Opportunity for novel alternate protein in sub-Saharan Africa

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UKaid
from the British people
Manufacturing Africa

Foreign & Commonwealth Office

UKRI Innovate UK

Global Alliance Africa

This study has been funded by UK Aid from the UK government; however, the views expressed do not necessarily reflect the UK government's official policies.

Context and objectives for this report

Context

This report was sponsored by the **UK Aid Manufacturing Africa** programme and **Innovate UK's Global Alliance Africa** project

All analysis was conducted in **Q1 2025,** and numbers, findings, and case studies are current as of that date

This report is intended as the **first full assessment of the novel alternate protein opportunity in sub-Saharan Africa,** to create awareness among food and agriculture companies, retailers, investors, and development partners of the opportunity and enablers required

Objectives

Provide an **overview of the global novel alternate protein market** as context for the sub-Saharan market

Assess the potential size of the novel alternate protein market in sub-Saharan Africa in 2035 in 4 market segments (consumer market, humanitarian food aid, animal feed, and supplying global demand)

Synthesise priority enablers that the private sector, development partners, and public sector can pursue to develop the novel alternate protein market

Our analysis of the alternate protein market in sub-Saharan Africa benefited from significant stakeholder and expert perspectives

NON-EXHAUSTIVE

■ Fermentation ▨ Edible insects ▦ Plant-based □ Other

50+

Stakeholder interviews with private companies (incl. start-ups, retailers, large food companies)

- ■ Essential
- ■ MycoSure
- ▦ Biago
- ▦ DryGro
- ▦ Fiber Foods Group
- ▦ Greenspoon
- ▦ Hilina
- ▦ mTofu
- ▦ Naivas
- ▦ Nuziwa
- ▦ One Acre Fund
- ▦ OnlyPlants
- ▦ Planta Food Factory
- ▦ Sydsel Africa
- ▨ Aiko
- ▨ BioLoop
- ▨ Carbonovia
- ▨ Chanzi
- ▨ Evonik
- ▨ InsectiPro
- ▨ Loop Pet Food
- ▨ Maltento
- ▨ MagProtein
- ▨ NeoFarm
- ▨ Sanergy Limited/ Regen Organics
- ▨ The Bug Picture
- □ Africa Improved Foods
- □ AgVentures
- □ Buhler Technologies
- □ Export Trading Group
- □ Insta Products
- □ Meatable
- □ Protein.Ke
- □ Sigma Feeds
- □ Victory Farms

10+

investors

Acumen
Bezos Earth Fund
Equator
Goodwell
HRSV
Light Rock
Nedbank
Pyramidia Ventures
RMB
Veris

10+

sector experts (incl. research institutions, humanitarian organisations)

Food 4 Education
Global Alliance on Improved for Nutrition (GAIN)
Greenwich/ Valid Nutrition
Novel Fermentation Action Lab
Rockefeller Foundation
TechnoServe
World Bank
World Food Programme

Multiple reports and articles

Gatsby/UK Aid Report – Study on Meat End Market Trends in Kenya

Global food security: Population protein intakes and food sustainability indices (Paul Moughan 2021)

Multiple data sources

100+ consumer interviews
UN COMTRADE
Euromonitor
FAOSTAT
IMF
World Bank Data
World Economic Forum
World Bank Commodity Markets Outlook

Terminology and abbreviations

Term / abbreviation	Description
Aflatoxin	Mycotoxin produced by fungi, contaminating crops like nuts, dried fruit, and oilseeds
AP	Alternate protein
Biomass	Organic materials, or byproducts, from biological sources like plants and animals that are otherwise discarded
bn	Billion
BSF	Black soldier fly
Codex Alimentarius	Set of international food standards, guidelines, and codes of practice published by FAO and WHO
Conventional protein	Proteins not considered novel or alternate and typically consumed (meat, dairy, legumes, tofu, seitan, etc.,)
DIAAS	Digestible Indispensable Amino Acid Score
ESG	Environment, Social, and Governance factors
FAO	Food and Agriculture Organisation
Favism	Favism is a genetic condition causing red blood cell breakdown after eating fava beans
Formal market	Regulated market with licensed modern retail channels (e.g., supermarkets, hypermarkets)
Formal meat market	Meat that is bought from licensed modern retail channels (e.g., supermarkets, hypermarkets)
Frass	Solid excrement or waste produced by insects
Humanitarian	Aiding human welfare and responding to crises affecting communities and individuals
Informal market	Unregulated market channels (e.g., open air markets) that are typically unlicenced
Isolates	Purified compounds, often protein, separated from their natural sources
k	Thousand
LNS	Lipid-based nutrient supplement

Term / abbreviation	Description
Mass market	Market that is targeted to low- and middle-income demographic
mn	Million
Mycoprotein	Alternate protein derived from fungi through a fermentation process
Novel AP	Novel alternate protein
PDCAAS	Protein Digestibility Corrected Amino Acid Score
Premium market	Market that is targeted to consumers willing to pay a higher price compared to a comparable substitute
Processed dairy	Dairy that has undergone pasteurisation and sold as either fresh milk, UHT (long life) milk, or a value-added dairy product
Processed meat market	Meat that has been modified to enhance flavour and extend shelf-life (e.g., sausages, canned meats)
Pulses	High-protein legumes, incl. chickpeas, lentils, and dry beans
QSR	Quick Service Restaurants
RUSF	Ready-to-use supplementary food
RUTF	Ready-to-use therapeutic food
Sphere guidelines	Minimum standards for humanitarian response to ensure quality & accountability
SSA	Sub-Saharan Africa[1]
Staples	Essential foods like rice, bread, pasta, dairy, and legumes
TVP	Texturised vegetable protein
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
USD	United States Dollar
Value-added dairy	Yogurts, cheese, ice cream, & any other dairy product aside from fresh or long-life milk
WFP	World Food Programme
WHO	World Health Organisation

1. For the purposes of this report, sub-Saharan Africa excludes South Africa

Agenda

Executive summary (1/3)

Market overview and methodology

Global novel alternate protein market

The global novel alternate protein market is expected to grow from USD ~20-30 in 2024, to **USD ~50-100 bn by 2035.** Estimates in 2035 vary widely due to differing assumptions on consumer adoption.

While the market has underperformed historic growth expectations, several global trends including changing consumer preferences, technology development, continued investment, and entrance of players along the value chain suggest that the market will continue to grow.

The role novel alternate protein could play in sub-Saharan Africa

Today, sub-Saharan Africa[1] has a protein **deficit of ~20%** (i.e., on average, people eat 20% or 13 g per capita per day too little utilisable protein compared to health recommendations). Animal protein demand in sub-Saharan Africa is **expected to double by 2035** based on population and income growth, halving the current protein deficit from 13g to 6g per capita per day. However, sub-Saharan Africa may not be able to meet the animal productivity required to supply this demand, let alone go further to close the protein gap.

Although novel alternate proteins are **unlikely to be a full substitute for animal protein in sub-Saharan Africa**, they could present a **complementary opportunity** to combat malnutrition, strengthen food security, provide affordable protein, and adapt to local cultural and dietary habits (e.g., fasting periods in Ethiopia, traditional use of protein-rich indigenous crops). The market faces some headwinds in sub-Saharan Africa, such as the low formalisation of the retail market and the important role livestock ownership plays in many cultures.

Despite the market still being small, there are already **>100 start-ups present** in the novel alternate protein space.

Methodology

This analysis was developed with input from **10+ reports, 70+ interviews with private companies, humanitarian organisations, investors, and experts, and focus groups with 100+ consumers across income bands.**

We size the opportunity considering 4 novel technologies (**plant-based, fermented, cultivated meat, and edible insects)** and we split the total novel alternate protein opportunity into 4 sub-markets for sub-Saharan Africa: **consumer market, humanitarian food aid, animal feed, and supplying inputs to the global novel alternate protein market.**

We applied **a 6-step approach** to assess the market potential or prioritised opportunities:

1. Identified **a long list** of 51 novel alternate protein opportunities
2. Filtered out 18 based on **technological maturity** expected by 2035
3. Screened out a further 18 based on **feasibility** scores (including factors such as expected price, consumer preferences, availability of inputs) to arrive at a prioritised shortlist of 16
4. Estimated the **market size** for the 16 prioritised
5. Outlined the **investment potential**
6. Identified critical **enablers**

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[1] For the purposes of this report, sub-Saharan Africa excludes South Africa

Executive summary (2/3)

Total opportunity for novel alternate protein in sub-Saharan Africa

By 2035, the total novel alternate protein market in sub-Saharan Africa could be USD ~1-2 bn, requiring USD ~1-2 bn in investment and creating ~40-80k jobs

We estimate the novel alternate protein market in sub-Saharan Africa in 2035 to range from **USD ~1-2 bn,** an expected **1-4% of the total global market.** With an estimated investment potential of **USD ~1-2 bn**, the market could generate **~40-80k jobs** by 2035.[2]

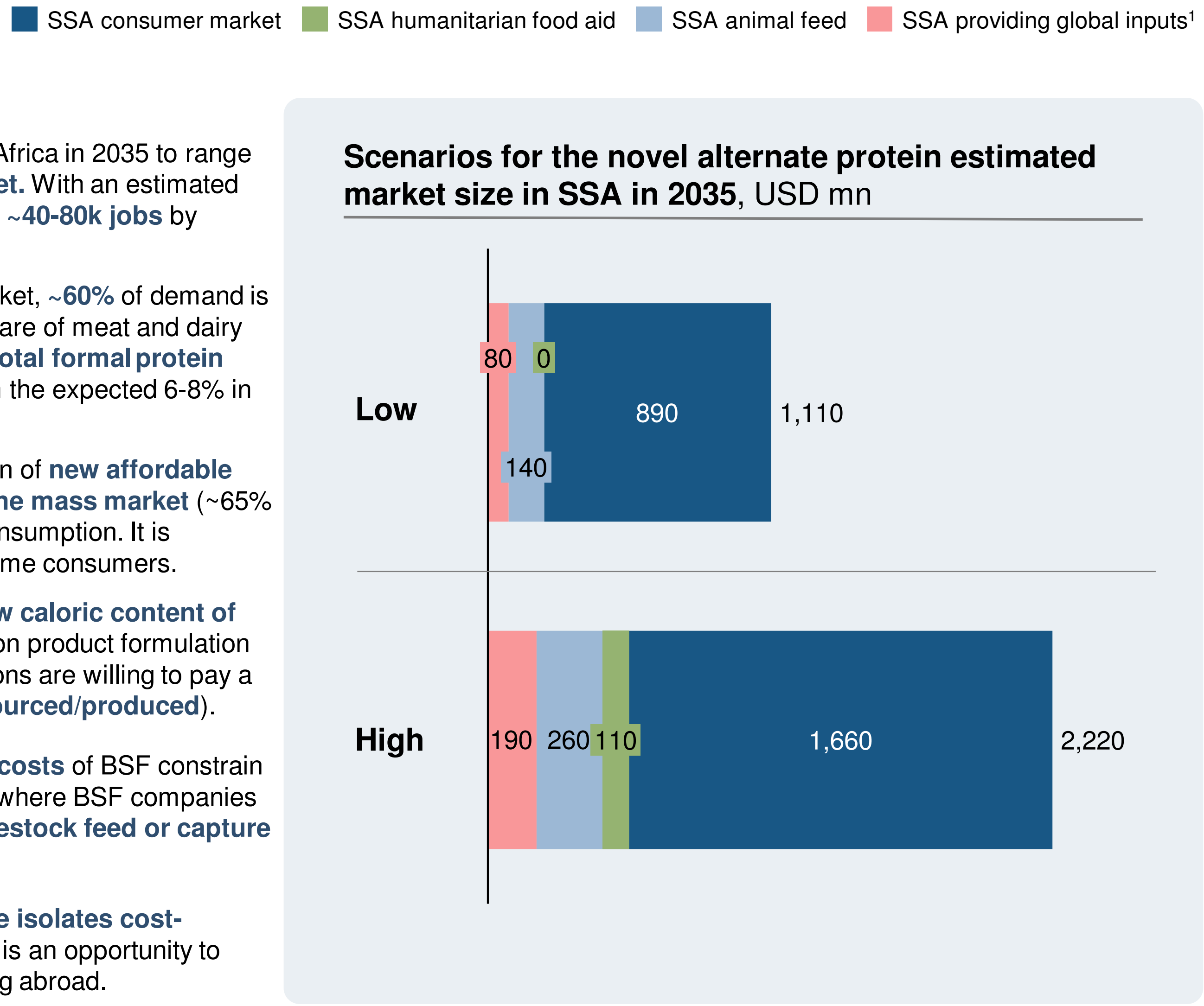
Sub-Saharan African consumer market: In the consumer market, **~60%** of demand is driven by high-income populations looking to substitute some share of meat and dairy consumption with alternatives. This translates into **1-3% of the total formal protein market by 2035** - roughly similar to the US today, but lower than the expected 6-8% in the US and Europe in 2035.[3,4]

The rest of the opportunity in the consumer market is the creation of **new affordable alternate protein products (e.g., protein chunks)** tailored to **the mass market** (~65% of population) and acting as a complement to existing protein consumption. It is expected that this will contribute to closing the protein gap for some consumers.

Humanitarian food aid: For humanitarian organisations, the **low caloric content of most alternate proteins, higher cost, and strict regulations** on product formulation are major barriers. Our high scenario assumes some organisations are willing to pay a premium and consider alternate proteins (especially if **locally sourced/produced**).

Animal feed: Limited **capturable biomass and high logistics costs** of BSF constrain the size of this market. Therefore, the opportunity is focused on where BSF companies can either **capture large sources of commercial waste for livestock feed or capture premiums in pet food.**

Inputs to global demand: Sub-Saharan Africa **cannot produce isolates cost-competitively** driven by a limited market for by-products. There is an opportunity to **export raw fava beans** and possibly mung for isolate processing abroad.



Scenarios for the novel alternate protein estimated market size in SSA in 2035, USD mn

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1. Export ingredients for the global novel alternate protein market
2. Based on an employment multiplier of 0.3 per USD ~8k revenue – assuming a multiplier similar to other agro- and food-processing sectors (e.g., grain milling)
3. Based on expected global market of USD ~50-100 bn in 2035
4. Formal market is the regulated market with licenced modern retail channels (e.g., supermarkets, hypermarkets)

Source: Euromonitor, ACRE for Alternative Protein Modelling

Executive summary (3/3)

Prioritisation of opportunities

16 novel alternate protein opportunities were prioritised for sub-Saharan Africa

In total, **51 novel alternate protein opportunities** were identified (combination of end-product, technology, and market segment), of which **16 were prioritised** based on screening criteria (technological maturity expected by 2035 and a range of feasibility factors such as expected price parity, consumer preference, and availability of inputs).

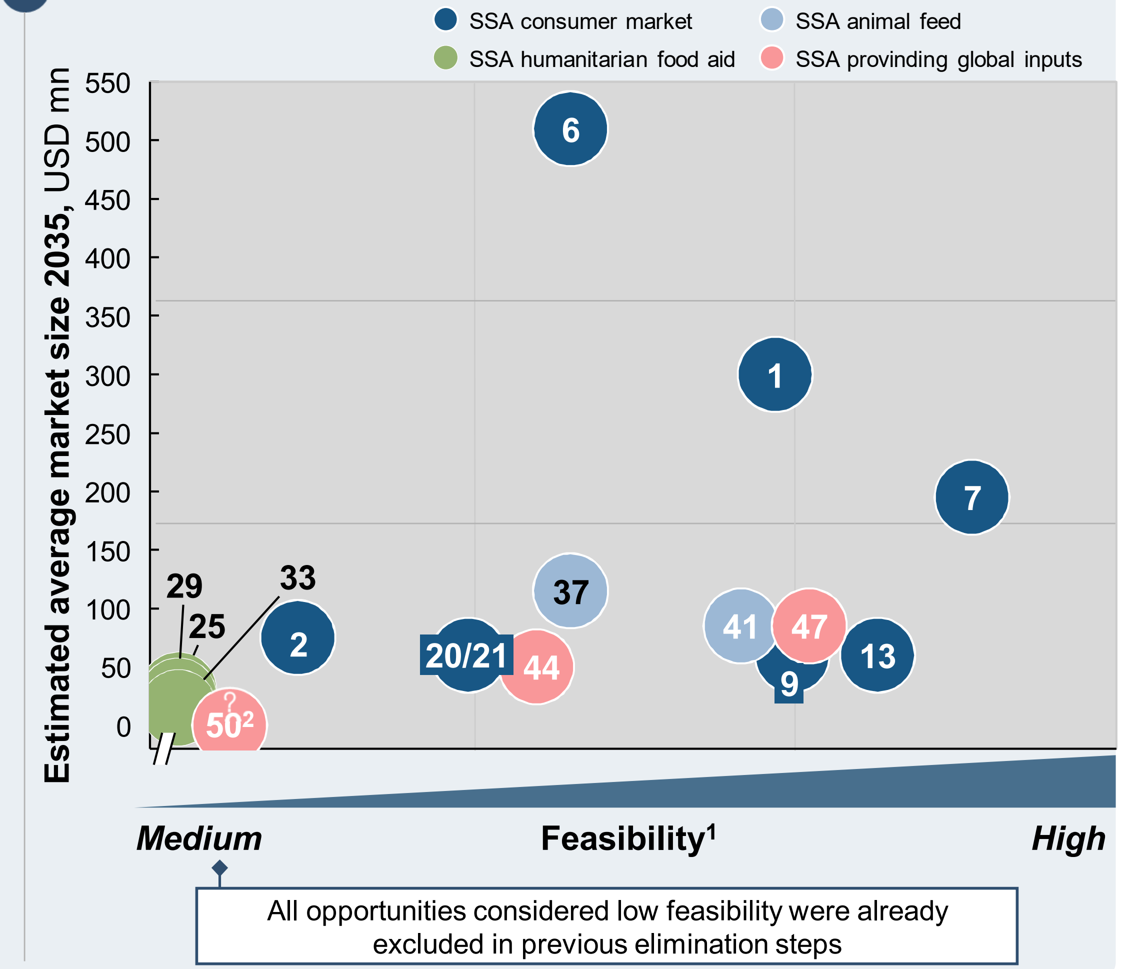
The **16 prioritised** opportunities were sized on estimated revenue potential in 2035, investment needed, and feasibility (shown right).

Mass market meat alternatives, **premium meat mimics**, and **plant-based milk mimics** for the consumer market account for **~50%** of the total opportunity.

Novel alternate protein opportunities

1	Premium plant-based meat mimic
2	Biomass fermented meat mimic
6	Mass market plant-based meat alternative
7	Plant-based milk mimic
9	Plant-based value-added dairy mimic
13	Plant-based sports nutrition
20	Plant-based fortified consumer foods
21	Biomass fermented fortified consumer foods
25	Biomass fermented therapeutic foods
29	Biomass fermented fortified general humanitarian food aid
33	Biomass fermented fortified school feeding
37	Insect-based pet food
41	Insect-based animal feed
44	Insect-based pet food (global)
47	Plant-based ingredients (global)
50	Biomass fermented mycoproteins (global)

Ranking of the 16 prioritised opportunities



All opportunities considered low feasibility were already excluded in previous elimination steps

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1. Feasibility includes 4 factors: price parity to conventional protein source, consumer preference, availability of inputs, and technology maturity
2. Market size not estimated given the high level of uncertainty on market evolution for biomass fermentation globally within this timeframe

Agenda

Agenda

Scope | For this report, we focus on sub-Saharan Africa, excl. South Africa

Source: Expert interview

Rationale

We exclude **North Africa and South Africa** because these regions have more developed consumer markets (i.e., higher access to processed foods, greater reach of formal retail) driven by higher socioeconomic levels, meaning their consumption patterns and preferences will be different from the rest of sub-Saharan Africa

Scope | We focus on 4 technologies for novel alternate protein

Details in appendix

● High ○ Low

	Plant-based	Fermented	Cultivated	Edible insects
Description	Protein derived from plant ingredients and processed into end-products	Protein created through a fermentation process, this can be either biomass fermentation (using microorganisms to produce protein) or precision fermentation (using genetically engineered microbes)	Animal cells grown in a controlled environment to mimic conventional animal protein	Insects that are suitable for consumption, could be as a whole insect or processed into an end-product (e.g., snacks)
Potential scalability in 2035[1]	●	◕ *Biomass* ◔ *Precision*	◔	◕
Example end-products	Burger made from pea protein (e.g., Beyond Meat) 	Protein shake from fermented powder (e.g., mycoprotein) 	Steak grown in a lab 	Black Soldier Fly (BSF) used in livestock feed or cricket meal 

! **Traditional plant-based proteins such as legumes (incl. soy meal for animal feed) and tofu are not included as they are not considered novel**

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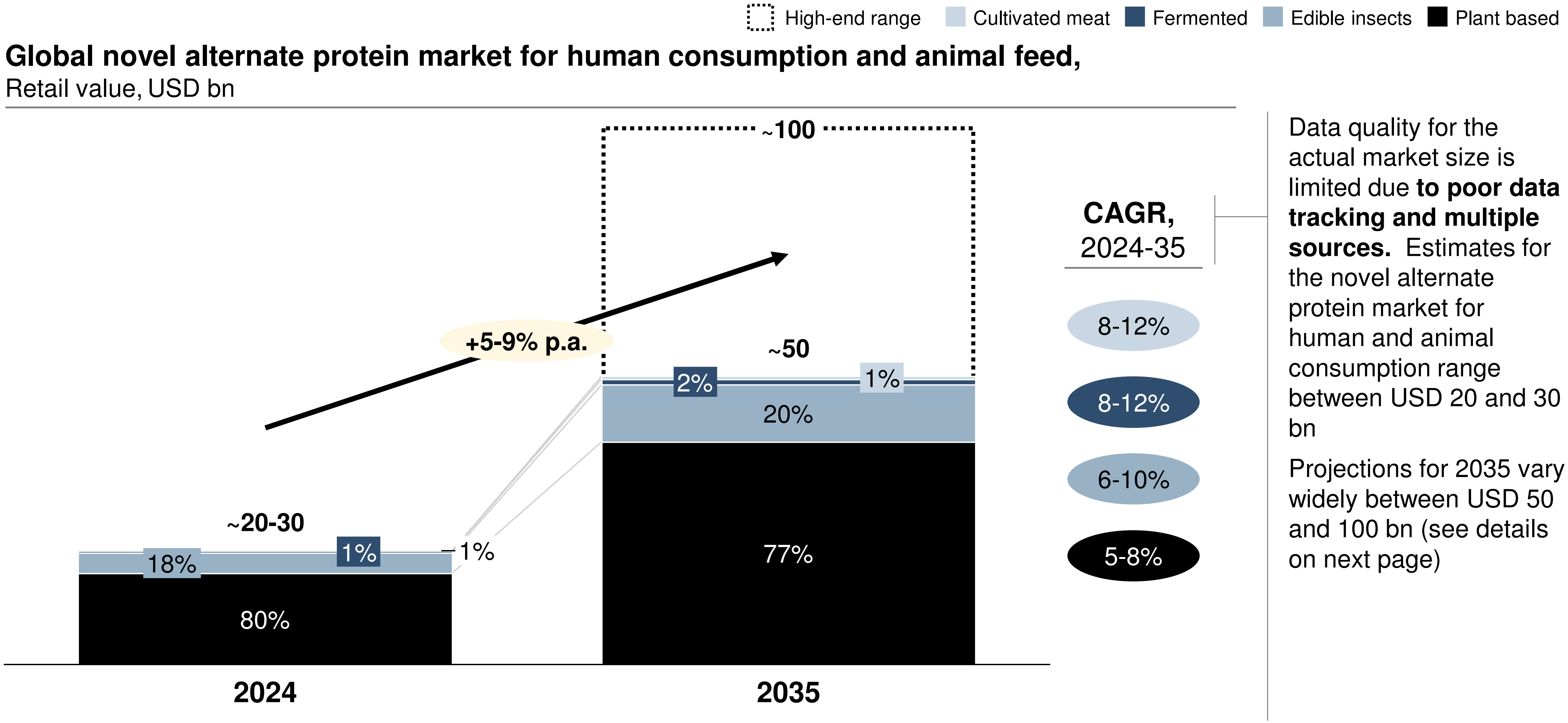
1. Low: technology in the pilot phase with limited commercial testing; High: well-established technologies that are commercially viable for mass production

Source: Press search

Agenda

Global market sizing | The global novel alternate protein market is expected to grow from USD ~20-30 bn in 2024 to USD ~50-100 bn in 2035

Global novel alternate protein market for human consumption and animal feed,
Retail value, USD bn



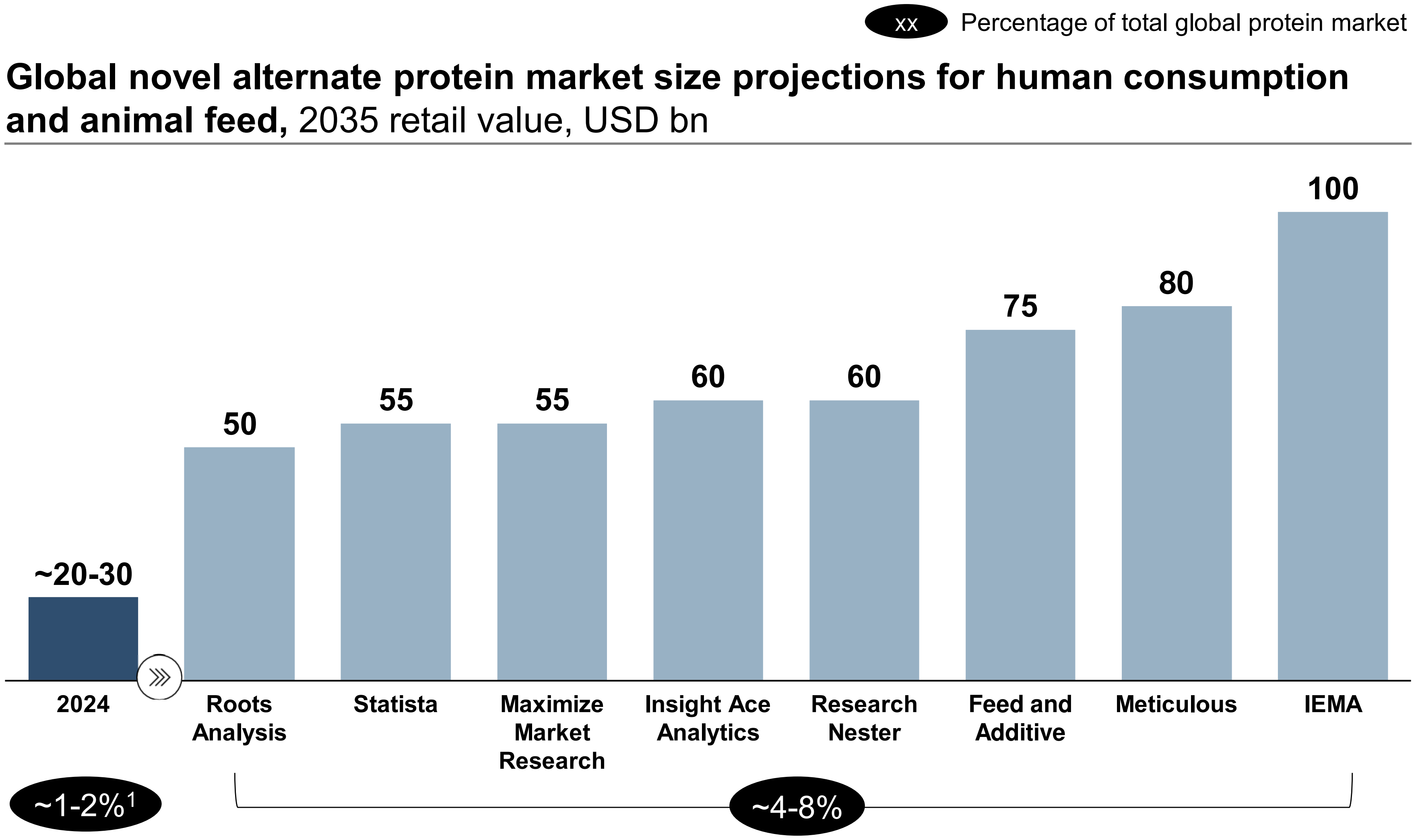
Data quality for the actual market size is limited due **to poor data tracking and multiple sources.** Estimates for the novel alternate protein market for human and animal consumption range between USD 20 and 30 bn

Projections for 2035 vary widely between USD 50 and 100 bn (see details on next page)

Source: Euromonitor, Statista, Research Nester; IEMA, Meticulous research, Feed and Additive Report, Synthesis Capital, press search

Global market sizing | Most estimates of the global market in 2035 range from USD 50-60 bn, some as high as USD 100 bn

Global novel alternate protein market size projections for human consumption and animal feed, 2035 retail value, USD bn



2024	~20-30
Roots Analysis	50
Statista	55
Maximize Market Research	55
Insight Ace Analytics	60
Research Nester	60
Feed and Additive	75
Meticulous	80
IEMA	100

Insights

Global projections on the novel alternate protein market vary widely due to different assumptions on consumer adoption

Most analyses anticipate that **price-parity with animal protein** will be reached around **2035-2040,** so the **market is expected to accelerate after this point (beyond the timeframe of this report)**

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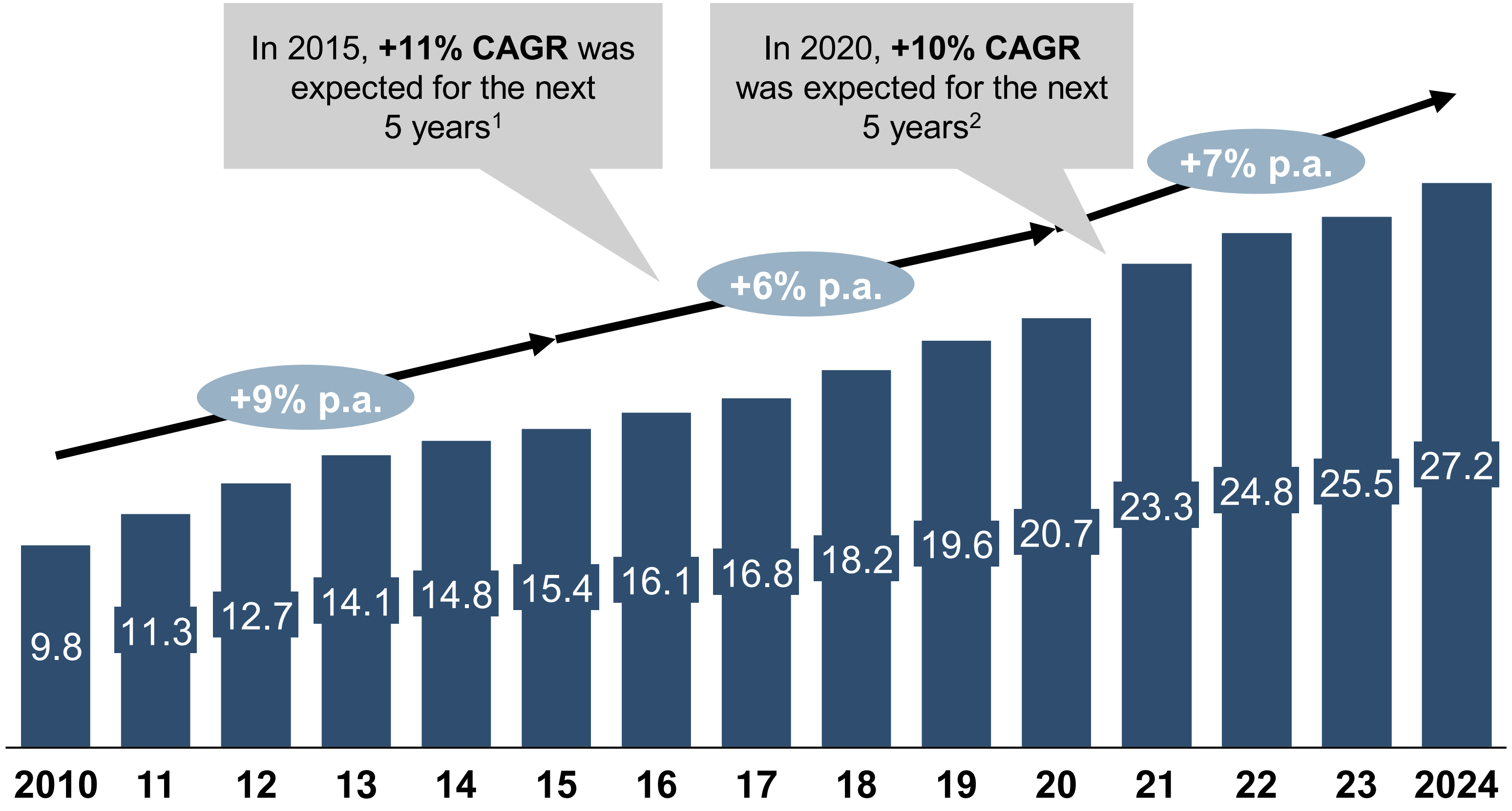
1. Based on total global protein market of USD 1 tn, including protein from all sources (animal and plant)

Source: Statista; Research Nester; IEMA; Meticulous research; Feed and additive report, Synthesis Capital; press search

Global market sizing | Past expectations of the global novel alternate protein market have not been met

Global novel alternate protein market size (human consumption only; excludes animal feed), retail value, USD bn



1. Food Engineering;
2. Meticulous Research

Source: Euromonitor, press search

Key insights

Past projections have often **over-estimated the actual growth**

A likely combination of **price, quality issues, market volatility,** and **supply chain disruptions** have challenged the more rapid expansion of novel alternate protein

Global market players | Globally, many players have entered the market

Category	Plant-based	Fermented	Cultivation	Insects
Meat	IMPOSSIBLE BEYOND MEAT Cargill ADM Tofurky LIGHTLIFE KERRY EMSLAND GROUP using nature to create Ingredion glanbia	PERFECT DAY Eden Brew Quorn TurtleTree NEW CULTURE Formo NEW CULTURE 100% CHEESE Animal Free c16 BIOSCIENCES motif FOODWORKS Fynd	FUTURE MEAT Vow AlephFarms® mosa meat UPSIDE Foods Finless FOODS Shiok Meats Seafood, reinvented MEMPHIS MEATS BlueNalu GOOD	MYBUGBAR DON BUGITO BUG BAZAAR DistriBugs BioInsect GaiaFood CRICKSTER™ CRIC Catch Your Bug INCREDIBLE INSECTS ALDENTO ChefBug DELIBUGS GRILLON LE PAIN CRICKBREAD INSTINCT Insektensnack Flying spark smart bites BITE CRICKEAT Chewow® MINUS FARM
Sea-food	GOOD CATCH BEYOND MEAT THE VEGETARIAN BUTCHER™ SEAVOLUTION forsea SAUKI ish™ Jack's Aiatineri Piscis	BlueNalu Shiok Meats WILDTYPE Bluu nourish INGREDIENTS	paleo FUNGI PERFECTI förij MUSHROOM Factory Mousam Valley Mushlabs	
Egg	MyEy evo JUST VEG EVERY cultured foods FOLLOW YOUR HEART ZERO EGG OGGS CRACKD	EVERY ONEGO bio evo Clara Foods VTT JUST Ingredion	Moolec CellX · FFX Future Food Factory X	
Dairy	THE ORIGINAL OATLY! alpro Silk Almond Breeze Milk	MIYOKO'S CREAMERY daiya deliciously dairy-free Violife GoodBelly PROBIOTICS kite hill TREELINE CHEESEMAKERS	Formo Better Dairy NEW CULTURE senara We love milk. change FOODS Perfect Day	

Source: Web research, updated Q1 2025

Global trends | We see global trends that support expected future market growth

Consumer trends

Despite slowing sales of some key players, consumers show **strong future intent to buy**

Nearly 1 out of 3 Americans are flexitarian and seek out alternate protein products, mostly driven by trends on **health, sustainability, and animal welfare**

Quality improvements

Greater emphasis is being put by novel AP players on improving **taste, texture, and health profiles** due to previous consumer dissatisfaction with these attributes

Technology and cost reduction

Several innovations are underway across the novel alternate protein value chain to improve nutrition and functionality and reduce cost

Category leaders (e.g., Impossible) introduced **lower prices** and precision fermentation players launched products at negative gross margin, betting initial losses can be recouped

The technology curve suggests that **price parity for alternate protein** is anticipated after 2035

Investments

After a boom in investments in 2021, the number and height of investments declined

However, AP ventures continue to raise successful rounds, e.g.:

- **Formo: USD 61 mn** for precision fermentation in Germany (Q3 2024)
- **Helaina: USD 45 mn** for precision fermentation in the US (Q3 2024)
- **Ecovative**: **USD 28 mn** for biomass fermentation in the US (Q3 2024)

Sustainability attention

Increasing attention on the sustainability impact of livestock farming is **accelerating investments in novel alternate protein R&D** (novel alternate protein can have 1-2% of the emissions of beef)

Some public organisations have launched programmes promoting alternate protein, e.g., New York City public schools “Meatless Monday” lunches

Global market dynamics

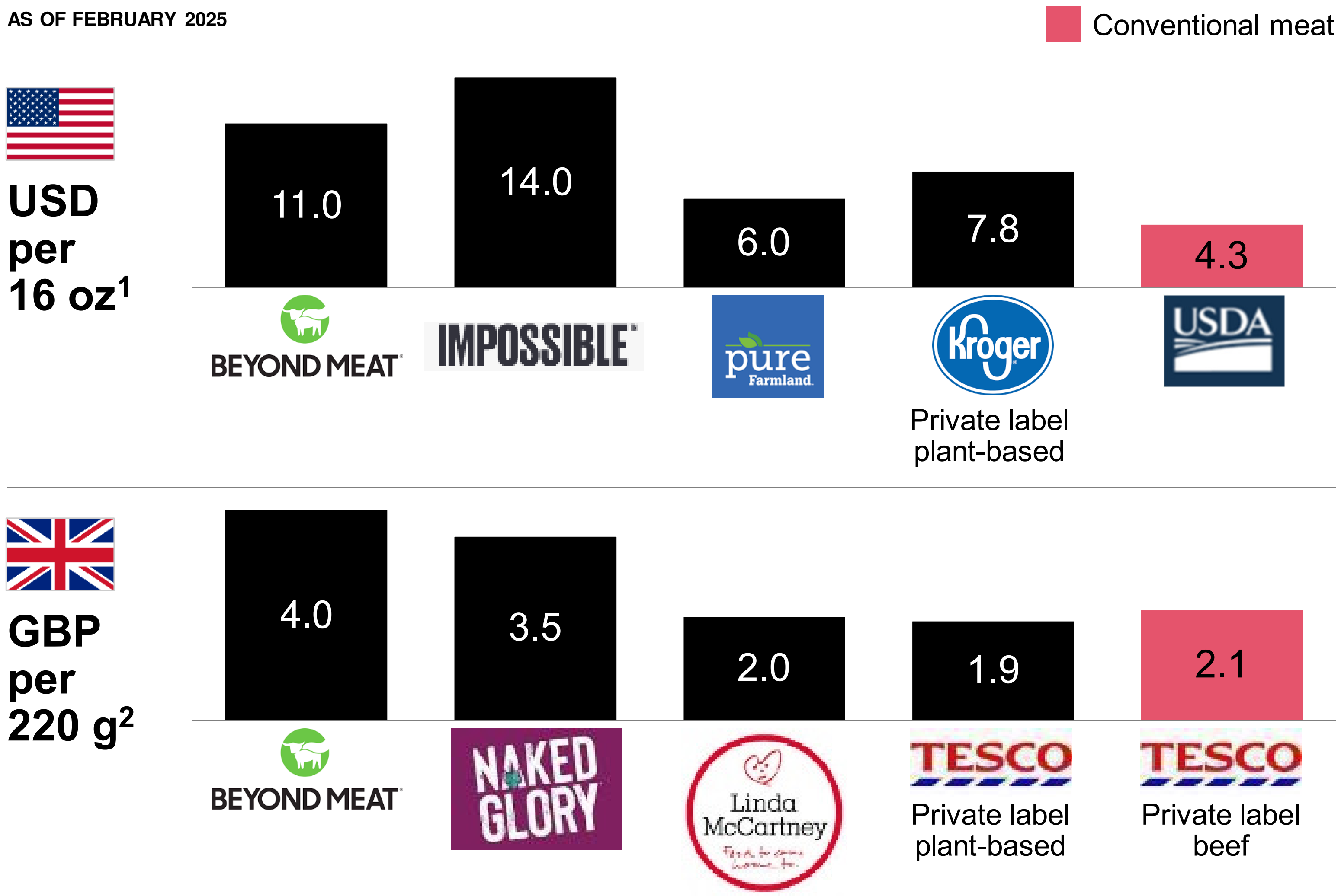
The novel alternate protein market is expanding into more geographies, with significant growth expected in Asia. (e.g., **China** with expected **CAGR of 12-20%**)

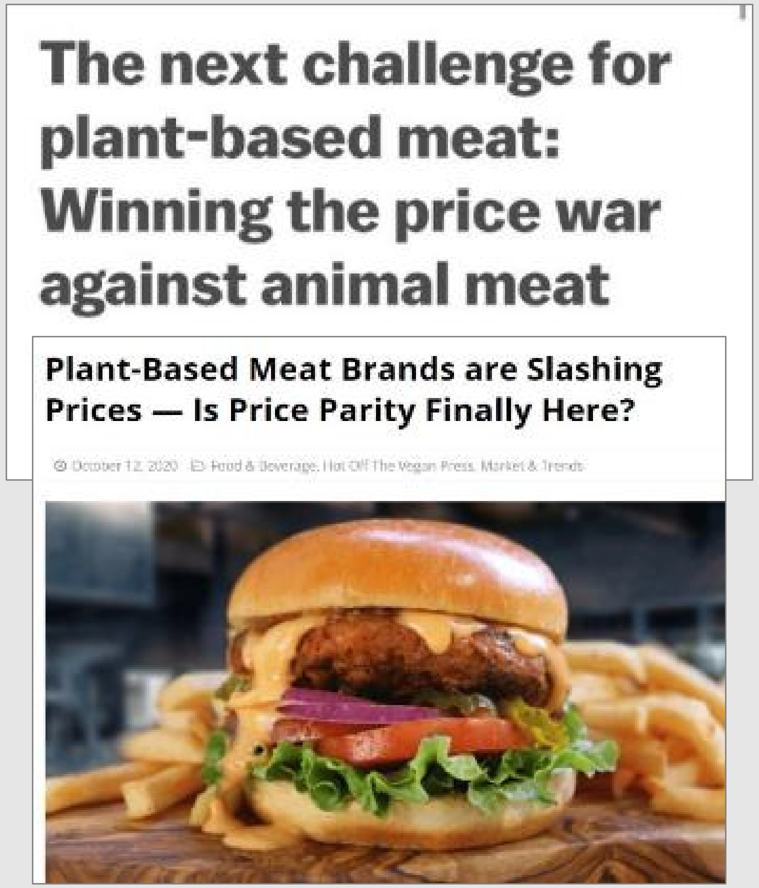
Source: EY report; Food Dive; The Good Food Institute; Statista; press search

Global trends | Most plant-based products are sold at a premium vs conventional meat

Retail sales price for plant-based product

AS OF FEBRUARY 2025




The next challenge for plant-based meat: Winning the price war against animal meat

Plant-Based Meat Brands are Slashing Prices — Is Price Parity Finally Here?

