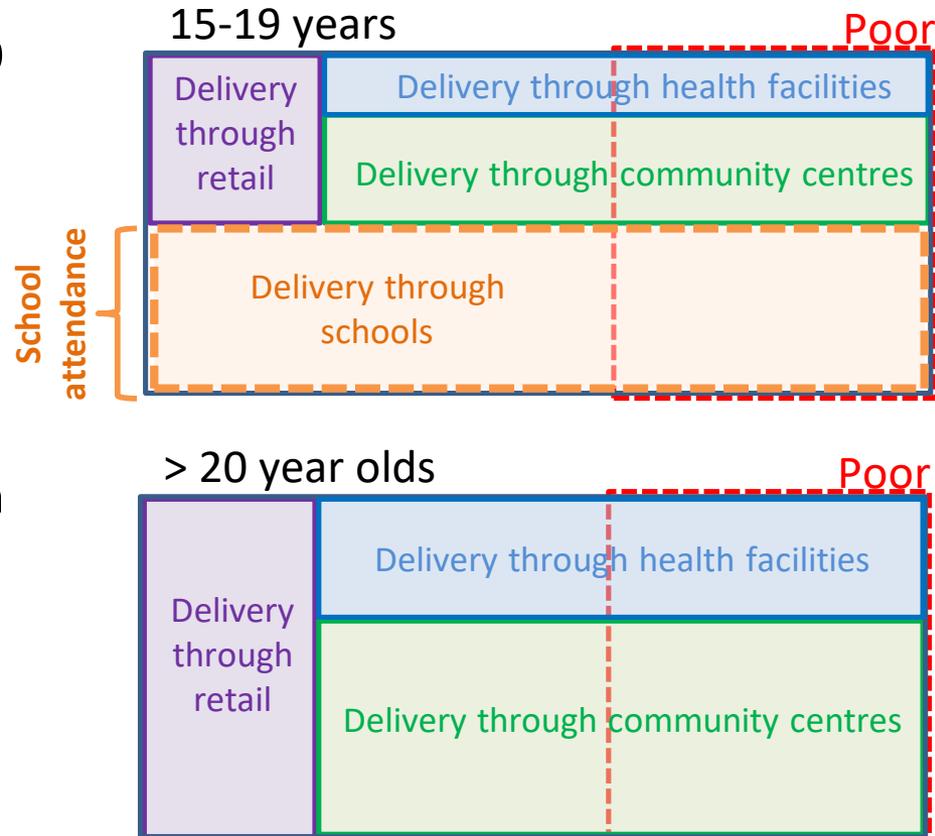
Interventions

IFA supplementation: non-pregnant women of reproductive age



- Delivered through four modalities:
 - Schools (the only modality for 15-19 year olds who attend)
 - Health facilities (available for those not at school and attending health facilities)
 - Community (available for everybody)
 - Retail (only available for the fraction who are not poor)
- The fraction of the population who are likely to access each modality are entered by the user

Target populations



*Coloured areas represent 100% coverage of IFA supplementation through a particular delivery mode.

Anaemia interventions



Intervention	Target population	Effects	Source / effect size
IFA supplementation for pregnant women	Pregnant women. Not given to women receiving MMS	Reduces anaemia Reduces SGA birth outcomes	Anaemia RRR = 0.33 [Pena-Rosas et al, Cochrane Database Reviews 2015] SGA RRR = 0.85 [Pena-Rosas et al, Cochrane Database Reviews 2015]
IFA supplementation for non-pregnant WRA		Reduces anaemia	RRR = 0.73 [Fernandez-Gaxiola & De-Regil 2011, Cochrane Database Syst Rev]
Multiple micronutrient supplementation	Pregnant women	Reduces risk of SGA birth outcomes	RRR = 0.77 [LiST]
IPTp	Pregnant women in areas where there is malaria risk	Reduces anaemia Reduces SGA birth outcomes	Anaemia RRR = 0.83 [Radeva-Petrova et al. 2014, The Cochrane Library] SGA RRR = 0.65 [Eisele et al. 2010, I J Epi]

Anaemia interventions

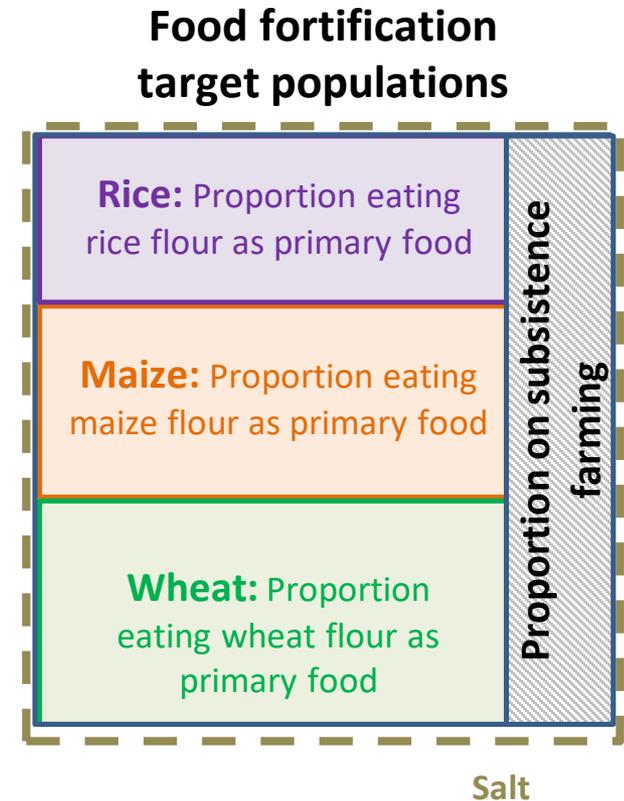


Intervention	Target population	Effects	Source / effect size
Food fortification	Everyone	Reduces anaemia Reduces neonatal mortality	Anaemia OR = 0.976 [RRR = 0.678 Barkley et al. 2015, B J Nutrition] Neonatal mortality RRR = 0.678 [congenital defects; Blencowe et al. 2010, I J Epidemiology]
Long-lasting insecticide-treated bed nets	Everyone in areas where there is malaria risk	Reduces anaemia Reduces SGA birth outcomes	Anaemia RRR = 0.83 [Eisele et al. 2010, Int J Epi] SGA RRR = 0.65 [Eisele et al. 2010, Int J Epi]
Lipid-based nutrition supplements (LNS)	Children 6-23 months below the poverty line	Reduces stunting Reduces incidence of MAM/SAM Reduces anaemia	Stunting OR = 0.89 [assumed the same as PPCF] MAM/SAM incidence RRR = 0.913 [assumed to be the same as PPCF] Anaemia RRR = 0.69 for all-cause anaemia [assumed to be the same as micronutrient powders]
Micronutrient powders	Children 6-59 months, not already receiving LNS	Reduces anaemia	RRR = 0.69 [De-Regil et al. Chochrane review 2013]
Delayed cord clamping	Pregnant women (at birth)	Reduces anaemia	RRR = 0.53 [Hutton and Hassan, 2007 Jama]

Interventions: fortification of foods



- Women of reproductive age (pregnant and non-pregnant) and children >6 months can be impacted by food fortification
- **Fortification with iron and folic acid is modelled as three separate interventions:**
 - Fortification of wheat, rice and maize flour
 - Coverage restricted to fraction who eat each food as their staple, determined from consumption data
 - Does not reach the fraction on subsistence farming
- Double fortification of salt (iron + iodine)
 - Targets entire population



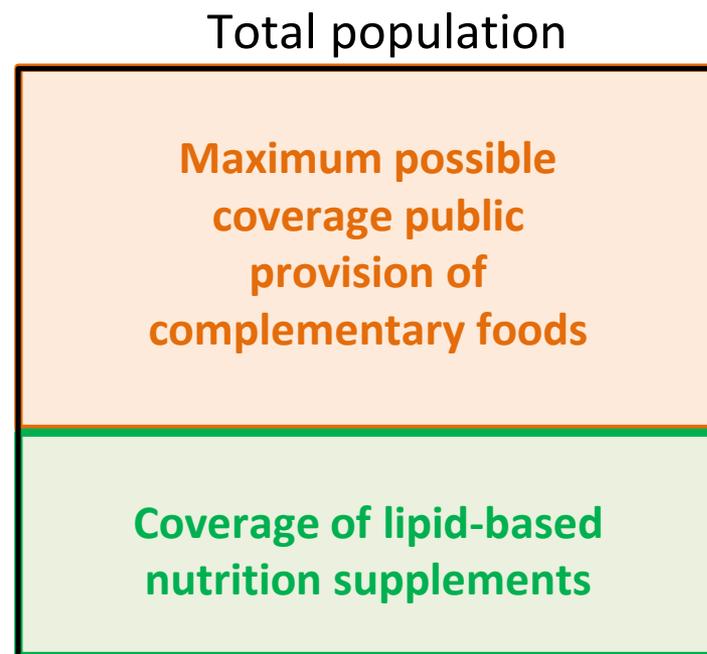
*Coloured areas represent 100% coverage of a particular food fortification.

**Depending on the country, the target population of a particular food vehicle may be zero



Two types of restrictions can be applied to interventions

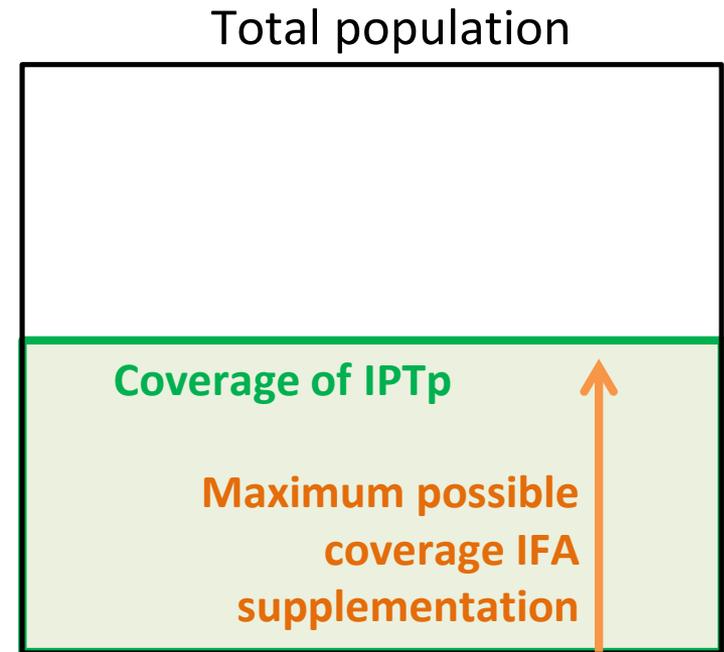
- **Exclusion dependencies**, to prevent interventions from being given simultaneously
- For example, by default the model restricts some interventions so that:
 - Lipid-based nutrition supplements and public provision of complementary foods are not given to the same children
 - IFA supplementation and multiple micronutrient supplementation are not given to the same pregnant women, because they both contain iron
 - Multiple micronutrient powders and lipid-based nutrition supplement are not given to the same children as they both contain iron



Threshold dependencies in the model



- **Threshold dependencies**, where an interventions can only be given at the same time as another.
- For example, it is possible to apply restrictions so that in areas at risk of malaria:
 - IFA supplementation may only be given to pregnant women if they are taking IPTp (WHO recommendation).
 - Micronutrient powders may only be given to children who have a bed net.