October 12, 2020 Food & Beverage, Hot Off The Vegan Press, Market & Trends

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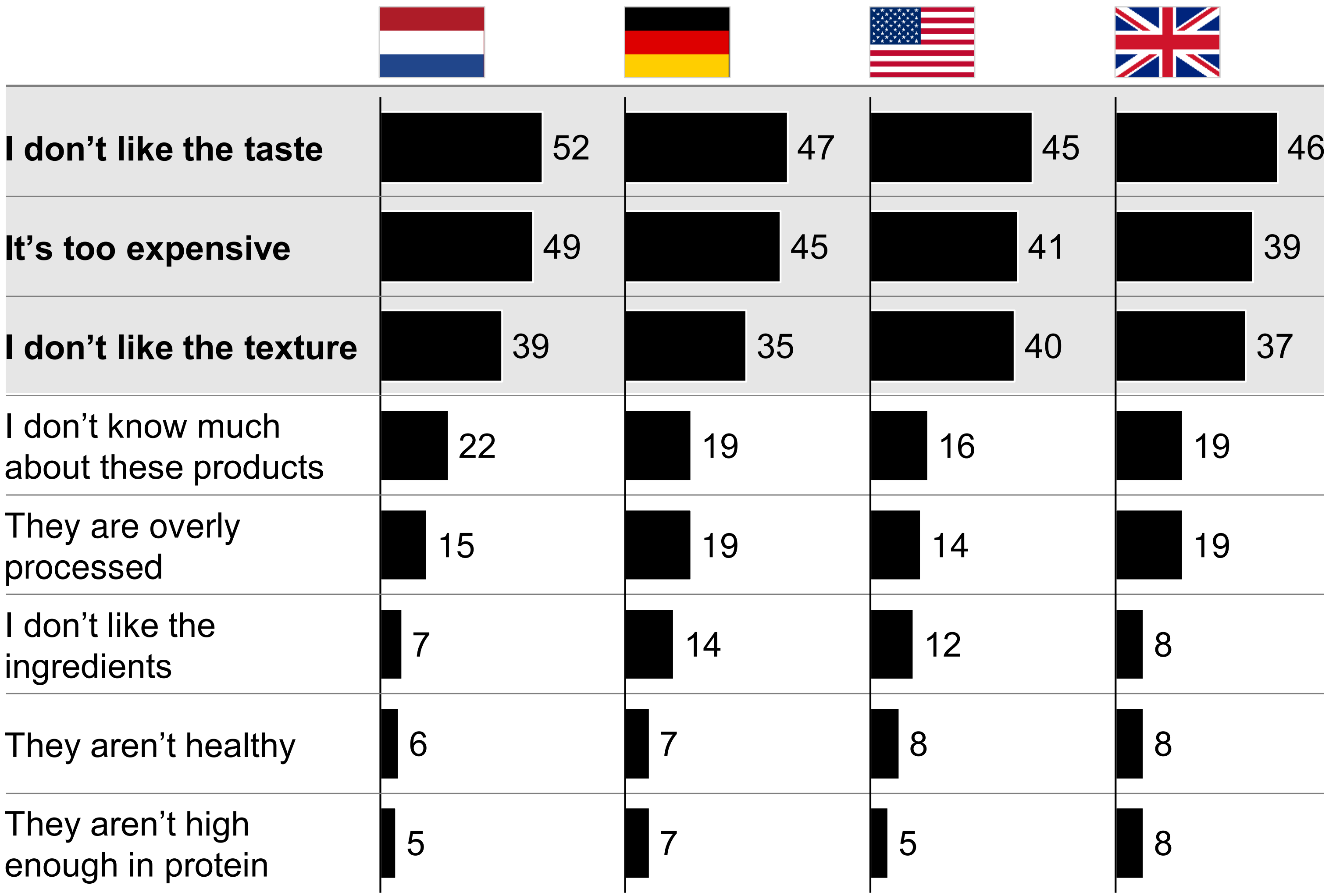
1. Average retail price for 16oz of ground beef in US on Amazon/InstaCart in February 2025
2. All prices from Tesco/Sainsbury/Ocada online website in February 2025

Source: Amazon; Tesco; Sainsbury; InstaCart

Global trends | Global Protein Survey indicates that price and taste are limiting adoption for consumers

2022 DATA; MORE RECENT NOT AVAILABLE

Why are you not consuming more alternate meat? Pick up to 3 reasons, % respondents



Poor consumer experience

Across geographies, nearly **half of consumers reported dissatisfaction with taste**

If products are to become mainstream, they will **need to meet a higher bar in terms of taste and texture**

High prices

Across geographies, **~2/5 of consumers** said they don't consume more alt protein **due to price**

13-25% of dairy consumers indicated a **willingness to pay at least 10% more for products with ESG values**, but the current premium for most alternatives is much higher

Source: McKinsey Global Protein Survey 2022, McKinsey Dairy Survey 2022

Global trends | Several innovations are underway in the alternate protein value chain to improve nutrition and functionality, and reduce cost

Emerging innovations

Agri (Inputs)

Advanced plant breeding using CRISPR-cas9 and advanced targeted non-GMO techniques to improve feedstock, including:

- **Ingredient yield improvements** - boost oil or protein concentration
- **Functional improvements** – enable easier processing or improvements in ingredient quality and function (e.g., high oleic acid oils)

Primary transformation from raw material

New protein sources – that better match animal protein, including:

- **Plant-based** – adoption of plant-based crops with superior functionality (e.g., mung bean with gelling qualities similar to eggs)
- **Fermentation** – production and extraction of fungal protein with unique properties that are similar to animal protein
- **Cultivated products** – lab-grown fats and tissues

Application and innovation and secondary transformation to finished product

Texturisation – improvements in visual presentation and mouth feel, including:

- **Improving existing extrusion technologies** (e.g., twin screw technology)
- **Scaffolding** – 3D printing and scaffolding of ingredients to create realistic textures and layering (e.g., steak marbling)
- **Weaving** – fibre spinning and aqueous fractionation methods to replace extrusion technology

New additives and improved formulations – new emulsifiers, thickeners, and active ingredients that improve texture, taste, and formulations

Distributions and sales network/ marketing and branding

Go-to-market partnerships to drive adoption and awareness (e.g., co-branding with QSR)

Grocers expanding private label offerings to new products (e.g., plant-based meals, mince pies)

Example players

Agri (Inputs): EQUINOM, Yield10 BIOSCIENCE, PLANTeDIT, calyxt, PAIRWISE, BENSON HILL

Primary transformation: 3FBIO, motif FOODWORKS, MycoTechnology, VerdientFoods, DUPONT, MISSION

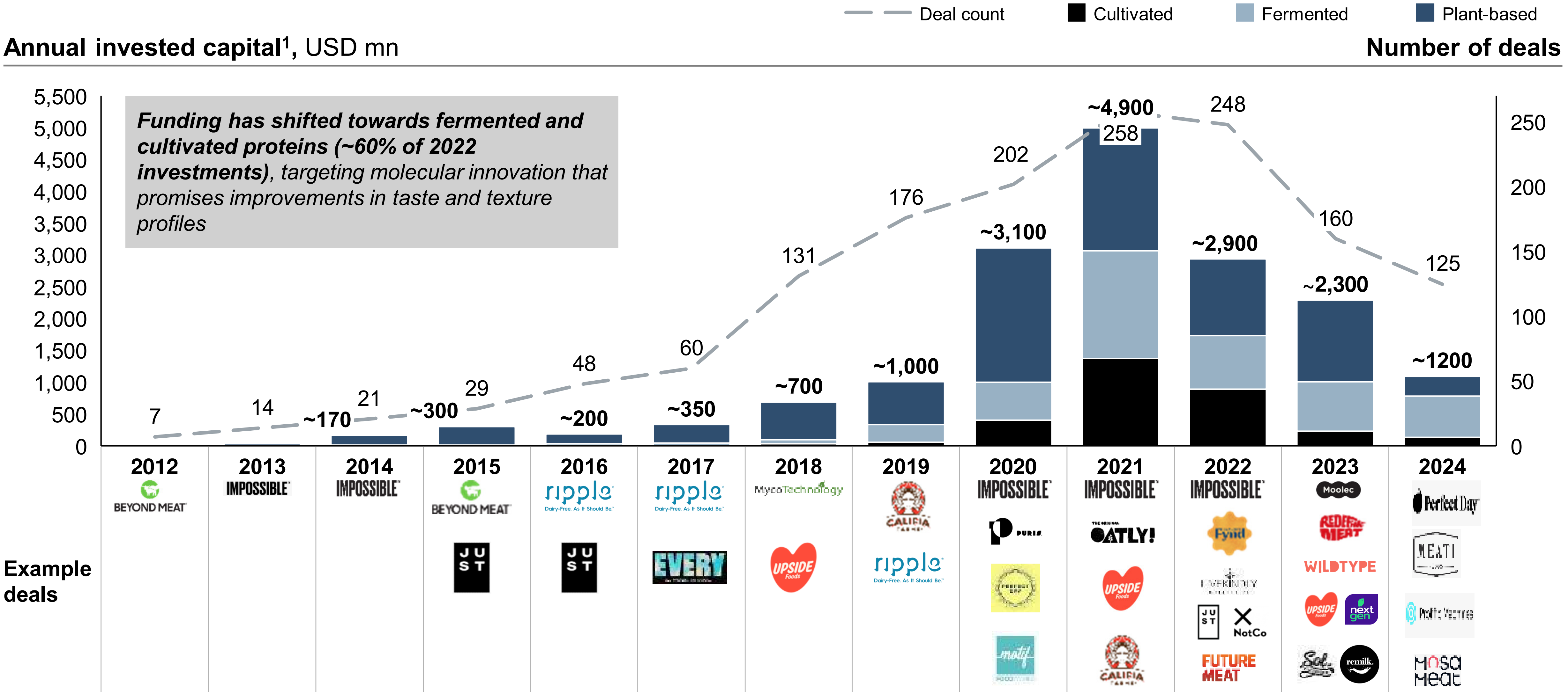
Integrated across steps: mosa meat, IMPOSSIBLE, Quorn, Cargill, JUST

Application and secondary transformation: ROQUETTE, redefine meat, rebellyous foods, BEYOND MEAT, motif, BUHLER, INNOVOPRO, NUTRIATI

Distribution and marketing: KFC, BURGER KING, ALDI, TESCO, GREGGS

Source: Expert interviews; The Good Food Institute; press search and company websites

Global trends | Investors have slowed investment in alternate protein since the boom in 2021, but investments still higher than 5 years ago



***Funding has shifted towards fermented and cultivated proteins (~60% of 2022 investments)**, targeting molecular innovation that promises improvements in taste and texture profiles*

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1. Invested capital including accelerator and incubator funding, angel funding, seed funding, equity and product crowdfunding, early-stage venture capital, late-stage venture capital, private equity growth/expansion, capitalisation, corporate venture, joint venture, convertible debt, and general debt completed deals

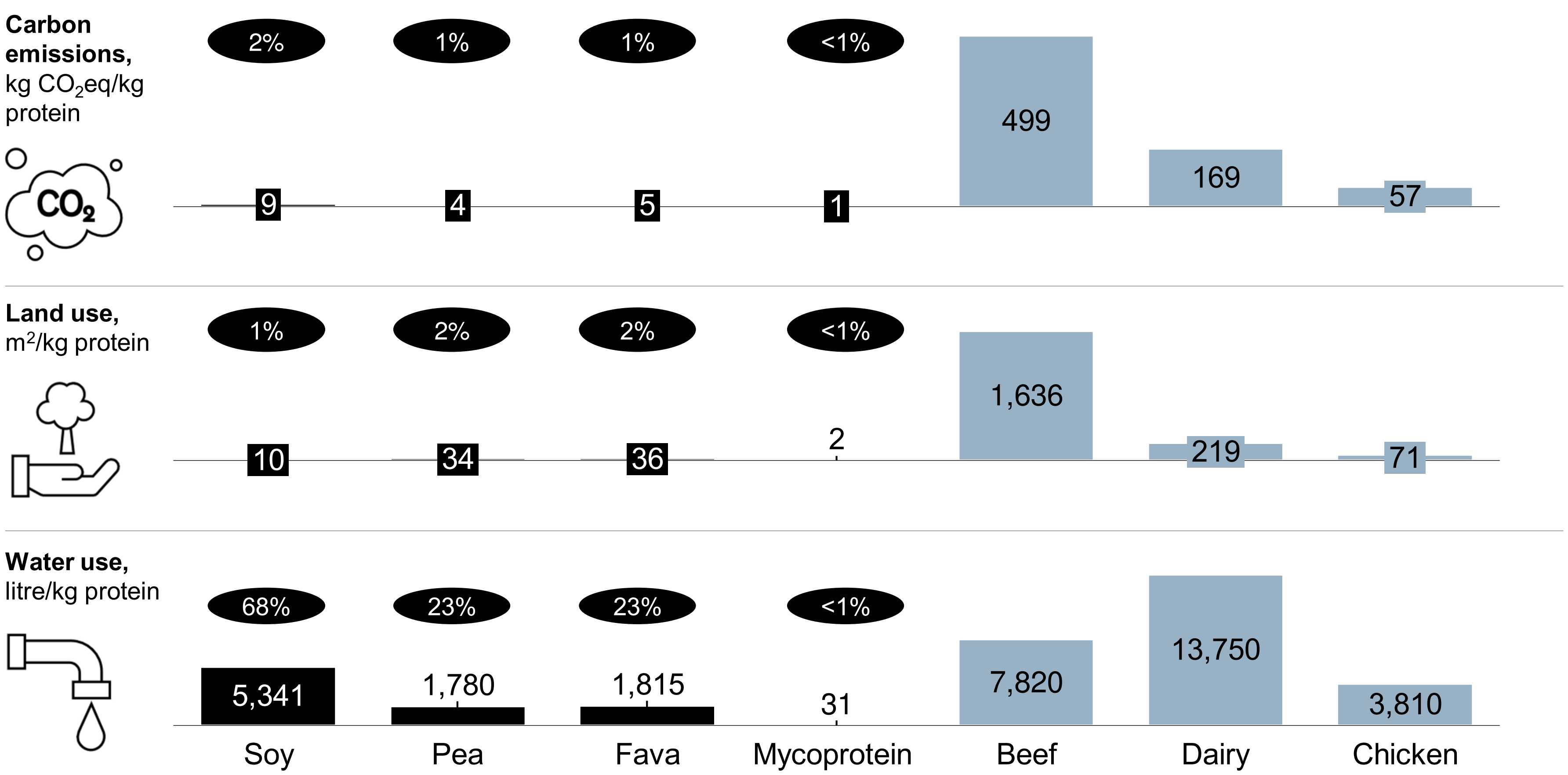
Source: GFI State of Industry reports; AgFunder; GFI analysis of PitchBook Data

Global trends | Novel alternate proteins emit only 1-2% of the carbon of beef production

NON-EXHAUSTIVE

xx Novel AP emissions, land, or water use compared to beef ■ Novel AP source or ingredient ■ Traditional protein source

Global emissions, land use, and water use of different protein sources



Key insights

Livestock is currently responsible for ~**12-20% of the total carbon emissions** and the industry is also land and water-intensive

Novel alternate proteins are more sustainable than conventional protein overall with much lower levels of carbon emissions, land use, and water use

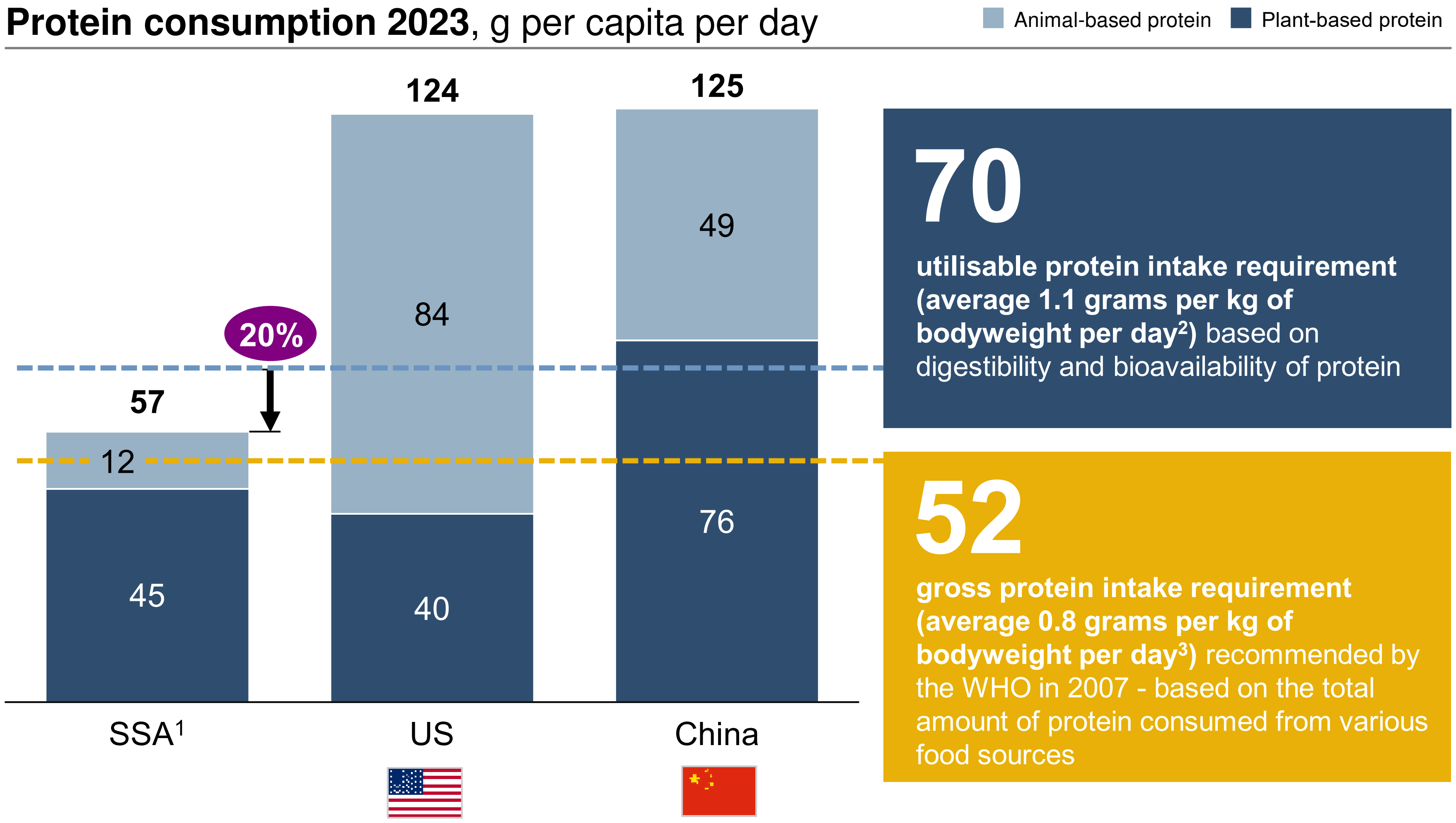
Source: Our World in Data, FAO, Quorn, expert input

Agenda

Sub-Saharan Africa | Novel alternate protein could play a role in expanding protein access in sub-Saharan Africa

Sub-Saharan Africa has a protein deficit of ~20% today	Unique among regions, sub-Saharan Africa has an average protein deficit of ~20% when compared to the minimum required intake based on utilisable protein recommendations, which consider the digestibility and bioavailability of protein
Animal protein demand in sub-Saharan Africa will double by 2035	Based on population growth and rising incomes, demand for animal protein will double in sub-Saharan Africa in 10 years. Even if this demand were met, sub-Saharan Africa would still be at a protein deficit
However, sub-Saharan Africa may not be able to reach the animal productivity required to meet that demand	Meeting this growing demand would require unprecedented increases in animal productivity in sub-Saharan Africa. This may mean that to fulfil its demand, sub-Saharan Africa may end up relying increasingly on imports (where it already imports ~6% of animal protein today)
And growing animal protein demand will also require an increase in animal feed	Even if sub-Saharan Africa grew animal productivity on a more realistic basis to at least meet some of its growing demand, this would require a significant increase in the amount of animal feed sub-Saharan Africa consumes (from ~7 mn tonnes in 2025 to ~29 mn tonnes in 2035) Currently, the protein composition in animal feed is largely soy. Meeting the realistic 2035 animal protein demand would mean that sub-Saharan Africa would need ~9 mn tonnes of soy, where sub-Saharan Africa already is at a deficit of ~1 mn tonnes today (which could grow to ~2-4 mn tonnes by 2035)
Although novel alternate proteins are unlikely to be a full substitute for animal protein, they could present a strategic opportunity with some unique considerations given the sub-Saharan African context	Novel alternate protein in sub-Saharan Africa could therefore play a role as a supplement to (but likely not a full replacement) for animal protein, to combat malnutrition, strengthen food security, provide affordable protein, and adapt to local cultural and dietary habits That being said, sub-Saharan Africa has several headwinds facing the novel alternate protein market, including many novel alternate proteins not being fully nutritionally equivalent to animal protein, high cultural preference for animal protein, low levels of food processing and formalisation of retail, and affordability challenges (for many consumers, animal protein is already expensive and novel alternate protein even more so)
Despite the market still being small, there are >100 start-ups in the sub-Saharan Africa novel alternate protein space	There are start-ups already working at this in sub-Saharan Africa, but the market is nascent. Despite growing potential, investment in the sector remains scarce limiting the ability of companies to scale

Protein gap | Sub-Saharan Africa has a ~20% utilisable protein deficit



Protein consumption 2023, g per capita per day

70

utilisable protein intake requirement (average 1.1 grams per kg of bodyweight per day[2]) based on digestibility and bioavailability of protein

52

gross protein intake requirement (average 0.8 grams per kg of bodyweight per day[3]) recommended by the WHO in 2007 - based on the total amount of protein consumed from various food sources

Key insights

Despite meeting the average global **recommended protein intake of ~52g per capita per day**, there likely is a **~13g per capita per day deficit** looking at the recommended utilisable protein (digestibility and bioavailability)

A large share of consumer protein in sub-Saharan Africa comes from plant sources (80% in SSA vs 40% in Europe), which have a lower amino acid balance

The **gap is expected to be much bigger in low-income rural areas** (e.g., some reports state Kenya has up to an ~80% deficit in rural areas)

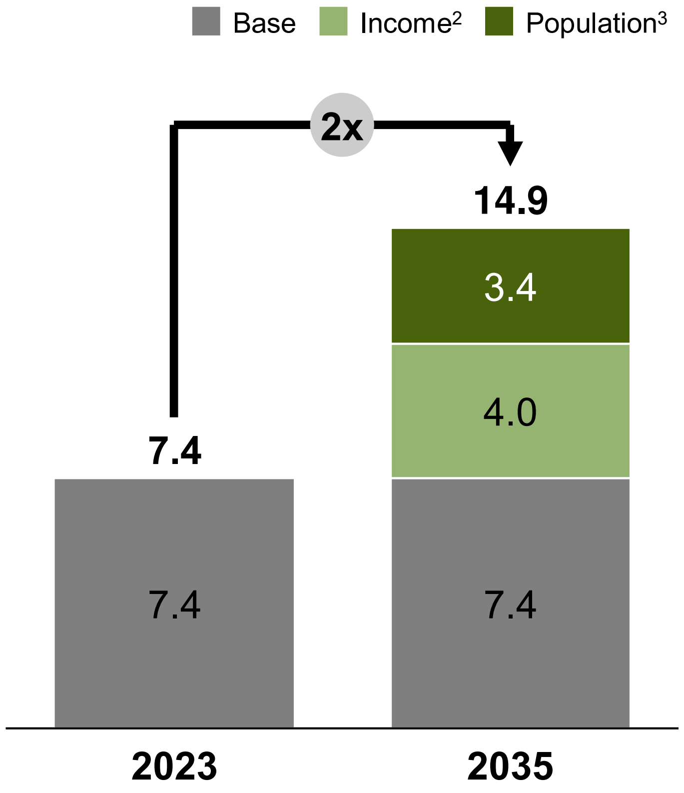
---

1. 2023 consumption estimate
2. Gram of protein per day per kg of bodyweight; from Moughan et al. (2021)
3. WHO/UNU/FAO, 2007

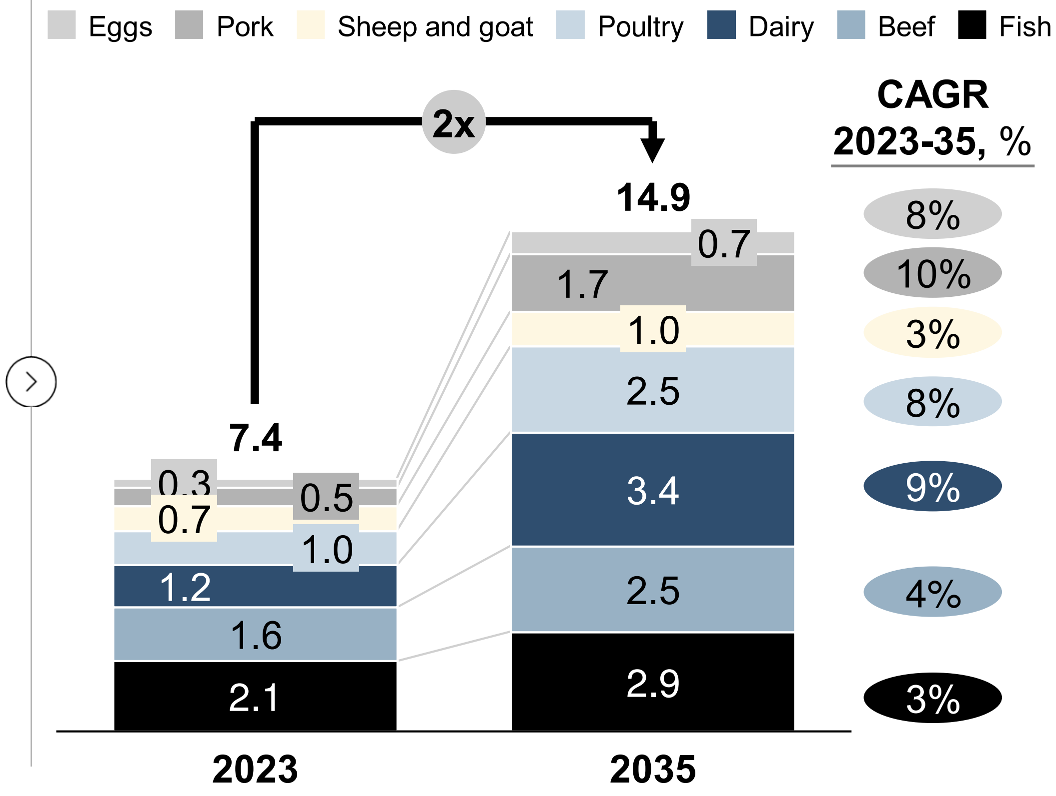
Source: Global food security: Population protein intakes and food sustainability indices; The metrics matter by Paul J. Moughan (2021), FAOSTAT; World Bank; World Population Review; International Monetary Fund; National Institutes of Health; expert input; Science Direct, Rapid Review Kenya Alternate Protein

Animal protein demand | Total animal protein demand in SSA is projected to double by 2035

Drivers of increased protein demand[1], mn tonnes



Animal protein demand in SSA by category, mn tonnes



Key insights

Animal protein consumption grows with increasing income and population, which leads to an **increase in protein consumption from 57g to 64g per capita per day**

Dairy, fish, beef, and poultry are expected to be dominant sources of animal protein (~80% share)

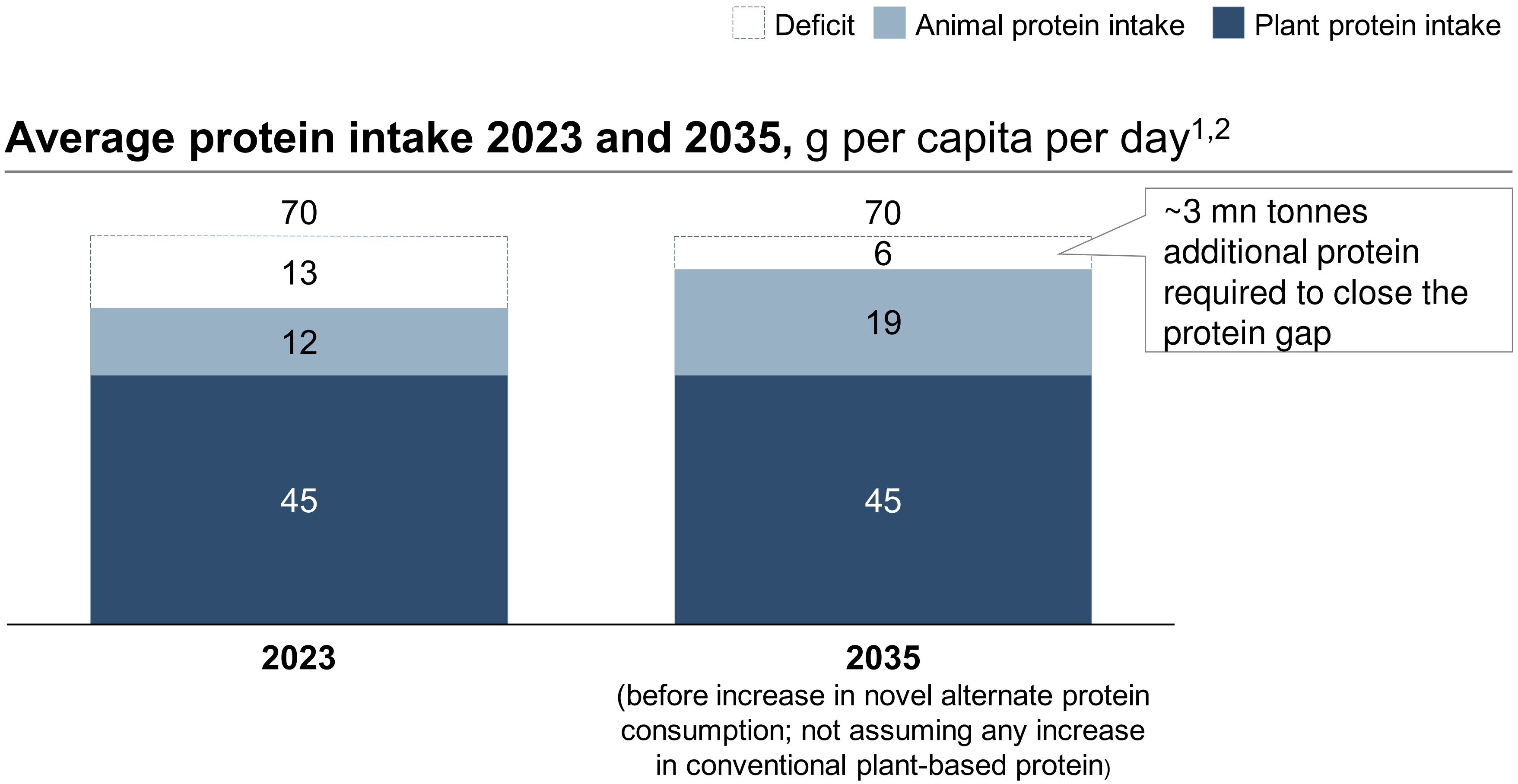
---

1. Total protein demand is based on total SSA production, minus exports plus imports, it is not corrected for food losses; therefore it is different from effective consumption
2. Based on IMF projection; protein consumption relative to income was benchmarked across countries (see appendix)
3. Based on World Population Review projections

Source: FAOSTAT; World Bank; World Population Review; International Monetary Fund

Protein deficit | Even with growing demand, there is still a protein deficit of 6 g person per day in 2035

Average protein intake 2023 and 2035, g per capita per day[1,2]



~3 mn tonnes additional protein required to close the protein gap

! *Actual protein intake is ~30% lower than protein demand due to food losses[3]*

Key insights

Even though protein consumption is projected to increase and the protein deficit halves from 2023-35, there **is still expected to be a protein gap[4]**

The estimated protein gap of **~6 g per capita per day** (~10%) in 2035 could (partially) be closed with novel alternate protein sources

---

1. Average actual intake is calculated based on the effective consumption in 2023 and estimate for 2035 based on expected income growth
2. Average recommended intake based on utilisable protein intake requirement (average 1.1.g per kilogram of bodyweight per day) from Moughan et al. (2021)
3. Based on FAOSTAT
4. Global food security: Population protein intakes and food sustainability indices; The metrics matter by Paul J. Moughan (2021)

Source: Global food security: Population protein intakes and food sustainability indices; The metrics matter by Paul J. Moughan (2021), FAOSTAT; World Bank; World Population Review; International Monetary Fund; National Institutes of Health; expert input; Science Direct

Animal productivity | However, meeting this demand would require significant improvements in animal productivity …

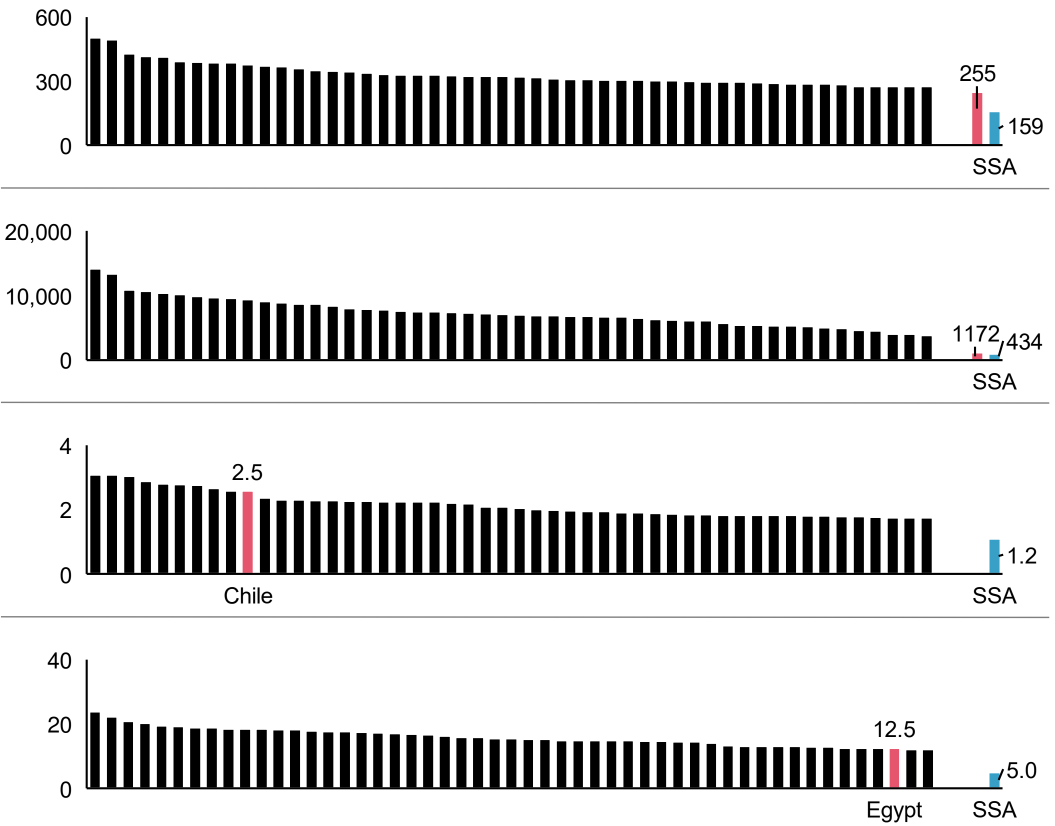
SELECT ANIMAL FOOD TYPES

🟦 Where SSA is in 2023 🟥 Where SSA would be need to be by 2035

Illustrative scenarios for SSA to meet demand

	Required improvement in animal productivity to meet 2035 demand	Scenario details		
		2023		2035
Beef kg per slaughtered animal	**1.6x** *herd productivity; assumes no increase in herd size[1]*	159 Kg of beef per slaughter; productivity like Ecuador (not in top 50 productive countries)	›	**255**
Milk litres per producing cow per annum	**2.7x** *herd productivity; assumes no increase in herd size[1]*	434 Annual litres per producing cow; productivity like El Salvador (not in top 50 productive countries)	›	**1,172**
Poultry meat kg per producing bird[2]	**2.1x** *bird productivity; assumes number of birds grows at 1.0% p.a.[3]*	1.2 Kg of meat per bird; productivity like Chile (in top 50 productive countries)	›	**2.5**
Eggs kg per producing hen	**2.5x** *hen productivity*	5.0 Annual kg of eggs per hen; productivity like Egypt (in top 50 productive countries)	›	**12.5**

Under these scenarios, SSA would catch up to the top productive countries for poultry and eggs
Productivity distribution of top 50 producing countries in each category



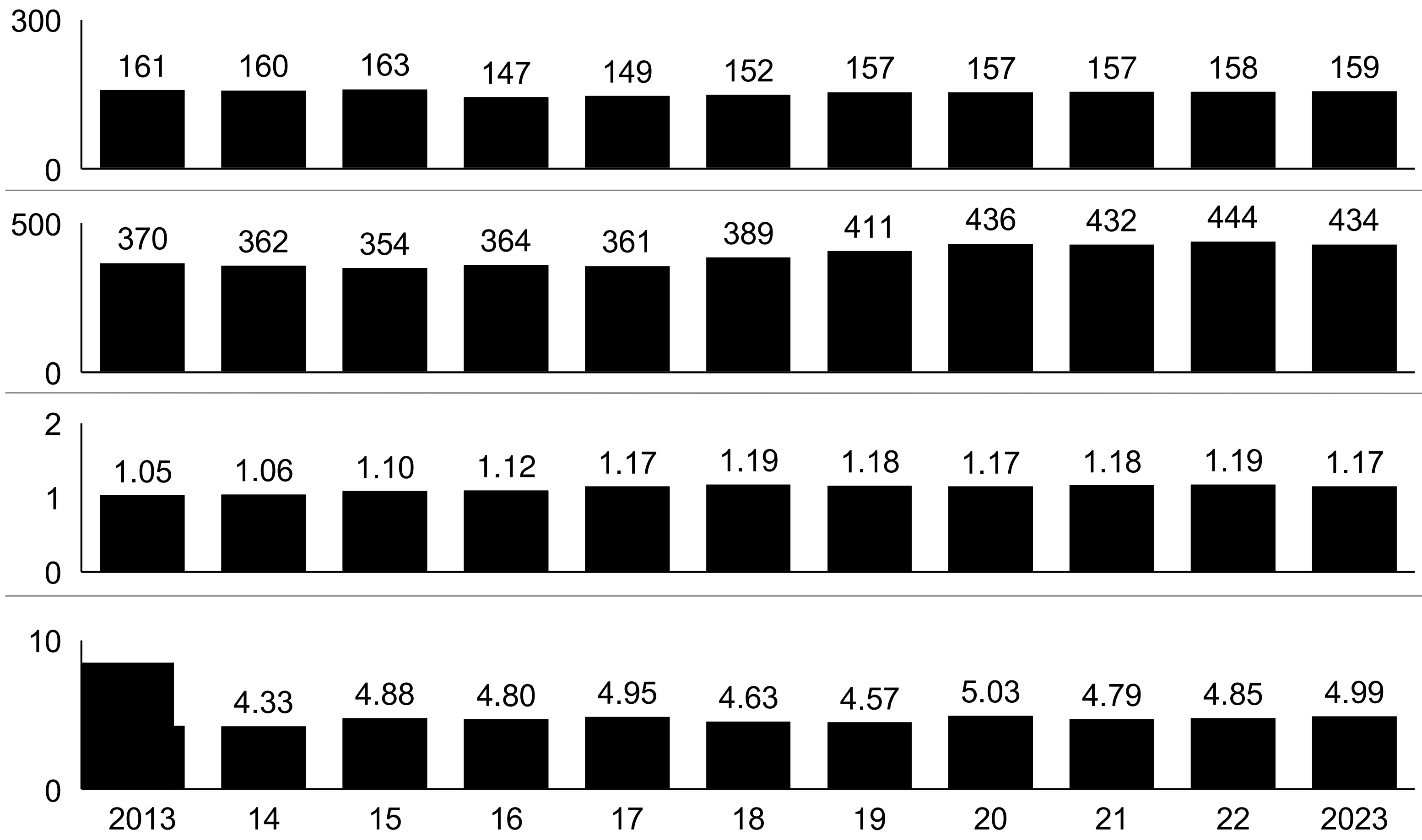
1. From 2023 (latest available data)
2. Chicken, turkeys, ducks, geese
3. Expert input

Source: FAOSTAT; World Bank; World Population Review; International Monetary Fund

Animal productivity | … where historically animal productivity has stayed relatively constant over the past decade

SELECT ANIMAL FOOD TYPES

SSA animal productivity, 2013-23



	2013	14	15	16	17	18	19	20	21	22	2023
Beef kg per slaughtered animal	161	160	163	147	149	152	157	157	157	158	159
Milk litres per producing cow per annum	370	362	354	364	361	389	411	436	432	444	434
Poultry meat kg per producing bird[1]	1.05	1.06	1.10	1.12	1.17	1.19	1.18	1.17	1.18	1.19	1.17
Eggs kg per producing hen		4.33	4.88	4.80	4.95	4.63	4.57	5.03	4.79	4.85	4.99

Change in animal productivity from 2013to 2023

0.99x

decrease in herd productivity; herd size increased by 16%

1.17x

increase in herd productivity; herd size increased by 8%

1.12x

increase in bird productivity; number of birds increased by 35%

1.15x

increase in hen productivity; number of hens increased by 18%

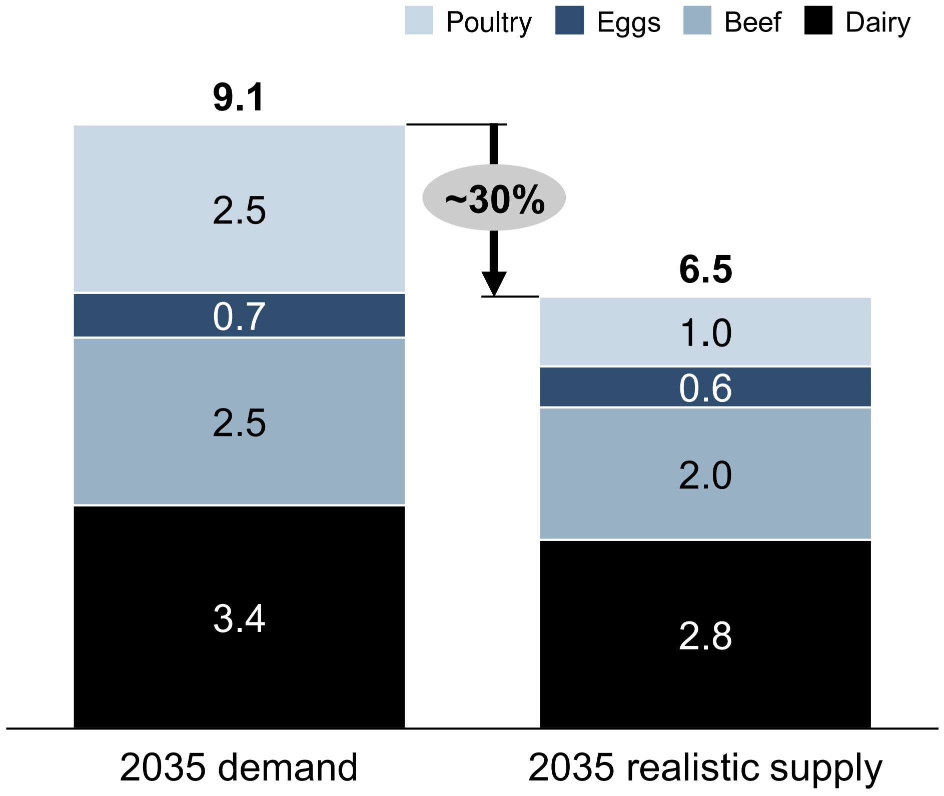
[1] Chicken, turkeys, ducks, geese

Source: FAOSTAT; World Bank; World Population Review; International Monetary Fund

Animal productivity | Assuming more realistic increases in animal productivity, SSA could meet ~70% of its 2035 animal protein demand

SELECT ANIMAL FOOD TYPES

Demand and realistic supply for select categories of animal protein[1], mn tonnes



Productivity growth assumed for the 2035 'realistic' supply[2]

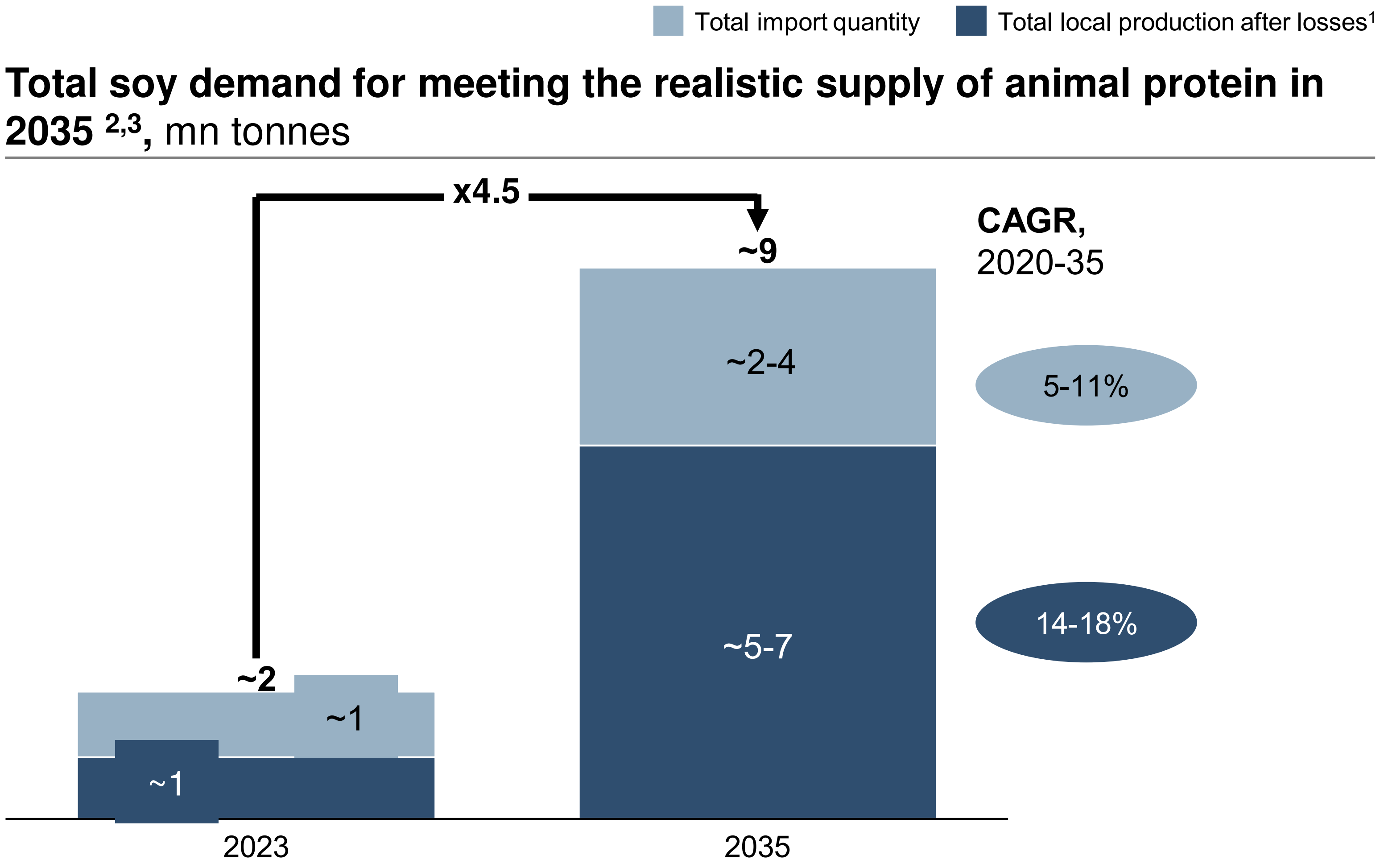
	2023	2035	
Beef kg per slaughtered animal	159	203	1.3x *assumes SSA achieves 65% of Turkey's 2023 productivity*
Milk litres per producing cow per annum	434	999	2.3x *assumes SSA achieves 50% of India's 2023 productivity*
Poultry meat kg per producing bird[1]	1.2	1.7	1.4x *assumes SSA achieves India's 2023 productivity*
Eggs kg per producing hen	5.0	11.7	2.4x *assumes SSA achieves India's 2023 productivity*

1. Animal protein from select food sources; excl. pork, sheep and goat, fish
2. Benchmarking against countries with similar production systems and growth trends

Source: FAOSTAT; World Bank; World Population Review; International Monetary Fund; expert input

Animal feed | Increasing animal productivity would increase the demand for soy in animal feed, while SSA is already at a soy deficit

Total soy demand for meeting the realistic supply of animal protein in 2035 [2,3], mn tonnes



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1. Assumption that yield losses are 60% in 2023 and reduces to between 30 and 50% by 2035
2. SSA only (excludes South Africa)
3. Import data accounts for cake of soy meal and soybean and local production accounts for soybean