Turning dependencies on and off



- Default dependencies are shown below
 - These can be removed by deleting them in the input sheet
 - More dependencies can be added by adding rows to the input sheet

	A	B	C
1	Program	Exclusion dependency	Threshold dependency
2	IFAS for pregnant women (community)	Multiple micronutrient supplementation	
3	IFAS for pregnant women (hospital)	Multiple micronutrient supplementation	
4	Public provision of complementary foods	Lipid-based nutrition supplements	
5	Micronutrient powders	Lipid-based nutrition supplements	
6			
7			
8			
9			
10			

Ready | Treatment of SAM | Programs cost and coverage | IYCF cost | **Program dependencies** | Incidence of conditions | P

Exercises



- See worksheet



2018 SKILLS BUILDING PROGRAM

BIG DATA, ARTIFICIAL INTELLIGENCE AND DECISION SCIENCE IN HEALTH AND NUTRITION

Nutrition-sensitive interventions Family planning, WASH

Day 4 – Session 1

In partnership with



Objectives of session

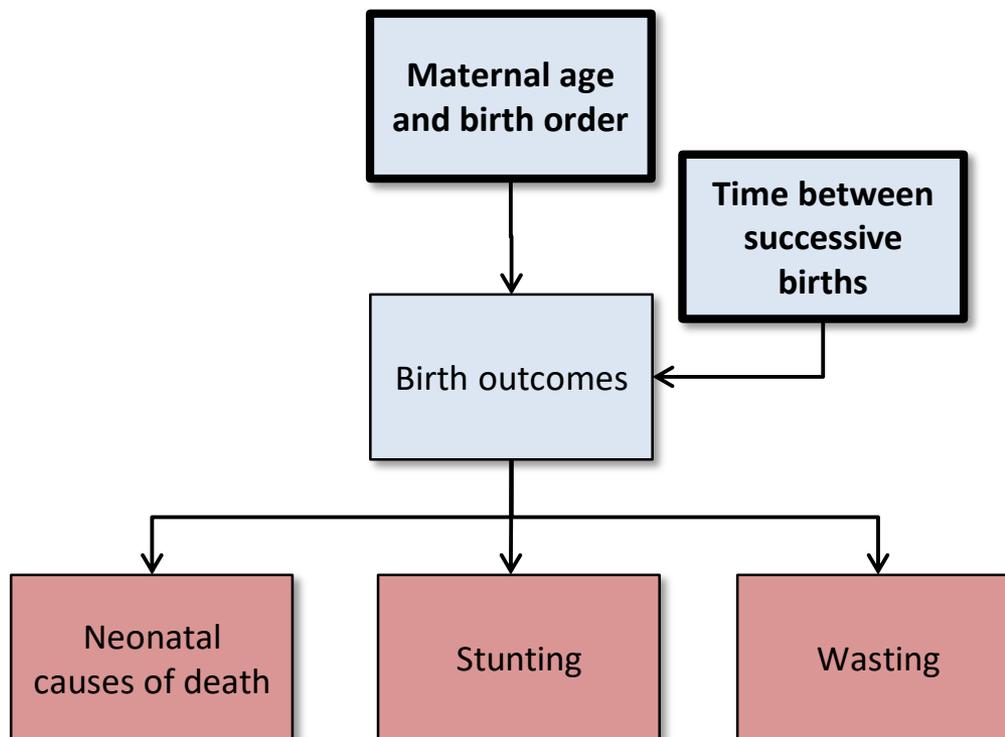


- The previous sessions have covered Optima Nutrition's main outcomes (stunting, wasting and anaemia).
- This session will cover:
 - Family planning and WASH interventions
 - Any supplement interventions that have not been covered in previous sessions
- We will start this module with a presentation and then do some exercises using the Optima Nutrition graphic user interface
- At the end of this module and exercises you should be able to:
 - Understand how to interpret model outcomes associated with family planning (specifically its impact on mortality rather than mortality rates)
 - Understand how family planning impacts birth outcomes through birth spacing
 - Change default parameter values in the model

Fertility risks



- Maternal age, birth order and time between successive births impact on birth outcomes
 - *Note: birth outcomes are also influenced by anaemia prevalence and the coverage of supplementation interventions in pregnant women*
- This impacts stunting, wasting and mortality





Illustrates that children have a greater risk of being pre-term or SGA:

- If they are the first child
- Their mother is <18 years
- They are born within 18 months of an older sibling

Relative risks of birth outcomes for age, birth order and birth spacing

Age and birth order	Pre-term SGA RR	Pre-term AGA RR	Term SGA RR
<u>Less than 18 years</u>			
First birth	3.14	1.75	1.52
Second and third births	1.6	1.4	1.2
Greater than third birth	1.6	1.4	1.2
<u>18 - 34 years old</u>			
First birth	1.73	1.75	1.52
Second and third births	1	1	1
Greater than third birth	1	1	1
<u>35 - 49 years old</u>			
First birth	1.52	1.75	1.52
Second and third births	1	1.33	1
Greater than third birth	1	1.33	1
<u>Birth intervals^a</u>			
First birth	1	1	1
less than 18 months	3.03	1.49	1.41
18-23 months	1.77	1.1	1.18
24 months or greater	1	1	1

How family planning works



- When family planning services are scaled up this decreases the number of projected births
 - Expanded services are restricted by unmet need
- Having fewer births means that the total number of the following will decrease:
 - unfavorable birth outcomes
 - total number of non-stunted children reaching age 5
 - total number of maternal and child deaths
- Family planning also decreases the odds of suboptimal birth spacing OR = 0.66 of of women without contraception achieving 24 months or greater birth spacing [de Bocanegra et al. 2014]
- There is a need to be cautious because family planning can radically reduce the number of stunted children (but only has a small and indirect impact on stunting prevalence)



- Five WASH interventions are available in the model:
 1. Improved water source
 2. Piped water
 3. Improved sanitation
 4. Hygienic disposal of stools
 5. Handwashing with soap
- Evidence on the effectiveness of these interventions is mixed and unclear, in particular given some recent large studies
 - WASH Benefits (Bangladesh and Kenya) and SHINE (Zimbabwe)

WASH Benefits and SHINE studies



- **The WASH Benefits study** (Bangladesh^a, N=5551 and Kenya^b, N=8426) compared diarrhoea and stunting between a control group and groups with:
 1. Chlorinated drinking water: no effect on diarrhoea or stunting
 2. Upgraded sanitation: diarrhoea prevalence ratio 0.61 in Bangladesh, no effect in Kenya; no effect on stunting
 3. Promotion of handwashing with soap: diarrhoea prevalence ratio 0.60 in Bangladesh, no effect in Kenya; no effect on stunting
- **The SHINE study** (Zimbabwe^c, N=5280) compared diarrhoea, stunting, anaemia and mortality between a control group and groups with:
 - WASH (treated water, latrines, handwashing facilities + promotion, hygienic disposal of stools): no effect on diarrhoea, stunting, anaemia, mortality
 - IYCF (breastfeeding promotion, complementary feeding education, provision of Nutributter): reduction in stunting and anaemia, no impact on diarrhoea and mortality

^aLuby et al. Lancet Glob Health 2018; ^bNull et al. Lancet Glob Health 2018

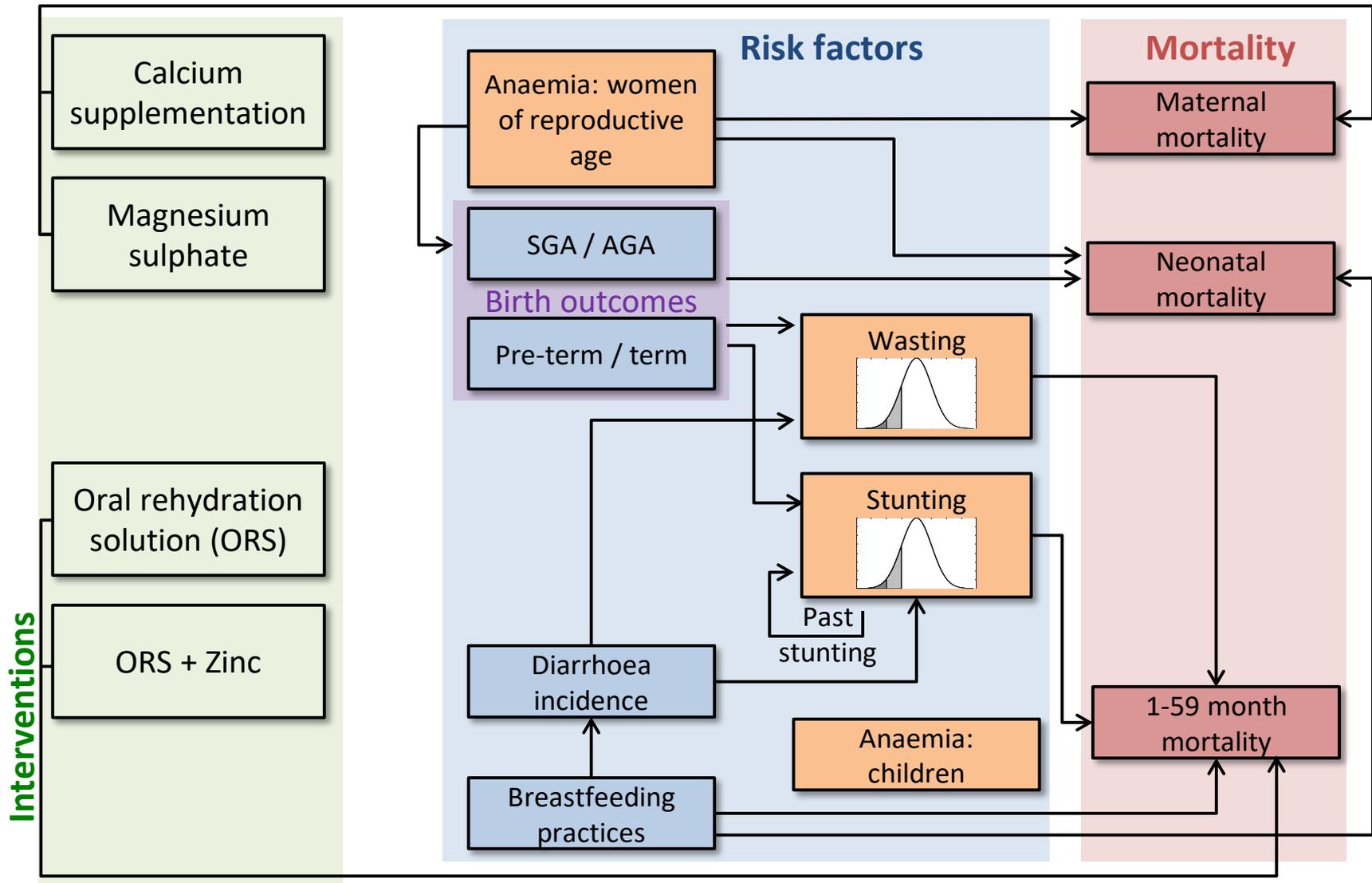
^cThe Sanitation Hygiene Infant Nutrition Efficacy Trial team. Clinical Inf Dis. 2017



For all five WASH interventions:

- Target population is all children (0-59 months)
- Interventions can be set to reduce diarrhoea incidence
- The current effect size estimates have been set to 1 (no effect);
 - This can be adjusted by users based on local evidence (see exercises).
- **Coverage of WASH interventions are assumed to not decrease** (i.e. funding cannot be removed and invested in other interventions)

Other supplement and diarrhoea interventions



Other supplement and diarrhoea interventions



16552

Intervention	Target population	Effects	Source / effect size
Oral rehydration salts (ORS)	Children 0-59 months (different quantity by age)	Reduces diarrhoea mortality	RRR = 0.18 [Munos, et al. 2010, I J Epi; Walker & Black 2010, I J Epi]
ORS + Zinc	Children 0-59 months (different quantity by age)	Reduces diarrhoea mortality	RRR = 0.14 [Munos, et al. 2010, I J Epi; Walker & Black 2010, I J Epi]
Calcium supplementation	Pregnant women	Reduces maternal mortality (hypertensive disorders) Reduces pre-term births	Mortality RRR = 0.80 [Ronsmans et al. 2011, BMC Public Health] Pre-term RRR = 0.78 [Imdad et al. 2011, BMC Public Health]
MgSO4 for pre-eclampsia / eclampsia	Pregnant women	Reduces maternal mortality (hypertensive disorders)	RRR = 0.41 [Ronsmans et al. 2011, BMC Public Health]

Exercises



- See worksheet



2018 SKILLS BUILDING PROGRAM

BIG DATA, ARTIFICIAL INTELLIGENCE AND DECISION SCIENCE IN HEALTH AND NUTRITION

The data input book: common data sources and model inputs

Day 4 – Session 2

In partnership with



Objectives of session



- The previous sessions have covered how interventions and outcomes are modelled in Optima Nutrition
- This session will cover how data is gathered, stored and used as inputs for a given setting
- At the end of this module and exercises you should:
 - Be familiar with the data inputs workbook. In particular, why each piece of data is relevant and where it is typically available from.
 - Be able to source appropriate data and fill out a workbook for a particular country. This can be challenging as often some of the data needs to be interpreted.
 - Make basic assumptions where data is missing or needs interpretation

Summary of data input tabs



- The model uses an Excel book to store all of the data inputs
- A template can be downloaded from the GUI
- The input book consists of tabs for:
 - Population inputs in a baseline year
 - Demographic projections
 - Mortality by cause
 - Nutritional status (stunting, wasting and anaemia status by age group)
 - Breastfeeding behaviours
 - Fertility risks (age of birth and birth order data)
- These data can be obtained from commonly available sources (largely DHS reports, shown in next slides) and are important for calibrating to the baseline characteristics of the setting being modelled.



Population inputs tab

Population inputs include some miscellaneous data, usually obtained from Demographic and Health Surveys (DHS), Multiple Indicator Cluster Surveys (MICS), or other population surveys.

- Poverty, school and health facility attendance, unmet need for family planning:
 - Important for defining the target populations and possible coverage of interventions
 - **Common source: DHS/MICS reports**

	A	B	C
1	Baseline year data		
2	Projection years		
3		Baseline year (projection start year)	2017
4		End year	2030
5			
6	Population data		
7		Percentage of population food insecure (default poor)	28%
8		Percentage of population at risk of malaria	100%
9		School attendance (percentage of 15-19 year women)	23%
10		Percentage of pregnant women attending health facility	51%
11		Percentage of children attending health facility	37%
12		Unmet need for family planning	22%
13			

Population inputs tab



- Food habits:
 - Important for defining the possible coverage / impact of food fortification interventions
 - **Common source: DHS/MICS reports, other consumption surveys**
- Birth age and spacing:
 - Important for the family planning module
 - **Common source: DHS/MICS reports**

13			
14	Food		
15		Fraction of subsistence farming	30%
16		Fraction eating rice as main staple food	0%
17		Fraction eating wheat as main staple food	0%
18		Fraction eating maize as main staple food	80%
19		Fraction on other staples as main staple food	20%
20			
21	Age distribution of pregnant women		
22		Percentage of pregnant women 15-19 years	13%
23		Percentage of pregnant women 20-29 years	45%
24		Percentage of pregnant women 30-39 years	33%
25		Percentage of pregnant women 40-49 years	9%
26			
27	Birth spacing		
28		First birth	20.8%
29		less than 18 months	63.7%
30		18-23 months	11.9%
31		24 months or greater	3.6%
32		<i>Total (must be 100%)</i>	100%
33			
34	Baseline year mortality and risk factors		
<div style="display: flex; justify-content: space-between;"> ⏪ ⏩ Baseline year population inputs Demographic projections </div>			

Population inputs tab



- Mortality rates, birth outcome distributions, and diarrhoea incidence:
 - Important for calibrating the model to the underlying determinants of malnutrition
 - **Common source: DHS/MICS reports**

	A	B	C
34	Baseline year mortality and risk factors		
35	Mortality		
36		Neonatal mortality (per 1,000 live births)	25
37		Infant mortality (per 1,000 live births)	43
38		Under 5 mortality (per 1,000 live births)	67
39		Maternal mortality (per 1,000 live births)	4.01
40		Fraction of pregnancies ending in spontaneous abortion	13%
41		Stillbirths (per 1,000 total births)	22.4
42			
43	Birth outcome distribution		
44		Pre-term SGA	3%
45		Pre-term AGA	11%
46		Term SGA	37%
47		Term AGA	50%
48			
49	Diarrhoea incidence		
50		Average episodes per year: <1 month	1.66
51		Average episodes per year: 1-5 months	1.66
52		Average episodes per year: 6-11 months	5.64
53		Average episodes per year: 12-23 months	5.43
54		Average episodes per year: 24-59 months	1.91
55			
56	Other risks		
57		Percentage of diarrhea that is severe	20%
58		Percentage of anaemia that is iron deficient	42%
59			
60			
61			
62			
63			
64			
65			



Demographic data tab

- Demographic data is required to project the expected number of births and changes in the number of women of reproductive age
- This is important to inform projections of number of deaths (and other outcomes)
 - **Common source: UN population division (<https://esa.un.org/unpd/wpp/>), national population projections**

	A	B	C	D	E	F	G	H	I	J
1	year	Number of births	Children under 5	WRA: 15-19 years	WRA: 20-29 years	WRA: 30-39 years	WRA: 40-49 years	Total WRA	Estimated pregnant women	non-pregnant WRA
2	2017	2,110,000	9,862,402	3,032,037	4,756,743	3,406,589	2,174,712	13,370,081	2,480,859	10,889,222
3	2018	2,150,000	10,050,371	3,164,674	4,882,700	3,520,083	2,275,309	13,842,766	2,527,889	11,314,877
4	2019	2,200,000	10,237,786	3,296,354	5,018,666	3,634,703	2,379,017	14,328,740	2,586,677	11,742,063
5	2020	2,240,000	10,438,537	3,418,969	5,168,014	3,750,324	2,484,409	14,821,716	2,633,708	12,188,008
6	2021	2,280,000	10,636,534	3,532,758	5,332,455	3,869,436	2,592,003	15,326,652	2,680,738	12,645,914
7	2022	2,330,000	10,854,967	3,637,390	5,508,952	3,990,560	2,701,259	15,838,161	2,739,526	13,098,635
8	2023	2,380,000	11,089,897	3,737,403	5,696,990	4,112,898	2,811,667	16,358,958	2,798,314	13,560,644
9	2024	2,420,000	11,331,595	3,840,674	5,895,615	4,235,117	2,922,818	16,894,224	2,845,345	14,048,879
10	2025	2,480,000	11,574,198	3,951,644	6,103,745	4,356,516	3,034,340	17,446,245	2,915,891	14,530,354
11	2026	2,530,000	11,838,769	4,065,313	6,319,831	4,477,188	3,144,612	18,006,944	2,974,679	15,032,265
12	2027	2,580,000	12,092,177	4,185,562	6,545,116	4,597,739	3,255,252	18,583,669	3,033,467	15,550,202
13	2028	2,630,000	12,338,218	4,309,237	6,776,307	4,722,286	3,366,750	19,174,580	3,092,255	16,082,325
14	2029	2,690,000	12,584,924	4,430,738	7,008,703	4,856,898	3,479,917	19,776,256	3,162,801	16,613,455
15	2030	2,740,000	12,839,335	4,546,624	7,239,465	5,005,361	3,595,278	20,386,728	3,221,589	17,165,139
16										
17										
18										
19										
20										
21										
22										

Causes of death tab



- Fraction of mortality attributable to various causes:
 - Important to appropriately model the impact of interventions
 - For example, ORS + Zinc lowers the relative risk of diarrhoea mortality, and so the model only applies this to the fraction of diarrhoea-attributable deaths.
 - **Common source: the Global Burden of Disease (GBD) project**
 (<http://apps.who.int/gho/data/node.main.ghe3002015-by-country?lang=en>), national bureau of statistics

	A	B	C	D	E	F
1	Percentage of deaths in baseline year (2017) attributable to cause	<1 month	1-5 months	6-11 months	12-23 months	24-59 months
2	Neonatal diarrhoea	0.27%	0	0	0	0
3	Neonatal sepsis	19.66%	0	0	0	0
4	Neonatal pneumonia	6.21%	0	0	0	0
5	Neonatal asphyxia	29.29%	0	0	0	0
6	Neonatal prematurity	24.71%	0	0	0	0
7	Neonatal tetanus	0.48%	0	0	0	0
8	Neonatal congenital anomalies	13.20%	0	0	0	0
9	Neonatal other	6.18%	0	0	0	0
10	Diarrhoea	0	13.68%	13.68%	13.68%	13.68%
11	Pneumonia	0	20.66%	20.66%	20.66%	20.66%
12	Meningitis	0	2.11%	2.11%	2.11%	2.11%
13	Measles	0	0.75%	0.75%	0.75%	0.75%
14	Malaria	0	8.62%	8.62%	8.62%	8.62%
15	Pertussis	0	2.86%	2.86%	2.86%	2.86%
16	AIDS	0	1.53%	1.53%	1.53%	1.53%
17	Injury	0	13.59%	13.59%	13.59%	13.59%
18	Other	0	36.20%	36.20%	36.20%	36.20%
19	Antepartum haemorrhage	0	0	0	0	0
20	Intrapartum haemorrhage	0	0	0	0	0
21	Postpartum haemorrhage	0	0	0	0	0
22	Hypertensive disorders	0	0	0	0	0
23	Sepsis	0	0	0	0	0
24	Abortion	0	0	0	0	0
25	Embolic	0	0	0	0	0
	Other direct causes	0	0	0	0	0



- Stunting, wasting and anaemia status:
 - Important for setting up background risks, in the absence of any changes to interventions.
 - It is important that these are entered for each age group due to the chronic nature of stunting*. For example, it would be typical for the prevalence of stunting to increase from younger to older age bands.
 - **Common source: DHS reports**

	A	B	C	D	E	F	G
1	Percentage of population in each category in baseline year (2017)	Status	<1 month	1-5 months	6-11 months	12-23 months	24-59 months
2	Stunting (height-for-age)	Normal (HAZ-score > -1)	54.5%	54.5%	45.0%	24.5%	23.3%
3		Mild (HAZ-score between -2 and -1)	32.2%	32.2%	35.9%	37.7%	37.4%
4		Moderate (HAZ-score between -3 and -2)	8.7%	8.7%	13.4%	24.7%	25.9%
5		High (HAZ-score between < -3)	4.6%	4.6%	5.7%	13.2%	13.4%
6							
7							
8	Wasting (weight-for-height)	Normal (WHZ-score > -1)	62.4%	62.4%	68.4%	73.2%	81.2%
9		Mild (WHZ-score between -2 and -1)	28.2%	28.2%	24.7%	21.5%	15.8%
10		MAM (WHZ-score between -3 and -2)	5.4%	5.4%	5.4%	4.3%	2.2%
11		SAM (WHZ-score < -3)	4.0%	4.0%	1.6%	1.0%	0.7%
12							
13	Anaemia		<1 month	1-5 months	6-11 months	12-23 months	24-59 months PW:
14		Prevalence of anaemia	10.0%	10.0%	78.1%	73.0%	48.4%
15		Prevalence of iron deficiency anaemia	4.2%	4.2%	32.8%	30.6%	20.3%
16							
17							

Ready | Nutritional status distribution | Breastfeeding distribution | Time trends | TYCF packages | Treatment of SAM | Programs cost and coverage | TYCF cost | Program

* Note that age-specific prevalence often needs to be recalculated because Optima uses smaller age bands than those commonly reported in DHS reports.

Breastfeeding distribution tab



- Breastfeeding distributions:
 - Important for capturing the impact of IYCF interventions
 - **Common source: DHS reports**
- Breastfeeding practice indicators available in DHS by age group:
 - Exclusive
 - Breastfeeding + liquids = predominant
 - Breastfeeding + solids = partial
 - None

	A	B	C	D	E	F	G
1	Percentage of children in each category in baseline year (2017)	Status	<1 month	1-5 months	6-11 months	12-23 months	24-59 months
2	Breastfeeding	Exclusive	84.0%	44.3%	1.4%	0.0%	0.0%
3		Predominant	9.2%	21.7%	3.3%	0.1%	0.0%
4		Partial	5.8%	31.6%	93.5%	72.1%	0.0%
5		None	1.0%	2.4%	1.9%	27.8%	100.0%
6							
7							
8							
9							
10							

Ready | Breastfeeding distribution | Time trends | IYCF packages | Treatment of SAM | Programs cost and coverage | IYCF cost | Program d | 115%

Exercises



- See worksheet



2018 SKILLS BUILDING PROGRAM

BIG DATA, ARTIFICIAL INTELLIGENCE AND DECISION SCIENCE IN HEALTH AND NUTRITION

Interpreting the data: costs and cost-coverage relationship

Day 4 – Session 3

In partnership with



Objectives of session



- The previous session covered where population and malnutrition data come from and how they are stored in Optima Nutrition
- This session will cover the relationship between intervention cost and coverage in the model, and some of the assumptions that are required
- At the end of this module you should be able to make reasonable assumptions to estimate the unit cost of interventions

How much do things cost?