Source: FAOSTAT; USDA; press search; market reports; expert interviews

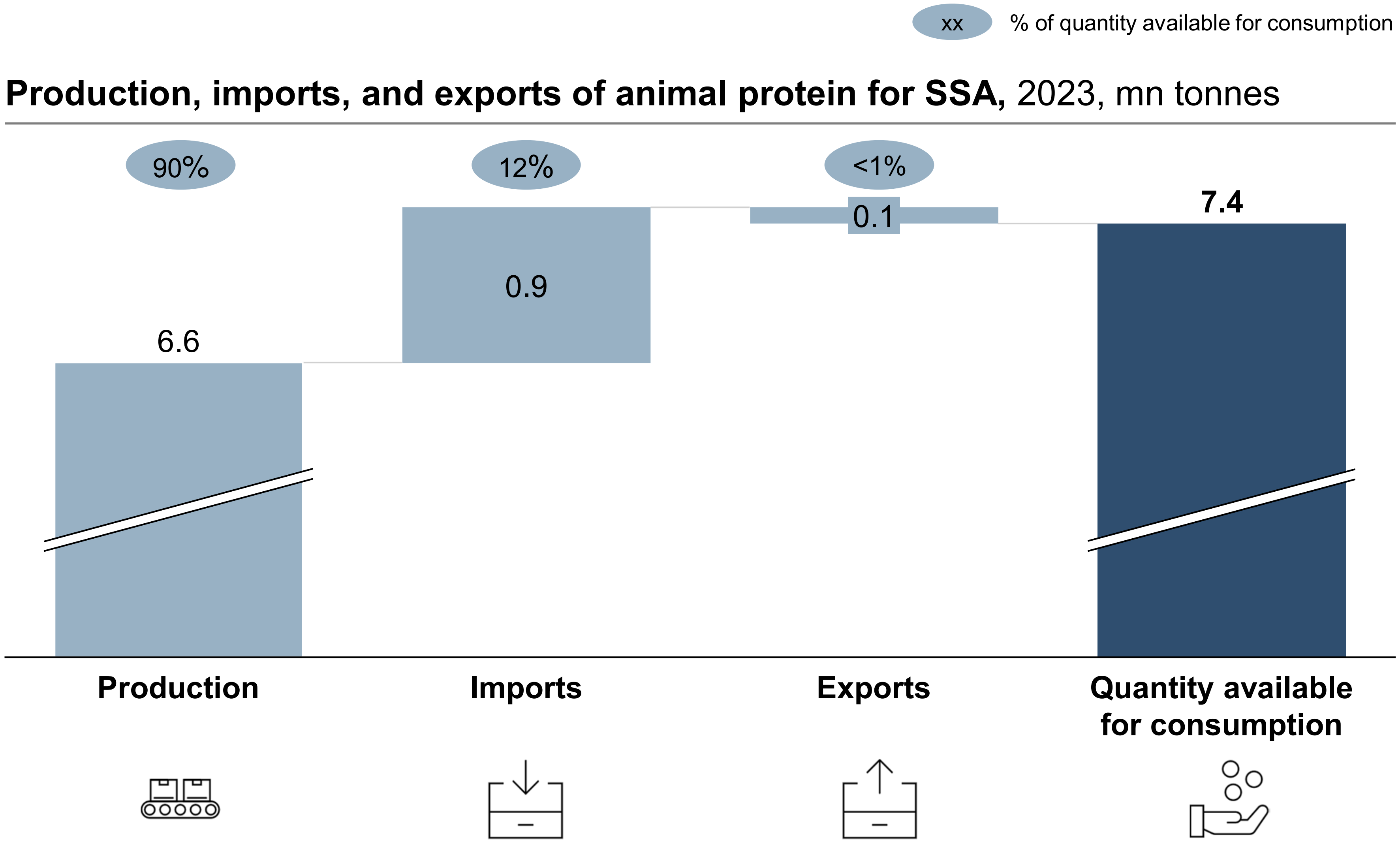
Key insights

While **>95% of soy globally is GMO**, most SSA countries have banned GMO soy, limiting imports to a few sources (e.g., India) which increases supply risks

Regional soy production is growing at ~12% annually (excl. losses), however, dependence on a few countries (e.g., Zambia and Tanzania) creates vulnerabilities (e.g., drought in Zambia)

Protein import | SSA imports 12% of its animal protein, creating an opportunity to bridge the supply deficit with novel alternative proteins

Production, imports, and exports of animal protein for SSA, 2023, mn tonnes



Key insights

12% of animal protein in SSA is imported, with West Africa accounting for >55% of all imports

Low imports suggest protein needs go unmet, especially during shortages (e.g., droughts in Kenya lead to reduced beef consumption rather than increased imports), implying people are consuming what is locally produced with limited protein supplements from imports

Source: FAOSTAT, UN Comtrade, expert input

Opportunity for sub-Saharan Africa | Novel alternate protein could present a unique strategic opportunity for sub-Saharan Africa…

… combat malnutrition

Sub-Saharan Africa is expected to still have a protein deficit in 2035 that would need to be filled

… reduce potential import dependence

Animal protein supply is unlikely to meet 2035 demand due to challenges growing animal productivity fast enough

… enable affordable protein

High price sensitivity limits meat affordability, creating space for some specific novel alternate protein products that can be made comparatively cheaper

… adapt to cultural and dietary habits

Traditional protein-rich sources (e.g., bambara nuts) are gaining **traction as climate-resilient options**

Religious fasting periods (e.g., in Ethiopia) increases demand for plant-based alternates

Widespread lactose intolerance in Africa

Globally, novel alternate protein demand is driven by sustainability, health, and animal welfare trends as substitutes for animal products. **In SSA, demand could be more about supplementing animal protein, not replacing it**

Source: expert input; press search

Implications for novel alternate protein in SSA | However, novel alternate proteins are unlikely to be a full substitute for animal protein in SSA

🟢 Positive trend for AP adoption 🔴 Negative trend for AP adoption 🟦 Detailed next

Trends for novel alternate protein

- 🟢 There is **availability and cultural acceptance of high-protein indigenous food sources** (e.g., bambara nuts, edible insects such as mopane worms and shea caterpillars) that could play a unique role in novel alternate protein
- 🔴 Leading research suggests that **most novel alternate proteins are not fully nutritionally equivalent** to animal protein (e.g., soy protein concentrate has a DIAAS[1] of 0.95 compared to 1.10 for chicken
- 🔴 **Animal proteins are expensive** for many sub-Saharan African consumers, and novel alternate proteins are even more expensive
- 🔴 Low formalisation of retail and consumption of processed/packaged products means that **access to novel alternate protein is a challenge** (e.g., even in a more comparatively developed consumer market like Kenya, only 20% of dairy is processed and only 30% of retail is formal)
- 🔴 Cultural dynamics may make moving away from meat challenging. **Meat and livestock may play an important cultural role** in Sub-Saharan Africa, with the consumption and ownership of these potentially signifying wealth in many communities

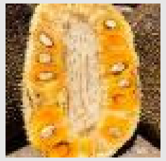
---

[1] Digestible Indispensable Amino Acid Score is a method to evaluate protein quality, taking into account the digestibility of individual essential amino acids

Source: FAOSTAT; World Bank; World Population Review; International Monetary Fund; National Institute of Health; Nestle Nutrition Institute; expert input

SELECT EXAMPLES

Indigenous protein | There is availability and cultural acceptance of high-protein indigenous food sources in SSA

Protein source		Protein content	Regions eaten (examples)
Crickets		55-75%	Burkina Faso Democratic Republic of Congo
Mopane worms		55-65%	Botswana Zimbabwe
Shea caterpillars		50-60%	Ghana Mali Burkina Faso
Bambara nuts		20-30%	Kenya Nigeria
Locusts		15-30%	Kenya South Sudan Somalia
Jackfruit seeds		5-8%	Uganda Tanzania Kenya

Source: National Institutes of Health; expert interviews

Nutritional equivalence | Most novel alternate proteins are not fully nutritionally equivalent to animal protein

NON-EXHAUSTIVE ■ Input for end-product □ End-product ↓ Lower than the average animal protein ↑ Higher than the average animal protein

		Protein type	DIAAS[1]		Protein content	
Animal protein		**Egg**	1.13		13%	
		Poultry	1.10		30%	
		Beef	1.10		26%	
		Salmon	1.08		21%	
		Whey protein concentrate	1.15		80%	
Novel alternate protein	■	**Soy protein concentrate**	0.95	↓	65%	↑
	■	**Pea protein concentrate**	0.89	↓	80%	↑
	■	**Mycoprotein**	0.97	↓	13%	↓
	□	**Beyond Meat**	0.93	↓	18%	↓
	□	**Crickets**	0.90	↓	65%	↑

Key insights

Animal protein **tend to have higher DIAAS** (contain more essential amino acids and are more digestible) and protein content than most novel alternate proteins, except cultivated protein, which is still in the testing stages

Inputs like concentrates and mycoprotein have a high DIAAS and protein content, but before reaching consumers, they need to be **processed into final products** (such as burger patties), which reduces the overall protein content

---

1. Digestible Indispensable Amino Acid Score is a method to evaluate protein quality, taking into account the digestibility of individual essential amino acids

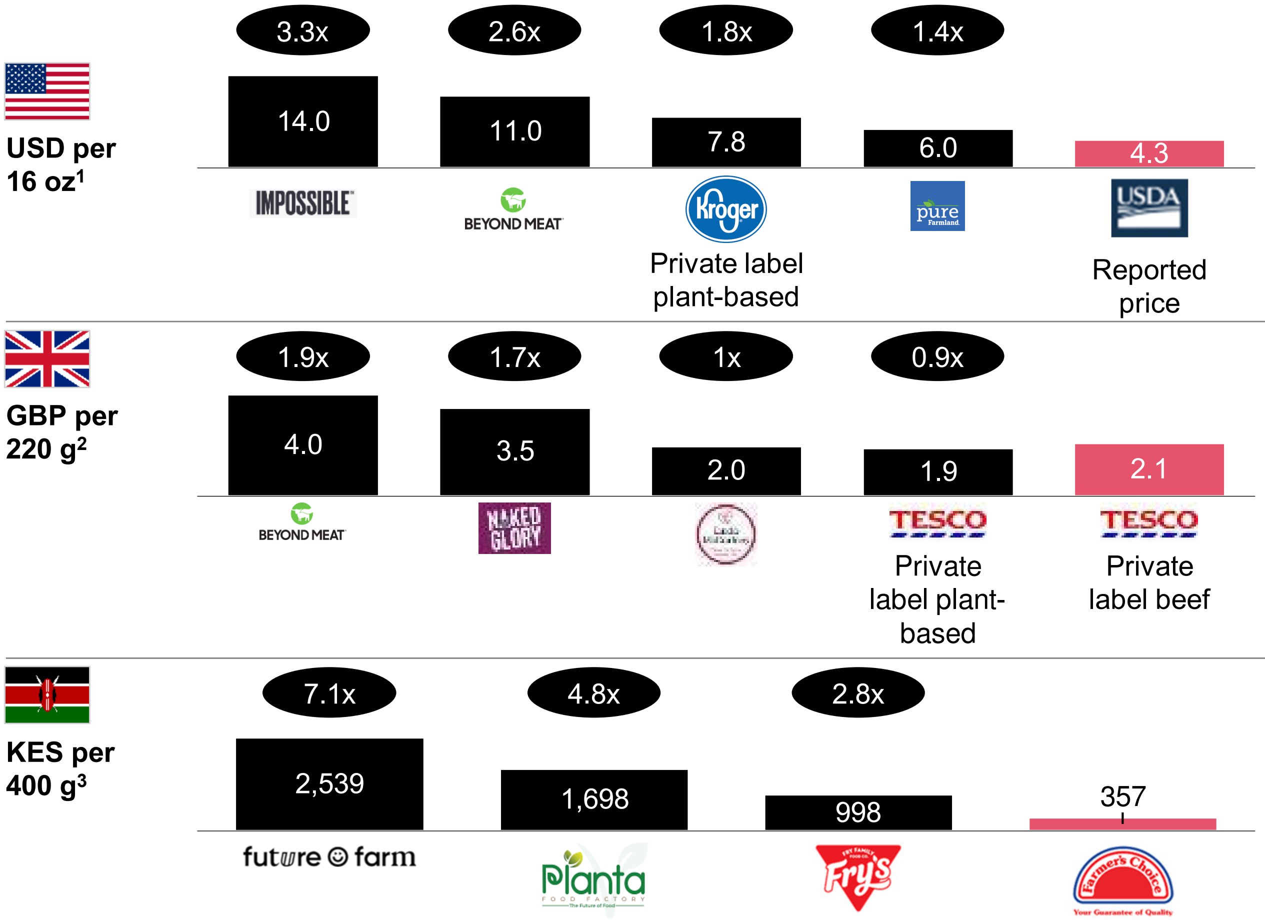
Source: USDA; expert interviews; National Institutes for Health; Science Direct; Healthline

Price of novel alternate protein | Animal proteins are expensive for many SSA consumers and novel alternate proteins are even more expensive

ILLUSTRATIVE: AS OF FEBRUARY 2025

● xx Premium between novel alternate protein and conventional meat ■ Novel alternate meat mimic 🟥 Conventional meat

Prices of food items



	Median monthly income	Difference between basic conventional meat item and median income
USD per 16 oz[1]	USD 1,800	423x
GBP per 220 g[2]	GBP 1,100	517x
KES per 400 g[3]	KES 10,000	28x

Key insights

Traditional animal protein in SSA tends to be costly for consumers, **taking up a larger proportion of median monthly incomes compared to consumers in developed nations** (e.g., UK, US)

Novel alternate proteins are even pricier than conventional protein in SSA; driven by high import costs and low production volumes – this could improve in the future with localised production at scale

1. Average retail price for 16 oz of ground beef in the US on Amazon/InstaCart in February 2025
2. Prices from Tesco/Sainsbury/Ocado online website in February 2025
3. Prices from Carrefour and Greenspoon websites in February 2025

Source: Amazon; Tesco; Sainsbury; InstaCart; Carrefour; Greenspoon; World Population Review; ExchangeRate.org; expert input

Sub-Saharan African landscape | A range of start-ups and players are emerging in SSA in different AP segments, but the space is still nascent

NON-EXHAUSTIVE

x Estimated number of players in SSA ☐ Human ☐ Animal ✓ Engaged during this research[1]

Novel plant-based

20+

- sossi ✓
- PlantA ✓
- de heus
- Fry's
- Only Plants ✓
- NUTRI FEEDS
- PHILAFRICA FOODS
- nu Zina
- ✓
- Veggie Victory
- KTOFU ✓

Novel fermented

0-10

- essential ✓
- mycoSURE ✓
- Tunga Nutrition
- immobazyme
- De Novo Dairy

Cultivated meat

0-10

- MOGALE ✓
- NEWFORM

Edible insects

40+[2]

- INSECTIPRO ✓
- LEGENDARY ✓
- FLYING FOOD
- EVONIK ✓
- Loop ✓
- regen organics ✓
- NEOFARM ✓
- UNIQUE BIOTECH
- CHANZI
- MAGOFARM
- endiro coffee

Start-ups say…

> Local sourcing of crops allows us to remain cost-competitive - Africa has interesting indigenous crops that aren't being used

> There's a big opportunity to supply to other countries. This is a technology that's far more efficient than traditional agriculture

> Africa has a real competitive advantage for BSF production in that the climate is optimal for year-round breeding

While there are a range of start-ups in this space, there is limited information available on investment sizes across the players

---

1. Engaged some South African companies as they are potential suppliers for the rest of SSA
2. Commercial insect farms considered

Source: Animal Frontiers: New insights into the emerging edible insect industry in Africa (2023); expert interviews

Agenda

Important note | As the market is still nascent and there are many unknowns even globally, we made some key assumptions

Overall assumptions

We do not assume as an input that alternate proteins will fill the protein gap

We take an **end-user perspective** (will the end-user adopt alternate proteins and why?) considering competition with other protein sources, access, and continued affordability gaps

We look out to 2035 (10 years), which somewhat reduces the unknowns (e.g., technology evolution)

Key assumptions made for market sizing *(detailed assumptions in each section and appendix)*

Short-listed technologies will reach some level of commercial scale and price parity by 2035

Taste, texture, and price will improve in line with what we expect globally

For true substitutes, we assume price parity (e.g., black soldier fly for livestock feed will have price parity with soybean meal)

Hard constraints that limit market growth will remain

Restrictions to what can be substituted or added in humanitarian food aid will remain

Availability of quality biomass for edible insects will remain a constraint

Consumer preferences can shift, but dramatic shifts unlikely to happen rapidly

Consumer switching behaviour is based on local focus groups, checked against global benchmarks

Methodology | In assessing the role for novel alternate protein in sub-Saharan Africa we look at 4 different market opportunities

Using ex-factory cost for all end-products (no margin and overhead costs included)[3]

Market		Description of opportunity sized	What we size for 2035 potential market demand		
			Ex-factory price of end-product	Novel AP input[1]	End-product[2]
Sub-Saharan Africa consumer market		Substitution of a share of animal protein with a novel alternate protein **or** providing a novel alternate protein as a supplement to existing diets	Meat mimics for premium market (e.g., plant-based burgers) Meat alternatives (e.g., vegetable "mince") Dairy alternatives (milk alternatives and value-added product alternatives) Nutritional alternatives (sports nutrition) Fortified foods (e.g., flour, bread, pasta, snacks)		✓
Sub-Saharan Africa humanitarian food aid		Substitution of existing protein or protein fortification for food distributed by humanitarian organisations (e.g., WFP, UNICEF) and local governments (can be in the form of emergency packs, general food aid, and school feeding)	Therapeutic foods (e.g., RUSFs/RUTFs) Fortified foods (e.g., flour, bread, cereals, porridge)	✓	
Sub-Saharan Africa animal feed	**Livestock**	Substitution of protein source (e.g., soy) in animal feed for livestock (e.g., poultry, dairy cows)	BSF meal	✓	
	Pet food	Substitution of protein source in pet food for companion animals (e.g., dogs, cats)	BSF-based pet food		✓
Sub-Saharan Africa supplying inputs to global novel alternate protein market		Substitution of protein source in pet food for export Export of fava and mung beans for fava or mung isolates	BSF-based pet food for export Fava beans for export, to be processed into isolate abroad	✓	

---

1. The protein ingredient such as the protein isolate, protein powder, or the insect
2. The end-product that is bought by consumers such as an alternate protein burger, alternate milk, or a bag of pet food
3. Allows for comparison against products that are being sized by ingredient instead of end-products

Methodology | We used a 6-step approach to prioritise the high-potential opportunities in the novel alternate protein market in sub-Saharan Africa

	Initial screening			Market sizing		
	1	2	3	4	5	6
Activity	**Identified a long list of novel alternate protein products across all 4 markets**	**Filtered based on technological maturity**	**Filtered based on feasibility scores to arrive at a shortlist**	**Estimated the market size for short-listed novel alternate protein opportunities**	**Outlined the investment potential**	**Identified critical enablers**
Method	Created a **long list of novel alternate protein products**[1] based on intersection of end-products and technologies	Removed technologies that are in **testing phase and not expected to reach commercial scale by 2035**	Developed a **heatmap** to compare novel alternate protein opportunities against feasibility (e.g., price, consumer preferences, availability of inputs, technological readiness, protein content, and sustainability impact)	Sized each opportunity based on consumer preferences, regulatory considerations, cost factors, and constraints on input availability	Determined the potential **investment size for SSA and global markets**	Determined requirements for short-listed opportunities to scale
Outcome	Long list of **51** novel alternate protein opportunities	**18** novel alternate protein opportunities eliminated, **33** remaining	**17** novel alternate protein opportunities eliminated, **16** remaining	← **16** major novel alternate protein opportunities further detailed with investment size and deep dive →		

---

1. Only technologies that currently exist in the market for given products have been included; therefore, technologies such as biomass fermentation and insect-based have been excluded for dairy and cultivated for dairy and sports nutrition

1. Long list of novel AP opportunities | We developed a long list based on end-products or ingredients made from different technologies

NON-EXHAUSTIVE

□ Novel AP opportunities for market sizing

Novel alternate protein opportunity for market sizing

End-product

For human consumption this is the **final consumer product;** for other market categories, this is the **novel alternate protein component** of the end-product

Consumer market
- Meat mimics/alternatives (e.g., sausages, novel TVP)
- Dairy mimics (i.e., milk, cheese, yoghurt)
- Egg mimics
- Fortified foods (i.e., staples, sauces, confectionary)
- Nutrition foods (i.e., snacks, sports nutrition)

Humanitarian food aid
- Ingredients for humanitarian food (RUTF/RUSF, food aid)

Animal feed
- Ingredients for compound livestock
- Pet food

Supply to global novel AP market
- Ingredients (e.g., isolates)
- Pet food

×

Technology

To produce the same end-products, different technologies can be used[1]

Ingredient

Raw materials

Technologies use different raw materials and ingredients; the same raw materials can be used to make different ingredients and end-products

Technology	Ingredient	Raw materials
Plant-based	Isolates Concentrates Hydrolysed protein Macroalgae …	Soy, pea, fava bean, lupin, mung bean, indigenous crop, spirulina …
Fermentation	Mycoprotein Microbial protein Microalgae (e.g., spirulina) …	Fungi Yeast Bacteria Algae …
Cultivation	Stem cells	N/A
Edible insects	Insect isolate Defatted meal Whole insect …	Crickets, mealworm, grasshopper, locusts, termites, caterpillars, black soldier flies …

Rationale

The novel alternate protein opportunity is sized on the end-product x technology level

Because the technology can have a significant impact on the product, the technologies are sized separately

The ingredients raw materials are not sized separately because each technology can use multiple different input sources for similar end-products

---

1. Currently there are also combinations between conventional meat and alternative technologies used (e.g., combined meat and plant-based burger); there are no combinations of different technologies

Source: expert input

1. Long list of novel AP opportunities | Long list of 51 novel alternate protein opportunities that sub-Saharan Africa could explore (1/4)

NON-EXHAUSTIVE

Market	End-product		Technology[1]	Novel AP opportunity	Example product	Ingredients	Raw materials
Sub-Saharan Africa consumer market	**Premium meat mimics**		Plant-based	① Premium plant-based meat mimic	Pea-based burger or sausage	Isolates, concentrates, hydrolysed, TVP	Soy, yellow and green pea, lupin, chickpea, mung bean, fava bean, indigenous crops
			Biomass fermentation	② Biomass fermented meat mimic	Chicken pieces from fermented fungi	Mycoprotein (fungi), single-cell proteins (e.g., yeast, bacteria, algae)	Fusarium venenatum (fungal protein), mycelium
			Precision fermentation	③ Precision fermented meat mimic	Sausage with precision fermented fat	Recombinant meat protein (myoglobin, soy leghemoglobin, actin, myosin)	Engineered microbes
			Cultivated	④ Cultivated meat mimic	Steak from cultivated meat	Cultured animal cells	…
			Insect-based	⑤ Insect-based meat mimic	Cricket burger	Defatted meals	Crickets, mealworm, grasshopper
	Mass market meat alternatives		Plant-based	⑥ Mass market plant-based meat alternative	Vegetable protein chunks	Isolates, concentrates, hydrolysed, TVP	Soy, yellow and green pea, lupin, chickpea, mung bean, fava bean, indigenous crops
	Dairy mimics	Milk mimic	Plant-based	⑦ Plant-based milk mimic	Soy or almond milk	Isolates, hydrolysed	Soy, yellow and green pea, rice, hemp, oat, almond, coconut
			Precision fermentation	⑧ Precision fermented milk mimic	Milk alternative	Whey protein alternative (beta-lactoglobulin, alpha-lactalbumin)	Engineered microbes
		Value-add dairy mimic	Plant-based	⑨ Plant-based value-added dairy mimic	Pea yoghurt or cashew cheese	Isolates, hydrolysed	Soy, yellow and green pea, cashew, almond, coconut
			Precision fermentation	⑩ Precision fermented value-added dairy mimic	Value-add dairy alternative	Caseins (for cheese), whey alternative (for yoghurt)	Engineered microbes
	Egg mimics		Plant-based	⑪ Plant-based eggs mimic	Mung-based egg white liquid	Isolates, hydrolysed	Mung bean, chickpea, soy, yellow and green pea, lupin
			Precision fermentation	⑫ Precision fermented egg mimic	Cheese from precision fermentation	Recombinant egg proteins (ovalbumin, ovotransferrin, Lysozyme)	Engineered yeast/microbes
	Nutritional	Sports nutrition (e.g., protein powders, shakes, recovery drinks, bars)	Plant-based	⑬ Plant-based sports nutrition	Hemp protein bar	Isolates, concentrates, hydrolysed, algae-based	Soy, yellow and green pea, rice, fava bean, chickpea, hemp, spirulina, chlorella, duckweed, indigenous crops
			Biomass fermentation	⑭ Biomass fermented sports nutrition	Protein shake from mycoprotein	Mycoprotein, microbial	Corynebacterium glutamicum, methylococcus capsulatus, mycelium
			Precision fermentation	⑮ Precision fermented sports nutrition	Protein shake from precision fermentation	Whey protein alternative (beta-lactoglobulin, alpha-lactalbumin)	Engineered yeast/microbes
			Insect-based	⑯ Insect-based sports nutrition	Supplement from cricket	Hydrolysed	Crickets, mealworm, grasshopper, locusts, termites, caterpillars

1. Only technologies that currently exist in the market for given products have been included; therefore, technologies such as biomass fermentation and insect-based have been excluded for dairy mimics and cultivated for dairy mimics and sports nutrition

Source: expert input

1. Long list of novel AP opportunities | Long list of 51 novel alternate protein opportunities that sub-Saharan Africa could explore (2/4)

NON-EXHAUSTIVE

Market	End-product		Technology[1]	Novel AP opportunity	Example product	Ingredients	Raw materials
Sub-Saharan Africa consumer market	**Nutritional**	Infant nutrition (e.g., fortified formula, baby foods, breast milk replacement)	Plant-based	⑰ Plant-based infant nutrition	Pea-based infant milk powder	Isolates, concentrates, hydrolysed proteins	Soy, yellow and green pea, oat, almond
			Biomass fermentation	⑱ Biomass fermented infant nutrition	Infant milk powder with mycoprotein	Mycoprotein, microbial	Corynebacterium glutamicum, methylococcus capsulatus
			Precision fermentation	⑲ Precision fermented infant nutrition	Infant milk powder from precision fermentation	Whey protein alternative (Beta-lactoglobulin, Alpha-lactalbumin)	Engineered yeast/microbes
		Foods (e.g., flour blends, pasta, snacks, porridges)	Plant-based	⑳ Plant-based fortified consumer foods	Fortified foods with pea protein	Isolates, concentrates, hydrolysed proteins, algae-based	Yellow and green pea, lupin, fava bean, chickpea, mung bean, duckweed
			Biomass fermentation	㉑ Biomass fermented fortified consumer foods	Fortified foods with mycoprotein	Mycoprotein, microbial	Fusarium venenatum, methylococcus capsulatus
			Precision fermentation	㉒ Precision fermented fortified consumer foods	Fortified foods with precision fermentation based protein	…	…
			Insect-based	㉓ Insect-based fortified consumer foods	Fortified foods with insect protein	Insect isolate, defatted meal	Crickets, mealworm, grasshopper, locusts, termites, caterpillars
Sub-Saharan Africa humanitarian food aid	**Nutritional**	Therapeutic foods (e.g., RUTF and RUSF)	Plant-based	㉔ Plant-based therapeutic foods	RUTF with chickpea isolate	Isolates, hydrolysed protein	Regular crops (soy, yellow and green pea, oat, almond) or indigenous crops (bambara nuts, amaranth, moringa, cowpeas, lablab, marama, baobab)
			Biomass fermentation	㉕ Biomass fermented therapeutic foods	RUTF with mycoprotein	Single-cell protein	Corynebacterium glutamicum, methylococcus capsulatus
			Precision fermentation	㉖ Precision fermented therapeutic foods	RUTF with precision fermentation	Whey protein alternative (beta-lactoglobulin, alpha-lactalbumin)	Engineered yeast/microbes
			Insect-based	㉗ Insect-based therapeutic foods	RUTF with insect protein	Insect isolate, defatted meal	Crickets, mealworm, grasshopper, locusts, termites, caterpillars
	General Aid	Staples (e.g., flour blends, enhanced grains, pasta and porridge)	Plant-based	㉘ Plant-based fortified general humanitarian food aid	Fortified staples with pea protein	Isolates, hydrolysed protein	Regular crops (soy, yellow and green pea, oat, almond) or indigenous crops (bambara nuts, amaranth, moringa, cowpeas, lablab, marama, baobab)
			Biomass fermentation	㉙ Biomass fermented fortified general humanitarian food aid	Fortified staples with mycoprotein	Single-cell protein	Fusarium venenatum, methylococcus capsulatus
			Precision fermentation	㉚ Precision fermented fortified general humanitarian food aid	Fortified staples with precision fermentation	Whey protein alternative (beta-lactoglobulin, alpha-lactalbumin)	Engineered yeast/microbes
			Insect-based	㉛ Insect-based fortified general humanitarian food aid	Fortified staples with insect protein	Insect isolate, defatted meal	Crickets, mealworm, grasshopper, locusts, termites, caterpillars

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1. Only technologies that currently exist in the market for given products have been included; therefore, technologies such as biomass fermentation and insect-based have been excluded for dairy mimics and cultivated for dairy mimics and sports nutrition

Source: expert input

1. Long list of novel AP opportunities | Long list of 51 novel alternate protein opportunities that sub-Saharan Africa could explore (3/4)

NON-EXHAUSTIVE

Market	End-product		Technology[1]	Novel AP opportunity	Example product	Ingredients	Raw materials
Sub-Saharan Africa humanitarian food aid	**School feed**	Staples (e.g., flour blends, enhanced grains, pasta and porridge)	Plant-based	㉜ Plant-based fortified school feeding	Fortified staples with pea protein	Isolates, concentrates, hydrolysed proteins, algae-based	Regular crops (soy, yellow and green pea, oat, almond) or indigenous crops (bambara nuts, amaranth, moringa, cowpeas, lablab, marama, baobab)
			Biomass fermentation	㉝ Biomass fermented fortified school feeding	Fortified staples with mycoprotein	Single-cell proteins	Fusarium venenatum, methylococcus capsulatus
			Precision fermentation	㉞ Precision fermented fortified school feeding	Fortified staples with precision fermentation	Whey protein alternative (beta-lactoglobulin, alpha-lactalbumin)	Engineered yeast/microbes
			Insect-based	㉟ Insect-based fortified school feeding	Fortified staples with insect protein	Insect isolate, defatted meal	Crickets, mealworm, grasshopper, locusts, termites, caterpillars
Sub-Saharan Africa animal feed	**Pet food**		Plant-based	㊱ Plant-based pet food	Algae pet food	Isolates, concentrates	Pea, fava bean, chickpeas, mung bean, bambara nut?
			Insect-based	㊲ Insect-based pet food	BSF pet food	Insect powder	BSF
			Biomass fermentation	㊳ Biomass fermented pet food	Pet food from fermentation	Mycoprotein	Fusarium venenatum (fungal protein), mycelium
			Cultivated	㊴ Cultivated pet food	Pet food from cultivated meat	.	.
	Livestock feed		Plant-based	㊵ Plant-based livestock feed	Algae livestock feed	Concentrates, algae-based	Lupin, pea, fava bean, chickpeas, mung bean, spirulina, bambara nut
			Insect-based	㊶ Insect-based livestock feed	BSF livestock feed	Insect powder	BSF, meal worms
			Biomass fermentation	㊷ Biomass fermented livestock feed	Livestock feed from fermentation	Mycoprotein	Mycelium powder
Sub-Saharan Africa supplying inputs to global novel AP market	**Pet food**		Plant-based	㊸ Plant-based pet food	Algae pet food	Isolates, concentrates	Pea, fava bean, chickpeas, mung bean, bambara nut?
			Insect-based	㊹ Insect-based pet food	BSF pet food	Insect powder	BSF
			Biomass fermentation	㊺ Biomass fermented pet food	Pet food from fermentation	Mycoprotein	Fusarium venenatum (fungal protein), mycelium
			Cultivated	㊻ Cultivated pet food	Pet food from cultivated meat	.	.

1. Only technologies that currently exist in the market for given products have been included; therefore, technologies such as biomass fermentation and insect-based have been excluded for dairy mimics and cultivated for dairy mimics and sports nutrition

Source: expert input

UK International Development
Partnership | Progress | Prosperity

1. Long list of novel AP opportunities | Long list of 51 novel alternate protein opportunities that sub-Saharan Africa could explore (4/4)

NON-EXHAUSTIVE

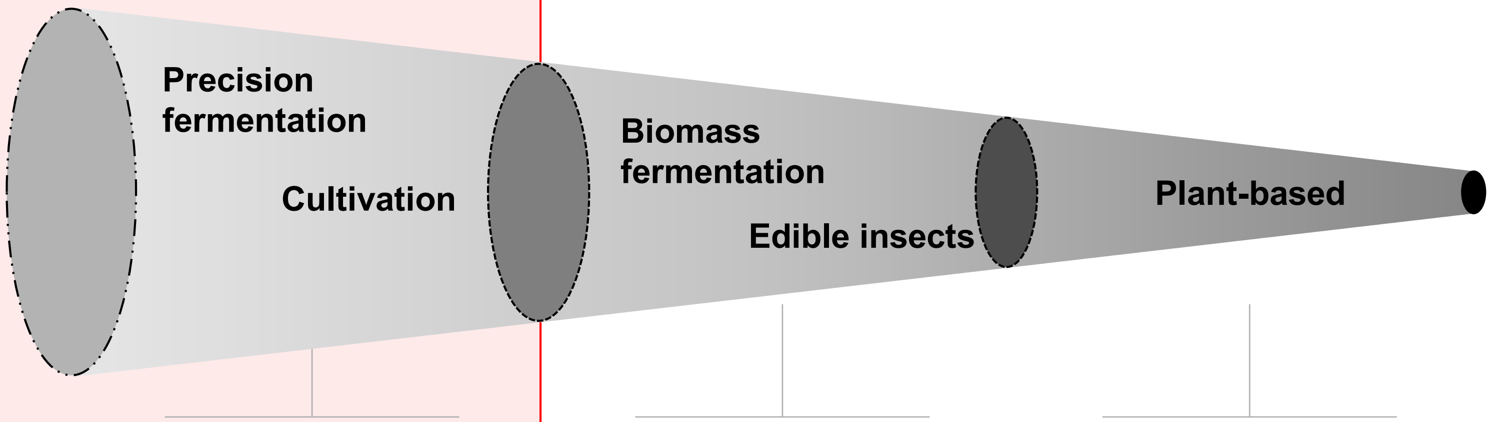
Market	End-product	Technology[2]	Novel AP opportunity	Example product	Ingredients	Raw materials
Sub-Saharan Africa providing inputs to global novel alternate protein consumption (human and animal)[1]		Plant-based	㊼ Plant-based isolates	Plant-based	Isolates	Green and yellow pea, fava beans, mung beans, chickpeas, lupin, soy, jackfruit, bambara nuts, amaranth, moringa, cowpeas, lablab, marama, baobab
		Plant-based	㊽ Plant-based concentrates	Plant-based	Concentrates	Green and yellow pea, fava beans, mung beans, chickpeas, lupin, soy, Jackfruit, bambara nuts, amaranth, moringa, cowpeas, lablab, marama, baobab
		Plant-based	㊾ Plant-based algae protein	Plant-based	Algae-based	Spirulina, duckweed, chlorella
		Biomass fermentation	㊿ Biomass fermented mycoproteins	Biomass fermentation	Mycoproteins	Fusarium venenatum (fungal protein)
		Insect-based	(51) Insect-based protein	Insect-based	Insect isolates	BSF, mealworms, housefly, crickets, mealworms, grasshoppers, locusts, termites, crickets, beetles, ants

1. For the global market we size the technology and ingredient to size the market instead of the end-product
2. Only technologies that currently exist in the market for given products have been included; therefore, technologies such as biomass fermentation and insect-based have been excluded for dairy mimics and cultivated for dairy mimics and sports nutrition

Source: expert input

2. Technological maturity | 18 opportunities were deprioritised due to expected technological immaturity by 2035

🟥 *Eliminated because of limited potential to reach commercial scale by 2035*



	Testing	Pilot	Commercialisation
Novel alternate protein technologies in SSA	**Precision fermentation** **Cultivation**	**Biomass fermentation** **Edible insects**	**Plant-based**
Description	Limited number of companies (only in South Africa), still testing the product Globally, these technologies are also not expected to reach commercial scale by 2035	A few companies in SSA piloting with production and commercial sales (BSF), but no commercial scale	Multiple companies (local and import) present on the market

Novel AP opportunities eliminated

- ③ Precision fermented meat mimic
- ④ Cultivated meat mimic
- ⑧ Precision fermented milk mimic
- ⑩ Precision fermented value-added dairy mimic
- ⑫ Precision fermented egg mimic
- ⑮ Precision fermented sports nutrition
- ⑲ Precision fermented infant nutrition
- ㉒ Precision fermented fortified consumer foods
- ㉖ Precision fermented therapeutic foods
- ㉚ Precision fermented staples for general food aid
- ㉞ Precision fermented staples for school feeding
- ㊱ Plant-based pet food (local)[1]
- ㊴ Cultivated pet food (local)
- ㊵ Plant-based animal feed[1]
- ㊷ Biomass fermented animal feed
- ㊸ Plant-based pet food (global)[1]
- ㊺ Biomass fermented pet food (global)[1]
- ㊻ Cultivated pet food (global)

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1. For animal feed and pet food, plant-based and biomass fermentation are also excluded because there are no proven use cases for novel AP

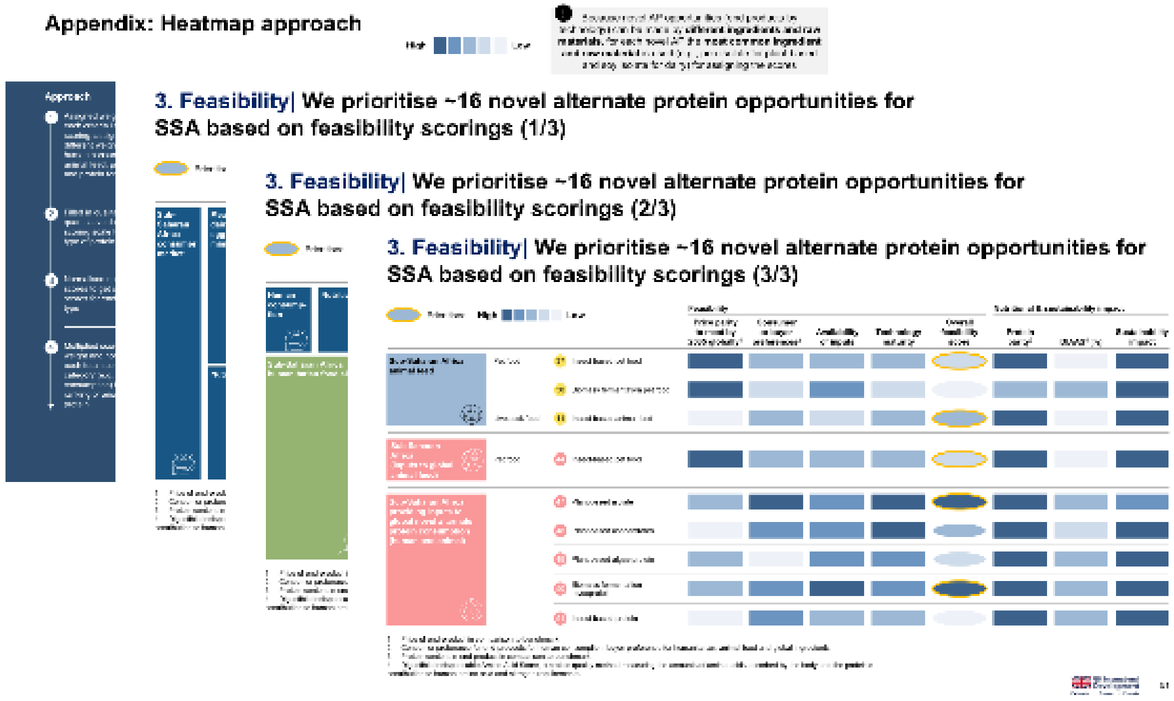
Source: expert input

3. Feasibility | We prioritised 16 novel alternate protein opportunities for sub-Saharan Africa based on feasibility scorings

Approach

Each opportunity was evaluated based on price parity with animal protein, consumer preference, availability of raw materials, and technology to determine its feasibility

The opportunities with lowest score were deprioritised



Appendix: Heatmap approach

3. Feasibility| We prioritise ~16 novel alternate protein opportunities for SSA based on feasibility scorings (1/3)

3. Feasibility| We prioritise ~16 novel alternate protein opportunities for SSA based on feasibility scorings (2/3)

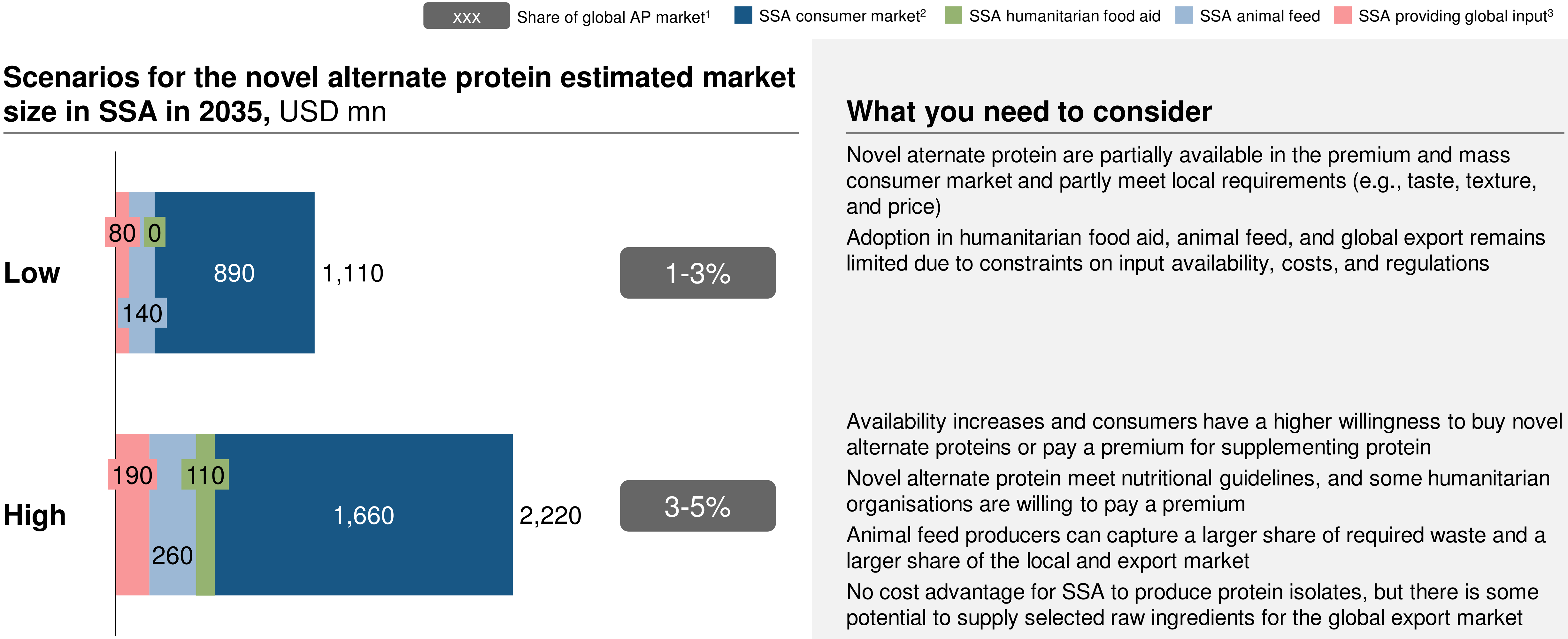
3. Feasibility| We prioritise ~16 novel alternate protein opportunities for SSA based on feasibility scorings (3/3)

! Methodology details in appendix

Prioritised opportunities

- 1 Premium plant-based meat mimic
- 2 Biomass fermented meat mimic
- 6 Mass market plant-based meat alternative
- 7 Plant-based milk mimic
- 9 Plant-based value-added dairy mimic
- 13 Plant-based sports nutrition
- 20 Plant-based fortified consumer foods
- 21 Biomass fermented fortified consumer foods
- 25 Biomass fermented therapeutic foods
- 29 Biomass fermented fortified general humanitarian food aid
- 33 Biomass fermented fortified school feeding
- 37 Insect-based pet food
- 41 Insect-based livestock feed
- 44 Insect-based pet food (global)
- 47 Plant-based isolate
- 50 Biomass fermented mycoproteins

4. Market size | In 2035, the novel alternate protein market in SSA could be USD 1-2 bn



Scenarios for the novel alternate protein estimated market size in SSA in 2035, USD mn

What you need to consider

Novel aternate protein are partially available in the premium and mass consumer market and partly meet local requirements (e.g., taste, texture, and price)

Adoption in humanitarian food aid, animal feed, and global export remains limited due to constraints on input availability, costs, and regulations

Availability increases and consumers have a higher willingness to buy novel alternate proteins or pay a premium for supplementing protein

Novel alternate protein meet nutritional guidelines, and some humanitarian organisations are willing to pay a premium

Animal feed producers can capture a larger share of required waste and a larger share of the local and export market

No cost advantage for SSA to produce protein isolates, but there is some potential to supply selected raw ingredients for the global export market

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1. Based on expected retail sales value of estimated market size for SSA and expected global market of USD 50-100 bn in 2035
2. Primarily driven by mass meat market which is not typically considered in global alternate protein numbers
3. Export ingredients for the global novel alternate protein market

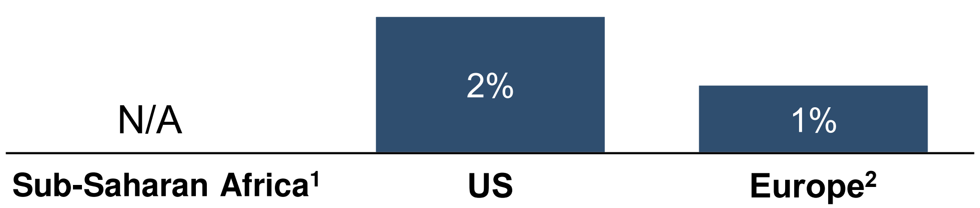
Source: Euromonitor; ACRE for Alternative Protein Modelling

4. Market size | The biggest total opportunity is in the SSA consumer market, with some smaller opportunities across the other markets