- Delivering an intervention to someone requires many different types of costs:
 - Commodity costs
 - Logistics and transport costs
 - Staff costs
 - Equipment costs
 - Infrastructure costs
 - Program management costs

Definition of costs:

- The *unit cost* of an intervention is defined as
 - total intervention cost divided by the number of people covered at a specific coverage level
 - Total cost/number of people covered
 - E.g. $\$100/10 = \10 unit cost
- The *marginal cost* of an intervention is defined as
 - cost of covering one more person

The cost of expanding interventions



- The cost of expanding the coverage of interventions may not be linear. It may depend on the coverage level from which we start:
 - Economies of scale can reduce the cost as interventions expand
 - The need for additional infrastructure can increase the cost as interventions expand
 - Saturation coverage as it becomes more difficult to reach the final few, and demand generation activities may be required
- Optima allows users to specify interventions with costs that vary depending on coverage
- We generally expect increasing marginal costs as interventions expand coverage to increasingly hard to reach populations [saturation]

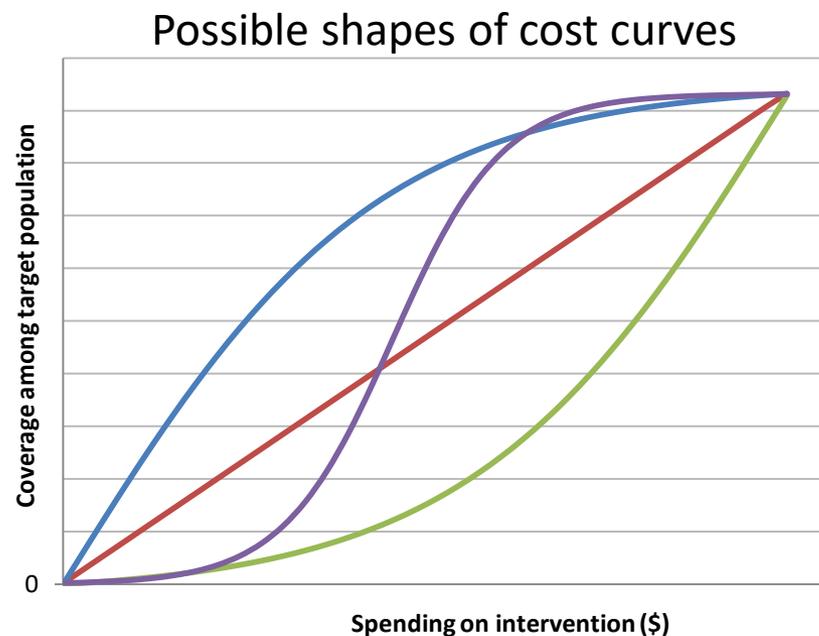


- Ideally, data would be available for several (total budget, total people reached) observations at different levels of funding:
 - This could be used to fit a curve
 - In nutrition, this information is rarely available, so assumptions need to be made
- Typically calculate a single “unit cost”, which includes a measure of the coverage of an intervention and the total cost at the base point in time.

Cost-coverage curves



- The model can use a variety of shapes of cost-coverage curve
- Possible options include:
 - Constant marginal costs (red)
 - Increasing marginal costs (blue, current)
 - Decreasing marginal costs (green)
 - Logistic (purple)
- Default curves are likely to be **constant** or **increasing** marginal costs





- Suggested currency (for consistency): USD
 - Any currency can be used, inform modelling team of currency used, consistently use the same currency across the entire project
- Model does not apply inflation or discounting
 - These adjustments to spending output can be made outside the model

Exercises



- See worksheet



2018 SKILLS BUILDING PROGRAM

BIG DATA, ARTIFICIAL INTELLIGENCE AND DECISION SCIENCE IN HEALTH AND NUTRITION

Optimization and the objective function

Day 4 – Session 4

In partnership with



Objectives of session



- The previous sessions have covered the model inputs, model structure and model outputs, including running scenario analyses using the graphical user interface.
- This session will cover how the model can be used for optimisation
- We will start this module with a presentation and then do some exercises using the Optima Nutrition graphic user interface
- At the end of this module and exercises you should be able to:
 - Understand how the choice of the objective function can produce different, and sometimes conflicting outcomes
 - Run optimisations with multiple objective functions to identify:
 - Which interventions regularly appear in the mix
 - Which interventions never do
 - Generate policy recommendations based on optimisation results

How the optimisation algorithm works



- When the model is run for a given amount of money spent on each intervention, it produces a collection of outcomes for:
 - Number of deaths
 - Number of stunted children leaving the model (i.e. turning age 5)
 - Stunting, wasting and anaemia prevalence among children at the end of the projection period
 - Anaemia prevalence among pregnant women and women of reproductive age
 - Number of maternal deaths
- When the model is run with a different allocation of funding, it will produce different set of outcomes.



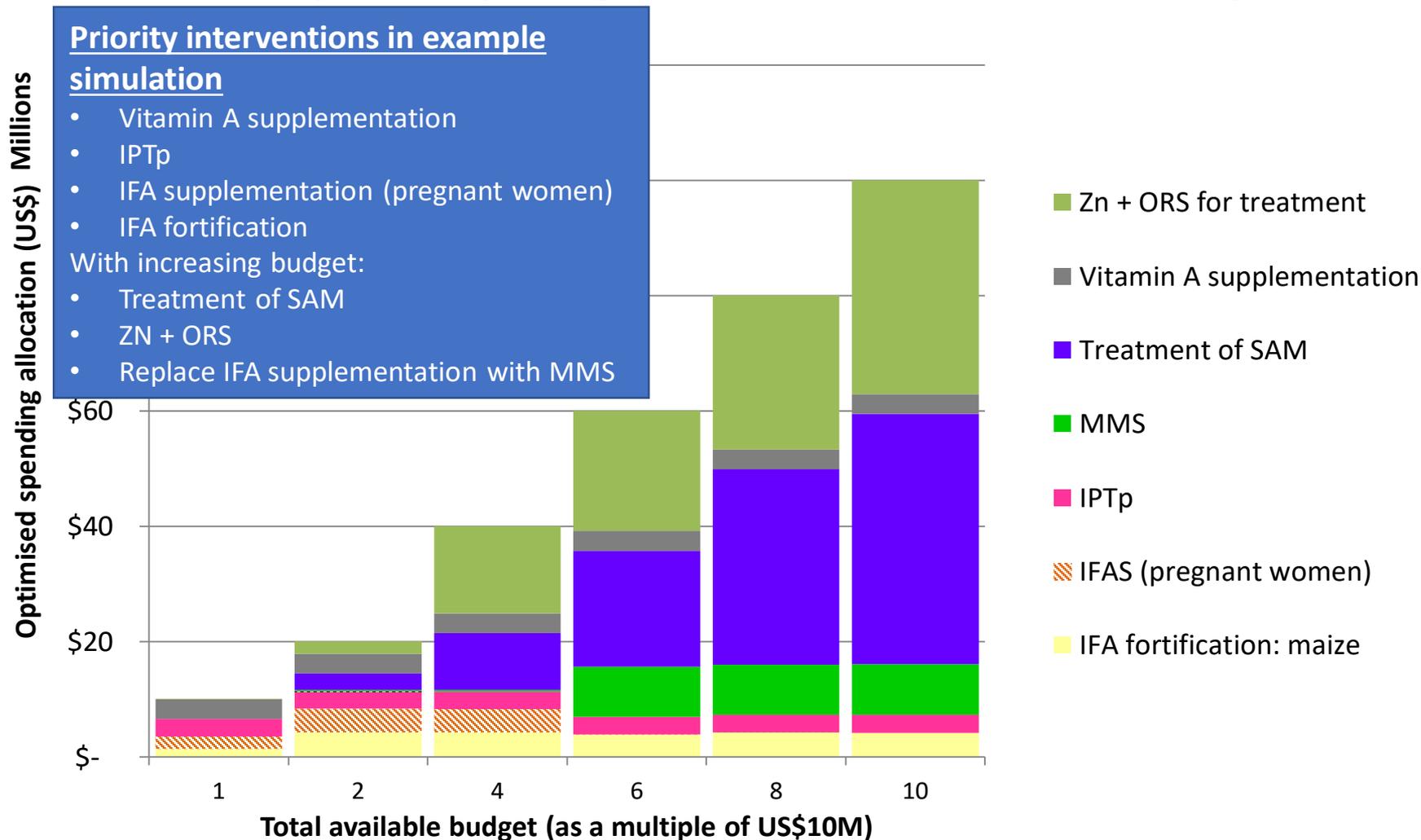
The objective function

- To run an optimisation, we need to define an “**objective function**”
- An objective function takes all of the model outcomes and combines them into **a single number**
- For example, an objective function could be the total number of child deaths
- The optimisation can then iteratively shift funding around until it finds the allocation that produces the highest (or lowest) value of the objective function
- For different objective functions, the model is likely to suggest different sets of interventions
- This is logical given the variety of interventions and outcomes in the model, but from a programming perspective requires consideration