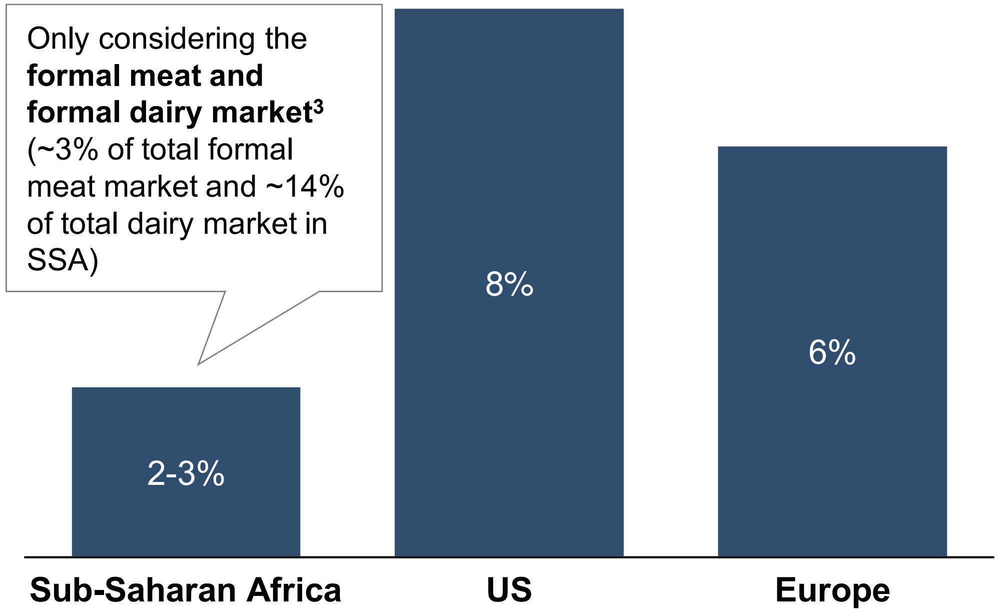
Market	**Highlights per market**	**Est. market size 2035,** USD mn
Sub-Saharan Africa consumer market	Demand driven by two categories (range driven by rates of consumer adoption): • **Higher-income populations** following trends on health, sustainability, and animal welfare demanding meat and dairy alternatives and sports nutrition • Creation and scaling of a **new affordable alternate protein products tailored for the mass market (protein chunks) –** *creating a "tofu for Africa"* Overall opportunity to use indigenous crops (e.g., Bambara nut milk)	**890 – 1,660**
Sub-Saharan Africa humanitarian food aid	The **low caloric content of alternate proteins** and **the higher cost**, plus **strict regulations on product formulation** are a major barrier High-end range assumes some organizations are willing to pay a premium for alternate protein (especially if locally sourced/produced) and there is some flexibility in formulations	**0 - 110**
Sub-Saharan Africa animal feed **Livestock** **Pet food**	Low input biomass availability and high cost of logistics make black soldier fly cost uncompetitive against soy except in certain cases Therefore, opportunity is limited to **where BSF companies can partner with large waste producers** to reduce logistics costs and improve waste quality **and to pet food (which is at a premium)**	**140 - 260**
Sub-Saharan Africa supply to global market	Sub-Saharan Africa cannot produce isolates cost-competitively driven by high raw material costs (e.g., for peas) and limited market for by-products. There **is an opportunity to export raw fava beans and possibly mung for isolate processing abroad**	**80 - 190**

4. Market size | SSA's expected demand for novel alternate protein would be 2–3% of the processed animal protein market, similar to Europe and the US today

Share of alternate protein of the total processed animal protein market, 2023 volume in %



Share of alternate protein of the total processed animal protein market, 2035 estimated volume in %



Only considering the **formal meat and formal dairy market**[3] (~3% of total formal meat market and ~14% of total dairy market in SSA)

Processed animal protein, mn tonnes	-	130	185	7.9	120	170
Novel alternate protein, mn tonnes	-	2	2	~0.2	15	20

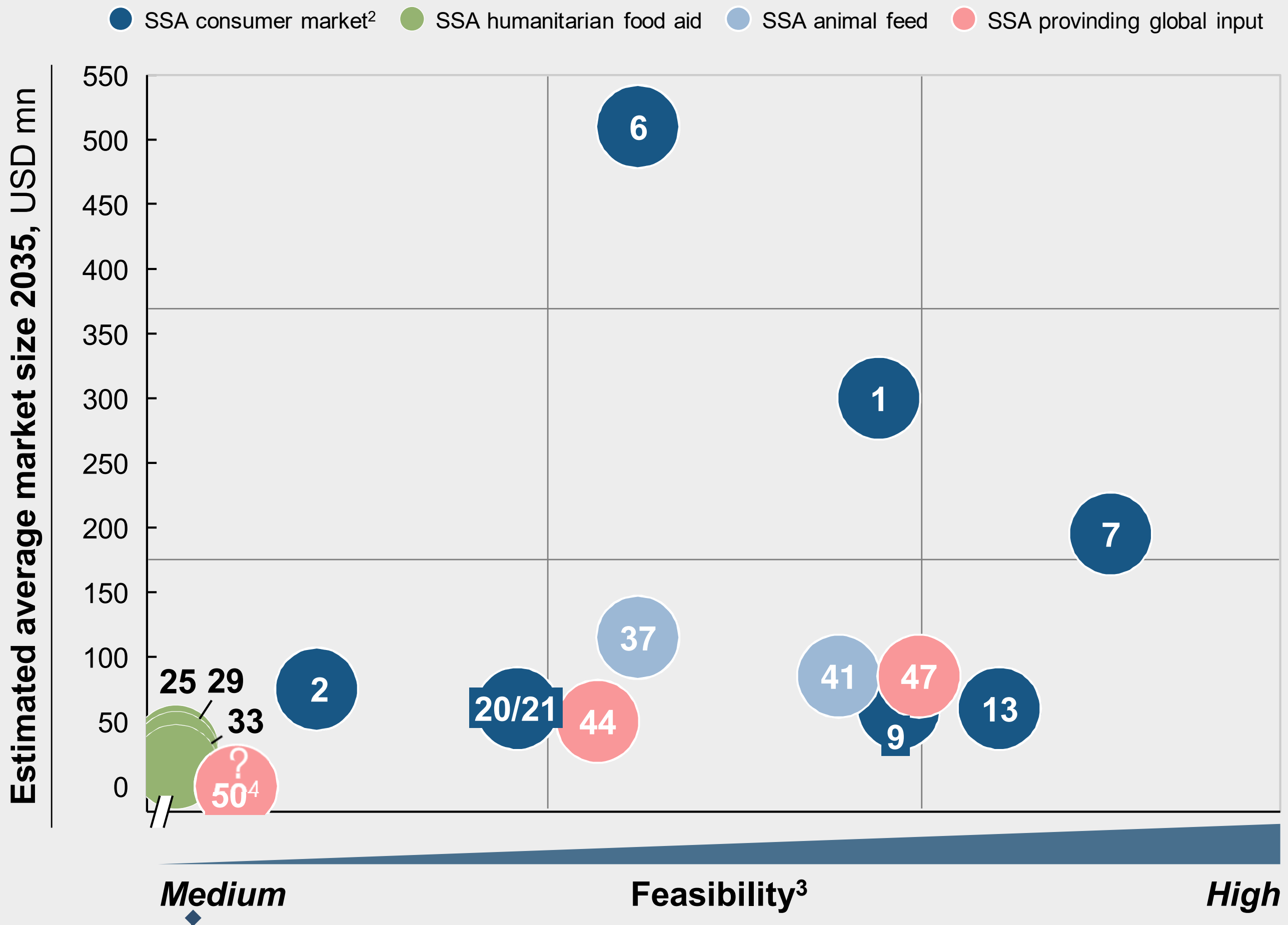
1. No data available
2. Including Western and Eastern Europe
3. Including meat, pasteurised milk, and value-added dairy sold in the formal market

Source: ACRE (McKinsey database)

4. Market size | We compared the short-listed opportunities based on estimated market size in 2035 and feasibility

Market	16 prioritised novel alternate protein opportunities
Sub-Saharan Africa consumer market	1 Premium plant-based meat mimic
	2 Biomass fermented meat mimic
	6 Mass market plant-based meat alternative
	7 Plant-based milk mimic
	9 Plant-based value-added dairy mimic
	13 Plant-based sports nutrition
	20 Plant-based fortified consumer foods
	21 Biomass fermented fortified consumer foods
Sub-Saharan Africa humanitarian food aid	25 Biomass fermented therapeutic foods
	29 Biomass fermented fortified general humanitarian food aid
	33 Biomass fermented fortified school feeding
Sub-Saharan Africa animal feed	37 Insect-based pet food
	41 Insect-based compound livestock feed
Sub-Saharan Africa providing inputs to global novel alternate protein consumption (human and animal)	44 Insect-based pet food (global)
	47 Plant-based ingredients (global)[1]
	50 Biomass fermented mycoproteins (global)

Ranking of the 16 prioritised opportunities



All opportunities considered low feasibility were already excluded in previous elimination steps

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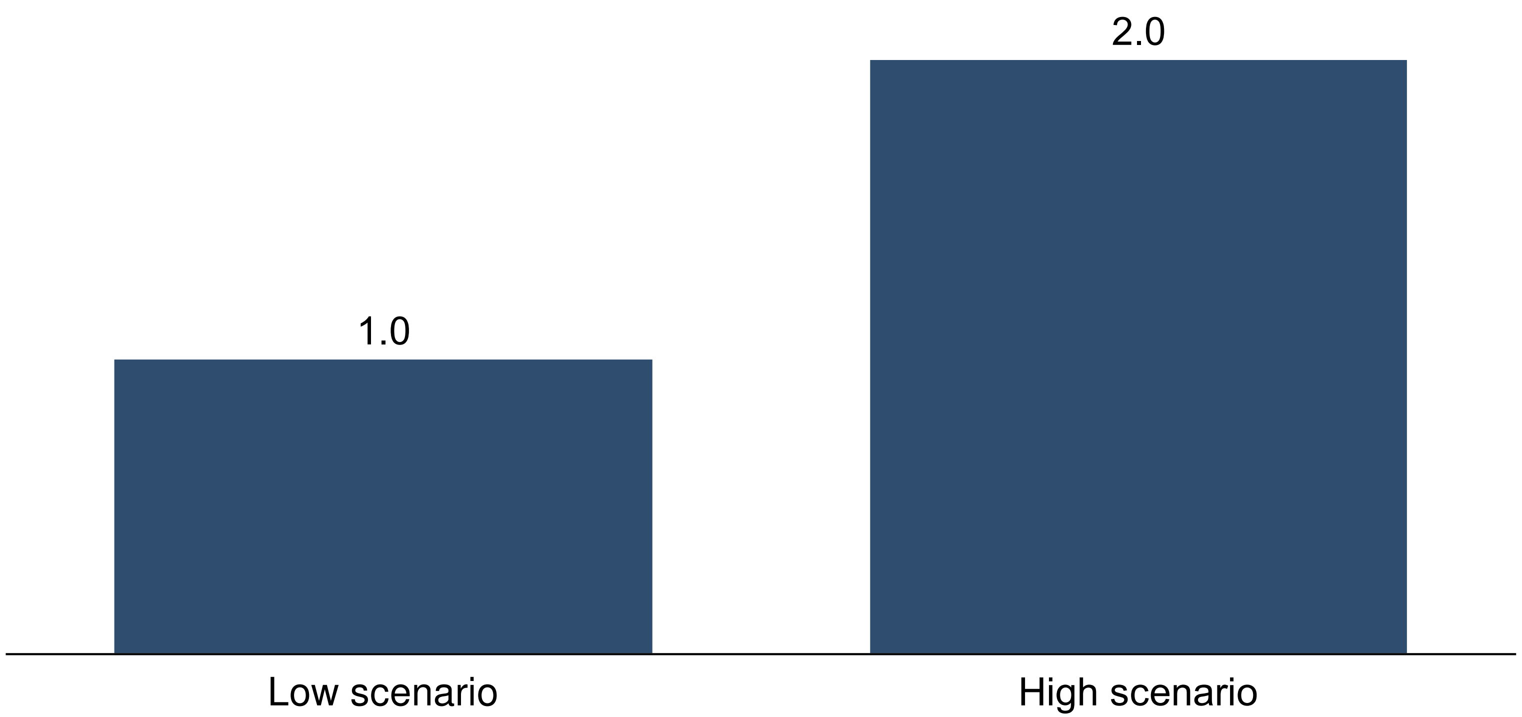
1. Only raw material (e.g., fava beans) sized as no cost-competitive opportunity in the processed products (e.g., isolates) for SSA
2. Sized using ex-factory price to align with other market sizings which are on an ingredient level
3. Feasibility includes 4 factors: price parity to conventional protein source, consumer preference, availability of inputs, and technology maturity
4. Market size not estimated given the high level of uncertainty in the global market

5. Investment size | Achieving this market size could require USD 1-2 bn in investment and create ~40-80 k jobs by 2035

☐ Deep dive next

Total investment[1], USD bn



Potential to create **~40-80 + k** jobs[2] by 2035

Key insights

The novel alternate protein space is **capital-intensive** given high R&D costs and specialised production equipment (e.g., bioreactors for fermentation, specialised extraction equipment)

The **revenue-to-investment ratio is estimated to be 1:1,** with a higher revenue per invested dollar for plant-based and edible insects compared to biomass-fermented technologies

Therefore, **profitability will likely depend on reaching economies of scale** and **reducing operating costs** (e.g., lower raw material costs using locally sourced ingredients)

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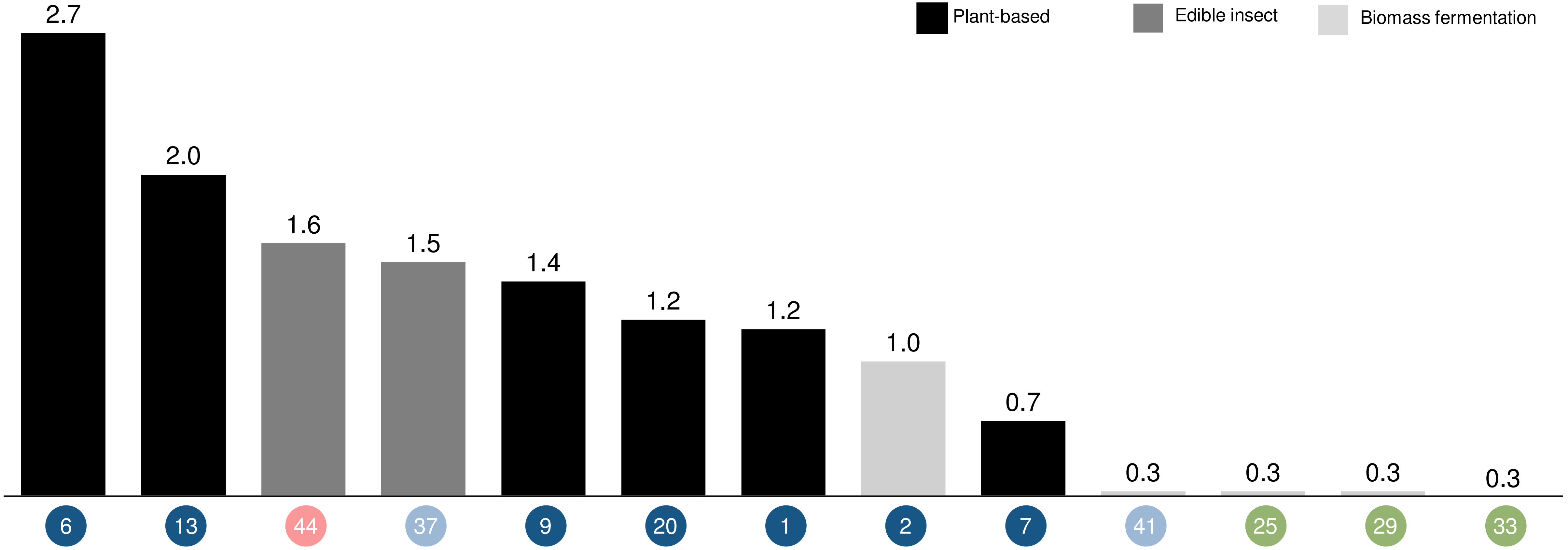
1. Based on mid-sized processing facilities
2. Based on an employment multiplier of 0.3 per ~USD 7,700 revenue – assuming multiplier similar to other food and agro-processing sectors (e.g., grain milling)

Source: Using output and labour multipliers to target incentives for fast economic recovery (AERC, 2022)

5. Investment size | Plant-based and edible insect technologies likely have the highest revenue per invested dollar

● Novel alternate protein opportunity

Annual revenue per dollar investment, USD[1, 2, 3]



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1. Average value for the estimated annual revenue against the investment for a mid-sized novel alternate protein manufacturing facility
2. End-consumer products (e.g., plant-based burgers) have a higher revenue per investment than ingredients (e.g., mycoprotein from biomass fermentation)
3. Export of raw materials (number 47) is not included as this does not require large capex investments (farming of fava beans) and is not comparable to the other opportunities which are processed products; export of biomass fermentation is not included as the market size is not estimated

Source: GFI 2025; expert interviews

3-5. Short-listed opportunities | 16 short-listed opportunities have a combined estimated market size of USD ~1-2 bn by 2035 (1/2)

ORDERED BY MARKET SIZE (LARGEST TO SMALLEST)

○ Low feasibility[1]

● High feasibility[1]

Opportunity	Explanation	**Potential market size 2035,** USD mn	Feasibility	**Investment size[2],** USD mn	SSA case example
6 **Mass market plant-based meat alternative**	**Affordable products designed for wide consumer adoption** to address protein deficit	340-680	◑	0-15	ONE ACRE FUND 
1 2 **Premium meat mimics**	**Higher-end products focused on closely replicating the taste and texture of meat for high-income consumers** looking for sustainable alternatives	250-500	◑	15-30	Planta FOOD FACTORY The Future of Food
7 9 **Plant-based dairy mimics**	**Milk mimics marketed to high- and middle-income consumers** looking for sustainable and lactose-free alternatives to dairy	220-290	●	15-30	ONLY PLANTS
37 **Insect-based pet food**	Growing niche opportunity tapping into **sustainable protein trends for pet nutrition**	70-160	◑	15-30	Maltento
41 **Insect-based livestock feed**	Opportunity to **replace soy in livestock feed with BSF** to reduce soy imports and integrate a more sustainable source of protein	70-100	◕	15-30	aiko
47 **Plant-based isolates**	**Raw fava beans supplied from SSA for isolate processing abroad,** leveraging the competitive cost advantage of raw material production	50-120	◕	0-15	N/A

1. Feasibility measured across price parity to conventional protein, consumer preference, technological maturity
2. Investment size is based on a mid-sized facility for end-product and ingredients production

Sources: company interviews; expert interviews; market size analysis; Good Food Institute

3-5. Short-listed opportunities | 16 short-listed opportunities have a combined estimated market size of USD ~1-2 bn by 2035 (2/2)

ORDERED BY MARKET SIZE (LARGEST TO SMALLEST)

○ Low feasibility[1]

● High feasibility[1]

Opportunity	Explanation	Potential market size 2035, USD mn	Feasibility	Investment size[2], USD mn	SSA case example
20 21 **Fortified consumer foods**	Protein-fortified staples and processed foods designed for **health-conscious high-income consumers**	50-100	◔	30-50	N/A
13 **Plant-based sports nutrition market**	Products designed for **high-income consumers that are physically active and value sustainability**	30-90	●	15-30	N/A
44 **Insect-based pet food (global)**	Opportunity to **supply the European pet food market** with insect-based protein ingredient	30 -70	◑	15-30	Maltento
29 33 **Biomass fermented fortified staples (general food aid and school feeding)**	Opportunity to substitute soy in corn-soy blend for **humanitarian organisations prioritising locally-sourced ingredients** and to **fortify school meals with protein** by organisations that are willing to pay for additional protein	0-80	○	30-50	essential
25 **Biomass fermented therapeutic foods**	Opportunity to substitute dairy protein in RUTF/RUSFs with novel alternate protein	0-30	○	30-50	essential
50 **Biomass fermented mycoproteins**	Opportunity to produce mycoproteins through biomass fermentation for global exports	N/A[3]	○	N/A	essential

1. Feasibility measured across price parity to conventional protein, consumer preference, technological maturity
2. Investment size is based on a mid-sized facility for end-product and ingredients production
3. Not sized due to uncertainty around the global market

Sources: company interviews; expert interviews; market size analysis; Good Food Institute

6. Overall enablers | The novel AP market in SSA could be supported with financing, industry collaboration, incentives, and technology access

○ Low feasibility ● High feasibility ▨ Deep dive ahead

Enabler	Details	Stakeholders				Feasibility[2]
		Development partners	Government and regulatory bodies	Academic/ research institutions	Private sector players[1]	
Available financing for start-ups	Create a **venture fund for novel alternate protein** using blended finance from grants and DFIs. Invest in 20+ early-stage ventures with a total fund size of USD ~100 mn	✓			✓	◕
Support industry collaboration	Create **15-20 offtake partnerships** (tied to venture fund) with end-consumers (e.g., retailers, animal feed manufacturers) to trial alternate protein, including sharing results of consumer/market and product testing to the broader market to drive adoption	✓			✓	◕
	Establish **shared production spaces with common equipment for multiple novel alternate protein start-ups** (e.g., set up a shared extrusion that multiple companies can use) to reduce start-up costs	✓		✓	✓	◔
Provide incentives and regulatory mechanisms	**Implement temporary financial incentives** (e.g., VAT exemptions, cheaper power, reduced import duties) for novel alternate protein players		✓		✓	◔
	Develop **industry standards** for labelling (e.g., aligned terminology on meat mimics), production processes (including quality standards for inputs and outputs), and quality regulations		✓		✓	◑
Enable technology access	Create **knowledge-transfer partnerships for technology and equipment** (linked to venture fund) by partnering with major equipment providers (e.g., Bühler) to supply and maintain technology		✓	✓	✓	●
Invest in research and development	Create partnerships with local and international research institutions (e.g., Wageningen University) to **increase R&D capacity for development of novel alternate proteins tailored to SSA consumer preference and locally available ingredients** (e.g., indigenous crops)			✓	✓	●

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1. Investors and companies
2. Low feasibility indicates high levels of collaboration required or government actions that might be challenging to implement; high feasibility indicates the enabler is tried and tested and likely to happen by 2035 with the right collaborations

Source: company interviews; expert interview

6. Overall enablers | A closed-end venture fund could increase investments in the novel alternate protein space in SSA

EXAMPLE STRUCTURE

Steps	Fund structure and set-up	Fund objectives	Compensation model	Fund thesis	Fund operations
Example for novel alternate protein fund in SSA	**Closed-end VC fund,** with a GP[1], LP[2], and an advisory board of novel alternate protein, food-tech, and SSA agribusiness experts	Fund size of ~USD 100 mn over 10 years with an IRR[3] of 15%	**GP compensated based on successful fund performance,** aligned with investor success, incl. management fees of 2%, hurdle rate of 8%, etc.	Invest in 20+ novel alternate protein start-ups with a **clear impact on food security and scaling potential using locally sourced raw materials** Provide de-risking mechanisms (e.g., technical assistance for early-stage, blended finance)	**Strong deal sourcing through development organisations, novel alternate protein networks, and industry platforms (e.g., Manufacturing Africa)** to ensure access to top opportunities

Potential partners

WAGENINGEN UNIVERSITY & RESEARCH

UNIVERSITY OF NAIROBI

AFRICAN DEVELOPMENT BANK

AFRICAN DEVELOPMENT FUND

agra

PROMASIDOR

UKaid from the British people

gfi

ACUMEN CHANGING THE WAY THE WORLD TACKLES POVERTY

SAHEL Capital

NOVASTAR VENTURES

BIG IDEA VENTURES

AgFUNDER

! Deeper analysis on start-up landscape and support required – example global fund detailed next

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1. General partner responsible for raising capital from investors
2. Limited partners; investors who put money into the fund
3. Internal Rate of Return, the annualised percentage return a fund or investment is expected to generate over its life

Source: Expert interviews

6. Overall enablers | Big Idea Ventures invests USD >50 mn in 100+ alternate protein companies

New protein fund by Big Idea Ventures (BIV) is a …

… seed stage fund dedicated to investing in **innovative companies within the novel alternate protein space,** with a focus on **plant-based, cultivated, and fermentation protein technologies and ingredients**

Additional support offered

- **Accelerator programme:** pre-seed funding and scaling business support
- **Mentorship:** access to a broad network of experts
- **Strategic partnerships:** connects start-ups to leading food processors

Example companies in the portfolio

GOURMEY	French start-up producing cultivated poultry – **raised EUR 48 mn in series A funding**
Black Sheep FOODS	US start-up creating plant-based lamb alternates – **raised USD 12 mn in series A funding**

Key fund partners across food processing, technology and finance:

AAK
Avril
BÜHLER
Givaudan
meiji
Tyson Ventures
TEMASEK HOLDINGS

USD >50 mn

assets under management

100+

companies invested

25+ countries

88%

of portfolio companies raised funds post BIV investment

Source: Big Idea Ventures

6. Overall enablers | Liberation Labs is a shared facility to support precision fermentation companies to scale production

Liberation Labs is a US start-up building large-scale, **purpose-designed precision fermentation facilities to help novel alternate protein and food-tech companies scale production**

Steps	**Identify the bottleneck**	**Secure financing**	**Design fit for purpose facility**	**Choose strategic location**	**Global replication**
Description	Precision fermentation industry is **constrained by outdated, repurposed facilities,** often 30-50 years old and originally built for pharmaceuticals or chemicals that **lack efficiency, scale, and food-grade readiness**	Liberation Labs secured **USD 20 mn** in equity and **USD 30 mn** in equipment funding to de-risk scale-up	**Purpose-built plants** with large-scale fermenters (4 x 150,000 litres) **Integrated downstream processing** (filtration, centrifugation, spray drying) **Flexible design** to accommodate diverse products	**Located in Richmond, Indiana** • Within an hour of 3 corn wet millers for dextrose feedstock • Close to 3 metropolitan areas • Access to ample electricity (50% of which is solar)	**Goal:** 4 mn litres of global capacity across 6-8 strategic sites

Source: Liberation Labs

6. Overall enablers | Knowledge transfer partnerships across the novel alternate protein ecosystem in SSA could happen with …

NON-EXHAUSTIVE AND ILLUSTRATIVE

☐ Example partners in SSA

… universities and research institutions to

- Co-design research on locally relevant protein sources
- Develop agronomic[1] practices
- Provide technical training, talent exchange, PhD partnerships related to novel alternate protein etc.

Global and local universities

WAGENINGEN UNIVERSITY & RESEARCH · cirad · ILRI · UNIVERSITY OF NAIROBI · IITA

Research co-creation and technical trainin

Technology capacity building

Peer-to-peer learning

… equipment providers to

- Provide affordable technology (e.g., extrusion technology)
- Conduct local operator training programmes
- Share maintenance know-how and technical support

Equipment developers

BÜHLER · ANDRITZ · GEA

… novel alternate protein start-ups to:

- Exchange data and outcomes from pilot trials in different regions (e.g., extruded products from different crop varieties)
- Share operational knowledge on best practices (i.e., across supply chain logistics, scaling, consumer education strategies etc.)

Regional start-ups Planta · MAGOFARM · INSECTIPRO · ecodudu · Essential

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1. Science and practice of growing crops and managing soils

Source: Expert interviews; press search

Agenda

Agenda

SSA consumer market | To project novel alternate protein demand for the SSA consumer market, we looked at 5 main consumption categories

	Consumption categories		Product description	Target market segment in SSA used for sizing[1], % of different indicators	
1 2	**Premium meat mimics**		**Meat mimics** made to replicate the taste and texture of meat (e.g., plant-based burgers, sausages)	**1.6%**	Share of processed meat purchased from formal retail and consumed by high-income population in SSA that could be substituted in part by novel AP
6	**Mass market meat alternatives**		**Affordable meat alternative** made to fill the price gap between conventional protein sources (conventional meat and legumes) and offer a nutritious, protein-rich supplement to diets	**65%**	Population across SSA in the middle- and lower-income bands (excluding high-income band and population below poverty line) that could consume this product as an addition to existing diet
7 9	**Dairy mimics**		Plant-based products designed to **replicate dairy staples** (e.g., milk, cheese, yogurt)	**12%**	Dairy consumed by high- income segment across select high dairy-consuming countries[3] that could be substituted in part by novel AP
13	**Plant-based sports nutrition**		**High-protein sports products** developed to support performance, endurance, and muscle recovery	**1.1%**	Population share of high-income consumers within the age range 18-45 that might consume sports nutrition products
20 21	**Fortified consumer foods**		**Protein-enriched versions of everyday foods** (e.g., cereals, baked goods, snacks) to improve nutritional intake	**1.1%**	Population share of high-income consumers within the age range 18-45 that might prioritise increased protein intake[2]

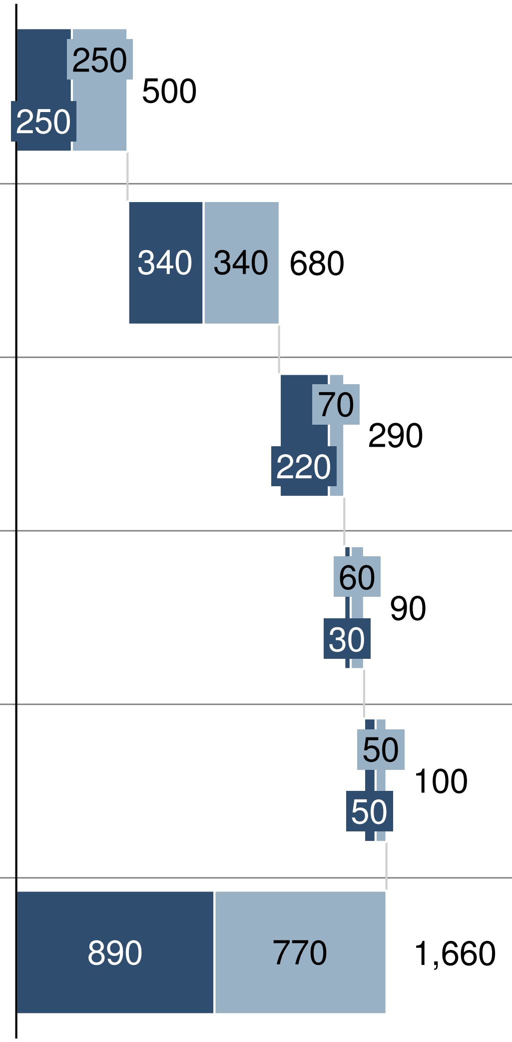
1. Groupings based on World Bank income bands
2. Fortified foods not considered for middle- or lower-income bands due to affordability gap and preference for "center of plate" protein
3. Countries with high aggregate dairy volume: Kenya, Ethiopia, Tanzania, Uganda, Nigeria, Zimbabwe, Zambia, Rwanda

Sources: Kenya National Bureau of Statistics (KNBS), Quantifying appliance access gaps (CLASP), Study on Meat End Market Trends in Kenya, Gatsby, UK Aid; FAOSTAT, World Bank, expert interviews

SSA consumer market | The total novel alternate protein opportunity for the SSA consumer market could be between USD ~0.9 and ~1.7 bn

▨ Increase to high scenario ■ Low scenario ⓧ Novel alternate protein opportunity number

Est. market size[1], USD mn



Novel AP opportunity	Explanation
① ② **Premium meat mimics**	Products (e.g., sausage mimics) are already available in modern retail, catering to high-income consumers willing to pay a premium for sustainability Adoption for low and high scenarios hinges on consumer perception of products as an occasional substitute versus a more frequent substitute
⑥ **Mass market plant-based meat alternatives**	Dependent on the development of a novel alternate protein that can match affordability, accessibility, and taste preferences of mass market consumers Adoption for low and high scenarios hinges on consumer awareness and availability in informal markets (e.g., small retailers in rural areas)
⑦ ⑨ **Dairy mimics**	Products already available in modern retail, catering to lactose-intolerant population and consumers looking for more sustainable alternatives Adoption for high and low scenarios is dependent on changing consumer perception (i.e., use in premium products like coffee or a more frequent substitute)
⑬ **Plant-based sports nutrition products**	Market is driven predominantly by high-income consumers following growing fitness trends; however, limited growth in this market by 2035 is expected given that whey protein is also growing, and whey can be sourced locally and more cheaply
⑳ ㉑ **Fortified consumer foods**	Market is driven predominantly by urban high-income consumers following the growing health consciousness trends on protein requirements and therefore with willingness to pay a premium for fortified foods Adoption for low and high scenarios' is dependent on consumer willingness to pay for extra protein and their usage frequency (e.g., occasional or regular usage)
Total	

---

1. Based on ex-factory cost (excluding packaging, overheads, processor margin and retail markup). We use ex-factory cost for retail products to ensure some comparability with other market segments (e.g., BSF for animal feed) where we only size the ingredient value.

SSA consumer market | Various players are present in the alternate meat and dairy market in SSA

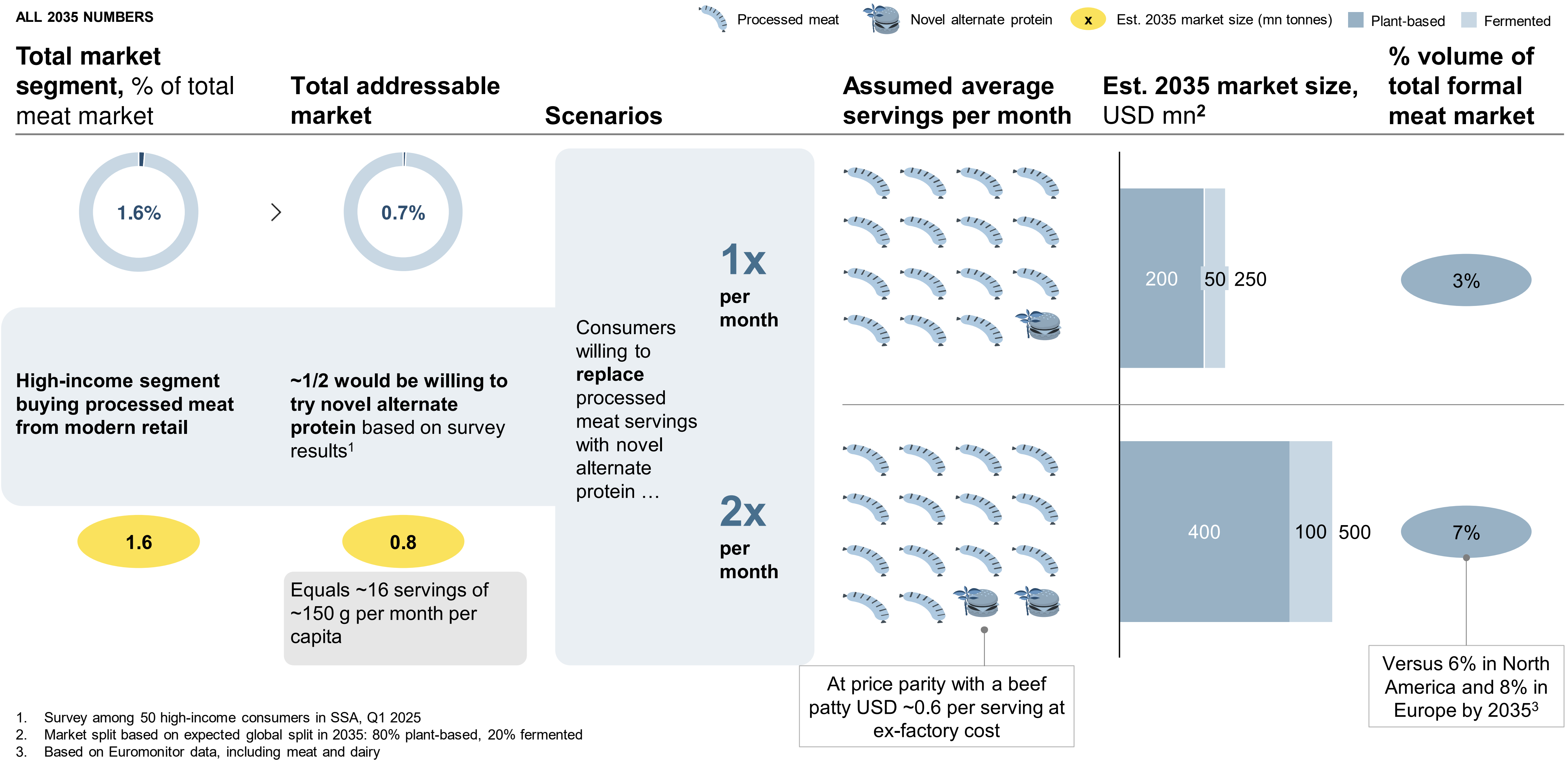
NON-EXHAUSTIVE

	Organisation	Country	Description
Premium meat mimics	Veggie Victory	🇳🇬	Soy-based meat alternatives integrated into restaurant menu
	Planta	🇰🇪	Range of frozen plant-based meats made from pea, fava bean, soy, and rice protein sold in retail
	Fry's	🇿🇦	Range of frozen plant-based meats made from soy and wheat protein sold in retail
	ATOFU	🇰🇪	Tofu-based meat alternatives sold in retail
Mass market meat alternative	sossi	🇰🇪	Textured soy protein as an affordable meat alternative sold in retail and mass market
		🇷🇼	Plant-based protein products for mass consumers
Dairy mimics	Nu Ziwa	🇰🇪	Plant-based dairy products (i.e., oat milk, soy milk, almond milk) sold in retail
	Only Plants	🇰🇪	Plant-based dairy products sold in niche markets (e.g., farmers markets)
	[illegible]	🇰🇪	Dairy company that has launched plant-based dairy products sold in retail
	chi	🇳🇬	Dairy and beverage company that has launched plant-based dairy products
	alpro	🇧🇪	Global leader in plant-based dairy alternatives (i.e., almond, soy, oat-based products)

Source: Press search; company interviews

① ② Premium meat mimics | The premium meat mimic market in SSA could be between USD 250 and 500 mn by 2035

ALL 2035 NUMBERS



Total market segment, % of total meat market	**Total addressable market**	**Scenarios**		**Assumed average servings per month**	**Est. 2035 market size,** USD mn[2]	**% volume of total formal meat market**
1.6%	0.7%	Consumers willing to **replace** processed meat servings with novel alternate protein …	**1x** **per month**		200 + 50 = 250	3%
			2x **per month**		400 + 100 = 500	7%

High-income segment buying processed meat from modern retail

~1/2 would be willing to try novel alternate protein based on survey results[1]

1.6

0.8

Equals ~16 servings of ~150 g per month per capita

At price parity with a beef patty USD ~0.6 per serving at ex-factory cost

Versus 6% in North America and 8% in Europe by 2035[3]

---

1. Survey among 50 high-income consumers in SSA, Q1 2025
2. Market split based on expected global split in 2035: 80% plant-based, 20% fermented
3. Based on Euromonitor data, including meat and dairy

Sources: Kenya National Bureau of Statistics (KNBS); Quantifying appliance access gaps (CLASP); Study on Meat End Market Trends in Keny; Gatsby, UK Aid; FAOSTAT; World Bank,; expert interviews

1 Premium meat mimics | Case example: Planta Food Factory

Introduction to the company

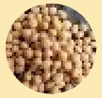
Kenya-based company established in 2022, specialising in plant-based food products, with 10 products across 3 alternative ranges - beef, chicken, and fish

Example products

Key ingredients in products

Pea

Rice



Soybeans

Fava beans

Plant-based end-products

Burger patty

Chicken nuggets

Fish fillets

Company history

2022: **R&D and pilot phase**

2023: **Entry into market**

2025: **Scaling production** i.e., adding sausages to product portfolio, in discussions on setting up local extrusion capabilities

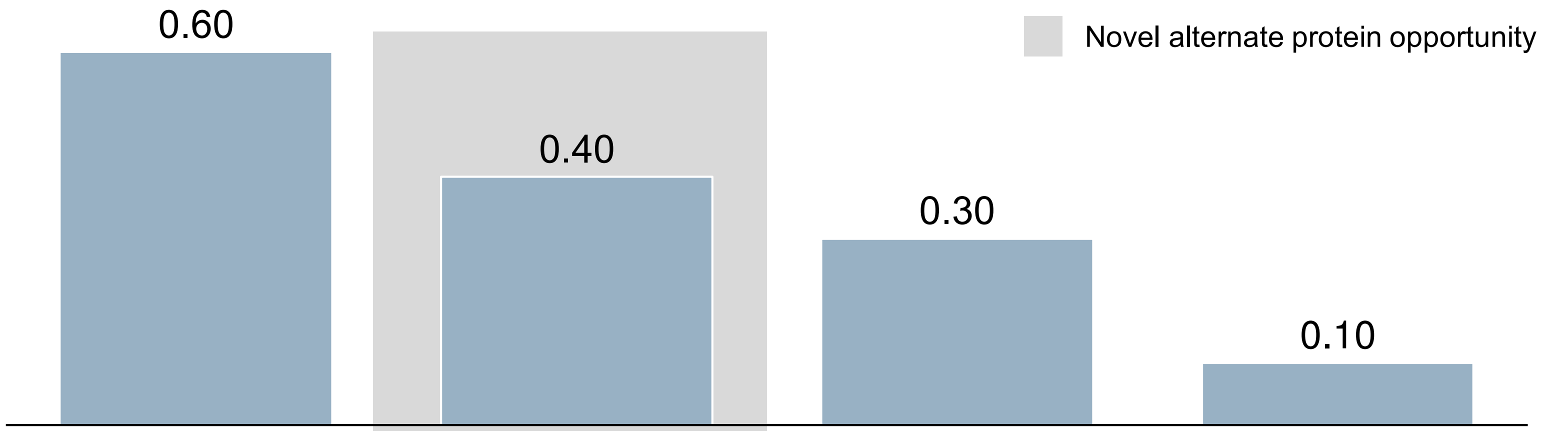
Products and strategy

- **Sourcing of raw ingredients:** import the raw materials (i.e., extruded protein isolates) and flavours in dried form from Europe
- **Pursuing local sourcing of raw materials and ingredients** to reduce the cost of production significantly (i.e., eliminating duties cost)
  - **Growing raw materials at scale** in sub-Saharan Africa at European quality
  - **Setting up extrusion capabilities in sub-Saharan Africa** in partnership with international firms within the industry
- **Market:** Kenya-focused, with Nairobi as the key market **(sold in major supermarkets in Nairobi)** and growing markets in Kisumu, Nyali, Nanyuki, and Diani. Possibly exploring some other East-African markets (e.g., Tanzania)

Source: company interview; press search

⑥ Mass-market meat alternative market | Plant-based protein chunks could fill the price gap between legumes and meat

Consumer retail price of protein products per serving, USD per average serving size



	Beef, 100 g	Plant-based protein chunk, 100 g (soaked)	Eggs, 100 g (~2 eggs)	Beans, 100 g (cooked)
Price of 100g of protein, USD	2.4	2.0	2.3	1.0
Protein share per serving, %	~25%	~20%	~13%	~10%
DIAAS, %	113%	90%	113%	70%

Source: Press search; Healthline Media; expert interviews

Key insights

There is a price gap between legumes (e.g., beans) and meat that could be filled by a novel alternate protein (i.e., plant-based protein chunks); however, there likely is competition from other cheaper animal protein sources such as eggs

6 Mass-market meat alternative market | This product also fulfils consumer preference for “centre of plate” protein for main meals

□ Preferred option

	Protein chunks	Fortified ugali
		
Price per meal, USD	1.5	1.2
Pure protein price, USD per 100g	2.0	0.5[1]
Protein share per serving, %	~20%	~8%
Calories per meal, kcal	~280	~200

Key insights

When asked to choose between a protein-fortified ugali with sukuma wiki (kale) for USD 1.1 or ugali, sukuma wiki, and vegetable protein chunks for USD 1.4, **~70 % of people chose the option with protein chunks**[2]

This indicates a **preference for a “centre of plate” protein addition to meals,** given other caloric and nutritional benefits and the perceived value of protein that is visible – based on cultural preferences and familiarity

---

1. Price of 100 g of protein in mycoprotein (USD 2.25 per kg)
2. Survey on fortification of staples against protein chunks, done for middle- and lower-income bands

Source: Press search, Healthline Media; expert interviews

6 Mass-market meat alternative market | To realise the potential of the mass market, innovation for products tailored to local preferences is key

Product requirements

- **Affordable**
- **Accessible**
- **Familiar**
- **Functional**
- **Nutritious**

Sub-Saharan Africa case examples

ONE ACRE FUND

Custom dry-extruded texturised vegetable protein[1] **made from a combination of local crop varieties,** making it **affordable and highly nutritional (~50% protein when dry)**

USD 0.4 per serving[2]

sossi

Affordable soy chunks widely **accessible across the country** (e.g., in rural retail shops) with different ready-to-cook varieties and flavours customised to local taste preferences

USD 0.2 per serving[2]

---

1. Currently in development
2. ~100 g serving size soaked

Source: Rapid review report on Kenya Alternative Proteins Sector (AgriFrontier, Innovate UK, 2025); expert interviews

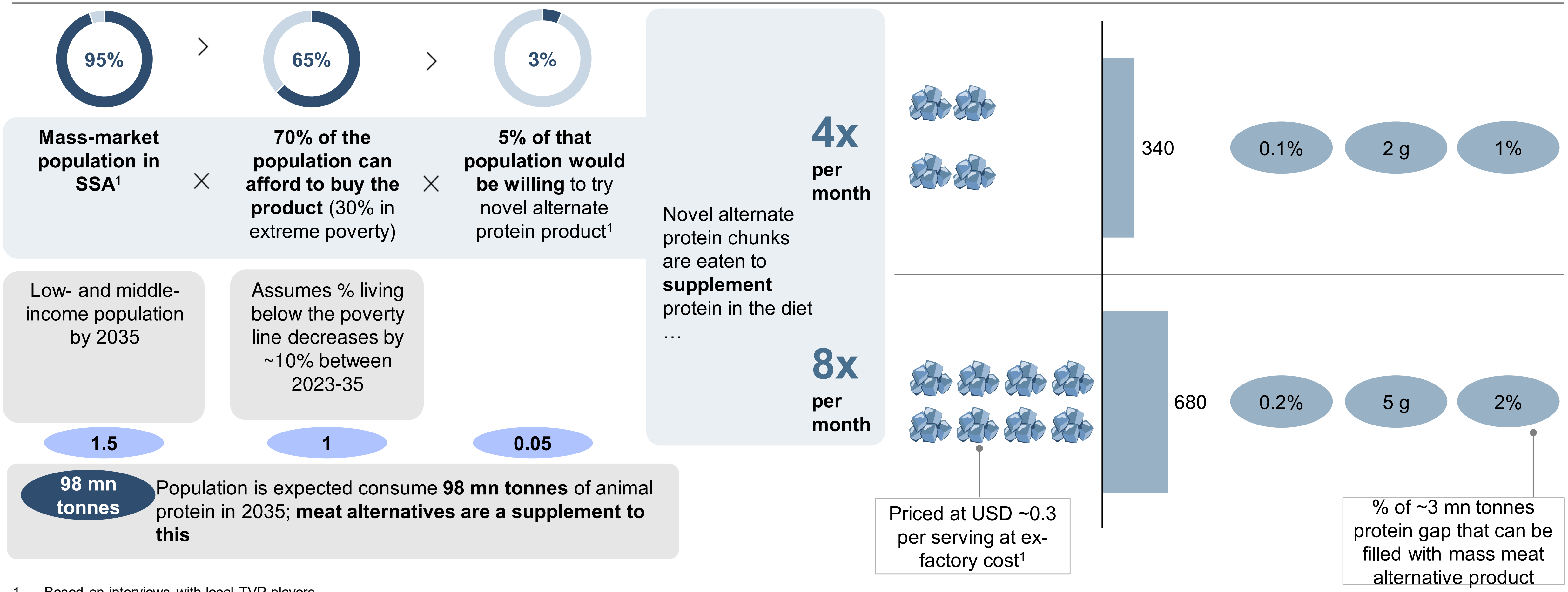
6 Mass-market meat alternative market | The mass-market meat alternative market in SSA could be between USD 340 and 680 mn by 2035