Sample optimisation: minimise child mortality



Optimised spending allocations to minimise child mortality

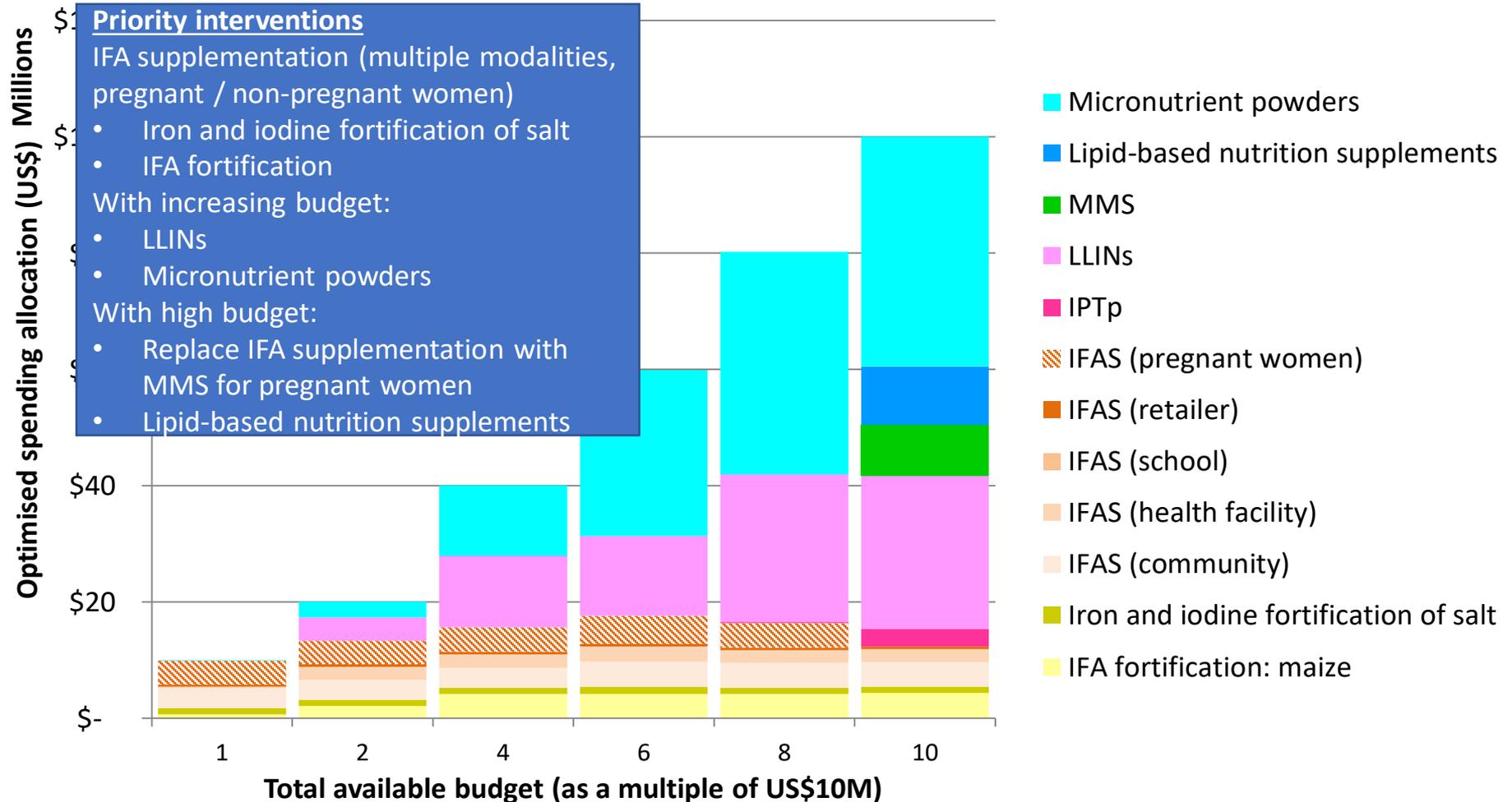


Sample optimisation: minimise anaemia



Optimised spending allocations to minimise anaemia prevalence

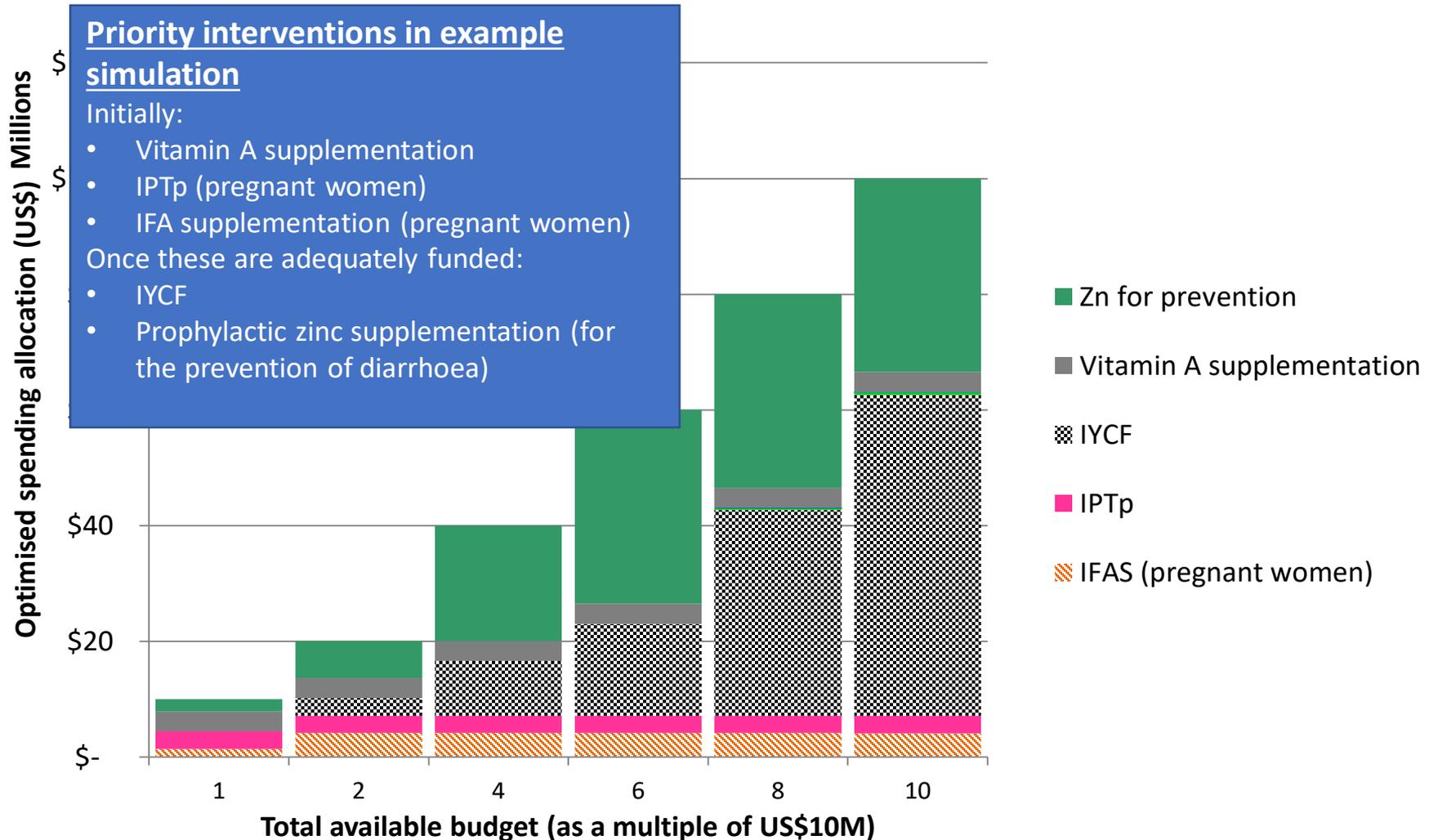
Among women of reproductive age and children



Sample optimisation: maximise alive and non-stunted children



Optimised to maximise alive and non-stunted children



How can Optima Nutrition help with programming choices



- There are several ways of selecting the best interventions for a specific nutrition program
- First, it is important to engage with nutrition planners to determine which interventions they are likely to consider feasible:
 - Which interventions are already implemented in a given country, which interventions may be implemented, and which interventions are unlikely to be implemented.
- Second, strategic objectives of the national nutrition and health plans and interventions can help define the outcomes that should matter.
 - The national strategic nutrition plan may prioritize stunting reduction over anaemia

How can Optima Nutrition help with programming choices



- Third, objective can be created using combinations of outcomes:
 - Maximise alive, non-stunted, non-wasted and non-anaemic children
 - Minimise the sum of maternal and child deaths

- Fourth, it is recommended that for a given setting, many different objective functions are tested:
 - What are the interventions that are “optimal” for multiple choices of objective?
 - What interventions can be eliminated because they are rarely or never considered “optimal”?

Exercises



- See worksheet



2018 SKILLS BUILDING PROGRAM

BIG DATA, ARTIFICIAL INTELLIGENCE AND DECISION SCIENCE IN HEALTH AND NUTRITION

Optimization and the objective function (continued)

Day 5 – Session 1

In partnership with



Objectives of session



- In the previous session we covered how to run optimisations in the Optima Nutrition model, and how to interpret the outcomes
- In this session we will cover how to create more complex objective functions
- At the end of this module and the exercises that it includes you should be able to:
 - Understand what an objective function is
 - Define appropriate weightings for objective functions
 - Create weighted objective functions in the graphic user interface

Weighted objective functions



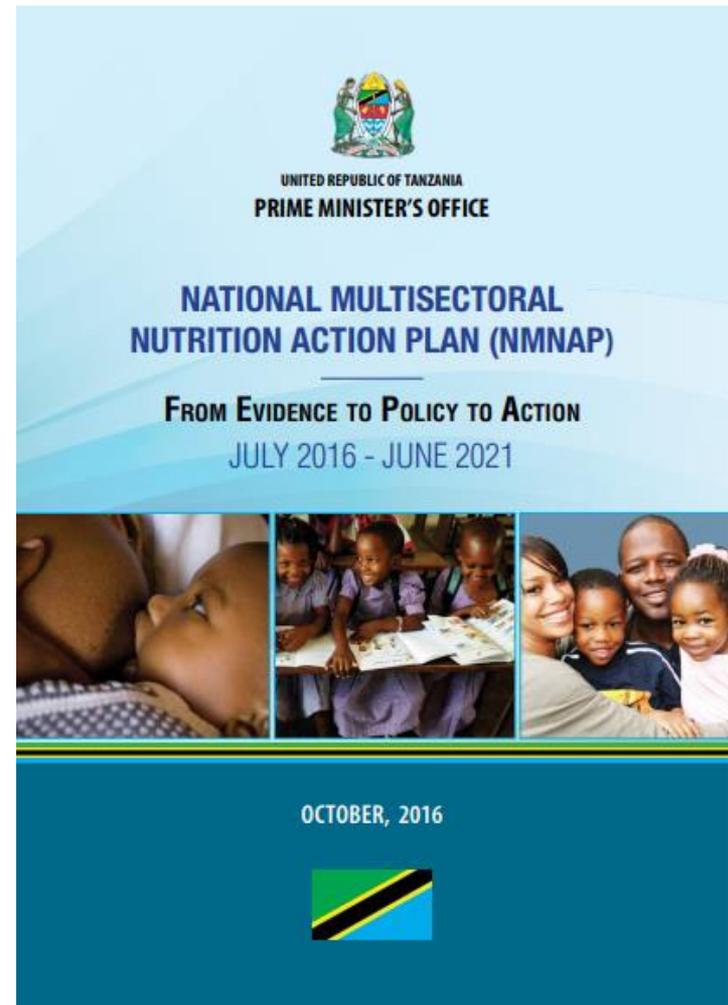
- It is possible to assign weights to particular outcomes
 - “Weights” are numbers that are used to assign a relative importance across each of the model outcomes
 - For example, we might care about stunting more than anaemia, so we could give stunting a larger weight
- In the model it is possible to minimise multiple outcomes. For example for some factors X and Y, minimise:

$$X * \text{number of child deaths} + Y * \text{number of stunted children}$$

Tanzania example, nutrition action plan



- If completely unsure about what is “best”, national nutrition strategies can provide some guidance.
- For example, Tanzania’s nutrition action plan includes:
 - Reduce stunting prevalence among children under 5 from 34% in 2015 to 28% in 2021
 - Reduce anaemia prevalence among children 6-59 months from 57% in 2015 to 50% in 2021
 - Maintain prevalence of wasting among children under 5 at < 5%
- This can help when choosing weights for outcomes



Tanzania example, nutrition action plan



- To come as close as possible to the targets, we need to include relative weightings for stunted and anaemic children
- Suggestion:
 - NMNAP targets aim for approximately equal relative reductions in stunting and anaemia
 - In Tanzania, it costs 3.37 times as much to prevent a case of stunting than a case of anaemia (determined by use of the model)
 - Therefore, we want to use weightings so that a stunting case averted counts for 3.37 anaemia cases averted
 - Use an objective that is to maximise:
*3.37 * alive and non-stunted children + alive and non-anaemic children*
 - BUT, wasting prevalence also has to remain below 5%. So we want to find a budget allocation that maximises:
*3.37 * alive and non-stunted children + alive and non-anaemic children*
- 1,000,000,000 if wasting >5%