ALL 2035 NUMBERS

Novel alternate protein chunks

x Est. population in 2035 (bn)

! Market sizing considers population instead of meat market by volume as this product t is a supplement rather than an alternative to existing meat consumption



Market assumptions

Total addressable market

Mass-market population in SSA[1] × **70% of the population can afford to buy the product** (30% in extreme poverty) × **5% of that population would be willing** to try novel alternate protein product[1]

Low- and middle-income population by 2035	Assumes % living below the poverty line decreases by ~10% between 2023-35	
1.5	1	0.05

98 mn tonnes Population is expected consume **98 mn tonnes** of animal protein in 2035; **meat alternatives are a supplement to this**

Scenarios

Novel alternate protein chunks are eaten to **supplement** protein in the diet …

Assumed average servings per month[2]	Est. 2035 market size, USD mn	% volume of total meat market	Additional protein per capita per day[3]	% of total protein gap filled
4x per month	340	0.1%	2 g	1%
8x per month	680	0.2%	5 g	2%

Priced at USD ~0.3 per serving at ex-factory cost[1]

% of ~3 mn tonnes protein gap that can be filled with mass meat alternative product

---

1. Based on interviews with local TVP players
2. Average intake of 40 g per serving (of dried product; will be 80-100g per person when soaked)
3. Assuming ~62 g average per capita consumption in SSA currently from setting the stage analysis plus additional protein from mass meat alternative products

Sources: Kenya National Bureau of Statistics (KNBS); Quantifying appliance access gaps (CLASP); Study on Meat End Market Trends in Kenya; Gatsby, UK Aid; FAOSTAT; World Bank; Sub-Saharan Africa Regional Analysis (ISS, Africa Futures, AUDA-NEPAD); expert interviews

6 Plant-based mass meat alternative market | Case example: Teka-Na

ONE ACRE FUND

Introduction to the company

- **Affordable, nutritious, shelf-stable** chunks for low- and middle-income households (launching 2025)
- **Made from locally sourced Texturised Vegetable Protein (TVP)[1];** currently imported from South Africa, with plans for a Rwandan facility
- Contains **~45% protein when dried;** comparable to conventional meat when soaked; versatile for soups, stews, and frying
- Developed by One Acre Fund in Rwanda with international partners (Wageningen University, Enviu, Griffith Foods)

Price, USD per 300 g

Assumptions

- A dried pack of 160 g costs around USD 1.6; when soaked this can feed 4 people (assumed average 300 g)
- This is ~55% cheaper than 300 g of chicken

Products and strategy

- **Affordable:** ~30% cheaper than conventional meat
- **Accessible:** distributed nationwide through supermarkets and village kiosks. Long shelf-life without refrigeration ensures access to suburban and rural areas
- **Adapted to local tastes and traditions**
  - Collaboration with Ravel Rwanda and Griffith Foods ensures **high quality and local flavour,** e.g., chicken, beef, and Nyama Choma
  - **Tailored local branding –**Teka-Na means “cook with” in Kinyarwanda, evoking the product’s versatility in a variety of Rwandan dishes

---

1. Texturised Vegetable Protein – plant-based food product made from defatted flour, isolates, or concentrates and extruded to create meat like texture
2. February 2025, Kimironko Market

Source: One Acre Fund; Rwanda Beef Prices; Agritop

7 Plant-based milk mimic | The milk mimic market in SSA could be between USD 170 and 220 mn by 2035

ALL 2035 NUMBERS

🐄 Traditional dairy
🥛 Novel alternate protein
● x Est. 2035 market size (mn tonnes)

Total market segment, % of total dairy market

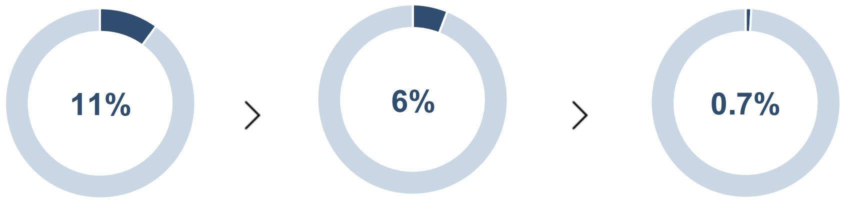
Total addressable market

Scenarios

Assumed average servings per week

Est. 2035 market size, USD mn

% volume of total formal milk market



Consumers buying pasteurised milk in modern retail × **~40%[4] of middle-income, and 100% of high-income consumers could switch** × **24% would be willing to partially switch[1]** + **5% would switch exclusively[1]**

Assuming high-income consumes might switch for sustainability reasons and middle-income consumers due to lactose intolerance

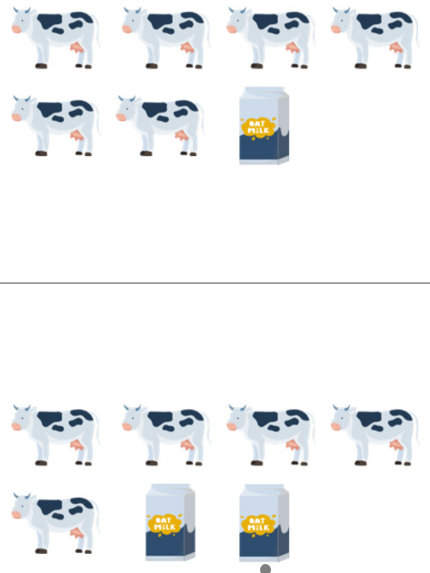
Assuming 0.14 mn tonnes per year is consumed through daily servings per capita (110 g)

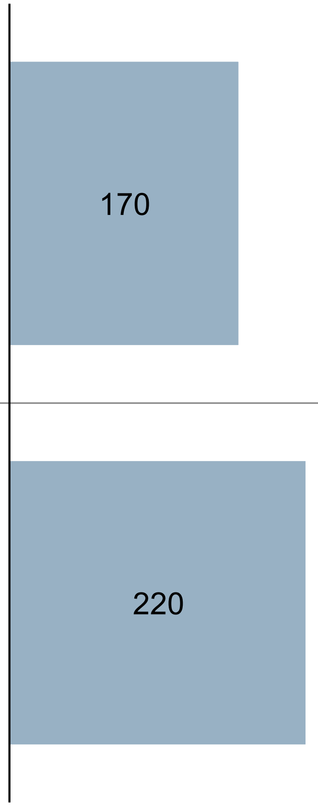
3.2 | 1.7 | 0.2

Of the population that switches partially, consumers replace dairy with novel alternate protein

1x per week

2x per week





3.6%

4.5%

Priced at USD ~1.4 per l based on ex-factory cost[3]

Versus 6.4% for the US in 2023 (including milk and value-added dairy)[2]

---

1. Based on a US consumer survey report and assuming similar acceptance rates in SSA in 2035
2. Based on Euromonitor data
3. Based on prices of global brands
4. Estimated population that is lactose intolerance based on World Population Review data

Sources: Kenya National Bureau of Statistics (KNBS); Quantifying Appliance Access Gaps (CLASP); Study on Meat End Market Trends in Kenya; Gatsby, UK Aid; FAOSTAT; World Bank; expert interviews; McKinsey's 2022 US Dairy Consumer Survey

7 Plant-based milk mimic | Case example: OnlyPlants

Introduction to the company

- OnlyPlants is a Kenya- and Uganda-based company that specialises in plant-based foods made from indigenous African crops to drive protein intake and empower smallholder farmers
- Product lines include plant-based sauces, nut butters, and milk

Key ingredients in products

Bambara nuts

Cowpeas

Macadamia nuts

Chia seeds

Sesame

Cashew nuts

Products and strategy

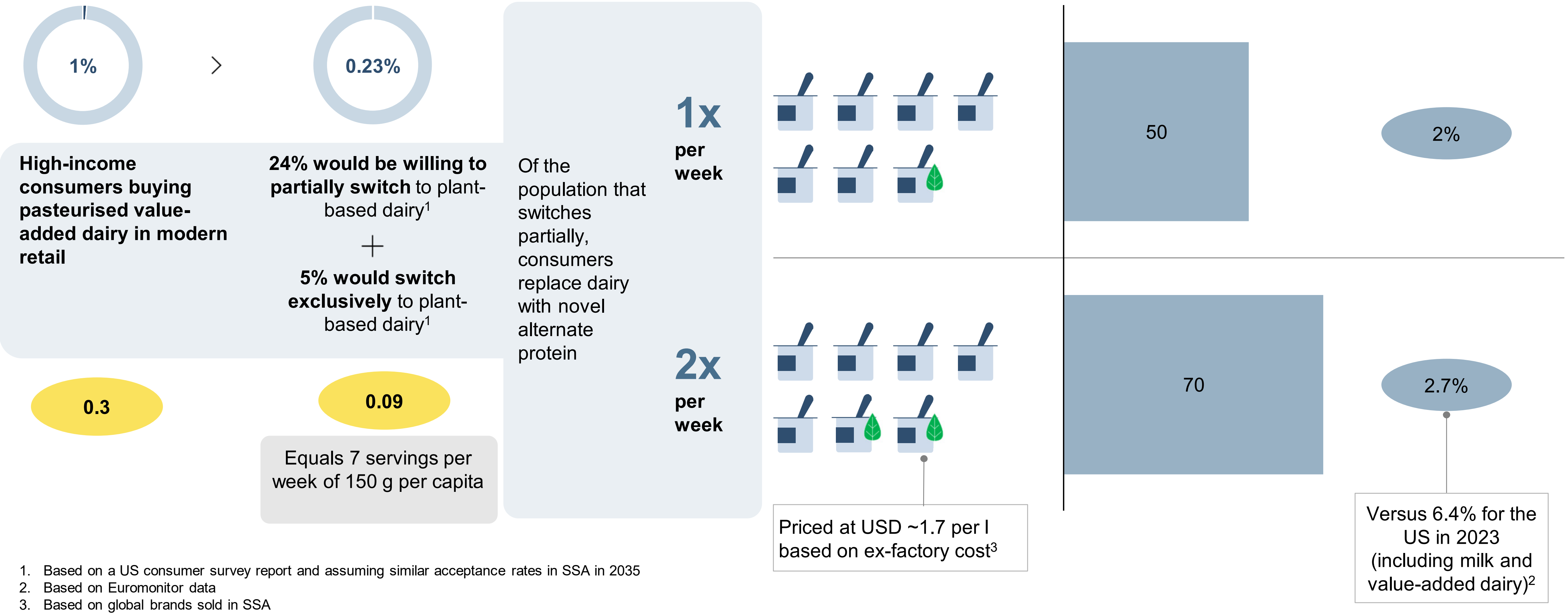
- **Sourcing of raw ingredients**
  - **Ingredients sourced locally from smallholder farmers** in Kenya and Uganda, with plans to scale across East Africa
  - **Investing in seed improvement** and **building an out grower program** for bambara nuts to build a robust supply chain
- **Market**
  - Currently selling in **premium urban grocery stores and direct-to-consumer channels** with plans to scale into lower-margin markets
  - **Exploring export potential to European markets**, capitalizing on nutrition and sustainability benefits of bambara milk

Source: OnlyPlants

9 Plant-based value-added dairy | The value-added dairy market in SSA could be USD 50 to 70 mn by 2035

ALL 2035 NUMBERS

Traditional dairy · Novel alternate protein · x Est. 2035 market size (mn tonnes)



Total market segment, % of total dairy market

High-income consumers buying pasteurised value-added dairy in modern retail

0.3

Total addressable market

24% would be willing to partially switch to plant-based dairy[1]

+

5% would switch exclusively to plant-based dairy[1]

0.09

Equals 7 servings per week of 150 g per capita

Scenarios

Of the population that switches partially, consumers replace dairy with novel alternate protein

1x per week

2x per week

Assumed average servings per week

Priced at USD ~1.7 per l based on ex-factory cost[3]

Est. 2035 market size (USD mn)

% volume of total formal value-added dairy market

2%

2.7%

Versus 6.4% for the US in 2023 (including milk and value-added dairy)[2]

---

1. Based on a US consumer survey report and assuming similar acceptance rates in SSA in 2035
2. Based on Euromonitor data
3. Based on global brands sold in SSA

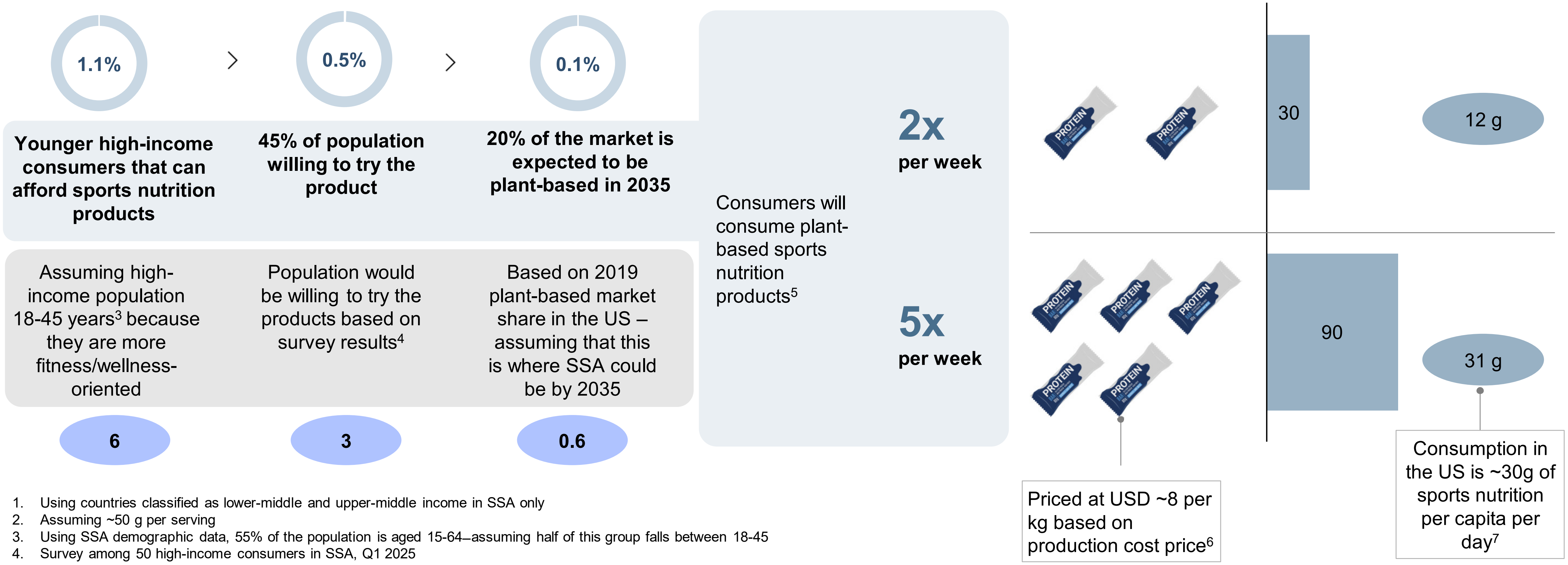
Sources: Kenya National Bureau of Statistics (KNBS), Quantifying Appliance Access Gaps (CLASP); Study on Meat End Market Trends in Kenya; Gatsby, UK Aid; FAOSTAT; World Bank; expert interviews; McKinsey's 2022 US Dairy Consumer Survey

⑬ Plant-based sports nutrition | The plant-based sports nutrition market in SSA could be between USD 30 and 90 mn by 2035

ALL 2035 NUMBERS

Novel alternate protein

x Est. population size in 2035 (mn)



Market assumptions in 2035[1]		**Total addressable market 2035**	**Scenarios**	**Assumed average servings per week**[2]	**Est. 2035 market size,** USD mn	**Grams per capita per day**
1.1%	0.5%	0.1%	Consumers will consume plant-based sports nutrition products[5]			
Younger high-income consumers that can afford sports nutrition products	**45% of population willing to try the product**	**20% of the market is expected to be plant-based in 2035**	**2x** **per week**		30	12 g
Assuming high-income population 18-45 years[3] because they are more fitness/wellness-oriented	Population would be willing to try the products based on survey results[4]	Based on 2019 plant-based market share in the US – assuming that this is where SSA could be by 2035	**5x** **per week**		90	31 g
6	3	0.6				

Priced at USD ~8 per kg based on production cost price[6]

Consumption in the US is ~30g of sports nutrition per capita per day[7]

---

1. Using countries classified as lower-middle and upper-middle income in SSA only
2. Assuming ~50 g per serving
3. Using SSA demographic data, 55% of the population is aged 15-64–assuming half of this group falls between 18-45
4. Survey among 50 high-income consumers in SSA, Q1 2025
5. Sports nutrition products include protein powder, meal replacement, protein snack bars, protein drinks
6. Based on global prices
7. Based on assumptions on the US market that consumes sports nutrition products and data on volume sold from expert interviews

Sources: Kenya National Bureau of Statistics (KNBS); Quantifying Appliance Access Gaps (CLASP); FAOSTAT; World Bank; expert interviews

20 21 Consumer foods fortification | There is a global trend on fortified processed food, mostly driven by health and fitness trends

			Protein ingredients[1]						
Processed product categories	**Example**		**Soy**	**Pea**	**Whey**	**Rice**	**Wheat**	**Additional protein share from fortification**	**Country**
Baked goods	**Bakery flour mixes**				✓		✓	~17%	🇺🇸
	Bread			✓			✓	~14%	🇬🇧
	Cookies			✓		✓		~8%	🇺🇸
Snacks	**Cereals**		✓					~10%	🇺🇸
	Chips			✓			✓	~25%	🇺🇸
Pasta and noodles	**Pasta**			✓				~5%	🇺🇸
	Instant noodles			✓				~25%	🇺🇸
Soup	**Soup**			✓				~8%	🇺🇸
Staple flours	**Maise, cassava flour**	N/A							

Protein-fortified products exist globally across a large range of products. Consumption of these are largely **driven by health and fitness trends** in high-income populations

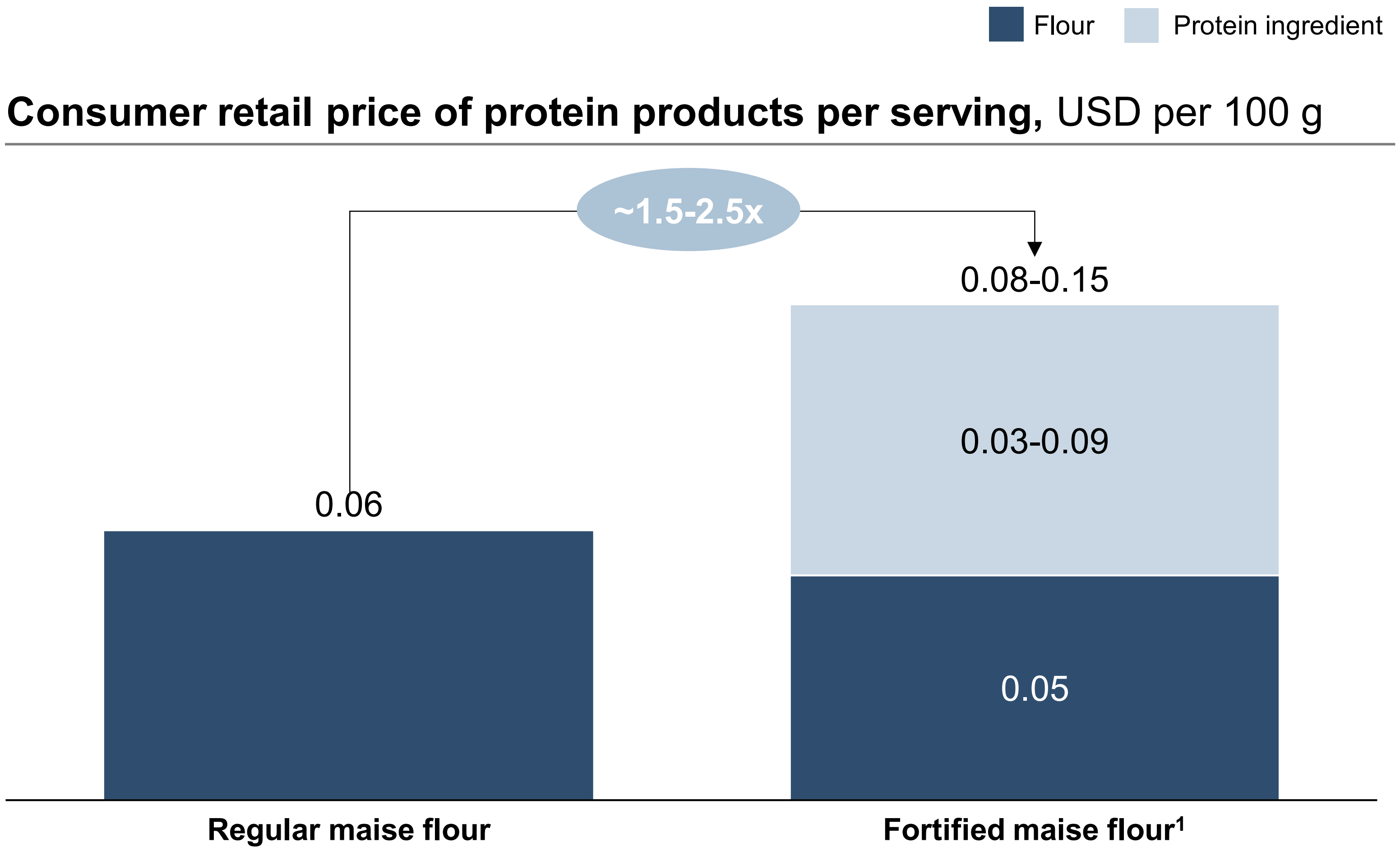
---

1. Incl. protein isolates and concentrates

Source: Press search

⑳ ㉑ Consumer foods fortification | Fortification in SSA may similarly be a focus for the higher-income segment

Consumer retail price of protein products per serving, USD per 100 g



1. Assuming fortification with 15 g of mycoprotein from biomass fermentation for low range and 15 g of pea isolate for high range
2. Survey on fortification of staples against protein chunks, done for presumed low- and middle-income members (n = 40) suggested 70% of consumers prefer a centre of plate protein over fortified products for main meals
3. While micronutrient fortification is mandated in 29 countries across SSA, it is low-cost and hard to get elsewhere; whereas protein fortification is more costly and there are other sources of protein available

Source: Press search

Key insights[3]

Protein **fortification in SSA will likely remain a market for high-income individuals** that are following global trends on health and fitness given

- **Consumer preference[2] for centre of the plate protein** for main meals (e.g., vegetable protein chunks)
- Globally, there is limited protein fortification in staple flours so this would require **extensive R&D to fit local consumer taste preferences in sub-Saharan Africa** (e.g., fortification of ugali or garri)

Some **option to create a fortified breakfast product** where the "centre of plate" protein is less of an issue; would require consumer education to incentivise adoption despite higher cost

20 21 Consumer foods fortification| The consumer food fortification market in SSA could be between USD 50 and 100 mn by 2035

ALL 2035 NUMBERS

Fortified consumer foods

x Est. population size in 2035 (mn)

Market assumptions[1]

1.1%

Younger high-income consumers that can afford protein-fortified products

High-income population within the age demographic 18-45 years[2] assuming they are more likely to follow health and wellness trends

6

×

Total addressable market

0.2%

20%[3] of this population willing to try fortified foods[5]

Population that would be willing to try the products based on survey results[4]

1.2

Scenarios

Consumers will consume fortified foods products[5]

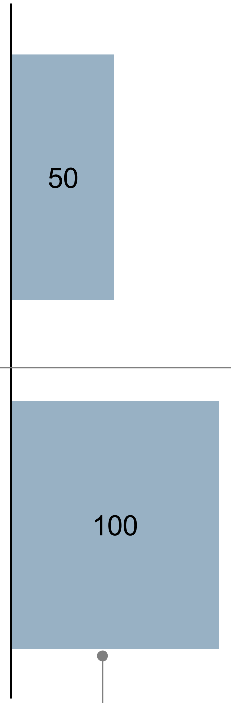
1x per week

2x per week

Assumed average servings per week[6]

Priced at USD ~2.5 per kg based on a weighted ex-factory[7]

Est. 2035 market size (USD mn)



Across plant-based and biomass fermentation technologies

Additional protein per capita per day

3 g

4 g

Total protein intake of ~120 g in China and ~125 g in the US in 2021[8]

1. Using countries classified as lower-middle and upper-middle income in SSA only
2. Using SSA demographic data, 55% of the population is aged 15-64–assuming half of this group falls between 18-45
3. 30% indicated in the survey that they would switch – we assume some difference between intentions and actions, adjusting by 10%
4. Survey among 40 consumers in SSA, Q1 2025
5. Fortified products include flours, porridge, bread, pasta, snacks, instant noodles, etc.
6. Assuming a weighted 100 g per capita consumption daily
7. Assuming a weighted total price for multiple fortified products; 15% fortification with protein ingredient
8. Based on the UN Food Agency Report

Sources: Kenya National Bureau of Statistics (KNBS); Quantifying Appliance Access Gaps (CLASP); FAOSTAT; World Bank; expert interviews; UN Food Agency

Sub-Saharan Africa consumer market enablers | Several enablers could help build the SSA novel alternate protein consumer market

○ Low feasibility ● High feasibility ▨ Deep dive ahead

Enabler	Details	Stakeholders				Feasibility[1]
		Government	Development partners	Research institutions	Private sector	
Develop novel AP product standards	**Engage national standards bodies** (e.g., Kenya Bureau of Standards, Standards Organisation of Nigeria) **to develop clear product specifications** for novel alternate proteins (e.g., product categorisation, safety criteria, labelling criteria)	✓			✓	◑
R&D for a novel alternate protein to fit SSA market	**Partner with a local university to develop formulations using locally available/indigenous crops** (e.g., products from bambara nuts, cowpeas, jackfruit) and **fortified blends for local traditional foods** (e.g., ugali or garri)[2]		✓	✓	✓	●
Generate consumer awareness	**Create strategic partnerships between foods processors and retail chains (e.g., supermarkets) to drive consumer education** through targeted marketing initiatives (e.g., sampling, product placement)[3]				✓	◕
Local processing at scale	**Invest in processing infrastructure** (e.g., crop fractionation, extrusion, biomass fermentation) to enable large-scale, cost-effective production of alternate protein			✓	✓	◔
Local production of raw materials	**Scale cultivation of key local protein-rich crops** (e.g., peas, mung beans) and establish aggregation systems to ensure consistent, affordable supply for novel alternate protein producers	✓	✓	✓		◕

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1. Developing standards requires coordination amongst the national standards bodies and industry stakeholders and overcoming bureaucratic hurdles
2. Many universities in SSA already study food science and agriculture innovation
3. Retailers already have the infrastructure for promotional marketing – success depends on retailer buy-in and coordination with processors

Source: company interviews; expert interview

Sub-Saharan Africa consumer market enablers | Example: EU regulations on food and safety have been tailored to novel alternate protein

NOT-EXHAUSTIVE

EU regulation	Application to alternate protein
Novel food regulation	Governed by EFSA[1], requiring companies to **submit a detailed safety dossier** (covering safety, nutrition, allergens, and intended use) Applies to cultured meat, insects, fermentation-based protein, and novel ingredients
GM food regulation	Governed by EFSA, mandating full **risk assessment for any genetically modified food and feed** Applies to any genetically engineered or GM-derived alternate protein
Nutrition and health claims regulation	Governed by EU compositional standards, requiring **proof for any nutrition- or health-related claims on alternate protein products** (e.g., at least 20% of the energy value is provided by protein to allow “high in protein” label)
Food information regulation	Governed by EU food labelling rules, ensuring **clear, non-misleading naming of alternate protein** (e.g., specify source like “almond milk”; “meat” is protected and cannot be used for alternates)[1]

To create a regulatory system for novel alternate proteins, SSA could consider a similar approach to the EU by …

… developing harmonised food safety standards for novel alternate proteins across SSA

… training regulators on risk assessment (i.e., allergen testing, nutritional evaluation)

… developing comprehensive labelling standards across novel AP products

… creating collaboration between private sector entities in the novel AP space, **nutritional bodies** in the government, and **international bodies** to provide expertise

[1] European Food Safety Authority

Source: Alternative protein and EU food law report

Sub-Saharan Africa consumer market enablers | Novel alternate proteins for the SSA market could be designed to be …

… affordable

Prioritise crops with low production costs (bambara nuts, cowpeas, etc.)

Ensure cheaper-than- conventional animal proteins

Package in small sachets that are affordable to low-income households

… accessible

Ensure wide accessibility in both retail markets and informal markets (e.g., roadside stalls)

Develop products with an extended shelf life

… familiar

Replicate textures similar to locally consumed foods (e.g., stews, meat)

Integrate flavour profiles common in local cuisines (e.g., smoky, spicy)

… functional

Adapt to quick-cooking formats, requiring minimal water and energy

Ensure compatibility with common kitchen tools (pots, firewood stoves, charcoal grills, etc.)

… nutritious

Develop products with protein quality comparable to animal-source foods (i.e., complete amino acids)

Add other nutritional content (e.g., fibre, vitamin A, iron)

Source: Rapid review report on Kenya Alternative Proteins Sector (AgriFrontier, Innovate UK, 2025)

Agenda

Humanitarian food aid | There are 3 categories of humanitarian food aid, with potential opportunities for novel alternate protein

	25 **RUTF/RUSF** (emergency food pack for malnourished children)	29 **Humanitarian general food aid**	33 **School feeding**
Description	Specialised food products designed to combat acute (RUTF) and medium (RUSF) malnutrition	Immediate food aid assistance to regions in crisis (e.g., for conflict areas or climate disasters) to address urgent nutritional needs and ensure food security	Food aid initiatives that provide nutritious meals to students to combat hunger and improve food security and educational outcomes
~60-65% of global humanitarian food aid is distributed in SSA			
Total volume[1], k tonnes	~82	~2,750	~5,250
Protein volume, k tonnes	~10	~410	~400
Potential for novel alternate protein	Potential to substitute protein with novel alternate protein	Potential to substitute soy in corn-soy blend (e.g., porridge) with novel alternate protein	Potential to fortify existing staples (e.g., cereals) with novel alternate protein

! **USAID provided humanitarian food support through organisations such as WFP and UNICEF; recent funding strategy changes could potentially have an impact on future food aid volumes**

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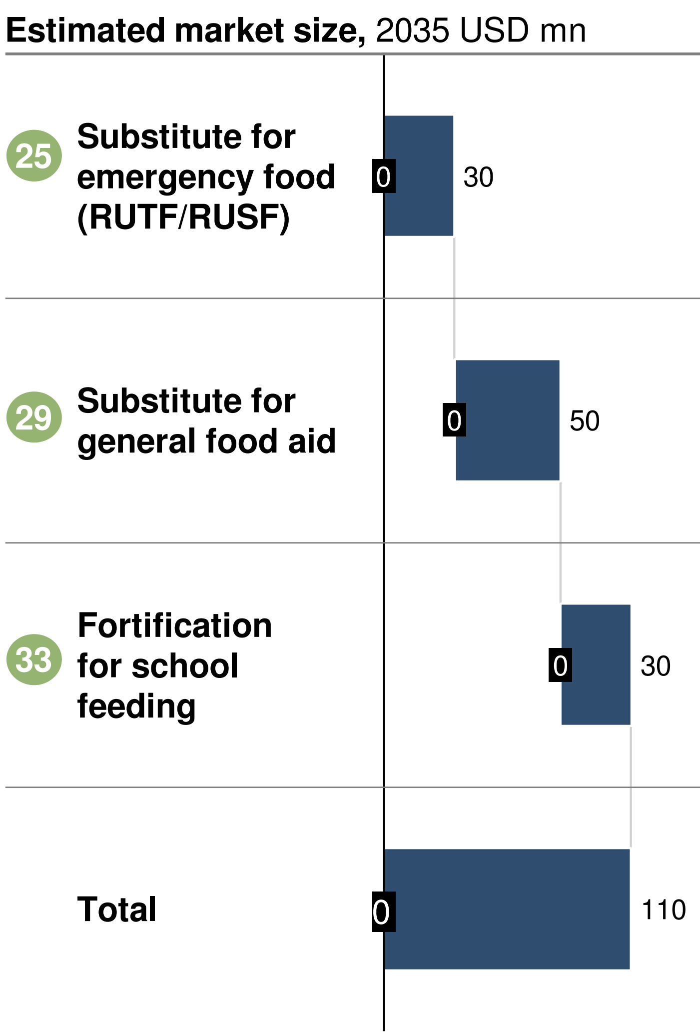
1. Total demand is based on the average volume of food for the years 2020-24

Source: WFP; UNICEF; WHO; Red Cross

Humanitarian food aid | The total novel alternate protein opportunity for the humanitarian food aid market in SSA could be between USD 0 and ~110 mn



Explanation

Currently, the protein in RUTF/RUSF comes from peanuts and dairy powder; only the latter could be substituted by novel alternate protein due to costs and nutritional reasons

In the low scenario, no substitution potential is assumed because of the strict guidelines on formulations

In the high scenario, we assume that the protein from dairy powder (~50% of total protein) will be substituted by a novel AP (e.g., mycoprotein). However, this would require a special assessment and embedding of novel AP in the Codex guidelines[1]

There could be an opportunity to substitute soy (in corn-soy blend for porridge) with a novel alternate protein

In the low scenario, no substitution potential is assumed because of price constraints and supply challenges

In the high scenario, there could be an opportunity to substitute 50% of soy in corn-soy blend with a novel alternate protein (e.g., mycoprotein). This would reduce the dependency on import and exposure to fluctuating global soy prices, but would require the willingness from funders to cover increased costs of up to USD ~15 mn

There could be a future opportunity to fortify staples in school feeding with a novel alternate protein

In the low scenario, no fortification potential is assumed because of price constraints and supply challenges

In the high scenario, there could be an opportunity to fortify staples with a novel alternate protein (e.g., fermented mycoprotein). However, this would require the willingness from funders (e.g., NGOs, partnerships or parents) to cover increased costs of up to USD ~30 mn

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1.The Codex Alimentarius is a set of international food standards, guidelines, and codes of practice established by the FAO and WHO to ensure food safety and quality. They are followed by many humanitarian organisations incl. WFP and UNICEF

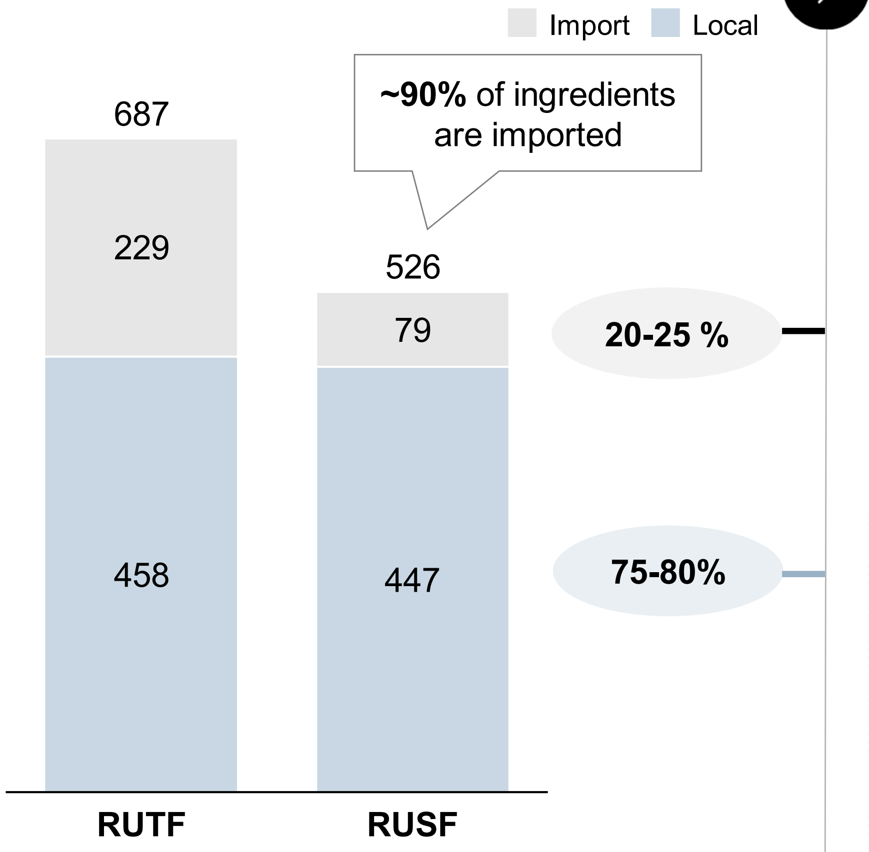
Humanitarian food aid | Various players are present in the humanitarian food aid market in SSA

NON-EXHAUSTIVE

	Organisation	Country	Description
Companies that make RUTF/RUSF	HILINA	🇪🇹	Manufacture RUTF/RUSF for humanitarian organisations
	InnoFaso	🇧🇫	
	VALID NUTRITION	🇰🇪	
	nutri K	🇳🇬	
	[illegible]	🇰🇪	
Humanitarian organisations and school feeding organisations and governments	WFP	🌍	Provides 60% of humanitarian food aid and collaborates with governments to improve school feeding and nutrition
	School Meals Coalition	🌍	Improves school feeding programme through collaboration and resource sharing among global stakeholders
	The Rockefeller Foundation	🌍	Supports school feeding programmes through funding, research, and innovative solutions
Companies that produce fortified products (e.g., fortified cereals)	PROCTOR & ALLAN	🇰🇪	Produce commercial products (e.g., staples) that can be fortified with protein
	ENP	🇰🇪	
	SOY AFRIC	🇰🇪	
	[illegible]	🇰🇪	
Companies that make protein for fortification	essential	🇰🇪	Produce a fermented protein that can be used to fortify products
	mycoSURE ENGINEERED BY NATURE	🇿🇦	
Research and guideline setters	Food and Agriculture Organization of the United Nations	🌍	Establish guidelines for food ingredients and formulations
	World Health Organization	🌍	

25 RUTF/RUSF | Most therapeutic food is locally produced, but most ingredients are imported

RUTF and RUSF volumes, annual average production, 2022-24, mn sachets



~90% of ingredients are imported

Example companies

Imported	Ingredient	Location of producer
Nutriset	Dairy powder, peanuts	France
Lipid Nutrient Supplement		France
Hexagon		India
MANA nutrition		US
Edesia		US
Local SSA		
Insta Products		Kenya
Hilina		Ethiopia
InnoFaso		Nigeria
Diva Nutritional Products		South Africa

Key insights

Dairy powder and peanuts are the primary protein ingredients in RUTF and RUSF, giving an average of **12-15% of protein content**

In sub-Saharan Africa, peanuts have a high risk of **aflatoxin contamination,** which poses significant risks to the quality of these products, and leading to high levels of importation of ingredients **(~90%)**

Source: UNICEF; WFP; Nutriset, Insta Products; Hilina Foods

25 RUTF/RUSF | Within the current Codex guidelines, there could be limited use of novel alternate protein

🟨 Mandatory 🟩 Advice

Codex guidelines[1]	Consequence for novel AP
🟨 **Protein should provide 10-12% of total energy**	Limited potential to add additional protein
🟨 **The PDCAAS should be at least 0.9**	Limited number of novel alternate protein sources are suitable to substitute • **Novel alternate protein that are suitable:** Soy isolate, pea isolate, mung bean isolate, and mycoprotein • **Novel alternate protein that are not suitable:** Chickpea isolate, spirulina and fava bean isolate[2]
🟩 **Advises that ~50% of protein could come from dairy for better quality**	~50% of protein in ready-to-use-foods needs to come from dairy and can therefore not be substituted with novel AP within the current Codex guidelines

Key insights

The Codex Alimentarius (or "Food Code“) is a **set of international food standards, guidelines, and codes of practice** established by the FAO and WHO to ensure food safety and quality. They are followed by many humanitarian organisations incl. WFP and UNICEF

Changes to therapeutic foods follow a defined process based on alignment with the Codex guidelines

- **Changes within guidelines** require the submission of a proposal with scientific evidence and could take several months
- **Changes outside the guidelines** need detailed assessment, testing and regulatory approval, and could take multiple years to be approved

> International guidelines could potentially pose a significant barrier to implementing new therapeutic formulations in Africa, despite their potential **– *Chief Product Officer, large local producer***

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1. Selected key guidelines for novel AP from the Codex Alimentarius “Food Code” for RUTF 2022
2. Fava beans are also excluded because of the risk of favism (breakdown of red blood cells)

Source: Codex Alimentarius “Food Code” 2022; expert interviews

25 RUTF/RUSF | Only dairy powder and potentially soy flour could be substituted by novel alternate protein

ILLUSTRATIVE

● High opportunity ○ Medium opportunity ● Low opportunity

		Current ingredients				Potential novel alternate protein source	
	Criteria	**Peanuts**	**Dairy powder**	**Soy flour**	**Lentils**	**Plant-based protein Isolates[1]**	**Mycoprotein**
Nutritional values	**Calorie,** kcal per 100 g	570	350	436	350	390	365
	Protein content, %	25%	35%	49%	25%	90%	45%
	Key vitamins	B, E	A, B, D, Choline	B, E	B, K	B, D, E	B
	Key minerals	Magnesium, phosphorous, zinc, iron	Calcium, magnesium, potassium, phosphorus	Phosphorous, magnesium, potassium, calcium, iron, zinc	Potassium, magnesium, phosphorous, magnesium, copper, iron, zinc, calcium	Calcium, phosphorous, magnesium, potassium, zinc, iron, manganese	Iron, phosphorous and zinc
	PDCAAS	0.6	1.0	0.9	0.6	0.85	1.0
Costs	**Costs,** USD per kg	1.0	3.0	~1.0	1.4	5.5	2.3[2]
	Cost, USD per kg of protein	4.0	8.5	2.0	5.5	6	5
Opportunity for substitution		✗ Not likely to be substitutable by novel AP, due to a higher **level of calories** and **lower costs**	✓ Could be substituted by novel AP because of high protein quality and lower cost; however, the novel AP would need to be fortified with missing vitamins and minerals	✓ Could be substituted by novel AP; however, this, would require an increase in costs and would require fortification with missing vitamins and minerals	✗ Not likely to be substituted by novel AP, due to a higher **level of calories** that you would replace		Novel alternate protein technology with potential because of price per kg of protein and DIAAS

2. Based on pea isolate
1. Expected future price of local player

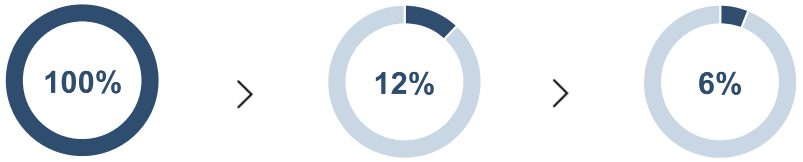
Source: Good Food Institute; press search

25 RUTF/RUSF | The RUTF/RUSF novel AP market in SSA could be between USD 0 and 30 mn by 2035

ASSUMING THE 2035 TOTAL MARKET IS THE SAME AS THE AVERAGE FOR 2022-24

RUSF ■ RUTF (x) 2020-24 market size, k tonnes

Market assumptions | **Total addressable market** | **Scenarios** | **Ingredients** | **Est. market size 2035,** USD mn | **Increase in costs, %**



Total expected demand for RUTF/RUSF in 2035 is based on average volume for 2020-24 assuming this demand stays flat

Total protein volume requirement is based on the Codex guidelines at ~12%

50% of the protein (coming from dairy powder) is suitable for substitution by a novel alternate protein; however, this is outside of the Codex guidelines

82

10

5

50% protein comes from peanuts and is not substitutable because peanuts are also rich in calories and are low in cost

No opportunity for novel alternate protein, because it would mean additional costs and an extensive testing and approval process

Peanut

Dairy powder

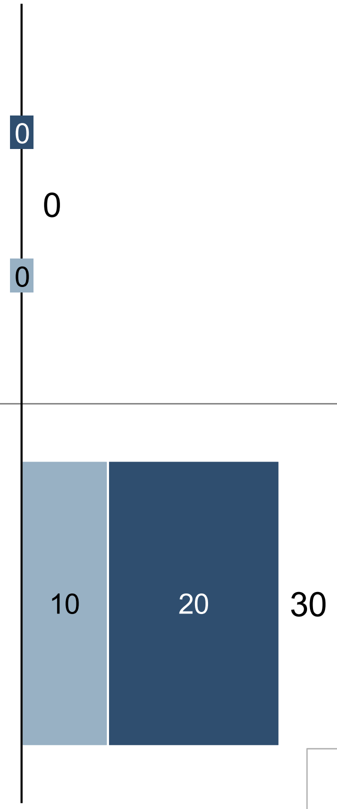
Substitution of dairy powder with mycoprotein

- Assuming the required approvals are granted to substitute dairy powder
- Total mycoprotein volume required will be **~12 tonnes,** based on 45% protein share of mycoprotein

Peanut

Myco-protein

Expected future price of mycoprotein USD 2.25 per kg[1]



0%

~1%

Total cost increase considering the total RUTF and RUSF market

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1. Expected future price from local biomass fermentation player

Source: UNICEF; WFP; ODA; The Codex Alimentarius; press search

29

33

General food aid and school feeding | There could be an opportunity to supplement or substitute some conventional protein with fortified staples

How	Reason	Considerations
Supplement *Add more protein to increase the total protein intake*	Adding high-quality novel alternate protein sources could enhance nutritional content	Supplementing comes at additional costs of USD 0.20-0.25 per 10 g per person
Substitute *Replace currently used protein*	There is limited potential for substitution, because it would increase costs (+USD 3.00 per kg of protein vs soy) and might also lose additional nutritional values such as calories	

Examples of fortified products

Porridge flour

Wheat flour

Maise flour

Cereals

Key insights

Although there could be an opportunity to supplement humanitarian food aid or school feeding, the opportunity might be limited as it could increase costs

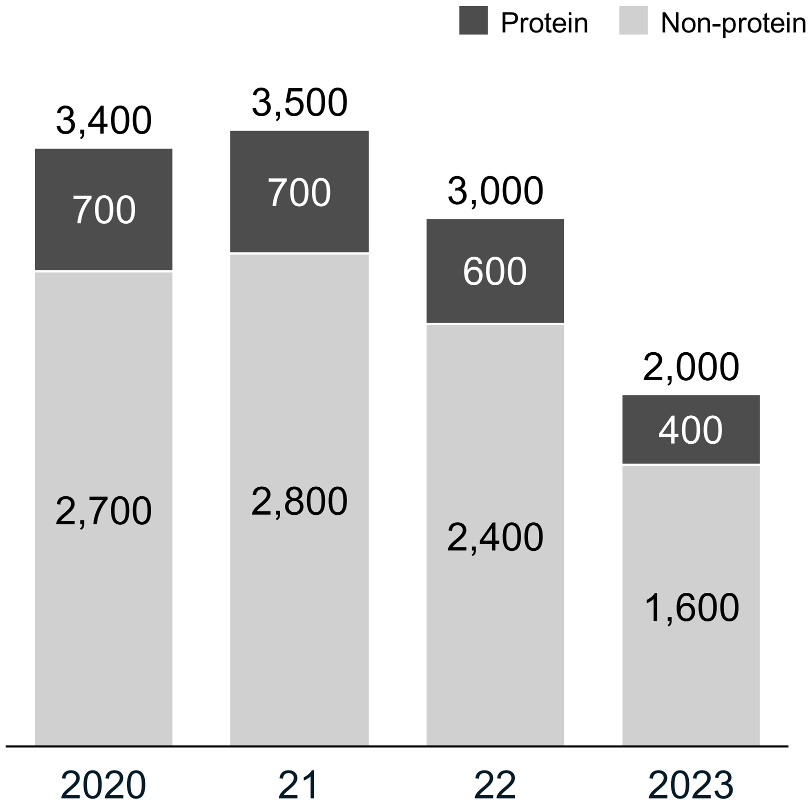
There could be potential to substitute protein sources (e.g., soy) to boost local production. However, the opportunity might be limited as replacing them may reduce other nutritional benefits (e.g., calories) and increase costs

Protein derived from fermentation (e.g., mycoprotein) is the most likely novel alternate protein to be used in school feeding due to its higher DIAAS compared to plant-based options

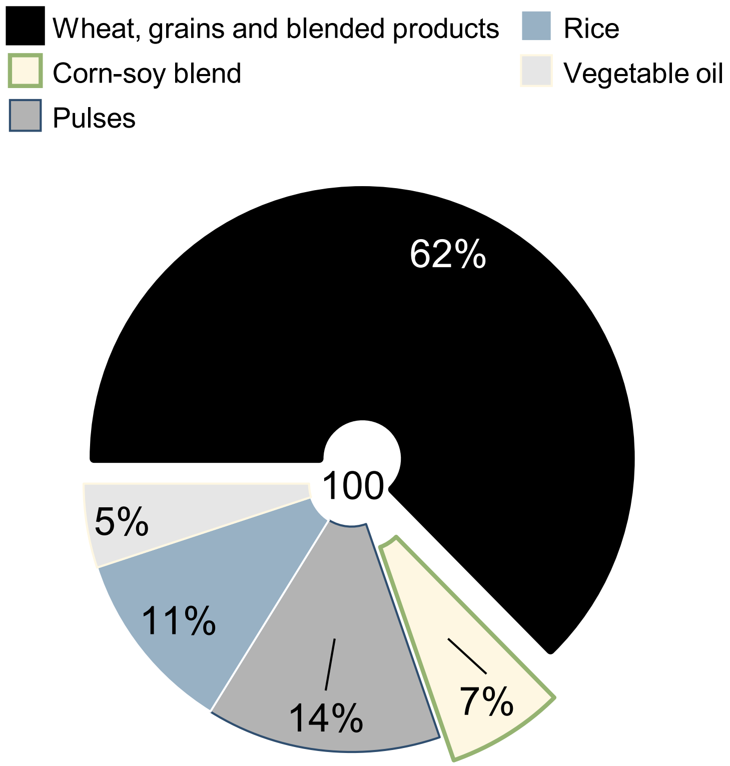
Source: Essential; AIF; press search

29 General food aid | Volume is volatile with an average of 400-700 k tonnes protein across SSA

Humanitarian food demand breakdown in SSA, k tonnes[1]



Food aid basket, % of total



Key insights

The current volume of food aid in SSA is ~2.000-3.500 k tonnes, of which ~20%[2] (400-700 k t) is from a protein source. The future is difficult to project, but some expected trends

- Food aid demand is expected to remain in the future due to **extreme weather events and conflicts**
- **Projected increase in food insecurity, with an estimated ~145 mn[3] hungry children by 2030**

The current food basket is based on Sphere guidelines. This means a recommendation of 52 g protein per capita per day (10-12%)[4]

1. The total is calculated by assuming WFP supplies 60% of the total African food aid while the rest covers the remaining 40%
2. Assumption: Food basket % from 2023 is used to calculate protein distribution for all the other years
3. According to WFP, FAO, UNICEF and WHO 582mn people would be undernourished with more than half of this in Africa and more than half as children
4. The Sphere Handbook: Minimum standards in humanitarian response

Source: WFP; USAID; UNICEF; press search

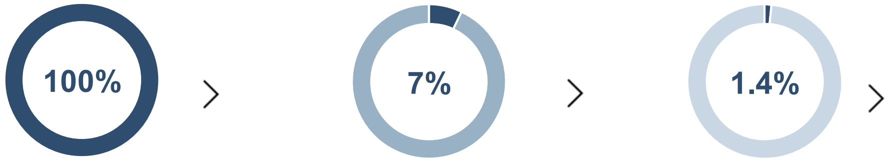
29 General food aid | The general food aid novel AP market potential in SSA could be between USD 0 and 50 mn by 2035

ASSUMING THE 2035 TOTAL MARKET IS THE SAME AS THE AVERAGE FOR 2022-24

x 2020-24 market size, k tonnes

Market assumptions

Total addressable market



Base demand for 2035 is taken as average food volume from 2020-24 in humanitarian food aid

2,75
0

×

Only corn-soy blend (~7% of total food aid) can be substituted with novel alternate protein

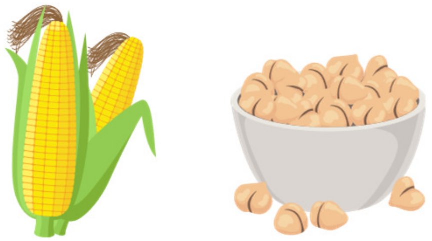
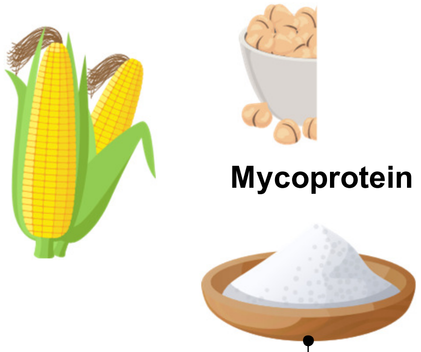
190

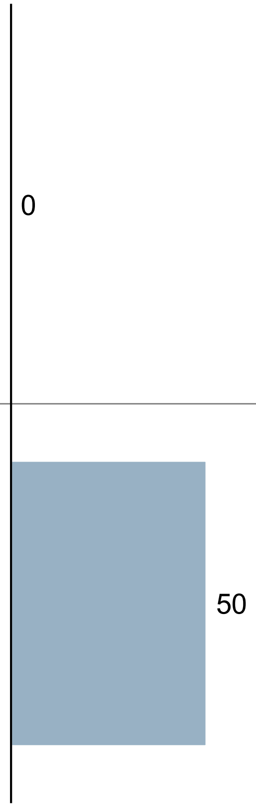
×

The soy in corn-soy blend will be replaced (~20% of the total corn-soy blend)

40

There are no other suitable products that can be substituted as this would increase costs or have other nutritional disadvantages such as a reduction in calories

Scenarios	Ingredients	Est. market size 2035, USD mn	Increase in cost, %[1]
There is no substitution of soy in corn-soy blend because of the increase in costs	**Corn** **Soy** 	0	0%
Substituting 50% of soy in corn-soy blend because humanitarian organisations are choosing to localise production, accepting a cost increase	**Corn** **Soy** **Mycoprotein** 	50	~1.5%



Expected future price of mycoprotein USD 2.25 per kg[2]

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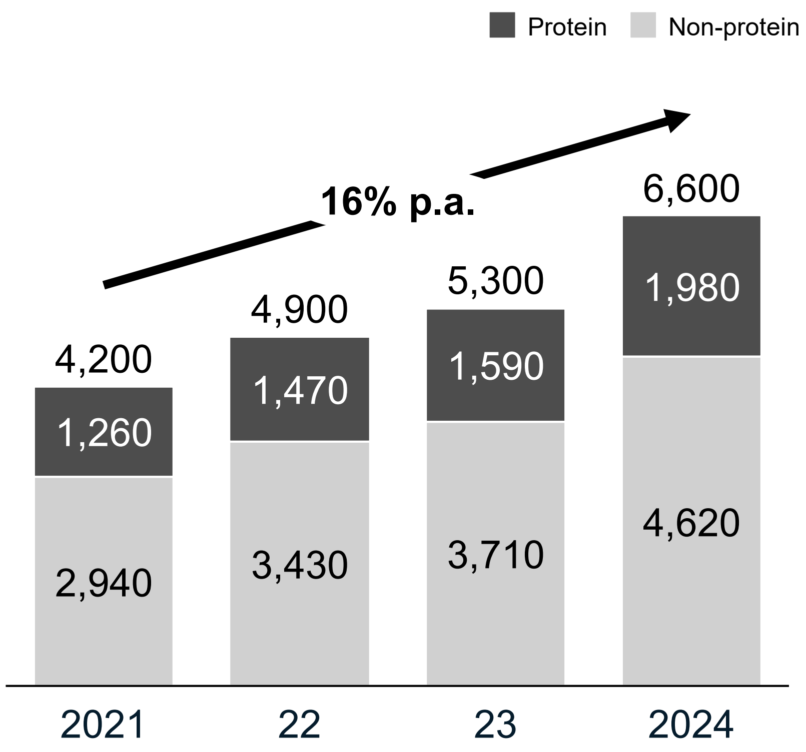
1. Percentage of the total annual general food aid costs in sub-Saharan Africa
2. Expected future price from local biomass fermentation player

Source: FAOSTAT; World Bank; KNBS; expert interviews; CLASP; consumer survey

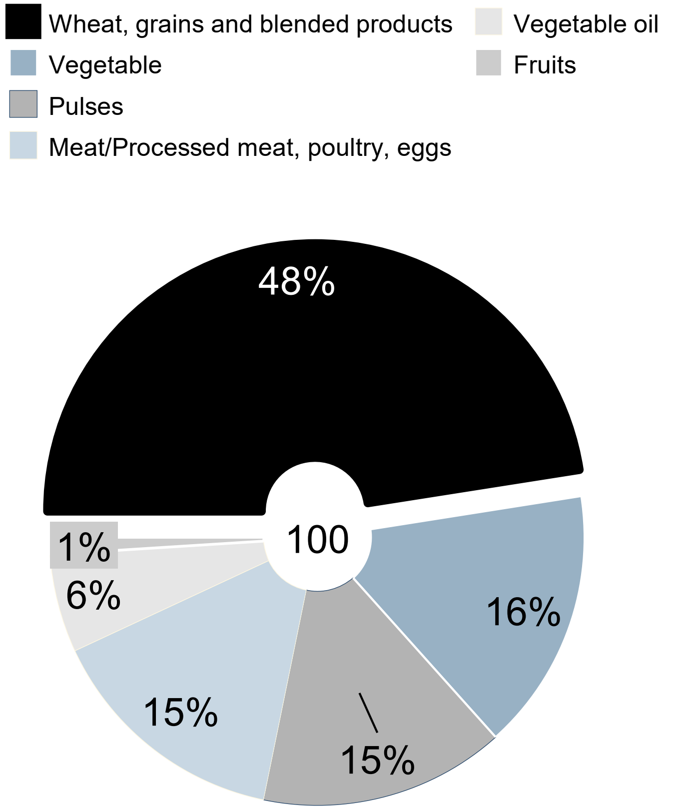
UK International Development

33 School feeding | Each year ~1,300-2,000 k tonnes protein are distributed through school feeding

School feeding demand in SSA,
k tonnes



School feeding basket[2], % of total



Key insights

- **~50%** of the programmes are run by the government and **~50%** by NGOs and partnerships
- School feeding has been increasing **(CAGR ~16%)** with **governments[1] stepping up** to run the programmes (e.g., national school feeding policies on 37 countries)

> For increased costs, many organisations would rather increase their school feeding reach than increase the protein nutritional value – ***Director, food initiative, large NGO***

---

1. Have implemented national school feeding policies to support the programmes
2. Assumption: Each student gets 450-500 g per day and is served for 200 days a year, 30% of the food is considered protein
3. According to a global survey of school feeding programmes

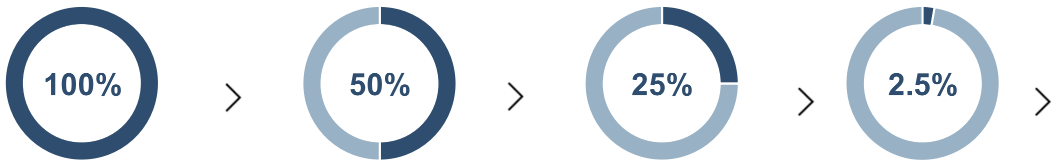
Source: School Meals Coalition, Global Child Nutrition Foundation, WFP, Global survey of school meal programmes, food for education, FAO

33 School feeding | The total school feeding market in SSA could be between USD 0 and 30 mn

ASSUMING THE 2035 TOTAL MARKET IS THE SAME AS THE AVERAGE FOR 2022-24

x 2020-2024 est, market size, k t

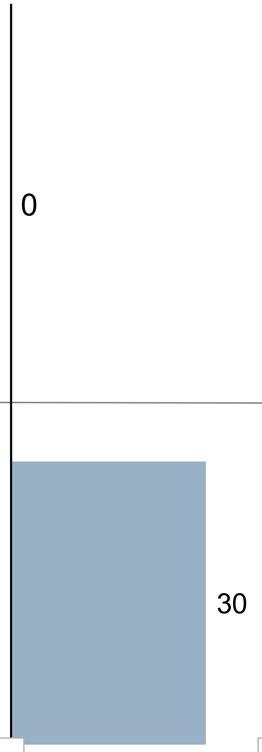
Market assumptions **Total addressable market**



The total expected school feeding demand for 2035 × There could be an opportunity in ~50% of the school feeding that is not funded by governments × Only 50% of the food basket (wheat, grain and blended products) have the potential of being fortified × Only 10% of the potential will be fortified due to high costs of protein fortification

5,250	2,630	1,315	130
Base demand for 2035 is taken as average food volume for 2020-24 in school feeding	NGOs and other funders might be willing to increase spend for an increased protein level		Only small amounts of protein (<15%), e.g., from mycoprotein can be added to avoid change in taste and texture of the staples

Scenarios	Ingredients	Est. market size 2035, USD mn	Increase in cost, %
No opportunity for fortification assumed because of the high costs	**Staples**: *Wheat flour*, *Porridge flour*	0	0%
10% alternate protein is added which is ~1.5 g per person per day of proteins added to the school meals	**Staples**: *Wheat flour*, *Porridge flour*; **Mycoprotein**	30	3%



Expected future price of mycoprotein USD 2.25 per kg[1]

Assuming every student used USD ~40 per year

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1. Based on the future expected price of a local player

Source: FAOSTAT; World Bank; KNBS; expert interviews; CLASP; consumer survey

Humanitarian food aid | In additional to governments, 3 key humanitarian organisations in the food aid sector are indispensable to capture the novel AP opportunity

▨ Priority organisations

Organisation	Annual reach (SSA), mn people	Regular food aid	RUTF/RUSF	School feeding
WFP	100	✓	✓	✓
Red Cross	20	✓	✓	✓
Action Against Hunger	17	✓		
Welthungerhilfe	17	✓		✓
UNICEF	9		✓	✓
Bread and Water for Africa	<1	✓		✓
CAMFED[3]	<1	✓		✓
OCHA	N/A[1]	✓		
USAID	N/A[2]	✓	✓	✓

! *USAID provided humanitarian food support through organisations such as WFP and UNICEF; recent funding strategy changes could potentially have an impact on future food aid volumes*

Key insights

WFP, Red Cross, and UNICEF are major players who distribute **~80%** of the humanitarian food ai:

- **WFP provides over 60%** of SSA food aid
- Red Cross has **presence in all 49 sub-Saharan African** countries
- **UNICEF** sources **over 80%** of the total RUTF products supplied in Africa

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1. Enables effective delivery of humanitarian organisations
2. USAID coordinates with WFP, UNICEF, and other organisations to provide humanitarian aid but does not have a dedicated unit for this purpose
3. Campaign for female education

Source: Press search

Humanitarian food aid | These organisations enforce strict quality standards and procedures for new formulations

	WFP	INTERNATIONAL COMMITTEE OF THE RED CROSS	unicef
Procurement process	**Decentralised procurement** in country offices (e.g., 60% local to stimulate economic growth) Global formulations changes take 2-3 years	**Centralised procurement system** in Geneva (IFRC), national societies like Kenya have their own procedures	**Centralised procurement office in Copenhagen** **Partnerships with governments for supply chain** and tech assistance Two-thirds of RUTF/RUSF are sourced **locally**[1]
Mentioned buying factors	**Market availability** and **cost-effectiveness** **Support for smallholder farmers**	**Cost-effective sourcing** **Acceptance** and **cultural sensitivity**	**Price** and **quality**

Implications for novel alternate protein

To ensure quality and the optimal nutritional balance, new ingredients need to **adhere to the Codex guidelines.** Potential changes that adhere to the codex guidelines could be approves within several months. Changes that do not meet the current threshold, require extensive testing and could take multiple years

Local production of novel alternate protein at scale might be costly and challenging to meet the quantity demand

Consumer acceptance varies geographically; therefore, changes to formulation need to be adapted to local preferences

! *USAID provided humanitarian food support through organisations such as WFP and UNICEF; recent funding strategy changes could potentially have an impact on future food aid volumes*

Key insights

WFP, Red Cross, and UNICEF provide ~80% of sub-Saharan African food aid, hence are the key players to interact with when exploring the opportunities for novel alternate protein to the humanitarian food basket

Realising the potential for novel alternate protein in the humanitarian aid market requires a further suitability assessment of novel alternate protein, cost-effective local production, and consumer acceptance

---

1. In 2021

Source: Interviews; WFP; Red Cross; UNICEF; press Search

Enablers - humanitarian food aid | Several enablers could be considered to further validate the novel alternate protein opportunity

○ Low feasibility ● High feasibility ▨ Deep dive ahead

		Stakeholders				
Enabler	**Details**	**Government**	**Development partners**	**Research institutions**	**Private sector**	**Feasibility[1]**
Conduct a suitability assessment for novel AP	Conduct a **special assessment of novel alternate protein** opportunities in humanitarian food aid, including defining the ideal composition, cost, and nutritional benefits to confirm the potential benefits of novel alternate protein in food aid for humanitarian organisations and their beneficiaries After confirmation of the special assessment, **embed suitable novel alternate protein** into the codex guidelines and/or school feeding guidelines	✓	✓	✓	✓	◔
Initiate a local production partnership	Set up a collaboration between government, development partners, research institutions, and the private sector to **develop products (e.g., RUTF with novel alternate protein) that meet humanitarian needs and comply** with codex guidelines Create a **local partnership** with farmers and local food production companies to realise low-cost and high-quality local production of novel alternate protein products	✓	✓	✓	✓	◑

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1. Low feasibility: likely complex process with high cost and long timelines; high feasibility: likely simpler process with lower cost and shorter timelines

Agenda

SSA animal feed market | We look at different market segments in the animal feed market

	㊲ **SSA dry pet food market**[2]	**SSA wet/fresh pet food market**	㊶ **SSA compound livestock feed market**
Description	Dried pet food (e.g., kibble for dogs and cats) bought by consumers to feed their pets	Wet pet food (e.g., canned food with chicken) bought by consumers to feed their pets	Total animal feed provided to livestock (e.g., poultry) by commercial farmers; the feed is typically a mix of grains, protein (soybean meal), fats, and other additives
			
Est. market size, 2035 mn tonnes	**0.6**	**0.5**	**20**[1]
Potential for novel AP	Potential to substitute dry petfood with edible insect (i.e., BSF), e.g., pet owners who care about sustainable alternatives for pet food	No potential for novel alternate protein, because pet owners that value fresh food are unlikely to switch	Potential to substitute soybean meal if the alternative (i.e., BSF) is at price parity or because of the perceived value-add of additional health benefits

BSF is the most likely edible insect to use for animal feed because of costs and quality; and is therefore used for the sizing in this section

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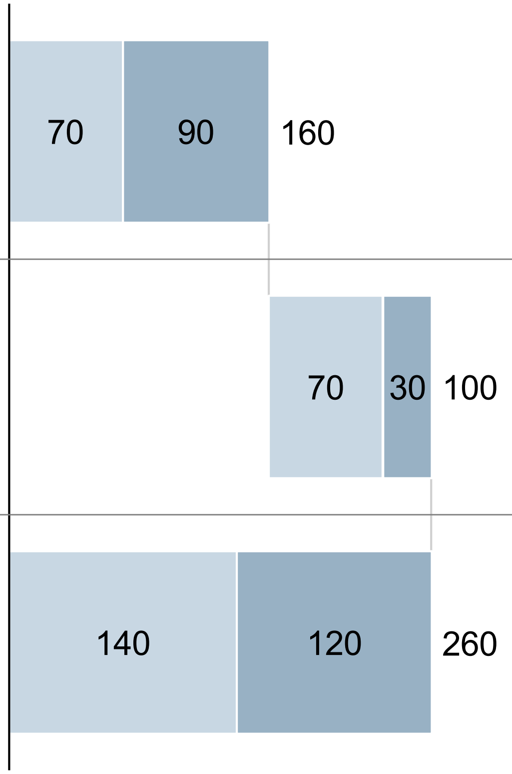
1. For poultry and eggs only (BSF not suitable for dairy feed); focus on large feed markets - Ethiopia, Kenya, Nigeria, Uganda, Rwanda, Tanzania, Zambia and Zimbabwe
2. Assumes that dogs consume 50% packaged (dry) pet food and cats consume 60% packaged (dry) pet food

Source: FAOSTAT; USDA; IMF; company interviews; expert input; Barth Haas group; Statista Market Insights; Future Market Insights

SSA animal feed market | The total novel AP opportunity for the sub-Saharan Africa animal feed market could be USD ~140 to ~260 mn

Estimated market size, 2035, USD mn



37 Insect-based protein for pet food

41 Insect-based protein for compound livestock feed

Total

Explanation

Insect-based protein for pet food:

Given **the premium pricing for pet food,** there is an opportunity for novel alternate protein to compete against conventional feed

Uptake in low versus high scenario is based on **accessibility and consumer preference based on sustainability benefits**

Insect-based protein for compound livestock feed:

Assuming that BSF **may not achieve price parity** with soybean meal except in limited circumstances (co-location with a large source of biomass) and there is a structural **shortage of biomass**

Uptake low versus high scenario is driven by the **amount of waste that can be captured** from large waste producers

Although, BSF is the most likely edible insect to use for animal feed because of costs and quality, there is a **structural issue to meet price parity and obtain sufficient biomass inputs to fully substitute** given BSF costs are currently ~40-50% higher than soybean meal and there is limited availability of biomass input

SSA animal feed market | Various players are present in the BSF market in sub-Saharan Africa

NON-EXHAUSTIVE

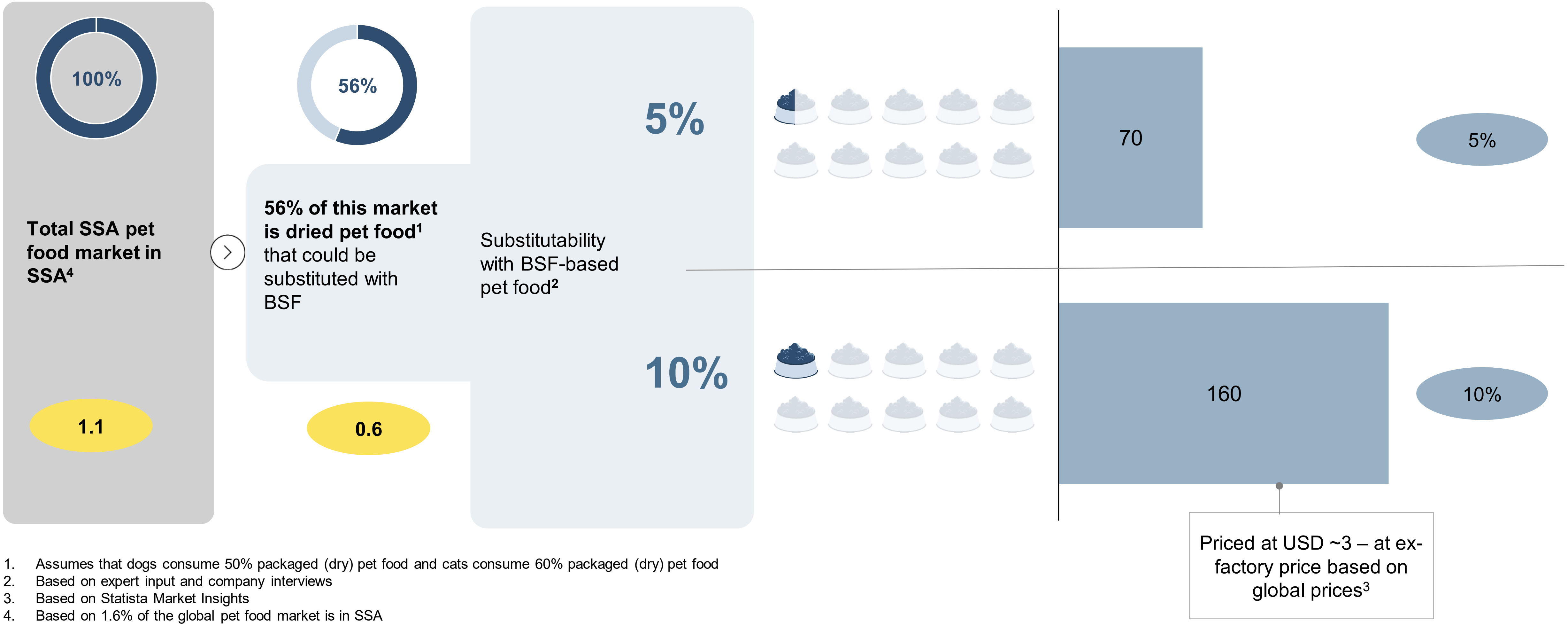
	Organisation	Country	Description
Compound livestock feed	[illegible]	🇹🇿	Production of protein for compound livestock feed and organic fertiliser using BSF
	ecodudu	🇰🇪	Production of protein for compound livestock feed and organic fertiliser
	CHANZI Protein For Animals	🇹🇿 🇰🇪	Production of protein for compound livestock feed and organic fertiliser using BSF; collocated with waste facilities
	INSECT PRO	🇰🇪	Production of insect-based protein, including BSF-based for compound livestock feed
	Ololo safari lodge & farm nairobi national park kenya	🇰🇪	Vertically integrated farm using on-farm waste to feed BSF, then used to feed poultry
	regen organics	🇰🇪	Collection and managing of organic waste and conversion into feed, fertiliser, and fuel (incl. using BSF)
	BIOLOOP	🇳🇬	Production of protein and organic fertiliser using BSF for direct sales to farmers; located <50 km from brewery
	UNIQUE BIOTECH	🇳🇬	Production of organic fertiliser, meal, and oil using BSF
	MAGOFARM	🇷🇼	Converting food waste and post-harvest losses into organic fertiliser and protein for compound livestock feed using BSF
	endiro coffee	🇺🇬	Production of BSF to feed own chickens and pigs
Pet food	Loop	🇰🇪	Production of BSF-based pet food

Source: Press search; company interviews

37 SSA pet food market | The opportunity for novel AP for the SSA pet food market could be between USD 70 and 160 mn

Conventional dried pet food that could be substituted with BSF pet food

x Total (mn tonnes)



Total SSA pet food market	Total addressable SSA pet food market	Scenarios	Substitutability, %	Est. 2035 BSF market, USD mn	Share of SSA dried pet food market, %
100%	56%	5%		70	5%
		10%		160	10%

Total SSA pet food market in SSA[4]

1.1

56% of this market is dried pet food[1] that could be substituted with BSF

0.6

Substitutability with BSF-based pet food[2]

Priced at USD ~3 – at ex-factory price based on global prices[3]

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1. Assumes that dogs consume 50% packaged (dry) pet food and cats consume 60% packaged (dry) pet food
2. Based on expert input and company interviews
3. Based on Statista Market Insights
4. Based on 1.6% of the global pet food market is in SSA

Source: Statista Market Insights; company interviews; expert input; Future Market Insights

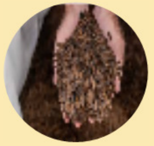
37 SSA pet food market | Case example: Maltento

Introduction to the company

- Maltento, founded in 2018, is a South African company specializing in **BSF production** for **pet food, animal feed, and frass**
- They produce **120 tonnes of live larvae per month,** supplying feed producers and farmers
- By emphasising the **functional benefits of BSF,** Maltento differentiates itself by offering **higher-value, performance-driven solutions** in animal nutrition

Example products

Product



Ingredient BSF

End-product palatants[1]

Consumers

Dogs

Cats

Products and strategy

- **Sourcing:** Partners with breweries to procure **clean, traceable spent grains,** ensuring compliance with **export standards** while avoiding the complexities and risks of waste management
- **Focus area**
  - **Emphasises functional benefits of BSF** (e.g., improved gut health, increased immunity) rather than substituting conventional protein (e.g., fishmeal, soymeal), allowing **BSF to compete outside of the commodity market**
  - Produces a range of ingredients for pet food and aqua, incl. **digests/palatants, meals, and oils**
- **Export:** Exports **95%** of its products, primarily to the **US and Europe,** positioning itself just below **premium US pet food brands**
- Model: The company's **cost-competitive production model** enables it to compete globally, offsetting higher export logistics costs

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[1] Enhance the taste and small of BSF-based feed to make them more appealing to animals

Source: Company interview; press search

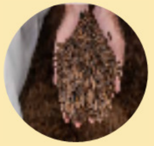
37 SSA pet food market | Case example: Aiko

Introduction to the company

- Aiko, founded in 2019, is a South African company specializing in **BSF production** for **pet food, animal feed, and frass**
- Inspired by her **dog's dietary issues,** the founder partnered with **Maltento** to develop a healthy, tasty, and sustainable alternative
- Aiko emphasises health, taste, and sustainability in its products, standing out for their fun and appealing design, redefining conventional pet food

Example products

Product



Ingredient BSF

End-product palatants[1]

Consumers

Dogs

Cats

Products and strategy

- **Sourcing:** Sources **insect protein** from **Maltento,** blending it with **locally sourced ingredients** at a **Cape-Town-based facility**
- **Focus area:** Caters to **dogs with sensitive digestion and skin issues,** appealing to **eco-conscious pet owners.** The brand prioritises **health, taste, and sustainability;** using a **playful and colourful** identity to stand out from conventional pet food brands
- **Availability and expansion:** Launched in **September 2023,** Aiko is sold in **nearly 100 South African stores,** partnering with **Absolute Pets** and **Pet Haven.** The company is exploring **exports,** starting with **Asia**, where insect protein is widely accepted
- **Growth and strategy: Growing at 20%+ annually**, Aiko is **expanding into direct-to-consumer sales and a subscription model.** Positioned in the premium pet food segment, it targets health-conscious and eco-friendly consumers

Source: Company interview; press search

41 SSA compound livestock feed | While largely substitutable for soybean meal, BSF will need to be cost-competitive to fulfil the theoretical market

Sub-Saharan Africa compound livestock feed market size[1], 2035 mn tonnes

	Poultry	**Eggs**	**Fish**	**Other[4]**	**Total**
Soybean meal consumption for compound livestock feed	4.5	1.1	0.3	0.6	6.6
Substitutability of soybean meal by BSF	100%	100%	100%	25%	~93%
Resulting theoretical max BSF volume by species[2]	4.0	1.0	0.3	0.1	5.5
Estimated theoretical market size for BSF in compound livestock feed[3], USD bn	~2-3	~0.5-0.7	~0.2	~0.1	~2.8-4.0

1. Considering compound livestock feed protein sources only; assumes that soy and BSF are primary sources of protein for compound livestock feed
2. Soy is assumed to be 45% protein content, while BSF is 50% protein content. 1 kg of soy has the same protein content as 0.9 kg BSF
3. Assuming price parity with soybean meal, and priced according to soybean meal average (USD 0.52-0.72)
4. Including dairy

Source: FAOSTAT; USDA; IMF; company interviews

Key insights

The BSF animal feed market could **theoretically** be between **USD ~2.8-4.0 bn by 2035, assuming**

- All soybean meal that could **theoretically be substituted** by BSF will be
- **BSF would be at price parity with soybean meal** – given price is the primary decision driver

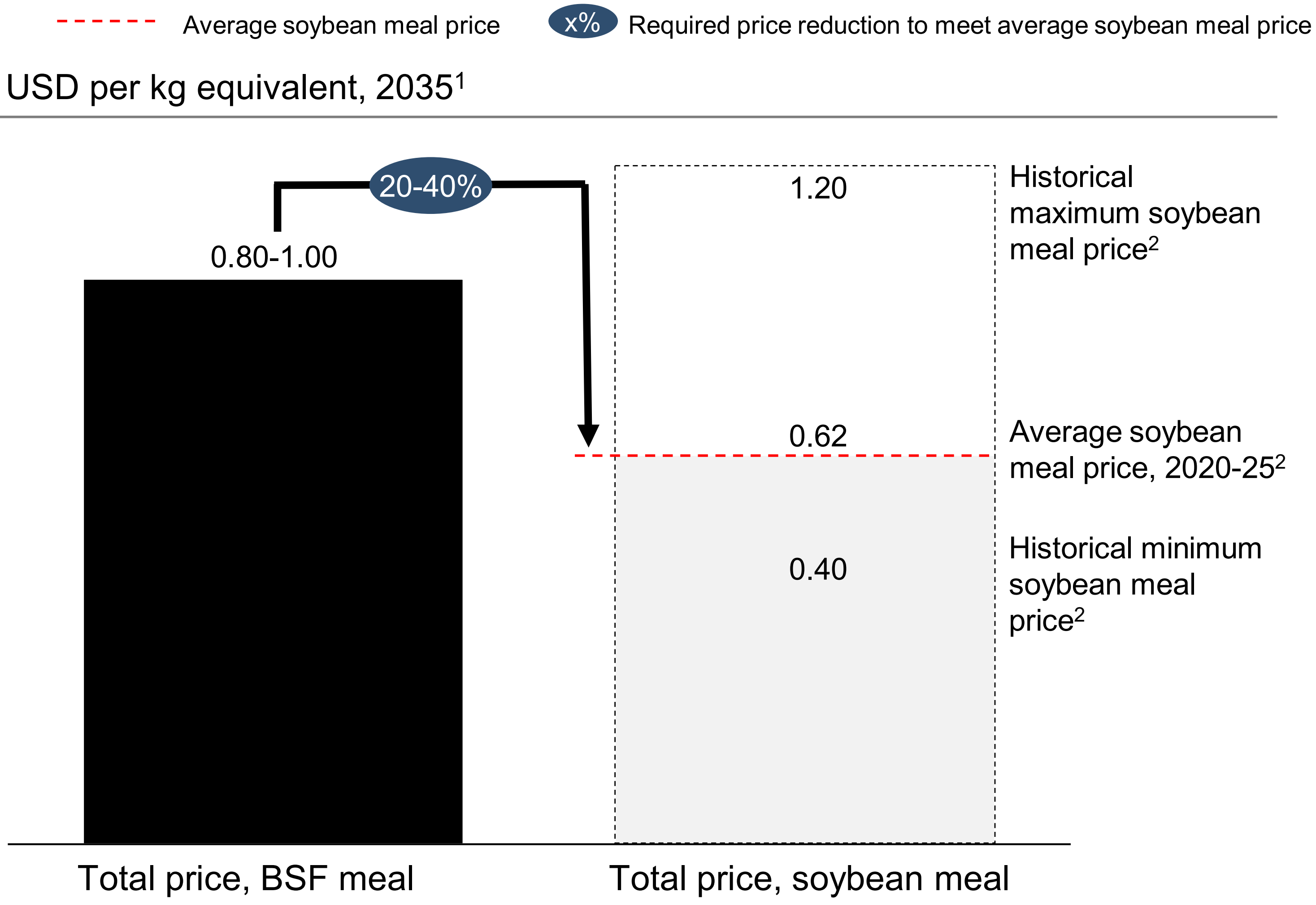
However, given the price sensitivity of livestock feed producers, BSF will likely need to be priced at parity with soybean meal.

Therefore, achieving the theoretical market size will depend on **cost-competitiveness and producers sourcing enough biomass** needed for BSF production at scale – a major challenge in sub-Saharan Africa

41 SSA compound livestock feed | BSF meal is priced 20-40% higher than soybean meal today

Detailed next

Price, USD per kg equivalent, 2035[1]



Key insights

- BSF is currently priced **~20-40% higher than soybean meal, driven primarily by biomass waste costs,** limiting its competitiveness in livestock feed given high price sensitivity of buyers
- **Revenue from frass could potentially reduce costs by USD 0.6[3] -** however, there are challenges on selling frass
- **Increasing biomass availability could reduce costs -** however, many sources have high costs of transportation
- While research on substitutability of BSF for soybean meal is evolving, **conclusive evidence on its indirect cost benefits remains limited**

> “” Even if we get biomass for free (landed price), we are not price competitive with soybean meal
>
> **– East African BSF producer**

---

1. 1.1 kg of soybean meal and 0.9 kg of BSF, which have equivalent protein content
2. Range based on historical prices 2020-2035; average disregards price increases around 2021-22 related to geopolitical disturbances
3. Assuming 6kg of frass produced for every kg of dried BSF larvae based on interviews

Source: FAOSTAT; USDA; IMF; company interviews; expert input

41 SSA compound livestock feed| The enablers to make BSF competitive with soybean meal are likely only in limited circumstances

○ Low feasibility ● High feasibility 🟦 Detailed ahead

Enabler	Lever	Feasibility	
Cost reduction	Increase frass (BSF by-product that acts as an organic fertiliser) sales	◔	For every kg of dried BSF larvae, 6 kg of frass is produced[1]; while frass is cheaper per kg than chemical fertiliser, its lower nutrient density means farmers need 5x more, making it more expensive overall To match the cost-effectiveness of chemical fertiliser (USD 0. per kg)[2], **frass would need to be priced at USD 0.1 per kg[3,4] - limiting its value as a by-product for BSF producers** Selling frass is challenging due to costly distribution from high-volume requirements, inconsistent quality from unregulated BSF feedstock, and seasonal fertiliser demand limiting year-round sales
	Reduce biomass costs	◔	Even in cases where BSF companies are getting the biomass for free, the **cost of transporting the biomass can destroy the economics** **Reducing these logistics costs assumes locating close to single large sources of waste** (e.g., breweries, large produce markets)
	Apply for carbon credits	○	**No existing methodology for carbon credits for BSF and difficulty proving additionality** (e.g., that BSF reduces methane produced by decomposition of organic waste)
Adequate biomass access	Improve access to biomass	◔	Given poor waste collection and sorting systems, a Kenya example shows that only **14-17% of organic waste collected is capturable** (i.e., commercially available).[1] This could be 4% or less of the total biomass required to produce enough BSF to substitute large volumes of soy Increasing organic waste availability would require **consumers to separate waste at the source and significant improvements in waste collection systems.** However, in markets where this is already done (like Canada and Europe), municipalities typically use the waste for their own revenue or cost-saving purposes (e.g., energy or fertiliser production). As a result, even with improved systems, governments may not provide this waste to BSF producers for free - keeping costs high

1. Based on Kenya estimates
2. Assuming 30% frass yield from feedstock
3. Using price of NPK 15:15:15 ratio
4. Using price for frass with nutrient density of NPK 3:3:3 ratio

Source: Expert input; company interviews

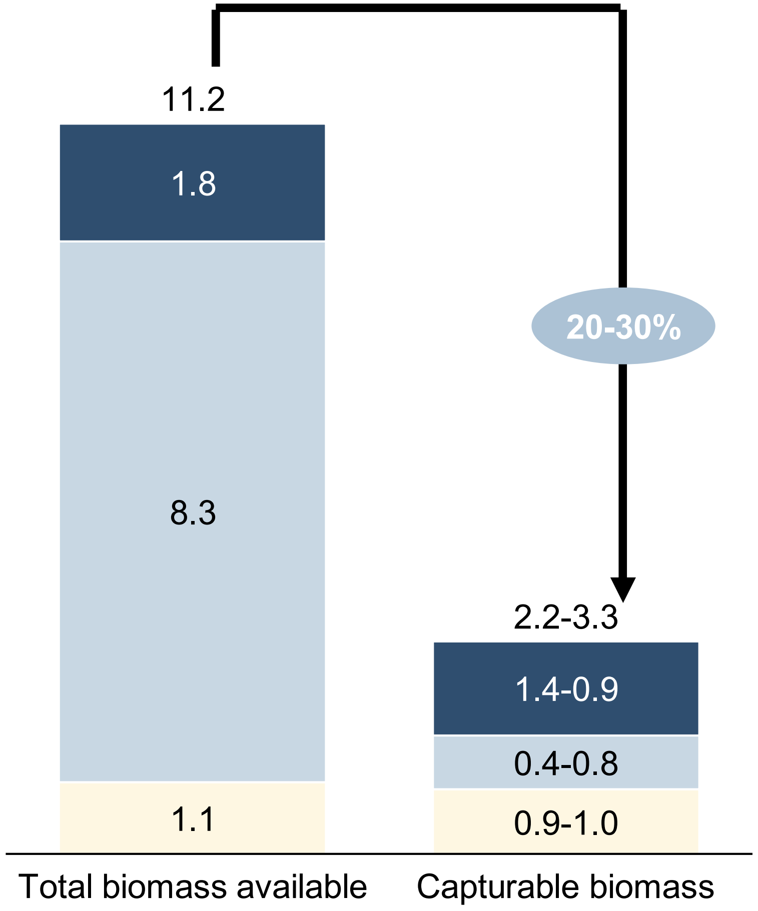
41 SSA compound livestock feed | ~20-30% of the total biomass available could potentially be collected for BSF production

- ■ Brewery spent grain
- ■ Farm waste[1]
- ■ Commercial waste (hotels etc.)[2]

Biomass availability in SSA, 2035 mn tonnes

Capturable biomass, %

Opportunity



50-80%

5-10%

80-90%

Brewery spent grain from the top 10 beer producers in SSA based on brewer buy-in and infrastructure for collection and processing

Farm waste from commercial farms producing vegetables based on available waste separation and processing capacity and logistics on transport (given bulky content)[1]

Waste from commercial sources (e.g., hotels, restaurants, catering services) based on available aggregation and separation infrastructure[2]

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1. Based on vegetable production from setting the stage, and applies 37% losses from FAOSTAT and assumes 23% is commercial farming from UNCTAD
2. Based on Kenya commercial waste availability and adjusted for other SSA countries

Source: FASOTAT; expert interviews; Kenyan Ministry of Environment and Forestry and National Sustainable Waste Management Policy

X% Share of total biomass that can be captured for BSF

Key insights

Total biomass availability in SSA is ~11 mn tonnes of which ~20% is capturable in the low scenario and ~30% in the high scenario

Aggregating farm waste is logistically complex, and most commercial sources of waste have high competition (e.g., organic fertiliser production)

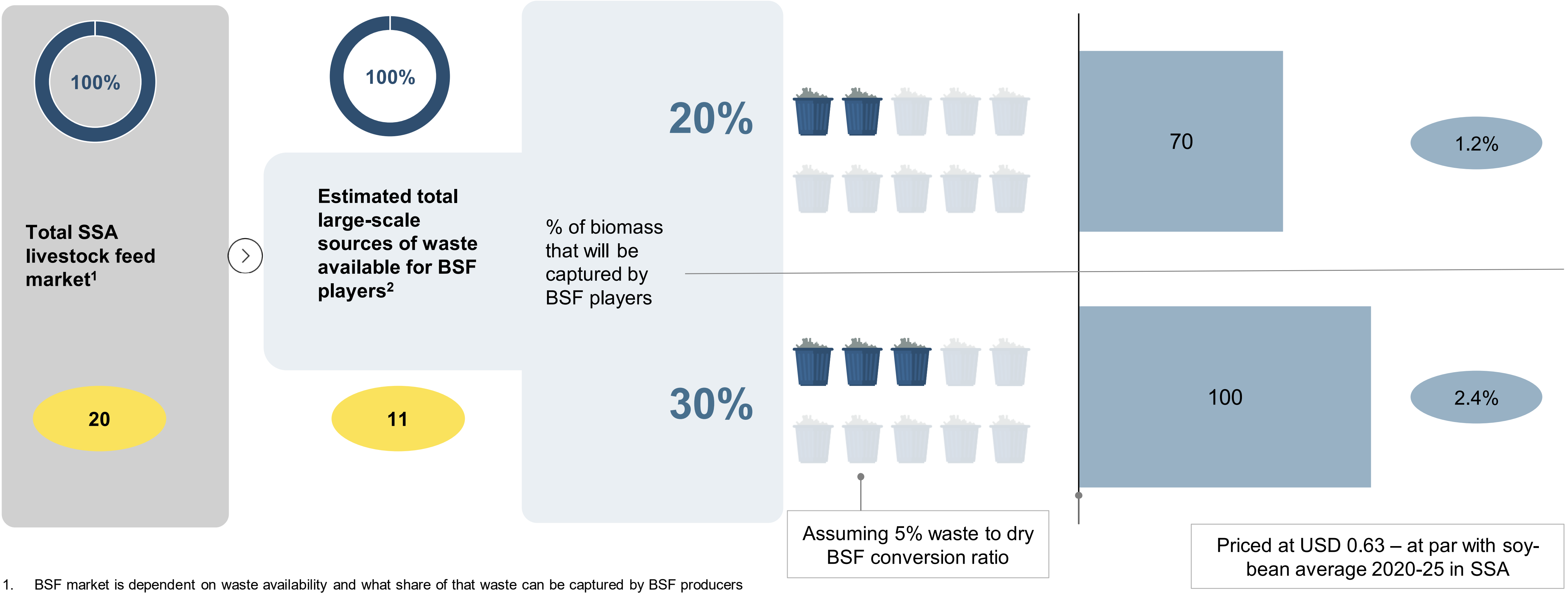
Therefore, **the BSF market is constrained by the size of the capturable biomass market**

41 SSA compound livestock feed | Opportunity for novel alternate protein for livestock feed could be between USD 70 and 100 mn

Share of biomass captured by BSF producers

x Est. 2035 market (mn tonnes)

Total compound livestock feed market	Total addressable waste market	Scenarios	Est. 2035 BSF market, USD mn	Volume share of total soybean meal market[3]



Total SSA livestock feed market[1]

20

Estimated total large-scale sources of waste available for BSF players[2]

11

% of biomass that will be captured by BSF players

Assuming 5% waste to dry BSF conversion ratio

Priced at USD 0.63 – at par with soy-bean average 2020-25 in SSA

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1. BSF market is dependent on waste availability and what share of that waste can be captured by BSF producers
2. From brewery waste, farm waste, and organic waste from produce markets or retailers in urban areas
3. Assuming a total soybean meal market of 6.6 mn tonnes