Exercise



- See worksheet



2018 SKILLS BUILDING PROGRAM

BIG DATA, ARTIFICIAL INTELLIGENCE AND DECISION SCIENCE IN HEALTH AND NUTRITION

Geospatial analysis

Day 5 – Session 2

In partnership with



Objectives of session

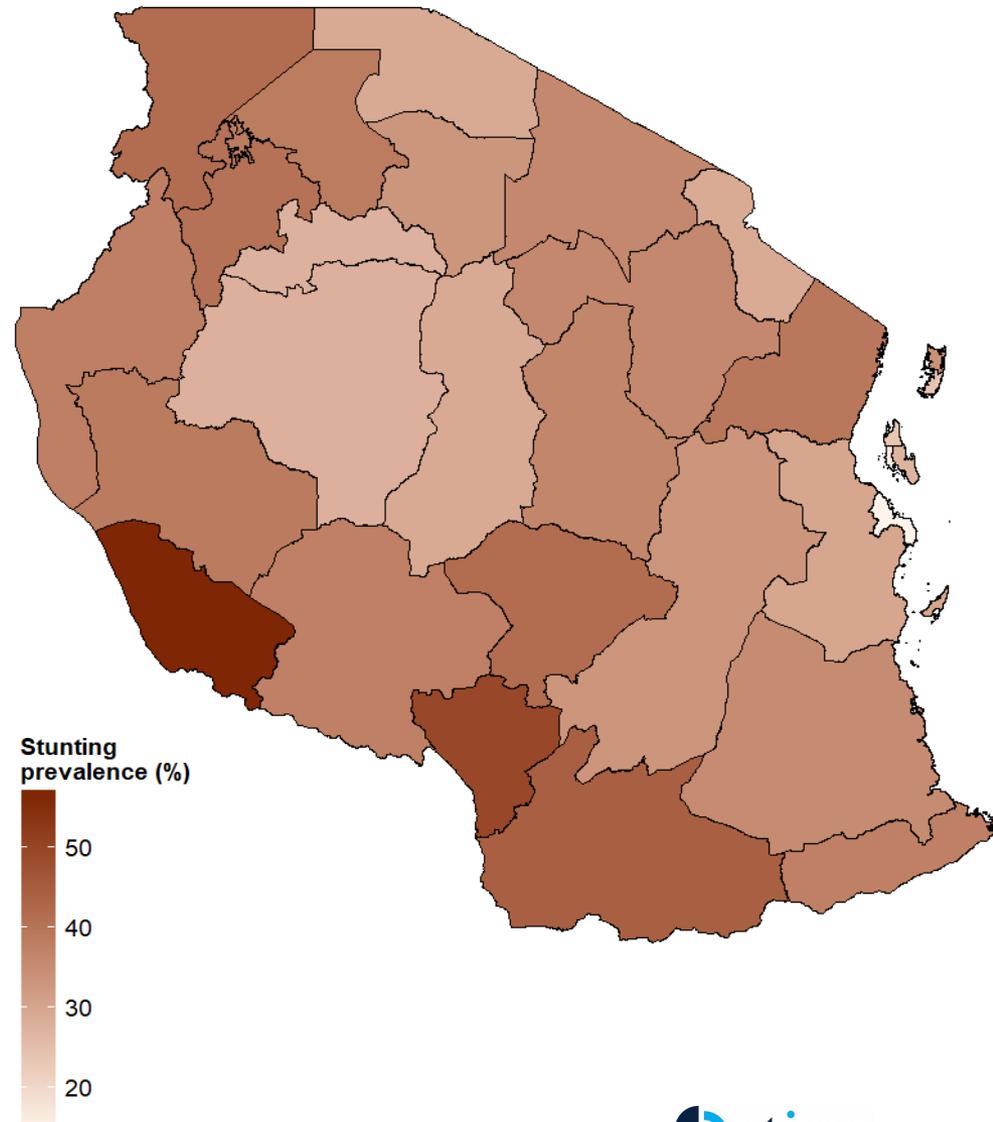


- The previous sessions have covered all of the essentials of a country level analysis using Optima Nutrition
- This session will cover how Optima Nutrition can be used for subnational analyses
- At the end of this module you should be able to:
 - Understand the need for geospatial analysis
 - Select an appropriate geographical resolution
 - Understand the different types of geospatial optimisations
 - Be able to perform geospatial and programmatic optimisations in the graphic user interface

Introducing the need for geospatial analysis



- The burden of malnutrition can vary significantly in different parts of a country
- Decision-makers may need to decide how much money to allocate to different regions
- These decisions are often made simply based on the number of people who reside in different regions.
 - **However, this is not necessarily the most efficient allocation of resources**
- Therefore, there is often a need to consider sub-national analyses



Defining the problem

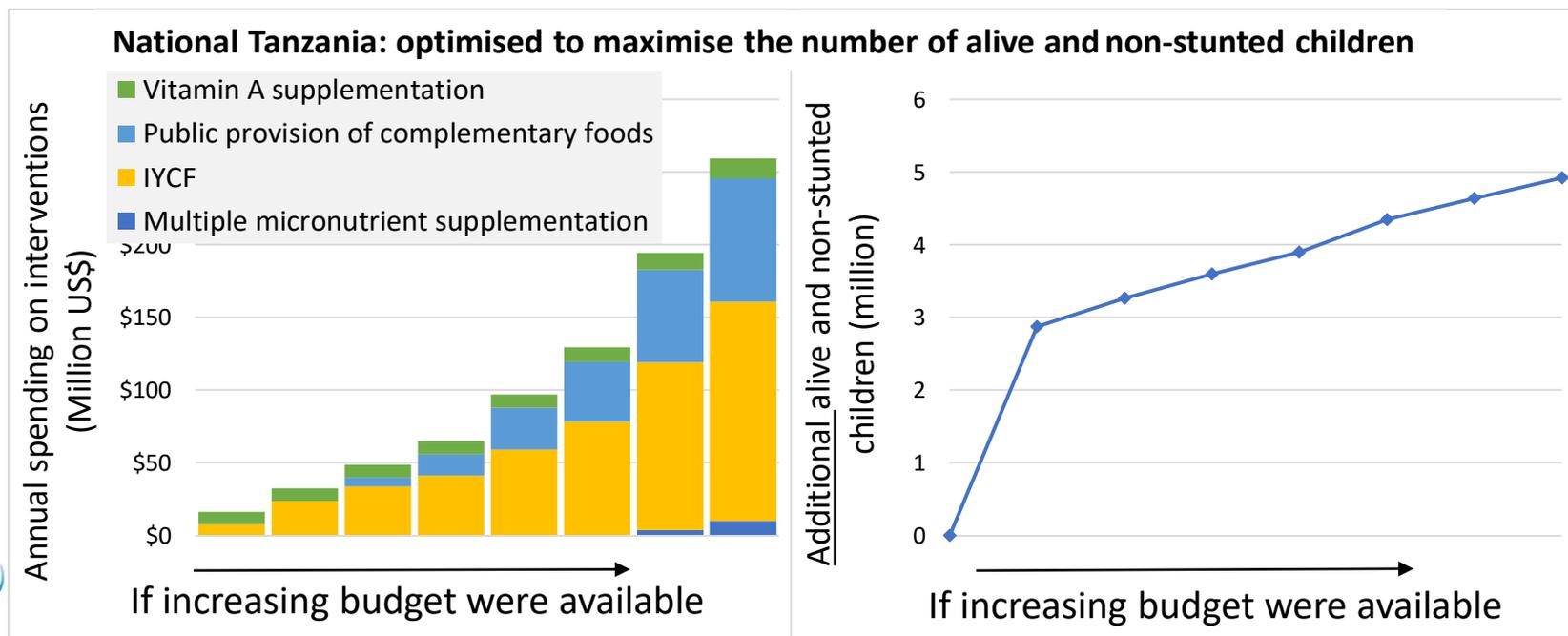


- The granularity that a sub-national analysis occurs at should be determined by the availability of data
 - Often where data is missing national estimates need to be used, so drilling down to more granular levels will not necessarily lead to more insight.
- Once the regions are selected, possible constraints need to be considered both within each region and across regions.
 - Within each region: are any interventions fixed (i.e. cannot be completely or partially defunded)?
 - Across regions: is the total amount of funding movable across regions? For example, if individual regions provide their own funding to nutrition interventions, they are unlikely to shift it to support interventions in other states
 - Is there any additional funding available?
 - What is the objective function? Is it the same for all regions?



Investment staircase for each region

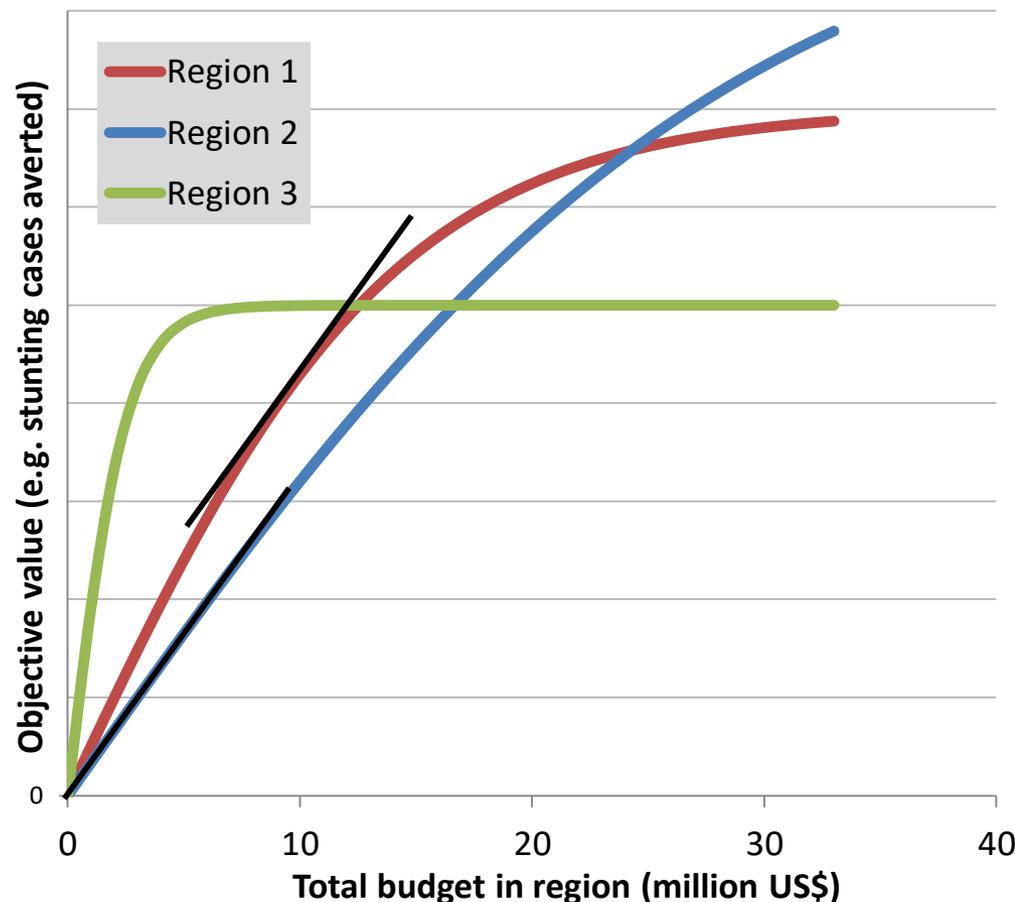
- For each region, an “investment staircase” can be produced
 - This is the impact that can be achieved for a range of different funding
- The impact can be measured as the objective function value, for example the total number of alive and non-stunted children that could be achieved with \$10 million, \$25 million, etc.
- For each region, a budget-impact curve (right) can be constructed
 - X-values are total amount available; Y-values are possible impact



Comparing budget-impact curves across regions



- When the budget-impact curves for each region are compared, we can see where the best value for money is.
- For example, the first ~\$4.5 million would have the best cost-per-outcome in region 3.
- The next ~\$8 million is best spent in region 1
- After this, the cost-per-outcome (black tangent line) becomes worse than in region 2.