Source: FAOSTAT; USDA; IMF; company interviews; expert input; Barth Haas group

Enablers animal feed | Implementing key enablers could support competitiveness of BSF producers

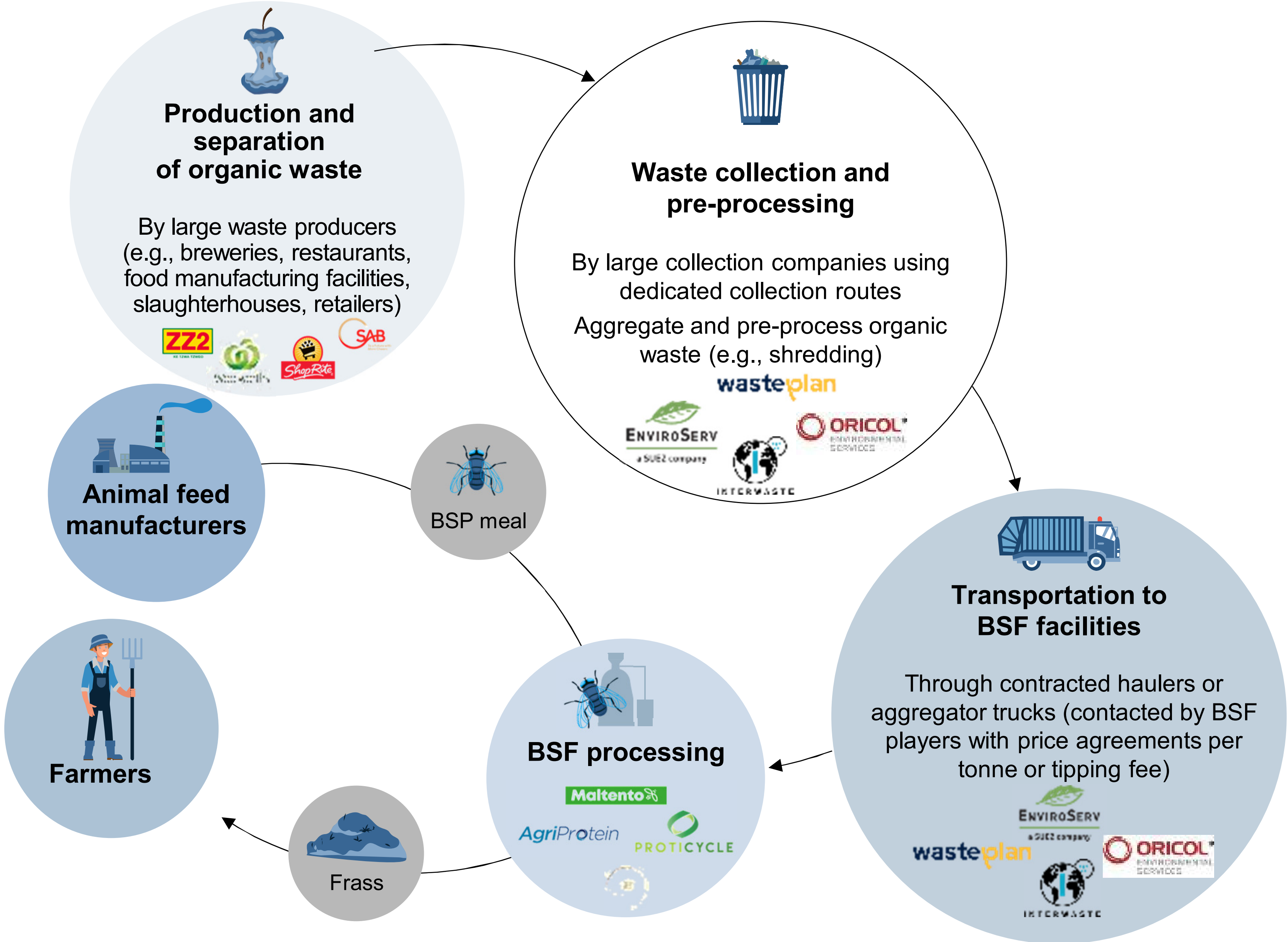
○ Low feasibility ● High feasibility ▨ Deep dive ahead

Enabler	Details	Stakeholders				
		Government	Development partners	Research institutions	Private sector	Feasibility[1]
Support industry collaboration	Set up **collective waste systems** to support better organic waste management (e.g., improve collection of organic waste, research sources of organic waste where overall cost to ecosystem would be lower if used for BSF than current processing methods (e.g., high levels of aflatoxin in maise))		✓		✓	
	Research and evaluate **benefits of BSF as a feed additive** for animal health (e.g., antibiotic, gut health), and model related cost savings	✓		✓	✓	
Provide incentives and regulatory mechanisms	Develop industry standards for quality, e.g., guidance on inputs needed to produce BSF with consistent and high nutritional value	✓	✓	✓	✓	
	Extend chemical fertiliser **subsidies for frass fertiliser** (and all organic fertilisers)		✓		✓	
	Consider **tax treaties** to support competitiveness of SSA's BSF-based exports (e.g., reducing or eliminating import tariffs for BSF-based pet food from SSA into Europe)		✓		✓	

1. Low feasibility: likely complex process with high cost and long timelines; high feasibility: likely simpler process with lower cost and shorter timelines

Source: Company interviews; expert interview

SSA animal feed market enablers | South Africa circular biomass aggregation for BSF production



Production and separation of organic waste

By large waste producers (e.g., breweries, restaurants, food manufacturing facilities, slaughterhouses, retailers)

Waste collection and pre-processing

By large collection companies using dedicated collection routes

Aggregate and pre-process organic waste (e.g., shredding)

Transportation to BSF facilities

Through contracted haulers or aggregator trucks (contacted by BSF players with price agreements per tonne or tipping fee)

BSF processing

Animal feed manufacturers

Farmers

Sources: Development Bank of Southern Africa; Western Cape Government new; AgriProtein; Woolworths

Enablers for circular biomass economy in South Africa

Projections for the South Africa Waste Flagship Programme[1] estimates **~950 k tonnes of organic waste collected by municipalities** (25% of generated organic waste)

Western Cape has an **organic waste landfill ban** – aiming for 100% by 2027

Municipalities (e.g., City of Cape Town) run **source-separation pilots for organic waste**

AgriProtein (BSF company) signs contracts with waste companies with **lower tipping fees than landfills**

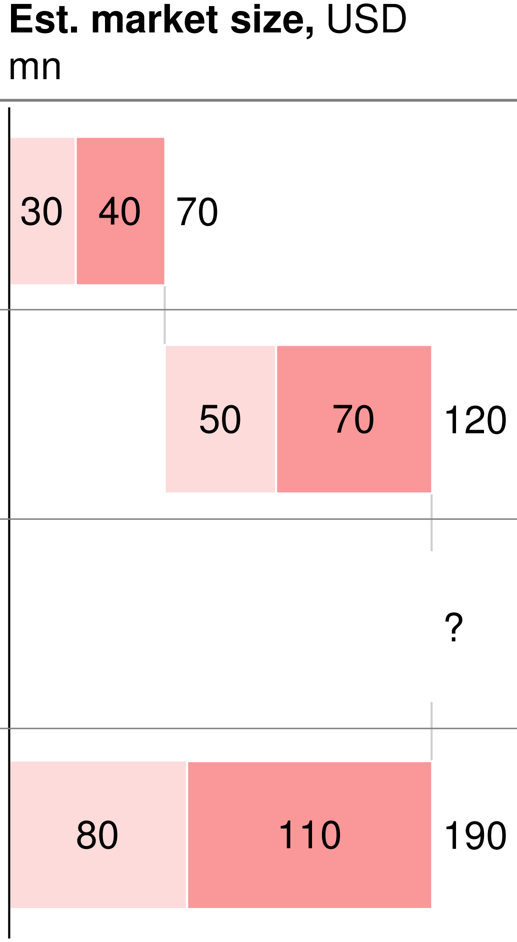
Large corporates (e.g., Woolworths, Shoprite) **commit to zero-food-to-landfill goals** and report progress in ESG reports

Agenda

SSA supplying inputs to global novel alternate protein market | SSA could address supply opportunities in targeted segments of the global alternative protein market

	㊹ **Insect-based pet food for global market**	㊼ **Inputs for plant-based isolate**
Description	Pet protein sources from insects e.g., BSF bought by consumers to feed their pets	Protein-rich crops (e.g., fava, mung beans) to be used as input for protein isolate production
		
Potential for novel AP	Potential to substitute dry pet food with edible insects (i.e., BSF), if produced cost-competitively compared to Europe	Potential to supply global protein isolate producers due to their cost competitiveness in sourcing from sub-Saharan Africa

SSA supplying inputs to global novel AP market | The total novel AP opportunity for the SSA input for global market could be between USD ~80 and ~190 mn



Novel AP opportunity	Explanation
㊹ Insect-based pet food for global market	Assuming BSF could be produced cost-competitively compared to Europe, even with higher logistics costs, sub-Saharan Africa could capture a share of the growing BSF pet food market in Europe Low vs high scenario depends on **consumer preference for sustainability and accessibility**
㊼ Inputs for plant-based isolate	Assuming SSA could supply raw fava beans for protein isolate processing abroad Low scenario assumes SSA supplies fava beans for a 20 k tonnes isolate plant; high scenario assumes supply for two fava isolate plants plus mung beans supply enough for 5 k tonnes mung isolate processing
㊿ Biomass fermented mycoproteins	Market not sized given the high level of uncertainties around biomass fermentation capacity
Total	

Sub-Saharan Africa supplying to global AP market | Protein isolate producers are mostly global, while SSA is home to crop suppliers and insect-based pet food producers

NON-EXHAUSTIVE

	Key players	Country	Description
Pea/fava isolate producers[1]	ROQUETTE	🇫🇷	Global nutrition companies offering plant-based protein isolates for both human and animal nutrition, including pea isolate and fava isolate
	cosucra	🇧🇪	
	PURIS	🇺🇸	
	Emsland	🇩🇪	
	ADM	🇺🇸	
Pet food producers	aiko	🇿🇦	Companies specialising in BSF production for pet food, animal feed, and frass
	Maltento	🇿🇦	
Commercial crop producers/ traders	[illegible]	🇪🇹	Leading agribusinesses in sub-Saharan Africa engaged in the production, processing, and export of key crops like mung beans and fava beans
	Olam Agri	🇳🇬	

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1. Potential crop off-takers of raw materials (e.g., fava beans)

Source: Press search; expert interviews, company websites

44 SSA global pet food market | Opportunity for novel AP for global pet food market could be between USD ~30 and ~70 mn

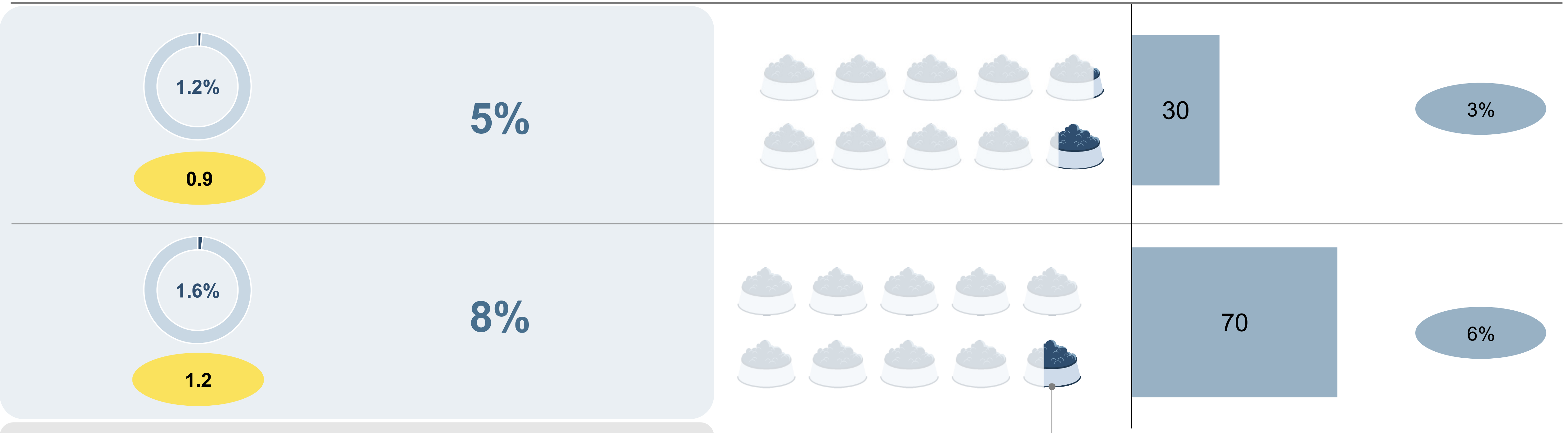
Conventional pet food   BSF pet food   x Total market (USD bn)

Share of European pet food market that is insect-based[1]

Share of European pet food market SSA could capture[2]

Est. 2035 market size, USD mn

SSA share of European insect-based pet food market, %



Priced at USD ~3 per kg at production cost price based on global prices[3]

Assumes that the formal pet food market in Europe is the most viable export market for SSA, given proximity and consumer preferences

Assumes that SSA's wholesale insect-based pet food value is ~30% cheaper than European market products

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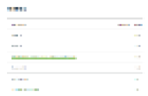
1. Based on Future Market Insights
2. Based on expert input and company interviews
3. Based on Statista Market Insights

Source: Statista Market Insights; company interviews; expert input; Future Market Insights

47 SSA supplying inputs to global isolate market | SSA could potentially play a role in ingredient production for global novel alternate protein

SIMPLIFIED, EXAMPLE PROCESS FOR PLANT-BASED MEAT PRODUCTION

⬚ Where sub-Saharan Africa could potentially play

Value chain	**Input**	**Ingredient production**			**Systems and applications**				**Downstream**		**End-customer**
		Primary processing	**Concentration**	**Isolation**	**Texturising**	**Recipe formulation**	**Mixing/ blending**	**Forming**	**Packaging and branding**	**Distribution to retail/food service**	
Process steps		Raw materials (e.g., peas, soy) are cleaned, graded based on size/shape classification, and grinded/ milled into a powder	Flour undergoes dry extraction[1] through air classification, separating the protein and starch fraction through electrostatic separation	Protein content is further purified from concentrates through wet extraction; slurry is neutralised and either dried into a high protein isolate or enzymatically hydrolysed to produce hydrolysates	Powdered ingredients (flour, concentrate, starch, isolate) are textured (e.g., using a power heater, dry/wet extrusion, hydrocolloid) to produce a variety of structured ingredients in the form of shreds/ strips/flakes	Specific ratios of primary and secondary ingredients are determined to achieve the desired taste, texture, and nutritional profile	Different ingredients are mixed and blended (e.g., protein ingredients from different sources, add. technical ingredients, e.g., starches) to produce a shelf-stable product-specific formulation	Mixes are finalised with flavours, colouring, etc. and processed (e.g., rehydrated, reconstituted) and shaped into the final alternate meat product; product can also be partially/pre-cooked	Products are filled into packaging and labelled, grouped into boxes/cartons, loaded onto pallets and warehoused as inventory	Products are distributed to retailers	
Output		Flour 	Concentrates 	Isolates Hydrolysates 	Texturised ingredient 	Batch plant-based recipe 	Plant-based blend 	Formed and "finished" meat-alternate 	Branded, packaged meat alternate 	Branded meat alternate ready for purchase 	

The high cost of shipping heavier (frozen or chilled) products limits SSAs' ability to compete in higher-value processed exports

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1. Protein concentrate can also be extracted through a wet separation process, e.g., acidic separation

Source: Expert interview

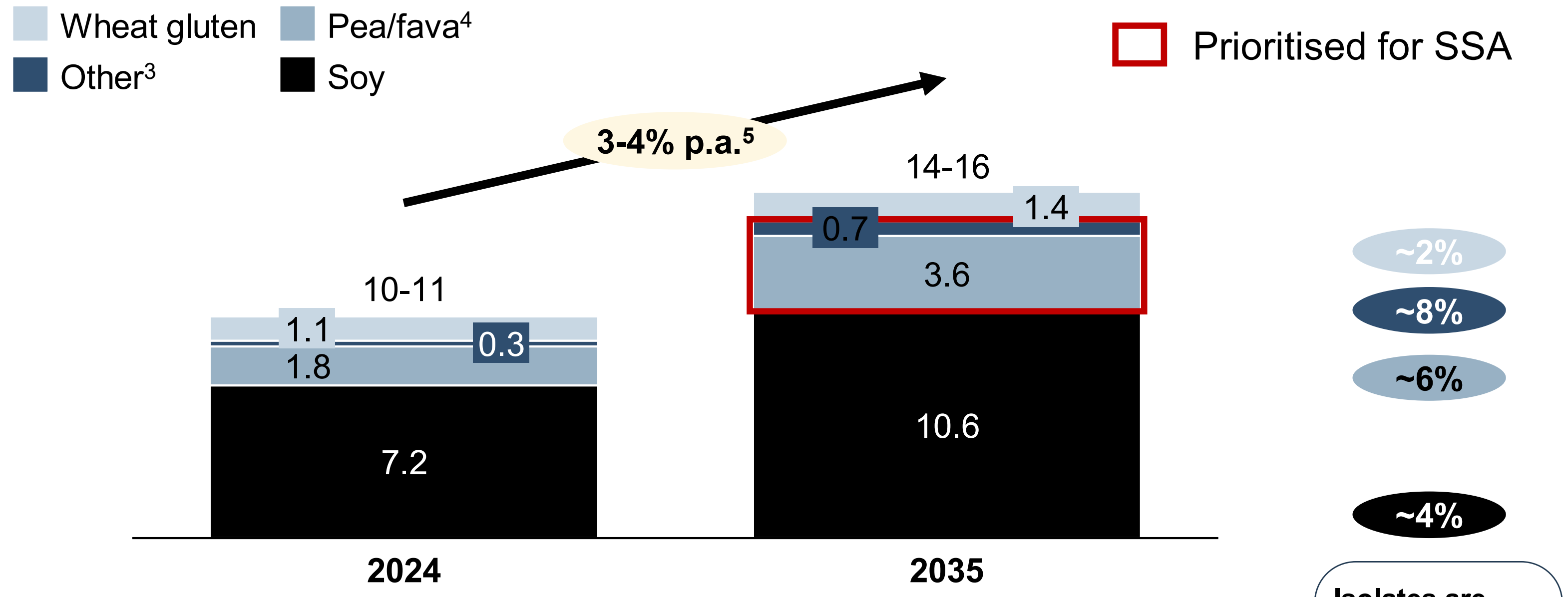
47 SSA supplying inputs to global isolate market | The global plant-based protein ingredient market in 2035 is expected to be USD ~14-16 bn

Focus of the analysis

ESTIMATES

Plant-based novel alternate protein ingredients market breakdown, global, USD bn[1,2]

2024-35 CAGR, %



Ingredient type split, %

Isolates 70-80%

Concentrates 20-30%

Isolates are prioritised over low-margin, commoditised concentrates due to better financial viability

---

1. Market size estimates based on bottom-up analysis; ingredient-level revenues only i.e. covering sales of protein ingredient manufacturer to food industry (e.g., pea protein isolate from Roquette to Beyond Meat); incl. isolates and concentrates
2. Estimate covers all end-use segments
3. Including range of smaller ingredients, including mung bean and others
4. Fava and pea may be used interchangeably in isolate production due to similarities in processing and end-use applications
5. Growth based on total global plant-based novel alternate protein market, which would make up 75% of projected USD ~50 bn total market in 2035

Source: Expert inputs; Euromonitor; GrandViewResearch; Markets&Markets, OECD; press research; Technavio

Key insights

✓ **Opportunities in SSA were assessed for isolates of pea, fava, and other[3] niche ingredients**

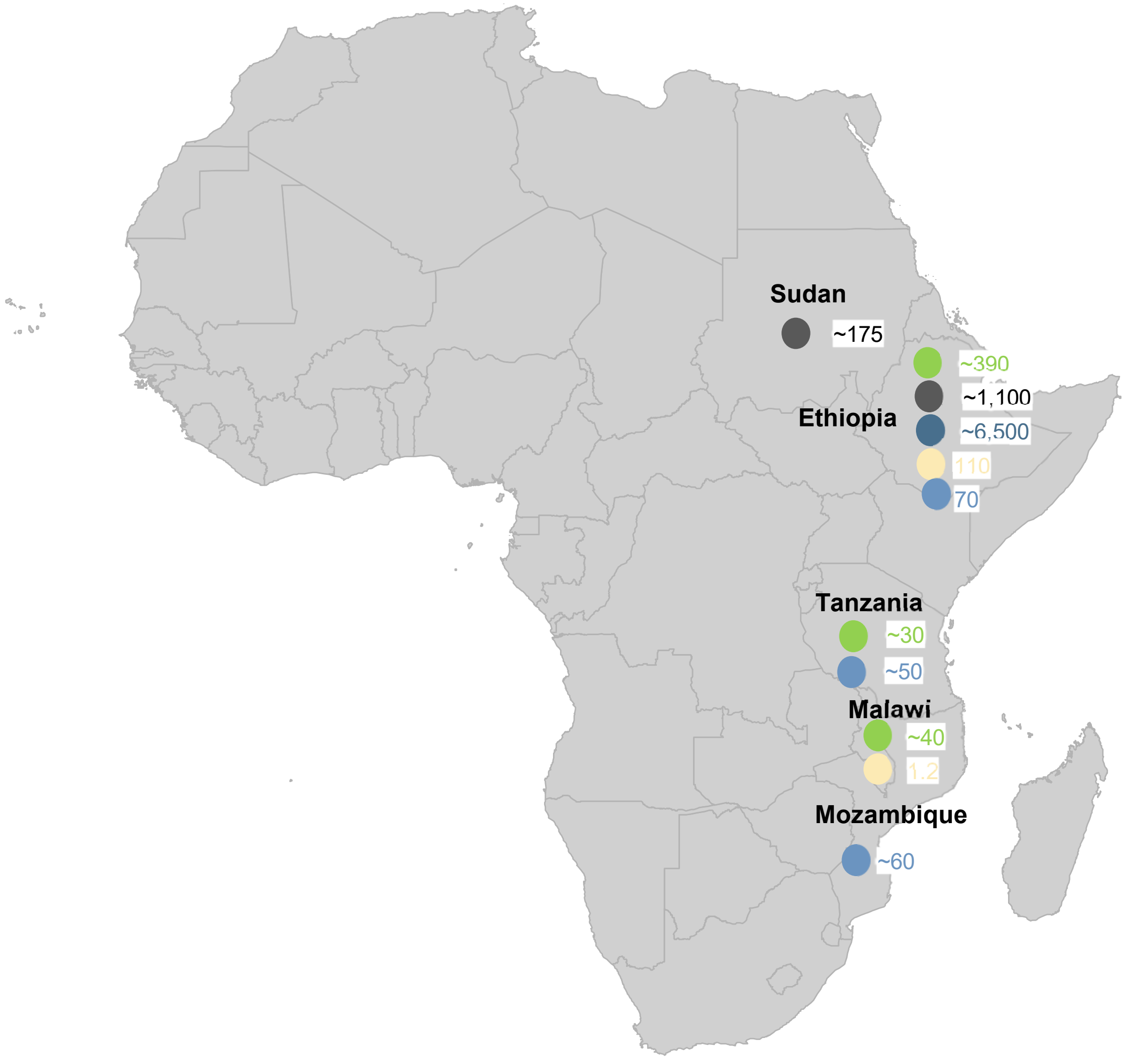
- **Pea protein** is amongst the fastest-growing
- **Niche ingredients[3] are gaining traction** for unique functional properties (e.g., gelling when cooked)
- **Isolates (70-80%)** offer higher value than more commoditised concentrates

✕ **Soy and wheat ingredients were deprioritised because:**

- Soy isolates are commoditised, **growth is slowing down** due to consumer scepticism, and production already has some over-capacity
- **Wheat gluten growth is low,** as it is **primarily used for gluten vs isolates**

47 SSA supplying inputs to global isolate market | Ethiopia is the primary producer in SSA for various protein-rich crops including peas, fava and mung beans

NON-EXHAUSTIVE ONLY TOP PRODUCING COUNTRIES CITED



Production volume by crop, k tonnes

Crops with known applications

- ● Dry peas[1]
- ● Fava bean[2]
- ● Mung bean[3]

Crops with limited known applications

- ● Teff
- ● Lentils

Key insights

Dry peas are mainly produced in Ethiopia, Malawi, and Tanzania, with Ethiopia being the largest at ~390 k tonnes

Fava beans are mainly produced in Ethiopia and Sudan, with Ethiopia being largest at 1,100 k tonnes average production

Mung bean production in sub-Saharan Africa is concentrated in a few countries, with Ethiopia and Tanzania considered key producers

Ethiopia could expand pea and fava farming without conflicting with high-value crops like coffee, as each thrives in distinct, non-overlapping regions and these also provide a rotational crop for staples such as teff, wheat, and maise

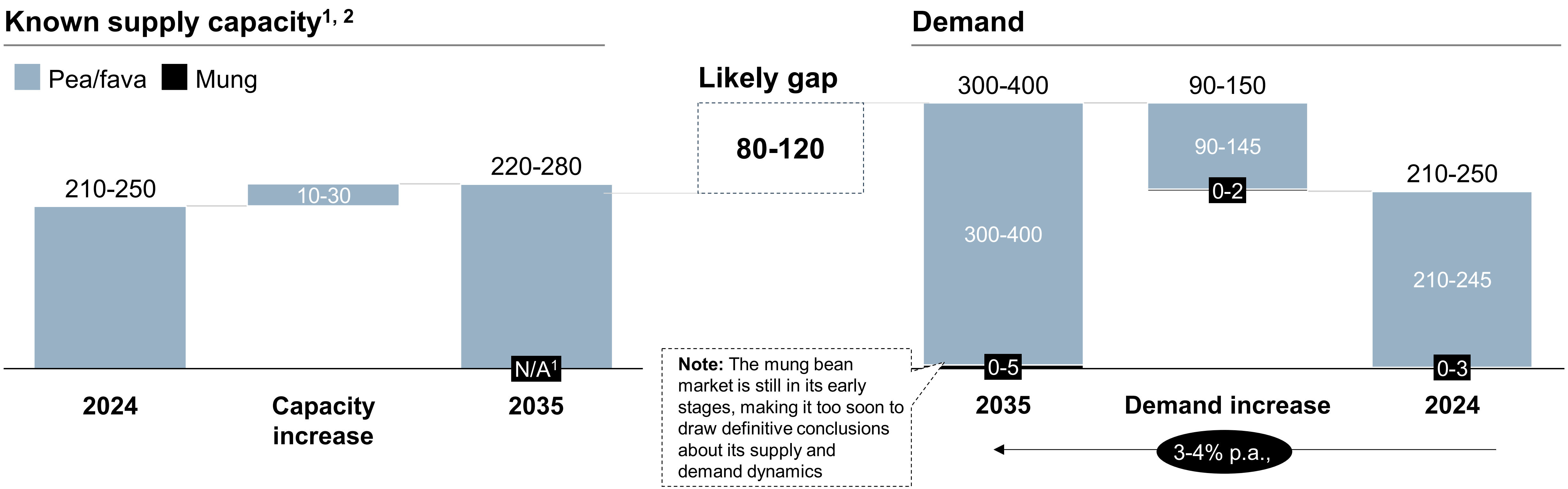
1. Average of 2021-23 due to data availability, top producing countries sited
2. Broad beans and horse beans category from FAOSTAT used
3. 2022 data used

Source: FAOSTAT; press search; expert inputs; global mung bean outlook

47 SSA supplying inputs to global isolate market | The pea, fava, and mung isolate market is projected to be undersupplied in 2035

ESTIMATES NON-EXHAUSTIVE

Pea protein, fava bean, and mung isolate supply-demand dynamics, 2024-35, k tonnes



Note: The mung bean market is still in its early stages, making it too soon to draw definitive conclusions about its supply and demand dynamics

Comments

Peas and fava beans are interchangeable in some alternate protein products processing

Fava isolates have strong growth prospects and **could capture market share from pea protein,** with many pea protein producers like Vestkorn and Roquette expanding into fava to take advantage of the opportunity for multi-crop use of pea facilities

---

1. Supply estimations included for pea and fava bean isolates, with limited data on others
2. Supply estimations based only on announced capacity by different companies

Source: Company websites; press search; market reports; expert inputs

47 SSA supplying inputs to global isolate market | Protein isolates are typically processed near crop areas to cut logistics costs, unless strong local by-product demand justifies remote processing

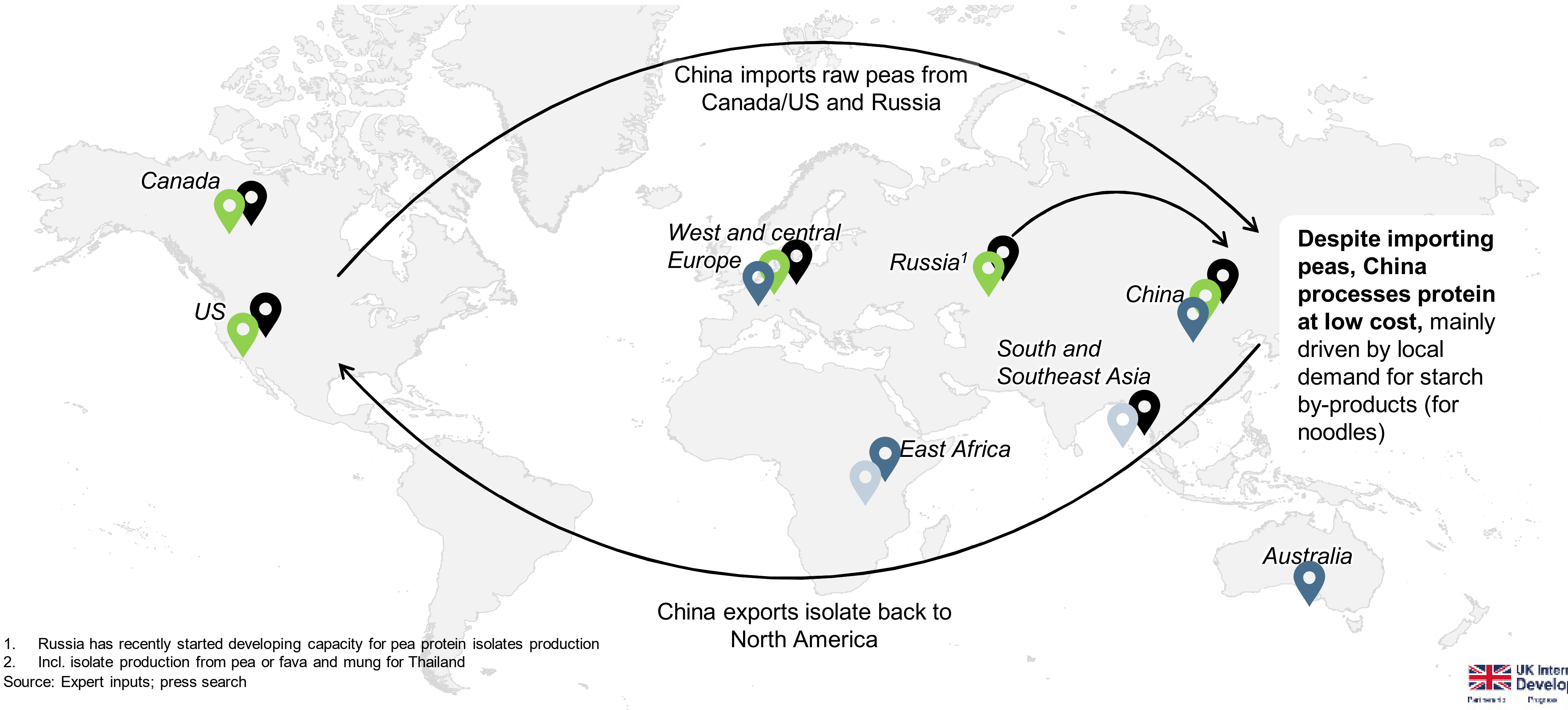
NON-EXHAUSTIVE ILLUSTRATIVE

Crop production areas

- ● Pea crop production
- ● Fava bean crop production
- ● Mung bean crop production

Isolate processing areas

- ● Key protein isolates production[2]



China imports raw peas from Canada/US and Russia

China exports isolate back to North America

Despite importing peas, China processes protein at low cost, mainly driven by local demand for starch by-products (for noodles)

---

1. Russia has recently started developing capacity for pea protein isolates production
2. Incl. isolate production from pea or fava and mung for Thailand

Source: Expert inputs; press search

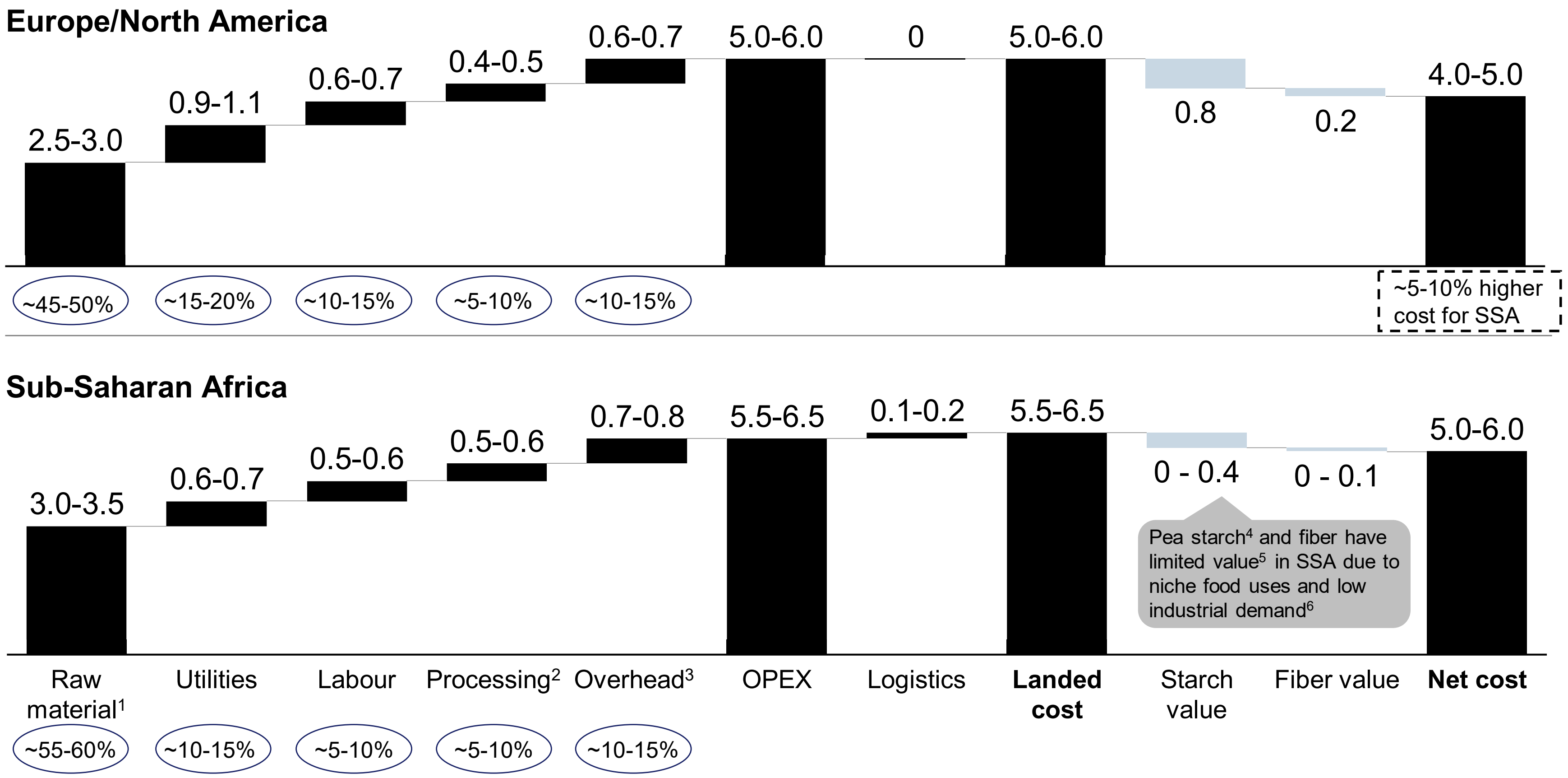
47 SSA supplying inputs to global isolate market | Producing pea isolate in sub-Saharan Africa is not cost-competitive, driven by high raw material costs and limited revenue from by-products

☐ deep dive next

INDICATIVE **ILLUSTRATIVE PEA USED FOR ILLUSTRATION**

■ Cost component ▨ By-product value ○ % share of opex

Cost structure, pea protein isolates production, USD/kg



Pea starch[4] and fiber have limited value[5] in SSA due to niche food uses and low industrial demand[6]

1. Assuming only local production price for raw materials
2. Equipment depreciation cost
3. R&D, SG&A, others
4. Accounts for 50–60% of the pea crop volume
5. From a range of USD 0.3-1.2 per kg, assuming majority would go to lower-range price for lower-end applications
6. Assumed SSA industrial starch demand by 2035 could absorb only ~50% of starch output from a single pea isolate plant

Source: Expert inputs; World Population Review; ILOStat; IHSMarkit; FAOstat; press search

Key insights

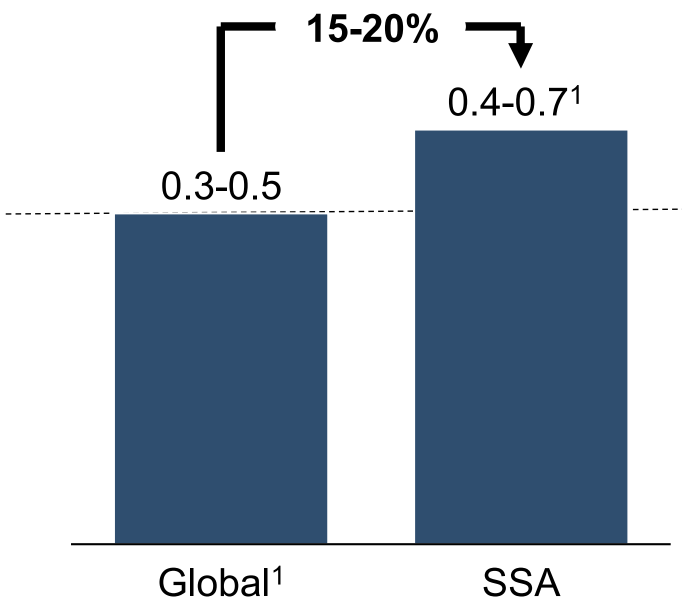
Pea protein isolate production in SSA is **~5-10% costlier than global** benchmarks, driven by **higher raw material costs in SSA, extra logistics costs** for shipping the final product, and limited value from by-products in SSA

Therefore, to ensure cost-competitiveness, the following would be essential:

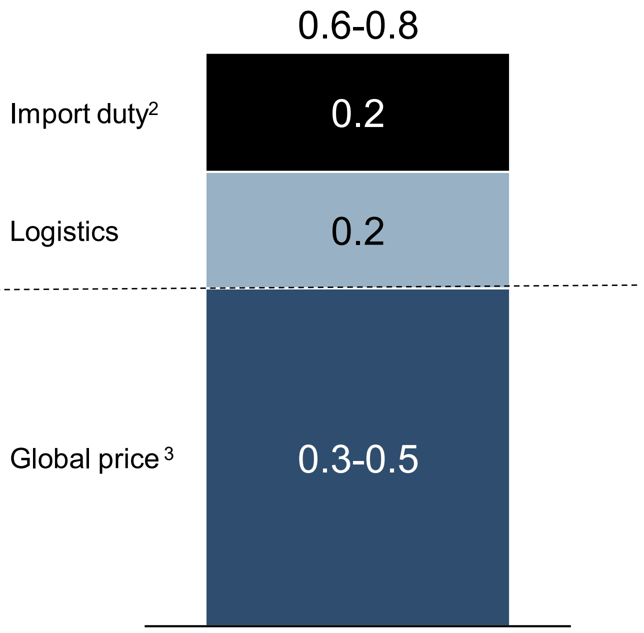
- **Reduce raw material costs** to align with global benchmarks
- **Ensure demand exists to capture value from starch[4]** by-product by linking it to local industry demand

㊼ SSA supplying inputs to global isolate market | Achieving pea price levels in SSA is unlikely due to structural cost inefficiencies

Locally produced peas, average price, USD/kg



Import peas at global prices, USD/kg



Key insights

Overall, SSA is unlikely to compete on pea isolate due to higher raw material cost compared to global prices

- Current prices for locally produced **pea are 15-20% higher than global prices**
- **Importing peas is not likely** due to high import duties and logistics costs

Crop pricing is usually **driven by regional supply-demand dynamics and quality of crops**

1. This is unit pea price that is part of raw material cost of USD 3.0-3.5 per kg
2. Assuming 35% import duty for EAC
3. Based on US and Canada producer prices

Source: EAC Common External Tariff; FAOSTAT; Selina Wamucii

47 SSA supplying inputs to global isolate market | Pea starch demand in SSA is low, limited mostly to industrial use

Pea starch demand potential

xx Price range, USD/kg ○ Low ● High

Use case	Example pea starch use	Potential demand
Industrial 0.3-0.5	Textile industry: sizing agent	◔
	Adhesives and binders: corrugated box manufacturing	
	Paper: additive in paper	
	Packaging: sustainable packaging (e.g., dissolvable starch packing peanuts)	
Food processing 0.5-1.2	Noodles: glassy noodles	○
	Bakery products: gluten-free baked goods	
	Confectionary: gummy candies and jellies	
	Soups and sauces: instant soup mixes	
	Snacks: extruded snacks	
Others 0.4-0.6	Pet food and treats	○

Key insights

Fava, mung bean, and pea starches have similar applications, primarily in industrial uses, with some in food processing and others

Pea starch demand in sub-Saharan Africa is limited

- **Maise starch dominates the SSA market,** with pea starch holding a small share in global starch trade (<4%[1])
- Pea starches are not a substitute for maise starch in food processing use, though **pea starch has some potential for industrial demand** where starch types can be used interchangeably
- However, **industrial demand for starch likely still limited,** with SSA demand projected at 15-25 k tonnes by 2035[2], **insufficient to absorb output from one isolate plant** (~40 k tonnes), and value capture constrained to niche food markets with higher prices

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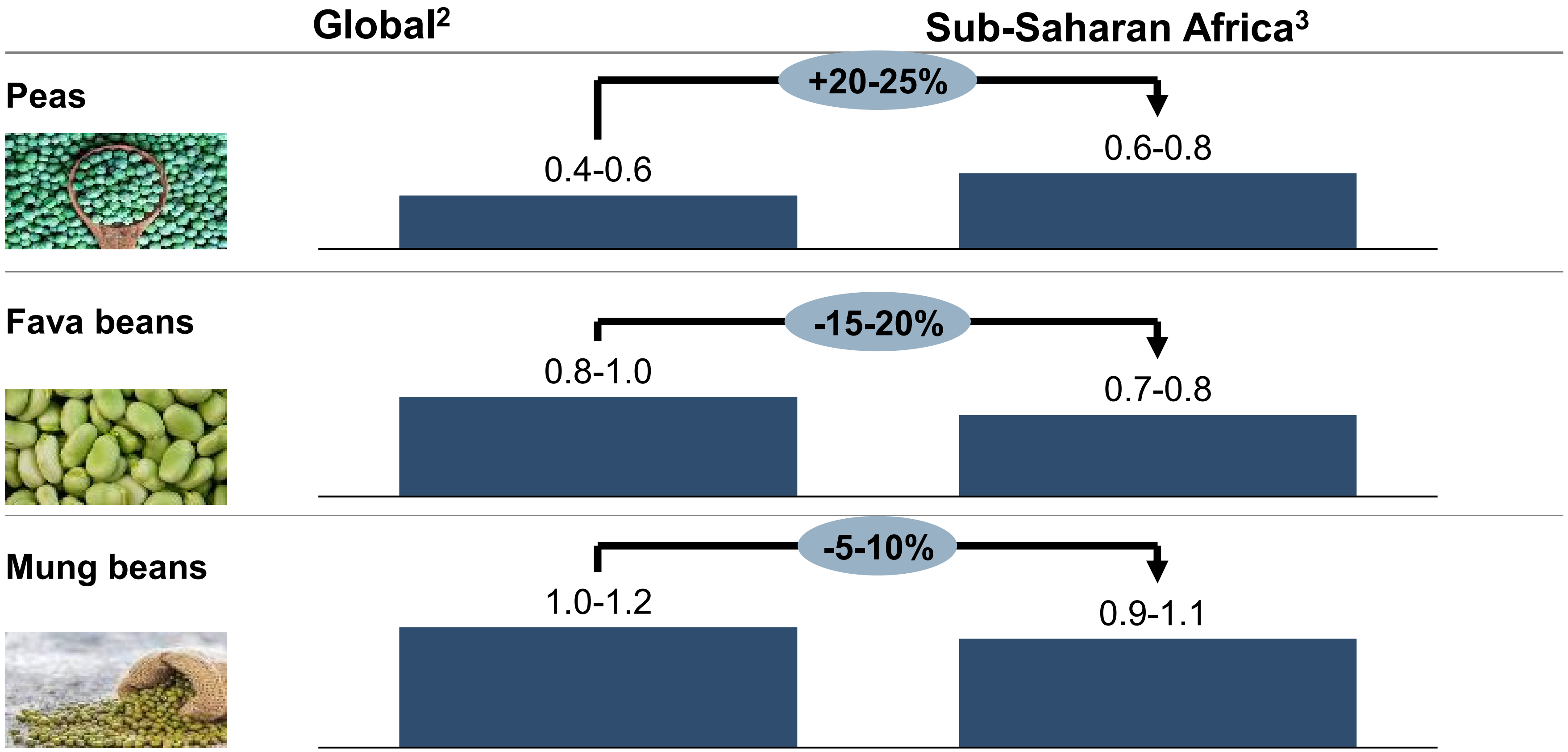
1. Based on world native starch imports, 2022
2. Assuming 10-20% of starch demand in SSA is for industrial use, and taking total maise starch imports in EAC and Nigeria as proxy and assuming 5% p.a., growth by 2035

Source: Press search; export inputs

47 SSA supplying inputs to global isolate market | While isolate processing is costly due to low by-product demand, fava and mung beans could still be exported for processing abroad

Export price[1], USD/kg



1. Based on unit export values from Trademap
2. Using the US and Canada for peas and fava and India for mung
3. Using Ethiopia, Tanzania, and Malawi for peas and Ethiopia for fava and mung
4. Despite similar prices to peas in SSA, the higher protein content of fava and mung beans (e.g., ~30% fava vs 20% peas) compensates for the price gap