Example geospatial analysis



AIM 1: Estimate the impact of programmatically optimising nutrition spending within 22 selected regions of Tanzania

AIM 2: Estimate the impact of an additional US\$200 million investment in Nutrition in Tanzania (over the period 2019-2025), if optimised geographically across the 22 selected regions and programmatically within each region

The following scenarios were projected for the period 2019-2025:

Scenario	Total budget	Programmatic optimisation	Geographic allocation of additional funding
1a	Continued estimated 2017 spending	--	--
1b	Continued estimated 2017 spending	Existing funding	--
2a	Continued estimated 2017 spending + US\$33 million per annum	Only additional funding	Optimised across regions
2b	Continued estimated 2017 spending + US\$33 million per annum	All funding (existing + additional)	Per capita
2c	Continued estimated 2017 spending + US\$33 million per annum	All funding (existing + additional)	Optimised across regions

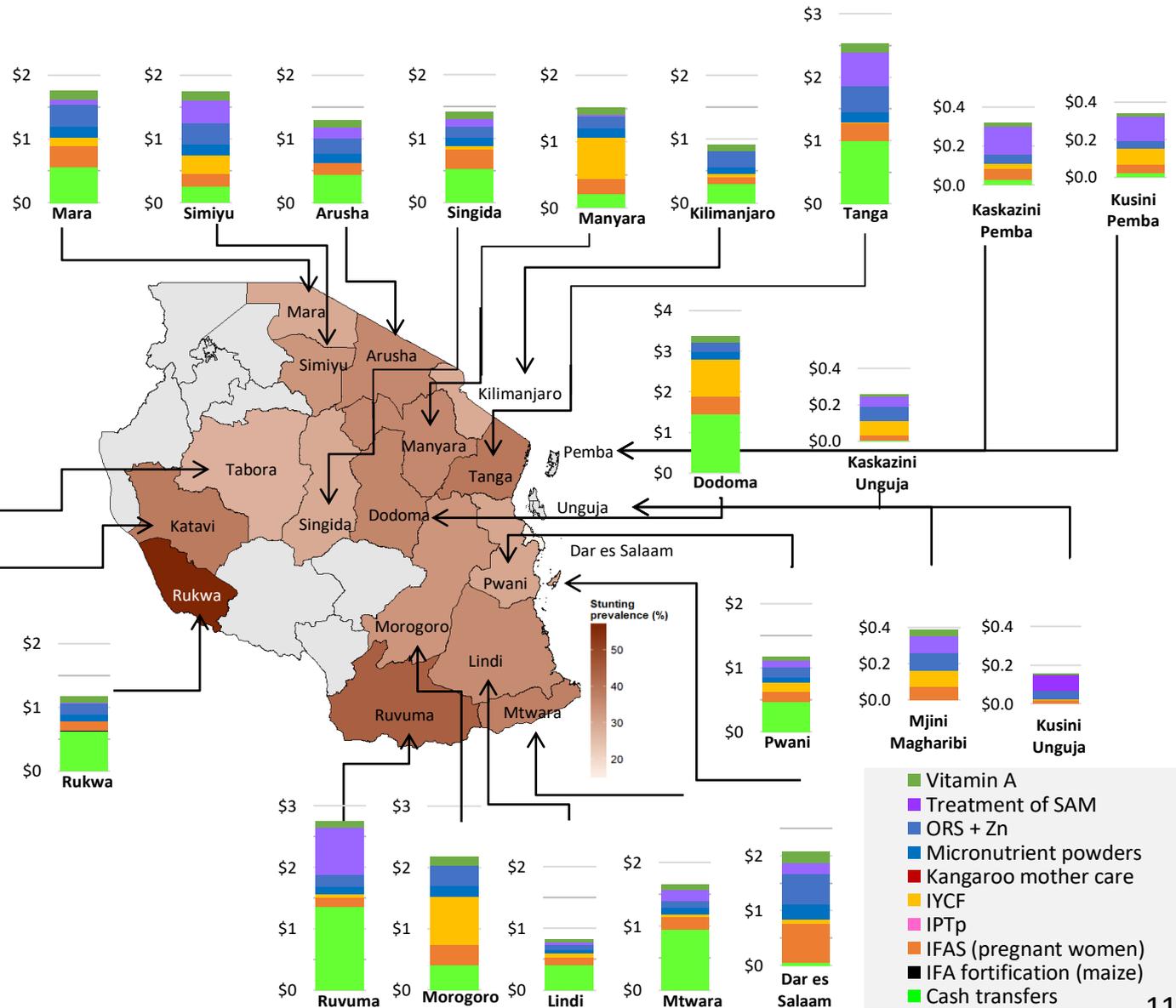


1a) Estimated 2017 spending

Projections:
 2017 spending across the 22 regions was estimated at US\$31 million per annum, based on intervention coverages and unit costs.

If continued between 2019-2025, this was estimated to lead to:

- 5,092,000 alive and healthy* children
- 1,064,000 child deaths
- 3,765,000 stunted children (29.6% under-5 prevalence)
- 51% under-5 anaemia prevalence
- 4.68% under-5 wasting prevalence



Estimated 2017 funding allocation (million US\$)

*Alive and non-stunted, non-wasted and non-anaemic children leaving the model 2019-2025



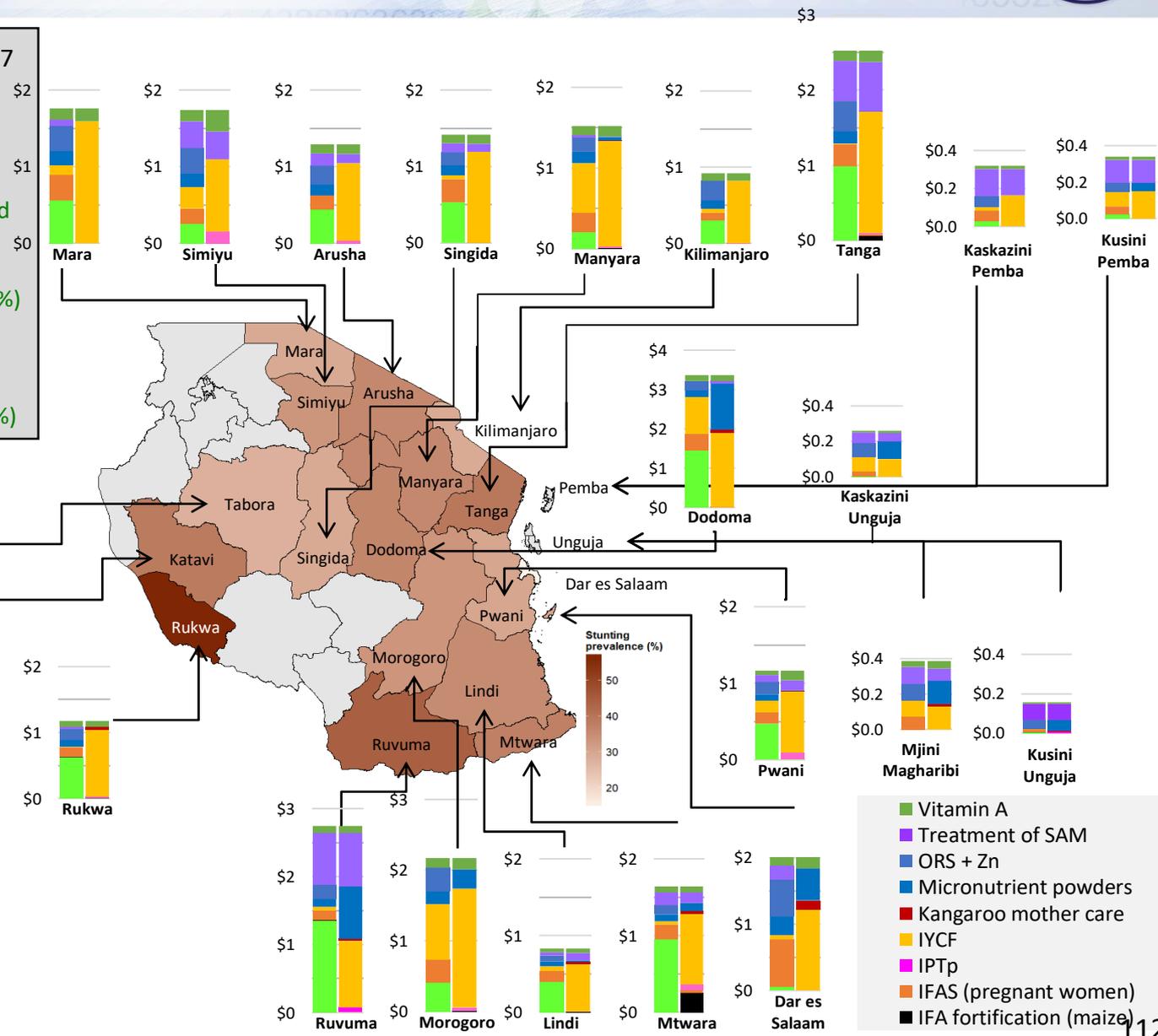
1b) Programmatically optimised spending

Impact (compared to continued 2017 spending, 2019-2025):

- 231,000 (5%) additional alive and healthy children
- 32,500 (3.1%) fewer child deaths
- 246,000 (6.5%) additional non-stunted children
- 11.1% relative reduction in under-5 stunting prevalence (from 29.6% to 26.3%)
- 3% relative reduction in under-5 anaemia prevalence (from 51% to 49%)
- 0.3% relative reduction in under-5 wasting prevalence (from 4.68% to 4.67%)

Estimated 2017 funding allocation (million US\$)

Optimised for NMNAP



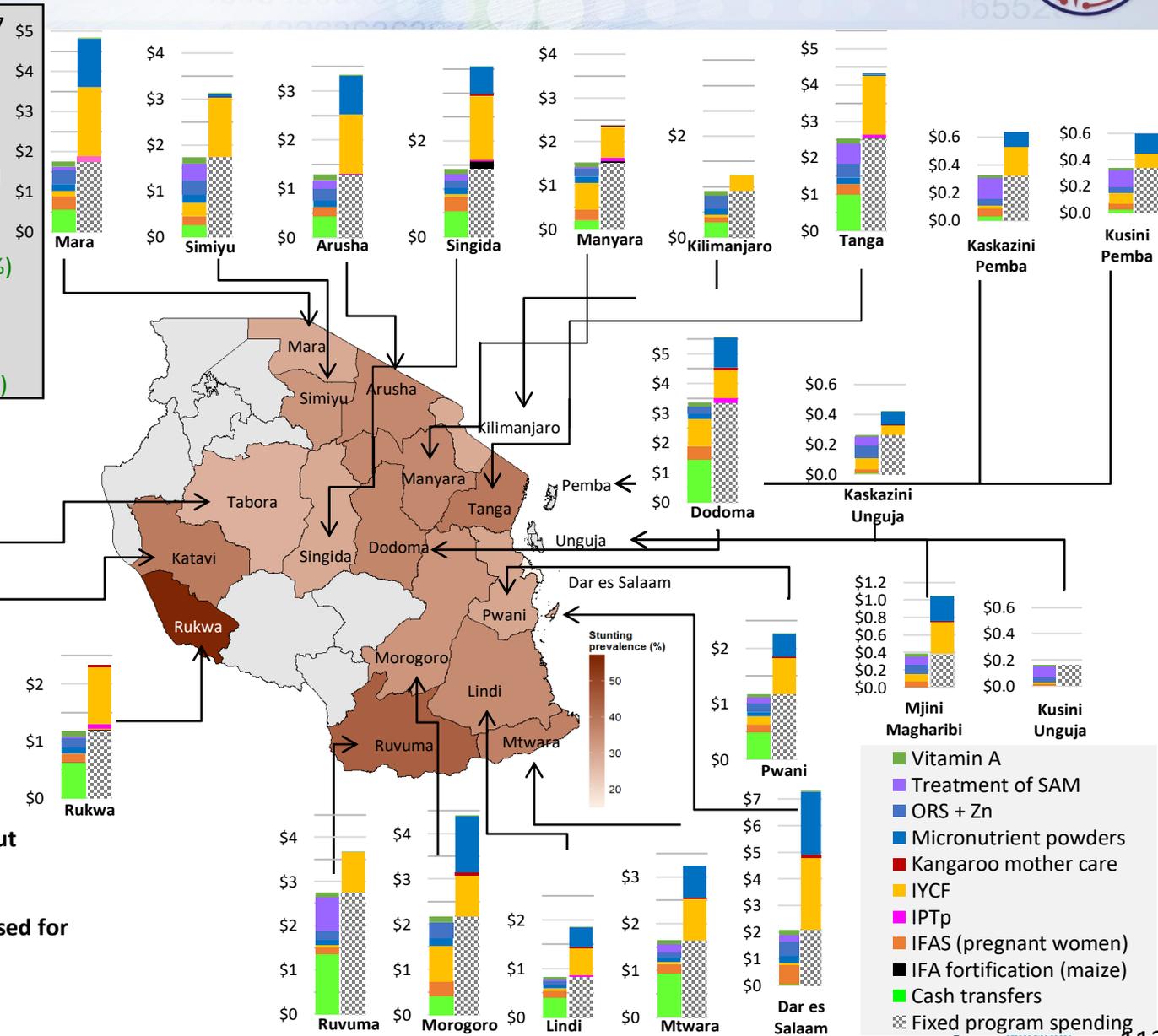
2a) An additional US\$33M per annum, distributed optimally across regions, only additional money programmatically optimised



Impact (compared to continued 2017 spending, 2019-2025):

- 484,000 (10%) additional alive and healthy children
- 67,900 (6.4%) fewer child deaths
- 311,000 (8.3%) additional non-stunted children
- 14.6% relative reduction in under-5 stunting prevalence (from 29.6% to 25.3%)
- 15% relative reduction in under-5 anaemia prevalence (from 51% to 43%)
- 1.1% relative reduction in under-5 wasting prevalence (from 4.68% to 4.63%)

Estimated 2017 funding allocation (million US\$) vs **Fixed current spending but additional funding geographically and programmatically optimised for NMNAP**



2b) An additional US\$33M per annum, distributed on a per capita basis, all money programmatically optimised

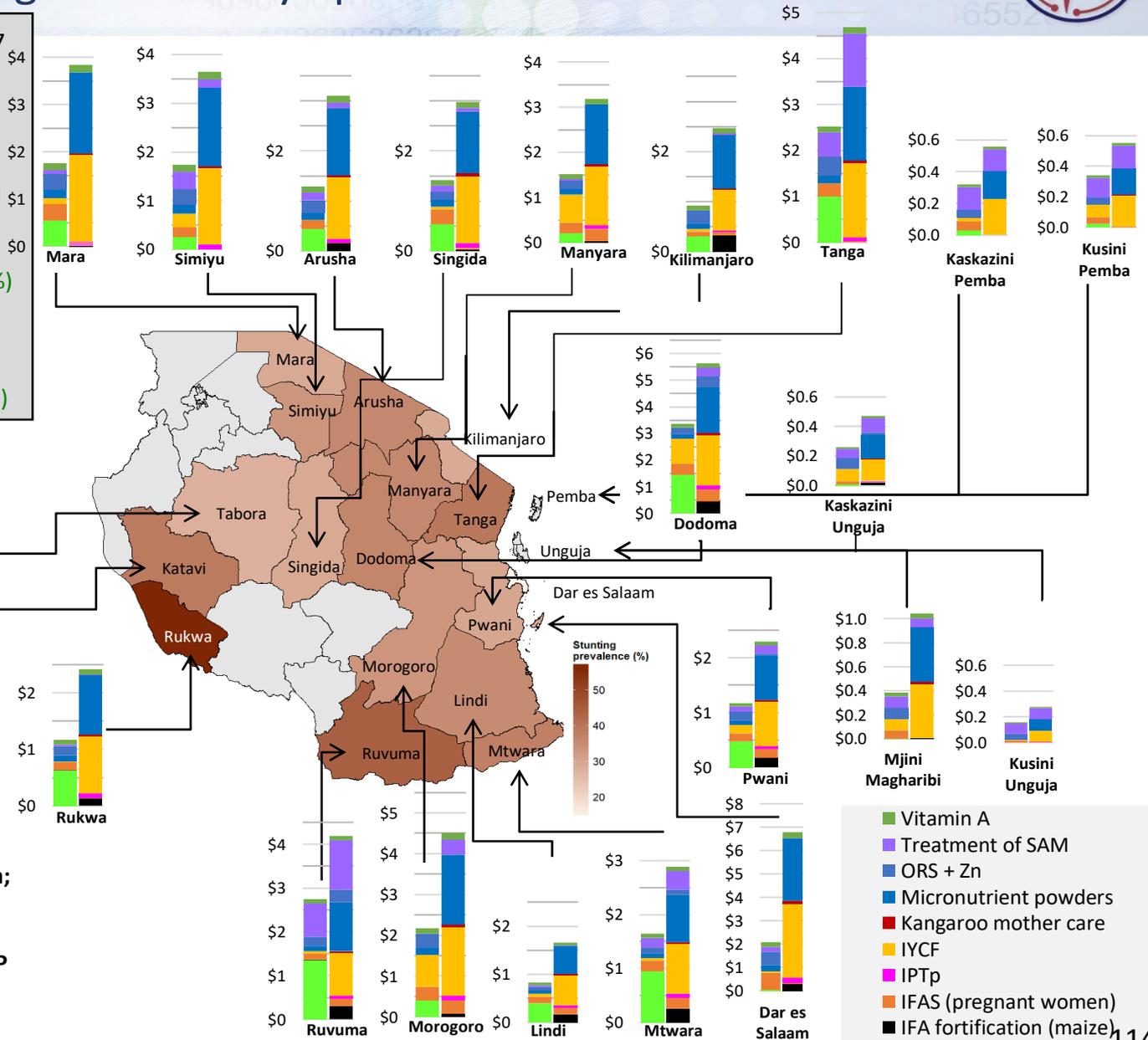


Impact (compared to continued 2017 spending, 2019-2025):

- 657,000 (13%) additional alive and healthy children
- 75,700 (7.1%) fewer child deaths
- 321,000 (8.5%) additional non-stunted children
- 15.2% relative reduction in under-5 stunting prevalence (from 29.6% to 25.1%)
- 27% relative reduction in under-5 anaemia prevalence (from 51% to 37%)
- 1.3% relative reduction in under-5 wasting prevalence (from 4.68% to 4.62%)

Estimated 2017 funding allocation (million US\$)

Additional funding distributed per capita; all funding programmatically optimised for NMNAP



2c) An additional US\$33M per annum, distributed optimally across regions, all money programmatically optimised

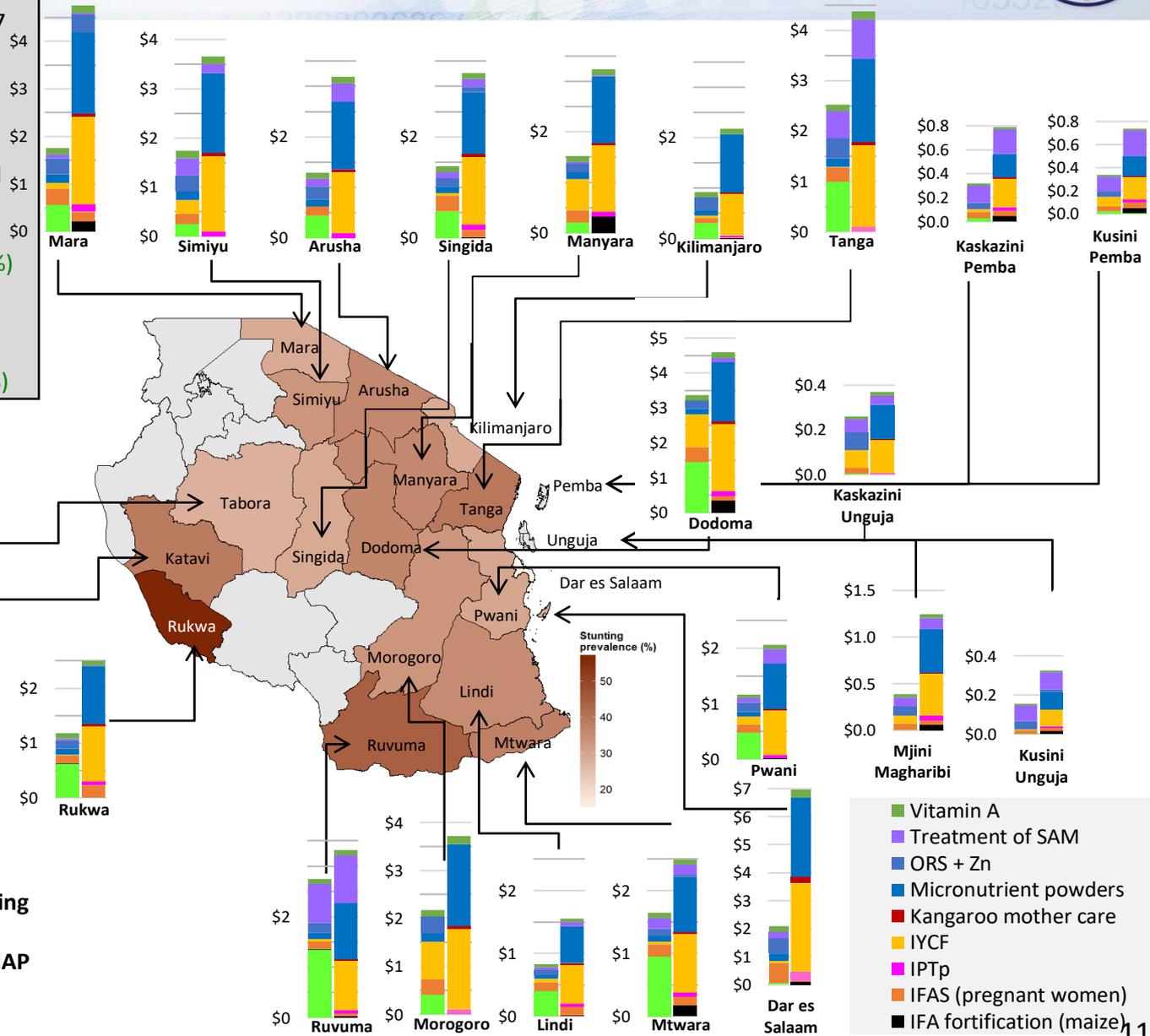


Impact (compared to continued 2017 spending, 2019-2025):

- 663,000 (13%) additional alive and healthy children
- 81,000 (7.6%) fewer child deaths
- 322,000 (8.5%) additional non-stunted children
- 15.2% relative reduction in under-5 stunting prevalence (from 29.6% to 25.1%)
- 27% relative reduction in under-5 anaemia prevalence (from 51% to 37%)
- 1.3% relative reduction in under-5 wasting prevalence (from 4.68% to 4.62%)

Estimated 2017 funding allocation (million US\$)

Additional funding geographically optimised; all funding programmatically optimised for NMNAP



Projected impact of scenarios (over 22 regions)



Scenario			Increase in healthy children* (2019-2025)	Reduction in number of stunted children (2019-2025)	Reduction in child deaths (2019-2025)	Relative reduction in 2025 under-5 prevalence of		
Total budget	Programmatic optimisation	Geographic allocation of additional funding				Stunting	Wasting	Anemia
1b) Continued estimated 2017 spending	Existing funding	--	231,000 (5%)	246,000 (6.5%)	32,500 (3.1%)	11.1%	0.3%	3%
2a) Continued estimated 2017 spending + US\$33 million per annum	Only additional funding	Optimised across regions	484,000 (10%)	311,000 (8.3%)	67,900 (6.4%)	14.6%	1.1%	15%
2b) Continued estimated 2017 spending + US\$33 million per annum	All funding (existing + additional)	Per capita	657,000 (13%)	321,000 (8.5%)	75,700 (7.1%)	15.2%	1.3%	27%
2c) Continued estimated 2017 spending + US\$33 million per annum	All funding (existing + additional)	Optimised across regions	663,000 (13%)	322,000 (8.5%)	81,000 (7.6%)	15.2%	1.3%	27%

*Additional alive and non-stunted, non-wasted and non-anaemic children leaving the model 2019-2025, compared to a scenario of continued estimated 2017 spending

Summary of analysis



- Vitamin A supplementation, IYCF and micronutrient powders were the highest impact interventions for achieving the NMNAP targets
- Relatively large gains may be possible by optimising existing funding
 - For most regions, existing funding volumes were sufficient to scale up the highest impact interventions
- Additional funding should be allocated to ensure that Vitamin A supplementation, IYCF and micronutrient powders interventions have high coverage in all regions
- The optimal distribution of additional funding was similar to the per capita distribution
 - Adequate coverage of the three highest impact interventions in all regions was a greater priority than incremental gains from geographical funding allocations

Geospatial analysis in the GUI



Optima Nutrition

Beta version 0.5.0 (2018-08-02)

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Exercises



- See worksheet



2018 SKILLS BUILDING PROGRAM

BIG DATA, ARTIFICIAL INTELLIGENCE AND DECISION SCIENCE IN HEALTH AND NUTRITION

Continuation of individual country case studies

Day 5 – Session 3

In partnership with



Country case studies



- See worksheet