Source: Trademap; press search

Key insights

Pea prices in SSA exceed global levels. However, **fava and mung beans could be cultivated more cost-competitively**

Although fava and mung beans can be grown cost-competitively, **sub-Saharan Africa is not cost-competitive in processing into isolates** due to limited by-product demand

However, fava and mung beans could be exported for isolate production abroad, leveraging their cost-competitive[4] cultivation in SSA

Note the mung isolate market is still nascent, with only one plant doing mung isolate currently

㊼ SSA supplying inputs to global isolate market | Fava and mung bean exports for isolate production has a potential market of USD 50 to 120 mn

x Est. 2035 market size (USD bn) ▨ Fava ■ Mung

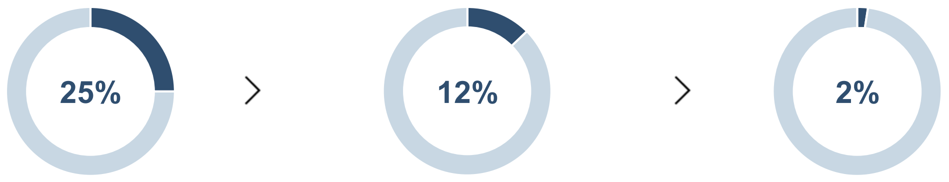
Market assumptions, est. % of total ingredient market

Total addressable market

Scenarios

Est. 2035 market size, USD mn

Est. SSA share of total global plant-based ingredients market[1], %



Total fava, pea, other ingredient market; considered for production in SSA, out of overall market[1]

Raw materials account for ~50% of total isolate production costs

SSA is better suited to supply raw material crops due to high isolate processing costs

The raw material required to fill the gap of 80-120 k tonnes pea/fava isolates gap

~4 **~2** **0.2-0.3[2]**

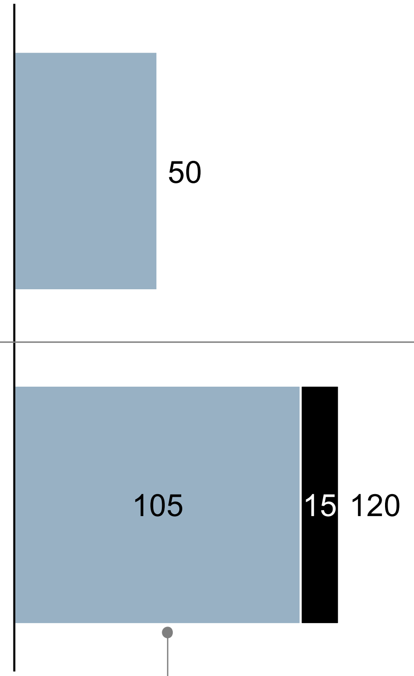
1 plant

Assuming SSA supplies 70 k tonnes of fava beans - enough for 1 isolate plant with a 20 tonnes capacity, meeting ~20% of supply gap

2 plants

Assuming SSA supplies 140 k tonnes of fava beans - enough for 2 isolate plants, meeting ~40% of supply gap

Additionally, assuming SSA supplies ~20 k tonnes of mung bean - enough to produce 5 k tonnes of mung isolate[2]



~0.4%

~0.8%

Assuming current fava bean (USD 0.75/kg) and mung bean (USD 0.8/kg) export prices from Ethiopia

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1. Based on value, out of overall ~USD 15 bn ingredients value
2. Preliminary estimates of mung isolate demand in 2035

Source: Expert input; Trademap; press search

50 SSA supplying global biomass fermentation market| Given significant uncertainties around biomass fermentation capacity, the opportunity is not sized

Dimension	Description
Context	Biomass fermentation is still in the **pilot stage of development,** with uncertain production capacity and scale-up timelines The space is currently **concentrated in North America and Europe.** Quorn is the most established player, but with many newcomers and no clear leader, **the market remains fluid** Input is mostly **carbohydrates sourced from crops** like sugar beet, sugarcane, corn, and wheat and **key nutrients (e.g., nitrogen, sulphur)** Many biomass proteins are new to human diets, **creating uncertainty in consumer uptake**
Estimated market size	Although the total global fermented market is expected to reach USD ~100-150 bn by 2050, the estimate for **2035 is limited to USD ~1-2 bn**[1] Detailed projections for **specific ingredients** remain very limited

Key insights

As the global biomass fermentation market is **still nascent,** there is limited data available on the capacity that can be expected

We acknowledge that **there could be potential** for sub-Saharan Africa to supply global demand **if predicted costs reductions and consumer preference will materialize,** especially after 2035 when the global market is expected to surge

Given the **unknown supply gap and uncertainties on the global market size** in 2035, the potential role for sub-Saharan Africa is not sized in this report

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[1] Including biomass fermented and others

Source: GFI; PitchBook; Website research; expert interviews; McKinsey report: Ingredients for the future

SSA supplying inputs to global novel AP market| Several enablers could help position SSA as a relevant player in the global novel AP market

○ Low feasibility ● High feasibility 🟨 Inputs for plant-based isolate 🟦 Insect-based pet food ⬜ Cross-cutting

Enabler	Details	Stakeholders: Government	Stakeholders: Development partners	Stakeholders: Research institutions	Stakeholders: Private sector	Feasibility[1]
🟨 **Support local crop production**	Provide farmers with **training** on crop management, pest control, and harvesting to ensure **high quality and increase yields**	✓	✓			◕
	Invest in **irrigation infrastructure** to enable **double-cropping and improve yield reliability**	✓	✓			◕
🟨 **Create commercial production hubs**	**Zone crop production** near major transport corridors and establish regional hubs with storage and logistics infrastructure to **reduce post-harvest losses and enhance market access**	✓			✓	◑
🟦 **Secure reliable input supply**	Secure **access to low-cost, consistent organic waste streams** (e.g., brewery waste, food/agri-processing by-products)	✓			✓	◑
🟦 **Meet global product standards**	**Standardise pet food formulations** and align with international nutritional, safety, and regulatory requirements in key export markets (e.g., EU Novel Food Regulation)	✓		✓	✓	◕
⬜ **Expand market access through trade agreements**	**Leverage trade agreements** such as the EU's Everything But Arms (EBA) and Economic Partnership Agreements (EPAs) to export fava beans for isolate processing and BSF-based pet food to premium markets in Europe	✓			✓	◕
	Establish bilateral trade agreements or investment partnerships with ASEAN countries to export mung beans to Southeast Asia for isolate processing, particularly Thailand, a key processing hub					

1. Low feasibility: likely complex process with high cost and long timelines; high feasibility: likely simpler process with lower cost and shorter timelines

Source: company interviews; expert interview

Agenda

Agenda

We also focus on "novel" alternate protein and exclude conventional alternate protein (e.g., tofu, brewers' yeast for animal feed) (1/2)

Novel alternate protein for human consumption

▢ **Human consumption**

	Novel alternate protein			
Technology	**Plant-based**	**Fermented**	**Cultivated meat**	**Edible insects**
Description	Protein from plant ingredients, designed to **mimic animal protein** in, e.g., texture and appearance	Use of **fermentation processes involving micro-organisms** to generate protein-rich food products that are processed into end-products (e.g., burgers, fortified flour)	**Growing animal cells in a controlled environment** to mimic conventional animal protein	Insects that are **suitable for human consumption or processed into end-products** (e.g., snacks) In Africa and Asia, some insects have traditionally been part of diets. For this report, edible insects are included under novel AP to keep in line with global definitions
Examples	• Plant-based meat and fish replacements (e.g., burgers) • Plant-based dairy (e.g., vegan cheese, milk, yoghurt) • RTE/RTD (e.g., protein bars, shakes, powders) • Algae protein (e.g., spirulina)	• Biomass fermentation: mycoprotein (e.g., from fungi, yeast, bacteria, algae) • Precision fermentation: animal-free dairy protein and egg protein	• Products with the same structure and taste as animal meat such as steak, burger, and chicken breast	• BSF • Crickets • Grasshoppers • Mealworms • Silkworms • Beetle larvae
				

! **Traditional AP are substitutes that have traditionally been part of human animal diets** (e.g., tofu-based "mock meat" and legumes). **These are not included in this report** because they have long been part of human diets and require limited processing

Source: Press search, expert interviews

We also focus on "novel" alternate protein and exclude conventional alternate protein (e.g., tofu, brewers' yeast for animal feed) (2/2)

Novel alternate protein for animal feed

	Novel alternate protein		
Technology[1]	**Plant-based**	**Fermented**	**Insect-based**
Description	Plant-based protein that aren't traditionally used (e.g., soy is a conventional plant protein)	Use of **fermentation processes involving micro-organisms** to generate protein-rich meals	Protein sources derived from insects, often processed into meal or oil for use in animal feed
Examples	• Algae protein (e.g., spirulina) 	Single-cell protein • Yeast protein • Bacterial protein • Mycoprotein (fungi-based) Fermented plant-based protein • Rapeseed meal • Palm kernel meal 	• BSF larvae • Meal worms • Crickets • House fly larvae 

! **Traditional AP are substitutes that have traditionally been part of animal diets** (e.g., brewers' yeast). **These are not included in this report** because they have been part of animal feed for a while

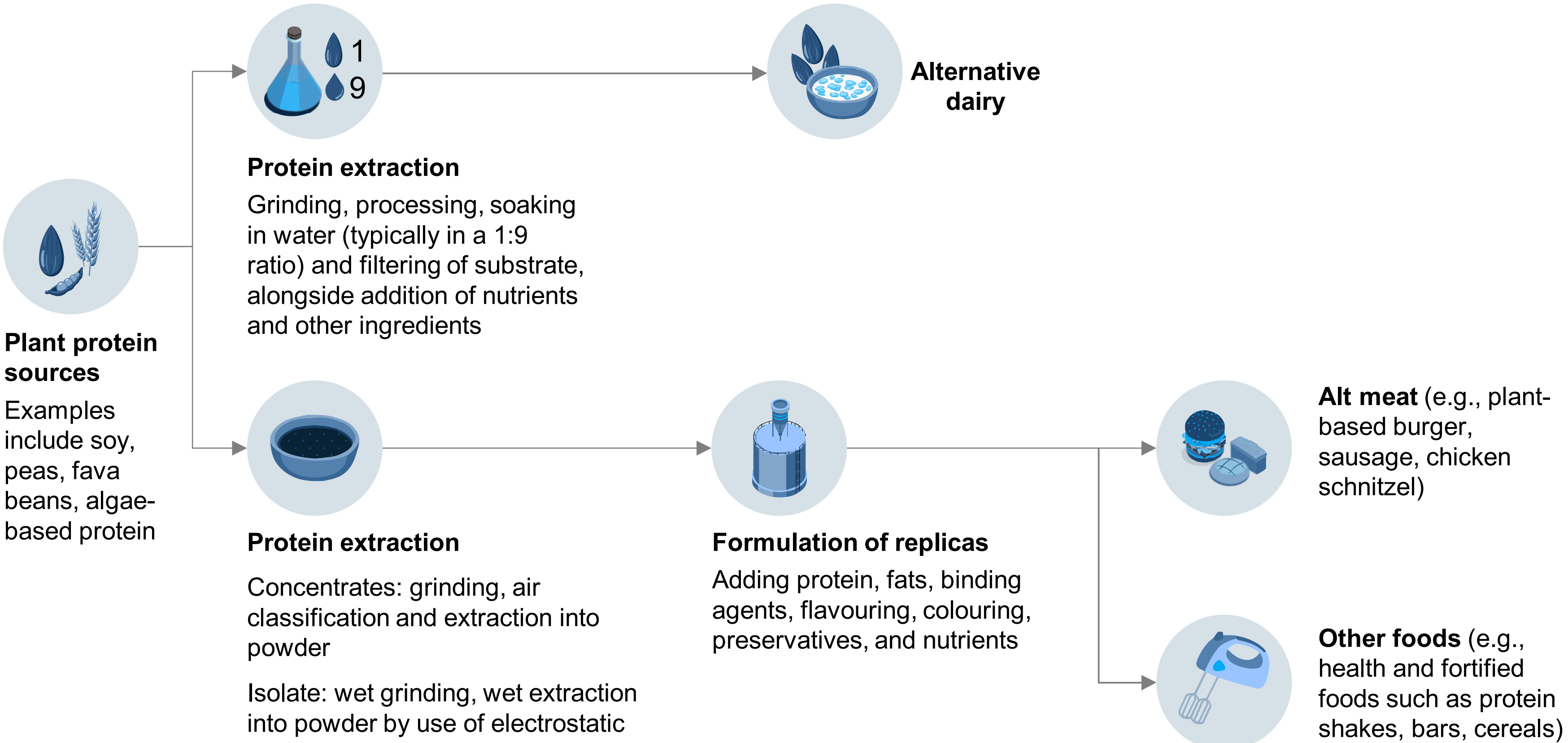
---

1. Cultivated meat is not applicable for animal feed and not shown

Source: Press search, expert interviews

Raw plant materials are used for protein extraction, which can be further processed into a variety of food groups

Meat or dairy replacements: **plant products imitating the taste, texture and/or properties** of the animal product they seek to replace. **Dairy products are historically the most popular,** and more recently beef, chicken and other meats are launched



Plant protein sources

Examples include soy, peas, fava beans, algae-based protein

Protein extraction

Grinding, processing, soaking in water (typically in a 1:9 ratio) and filtering of substrate, alongside addition of nutrients and other ingredients

Alternative dairy

Protein extraction

Concentrates: grinding, air classification and extraction into powder

Isolate: wet grinding, wet extraction into powder by use of electrostatic process (energy-intensive)

Formulation of replicas

Adding protein, fats, binding agents, flavouring, colouring, preservatives, and nutrients

Alt meat (e.g., plant-based burger, sausage, chicken schnitzel)

Other foods (e.g., health and fortified foods such as protein shakes, bars, cereals)

Current stage of development	Potential scalability 2035
Commercial	◕

Trends

- Gene-editing[1] technologies and new plant-breeding methods are **accelerating the speed of breeding, lowering cost, and improving crop and protein yields**
- **Extrusion technologies are being improved to enhance texture and appearance** (e.g., twin screw[2] technology to improve existing technologies, 3D printing[3], and scaffolding of ingredients and a new weaving technology)

Considerations

- Plant-based products **have a lower amino acid score than conventional meat;** consumers need to eat many different plants for the same nutritional value. Some producers of plant-based alternates are now trialling different compositions to get to the full amino acid profile

1. Gene editing
2. Twin screw
3. 3D printing

Source: Green Queen

Isolates and concentrates are the most used ingredients for plant-based products

	Isolates: high protein content, expensive to produce and sold in premium applications	↔	**Concentrates: lower protein content and used as low-cost ingredient in feed and selected food applications**
Protein attributes	Isolate protein content range is typically **>80%;** higher **protein purity** requires more **intensive processing** through wet extraction Higher standardisation for protein purity, higher digestibility, and bioavailability		Concentrate protein content can range **from 50-80%;** final protein content depends on raw material protein fraction and processing efficiency Higher impurity concentration and increased starch fraction (15-35%) limit functional protein applications
Application	Isolates are commonly used in **meat alternatives, dairy alternatives, and functional foods and snacks** to capitalise on the following characteristics • **High protein** content and **neutral taste** for flavour profiling • **High solubility** and **emulsification** for smooth textures (milk, yoghurt, and cheese) • **High digestibility** and **protein purity** for health products (protein bars)		Concentrates are predominantly used in bakery, meat alternates, animal feed, and pet food applications to capitalise on the following characteristics • **Higher starch fraction** contributes to moisture retention, improving texture • **Effective water binding** capacity facilitates moulding and forming of products

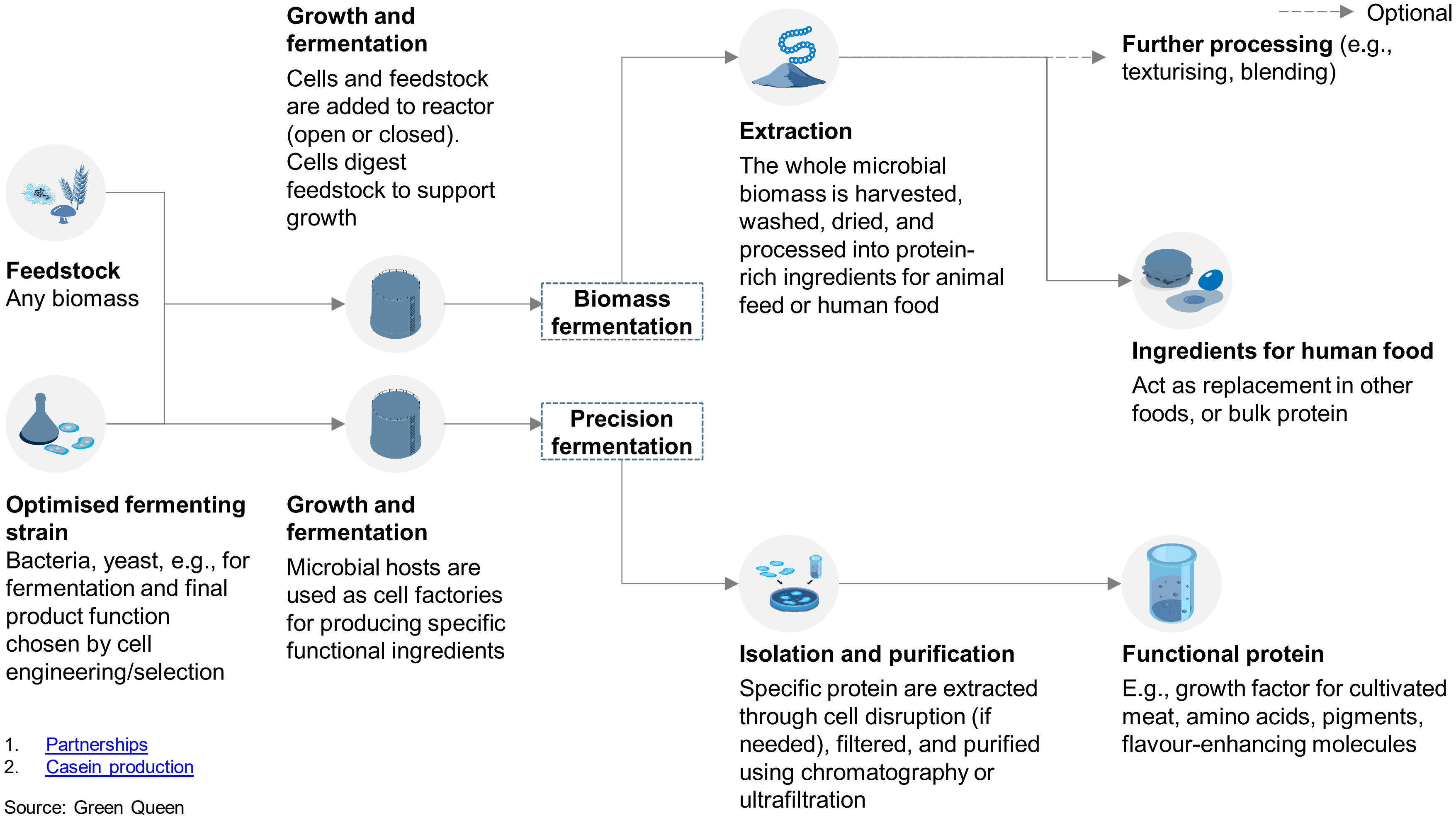
Economics

Production costs	*Energy-intensive and complicated process (e.g., selective precipitation) increase cost*	*Lower production costs due to simplified production process*
Price	*Higher price point as sold in premium food applications*	*Commodity market, little to no margin on product*
Capex	*Higher capex for advanced processing equipment not required in concentrate production*	*Relatively basic equipment required (e.g., grinder, mill)*

Source: Press search, expert interviews

Fermentation uses bacteria or yeast to ferment biomass into replacement ingredients or specific protein

Fermenting plant or fungal ingredients with bacteria or yeast enhances function or flavour; alternatively, **micro-organisms can be grown as alternate protein and modified to produce specific ingredients,** serving as 1:1 replacements (regarding protein content/amino acid composition) or novel additions



Optional

Feedstock
Any biomass

Optimised fermenting strain
Bacteria, yeast, e.g., for fermentation and final product function chosen by cell engineering/selection

Growth and fermentation
Cells and feedstock are added to reactor (open or closed). Cells digest feedstock to support growth

Growth and fermentation
Microbial hosts are used as cell factories for producing specific functional ingredients

Biomass fermentation

Precision fermentation

Extraction
The whole microbial biomass is harvested, washed, dried, and processed into protein-rich ingredients for animal feed or human food

Isolation and purification
Specific protein are extracted through cell disruption (if needed), filtered, and purified using chromatography or ultrafiltration

Further processing (e.g., texturising, blending)

Ingredients for human food
Act as replacement in other foods, or bulk protein

Functional protein
E.g., growth factor for cultivated meat, amino acids, pigments, flavour-enhancing molecules

1. Partnerships
2. Casein production

Source: Green Queen

	Current stage of development	Potential scalability 2035
Biomass	Pilot	◑
Precision	Testing	◔

Trends

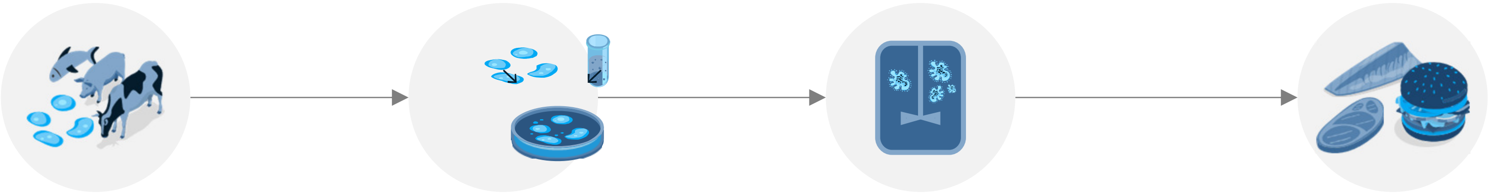
- Food giants (e.g., Nestle and Unilever) **are partnering with start-ups to commercialise microbial protein**[1]
- **Innovative yeast strains** to produce casein and lactoferrin for alternate dairy **being piloted and launched** (i.e., precision fermentation)[2]

Considerations

- **Feedstock sourcing** remains a **major cost and scaling constraint**
- Fermentation is **difficult to scale;** multiple fermentation tanks are needed, which can be costly
- Precision fermentation is **additionally costly because of expertise needed**
- **Approval processes vary regionally;** SSA has no standardised approval processes yet
- **Innovation in making taste similar to conventional protein** is critical as currently, taste is a major constraint leading to consumer rejection

Cultivated meat uses animal cells as a basis, and these will likely be able to replace most meat products

Meat cultivated **using cells taken from an animal,** most commonly **multiplied and grown in a bioreactor.** Can take on a variety of cell characteristics, such as muscle and fat of any animal origin, to be moulded into a **variety of cuts and patties**



Cells are taken from animal or cell line is used

Muscle tissue is taken by biopsy and split into cells, or an established cell line is used

Cells grow in a nutrient-rich media in seed train bioreactors

As cells grow in volume and increase in density, they get moved into progressively larger bioreactors

Cells reach desired density in the main bioreactors

The optimal cell density strikes a balance between cell volume and batch time. Cells can be grown on scaffolds or in clumps, and be muscle, fat, or others

Cells are harvested through a centrifugation process and prepared for distribution

Cells pass through a continuous centrifuge that separates the media from the cells. End-products can be processed into a patty or 3D printed with other cell types into a whole cut of meat (also fish)

Current stage of development	Potential scalability 2035
Testing	◔

Trends

- The most important factors influencing consumer acceptance/rejection of cultivated meat **include public awareness, perceived naturalness, and food-related risk perception**[1]
- Start-ups are focusing on precision cell placement and creating vascular structures **to improve quality and are forming technical and commercial alliances to achieve this**

Considerations

- Singapore became the **first country to approve cultivated meat** in 2020, while Italy has banned cultivated meat
- Although **costs have been reduced by ~99% from the first prototypes, cultivated meat is expected to cost USD 63 per kg,** making it still unaffordable for most consumers (even more so in SSA)[2]

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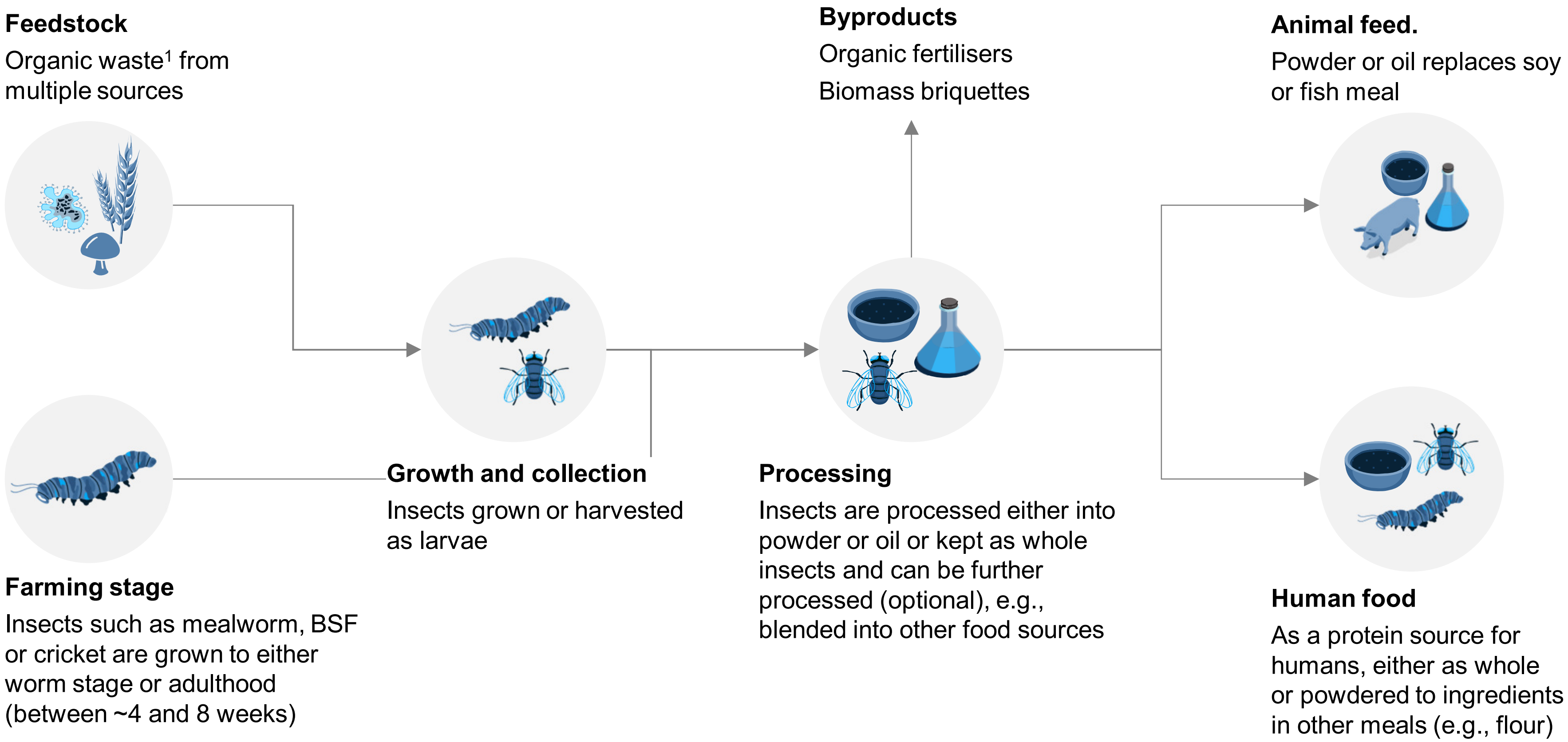
1. Ashkan et al., Review of factors affecting consumer acceptance of cultured meat (2022)
2. Garrison et al., How much will large-scale production of cell-cultured meat cost? (2022)

Source: Green Queen

Insect-based protein are produced using organic waste consumed by insects, then processed into protein

Insects such as **crickets and mealworms are protein- and nutrient-dense**, and while these have been used in parts of the world for millennia, they are now making inroads in new markets as **flours, protein bars, and animal feed**



Feedstock

Organic waste[1] from multiple sources

Farming stage

Insects such as mealworm, BSF or cricket are grown to either worm stage or adulthood (between ~4 and 8 weeks)

Growth and collection

Insects grown or harvested as larvae

Byproducts

Organic fertilisers

Biomass briquettes

Processing

Insects are processed either into powder or oil or kept as whole insects and can be further processed (optional), e.g., blended into other food sources

Animal feed.

Powder or oil replaces soy or fish meal

Human food

As a protein source for humans, either as whole or powdered to ingredients in other meals (e.g., flour)

Current stage of development	Potential scalability 2035
Pilot	◐

Trends

- Insect-based protein are being integrated into **circular economy models** globally because they use waste as an input
- **Advanced breeding techniques and automated farming systems** are enhancing the efficiency and nutritional profiles of insect farming
- From 2020-24, **investments into insect-based protein have decreased** by 23% p.a.

Considerations

- While some communities have eaten insects as part of their culture for years, there is **still a negative perception towards eating insects** that would need to be overcome
- **Costs of scaling up insect-based protein for animal feed are high due to biomass availability,** limiting potential scalability

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[1] Waste used depends on compliance with country regulations and can vary, e.g., kitchen waste, agriculture waste, and agri-food co-products, cereals, dairy wastewater, bovine blood, human waste for some insects (e.g., Black Soldier Flies)

Source: Green Queen

Agenda

Feasibility | Approach

High ■ ■ ■ ■ □ Low

! Because novel AP opportunities (end-products by technology) can be made with **different ingredients and raw materials,** for each novel AP the **most common ingredient and raw material** is used (e.g., pea isolate for plant-based and soy isolate for dairy) for assigning the scores

Approach

① Assigned weights to each criteria listed for scoring, assigning different weights for human consumption, animal feed, pet food, and protein for export

② Filled in qualitative and quantitative data as per scoring scale for each type of protein

③ Normalised quantitative scores to get overall scores for each protein type

④ Multiplied scores by weight and normalise each total score for each category (e.g., human consumption) to geta ranking of prioritised protein

Criteria and scoring

Qualitative scale description

	1	2	3	4	5
Price parity by 2035 globally	Novel AP more expensive than conventional protein	N/A	Novel AP at price parity with conventional protein	N/A	Novel AP cheaper than conventional protein
Consumer or buyer preferences in SSA[1]	Very low consumer acceptance[2] (less than 10% market acceptance)	Low consumer acceptance (10-30% market acceptance)	Moderate consumer acceptance (30-50% market acceptance)	High consumer acceptance (50-70% market acceptance)	Very high consumer acceptance (more than 70% market acceptance)
Availability of inputs in SSA	Inputs are very scarce (imported, limited suppliers)	Inputs are scarce (limited domestic suppliers)	Inputs are moderately available (some domestic suppliers)	Inputs are readily available (many domestic suppliers)	Inputs are very easily available (abundant domestic suppliers)
Technology maturity for end-products in 2035 in SSA	N/A[3]		Moderate maturity (product being piloted for production)	High maturity (product being commercially produced, not yet at scale)	Very high maturity (product being commercially produced at scale)
Protein parity	Protein content lower than benchmark[4]	N/A	Protein content at parity with benchmark	N/A	Protein content higher than benchmark
DIAAS[5]	DIAAS lower than benchmark	N/A	DIAAS at parity with benchmark	N/A	DIAAS higher than benchmark
Sustainability impact	Sustainability impact more negative than benchmark (higher carbon footprint and resource use)	N/A	Sustainability impact at parity with benchmark (similar carbon footprint and resource use)	N/A	Sustainability impact more positive than benchmark (lower carbon footprint and resource use)

1. Derived from a survey of ~50 of the top 1% highest income consumers in SSA and interviews
2. Willingness to buy and use novel AP product
3. Already excluded based on the maturity funnel
4. Comparable conventional animal protein
5. Digestible Indispensable Amino Acid Score

Feasibility | Products from the same technology can receive different feasibility scores

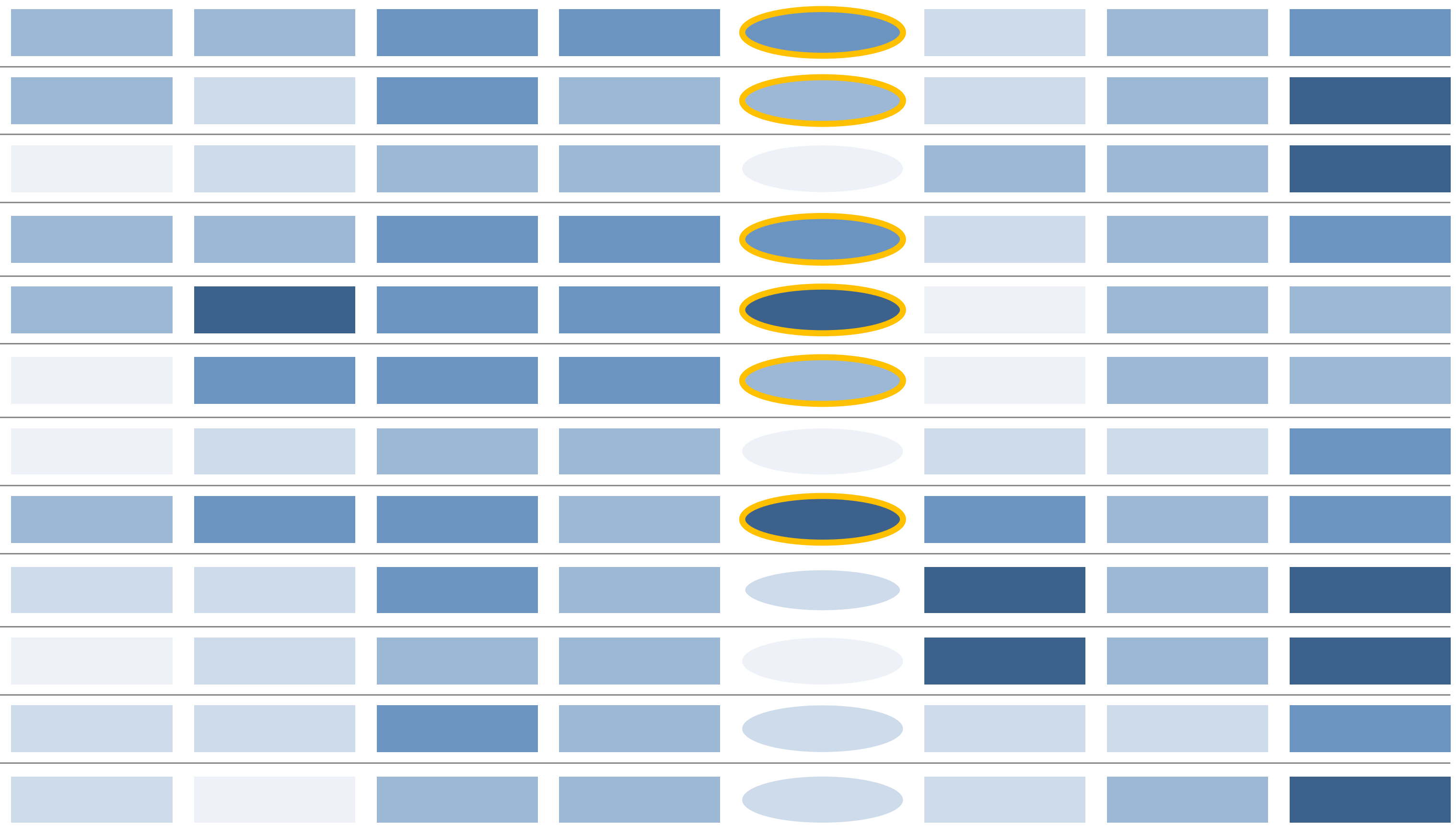
High ■ ■ ■ ■ ■ Low

	Example	Pea protein burger	Soy milk	Hemp protein shake
	End-product	Burger	Milk	Shake
	Technology	Plant-based	Plant-based	Plant-based
Feasi-bility	Price parity to meat by 2035 globally	Beyond patty at USD ~15/kg (similar to the ability price of a beef patty)	Plant-based soy milk at USD ~0.5 per l (similar to the price of dairy)	Protein powder at HealthyU selling at USD ~70/kg (similar cost of whey protein powder)
	Consumer or buyer preferences	Moderate consumer acceptance (based on survey)	Product already in premium market; and high lactose intolerance results in high demand	Product already in premium market, recently changing fitness and nutrition trends
	Availability of inputs	Inputs are available (e.g., peas) but not produced at scale in SSA	Raw ingredients not produced at scale in SSA (e.g., SSA is at a soy deficit)	Inputs are available (e.g., peas) but not produced at scale in SSA
	Technology maturity	Commercial processing exists but not at scale	Commercial processing exists but not at scale	Commercial processing exists but not at scale
Im-pact	Protein parity with comparable animal protein	18% protein content in product (vs 22% in poultry and beef)	3% protein content in soy milk (~2x higher than dairy)	40% protein content in plant protein powder (~20x that of dairy)
	DIAAS, %	DIAAS level for pea protein is lower than benchmark	DIAAS level for soy milk lower than benchmark	DIAAS level for pea protein lower than benchmark
	Sustainability impact	Lower emissions, land and water use compared to benchmarks	Lower emissions and land use than dairy	Lower emissions, land, and water use compared to benchmarks
	Total feasibility score (out of 5)	4	5	5

Source: Press search; expert interviews

Feasibility | We prioritise ~16 novel alternate protein opportunities for SSA based on feasibility scorings (1/3)

◯ Prioritised **High** █ ▓ ▒ ░ □ **Low**



					Feasibility					**Nutritional and sustainability impact**		
					Price parity to meat by 2035 globally[1]	**Consumer or buyer preferences**[2]	**Availability of inputs**	**Technology maturity**	**Overall feasibility score**	**Protein parity**[3]	**DIAAS**[4] **(%)**	**Sustainability impact**
Sub-Saharan Africa consumer market	**Meat, dairy, and egg mimics**	Premium meat mimic	1	Premium plant-based meat mimic	▒	▒	▓	▓	◯ ▓	░	▒	▓
			2	Biomass fermented meat mimic	▒	░	▓	▒	◯ ▒	░	▒	█
			5	Insect-based meat mimic	□	░	▒	▒	□	▒	▒	█
		Mass market meat alternative	6	Mass market plant-based meat alternative	▒	▒	▓	▓	◯ ▓	░	▒	▓
		Premium dairy mimics	7	Plant-based milk mimic	▒	█	▓	▓	◯ █	□	▒	▒
			9	Plant-based value-added dairy mimic	□	▓	▓	▓	◯ ▒	□	▒	▒
		Eggs mimic	11	Plant-based eggs mimic	□	░	▒	▒	□	░	░	▓
	Nutritional	Sports nutrition (e.g., protein powders, recovery drinks, supplements)	13	Plant-based sports nutrition	▒	▓	▓	▒	◯ █	▓	▒	▓
			14	Biomass fermented sports nutrition	░	░	▓	▒	░	█	▒	█
			16	Insect-based sports nutrition	□	░	▒	▒	□	█	▒	█
		Infant nutrition (e.g., fortified formula)	17	Plant-based infant nutrition	░	░	▓	▒	░	░	░	▓
			18	Biomass fermented infant nutrition	░	□	▒	▒	░	░	▒	█

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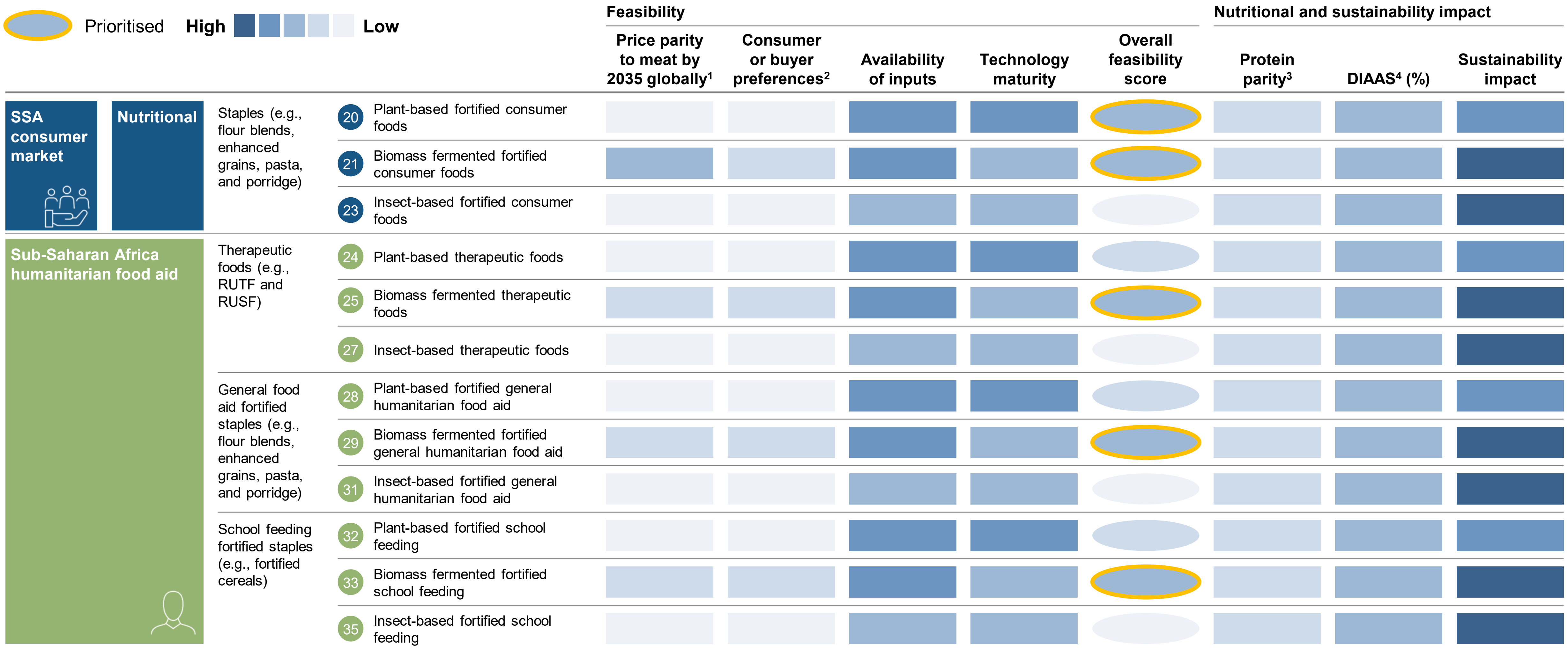
1. Price of end-product in comparison to benchmark
2. Consumer preference for end-products for human consumption, buyer preference for humanitarian, animal feed, and global ingredients
3. Protein content in end-product in comparison to benchmark
4. Digestible Indispensable Amino Acid Score, a protein quality method measuring the amounts of amino acids absorbed by the body and the protein's contribution to human amino acid and nitrogen requirements

Source: Press search; expert interviews

Feasibility | We prioritise ~16 novel alternate protein opportunities for SSA based on feasibility scorings (2/3)



⬭ Prioritised **High** █ ▓ ▒ ░ □ **Low**

					Feasibility					**Nutritional and sustainability impact**		
					Price parity to meat by 2035 globally[1]	**Consumer or buyer preferences**[2]	**Availability of inputs**	**Technology maturity**	**Overall feasibility score**	**Protein parity**[3]	**DIAAS**[4] **(%)**	**Sustainability impact**
SSA consumer market	**Nutritional**	Staples (e.g., flour blends, enhanced grains, pasta, and porridge)	20	Plant-based fortified consumer foods	□	□	▓	▓	⬭ ▒	░	▒	▓
			21	Biomass fermented fortified consumer foods	▒	░	▓	▒	⬭ ▒	░	▒	█
			23	Insect-based fortified consumer foods	□	□	▒	▒	□	░	▒	█
Sub-Saharan Africa humanitarian food aid		Therapeutic foods (e.g., RUTF and RUSF)	24	Plant-based therapeutic foods	□	□	▓	▓	░	░	▒	▓
			25	Biomass fermented therapeutic foods	░	░	▓	▒	⬭ ▒	░	▒	█
			27	Insect-based therapeutic foods	□	□	▒	▒	□	░	▒	█
		General food aid fortified staples (e.g., flour blends, enhanced grains, pasta, and porridge)	28	Plant-based fortified general humanitarian food aid	□	□	▓	▓	░	░	▒	▓
			29	Biomass fermented fortified general humanitarian food aid	░	░	▓	▒	⬭ ▒	░	▒	█
			31	Insect-based fortified general humanitarian food aid	□	□	▒	▒	□	░	▒	█
		School feeding fortified staples (e.g., fortified cereals)	32	Plant-based fortified school feeding	□	□	▓	▓	░	░	▒	▓
			33	Biomass fermented fortified school feeding	░	░	▓	▒	⬭ ▒	░	▒	█
			35	Insect-based fortified school feeding	□	□	▒	▒	□	░	▒	█

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1. Price of end-product in comparison to benchmark
2. Consumer preference for end-products for human consumption, buyer preference for humanitarian, animal feed and global ingredients
3. Protein content in end-product in comparison to benchmark
4. Digestible Indispensable Amino Acid Score, a protein quality method measuring the amounts of amino acids absorbed by the body and the protein’s contribution to human amino acid and nitrogen requirements

Source: Press search; expert interviews

Feasibility | We prioritise ~16 novel alternate protein opportunities for SSA based on feasibility scorings (3/3)

◯ Prioritised **High** █ ▓ ▒ ░ □ **Low**

				Feasibility					**Nutritional and sustainability impact**		
				Price parity to meat by 2035 globally[1]	**Consumer or buyer preferences**[2]	**Availability of inputs**	**Technology maturity**	**Overall feasibility score**	**Protein parity**[3]	**DIAAS**[4] **(%)**	**Sustainability impact**
Sub-Saharan Africa animal feed	Pet food	37	Insect-based pet food	█	▒	▒	▒	▓ ◯	█	□	█
		38	Biomass fermented pet food	█	░	▓	░	□	▒	▒	█
	Livestock feed	41	Insect-based animal feed	□	▓	▒	▒	▓ ◯	█	□	█
Sub Saharan Africa (inputs to global animal feed)	Pet food	44	Insect-based pet food	█	▒	▒	▒	▓ ◯	█	□	█
Sub-Saharan Africa providing inputs to global novel alternate protein consumption (human and animal)		47	Plant-based isolate	▒	█	▓	█	▓ ◯	█	▒	▓
		48	Plant-based concentrates	□	▓	▓	█	▒	█	░	█
		49	Plant-based algae protein	▒	□	▓	▓	░	█	▒	█
		50	Biomass fermented mycoprotein	▒	▓	█	▓	▓ ◯	█	▒	█
		51	Insect-based protein	□	▓	▒	▒	□	█	▒	█

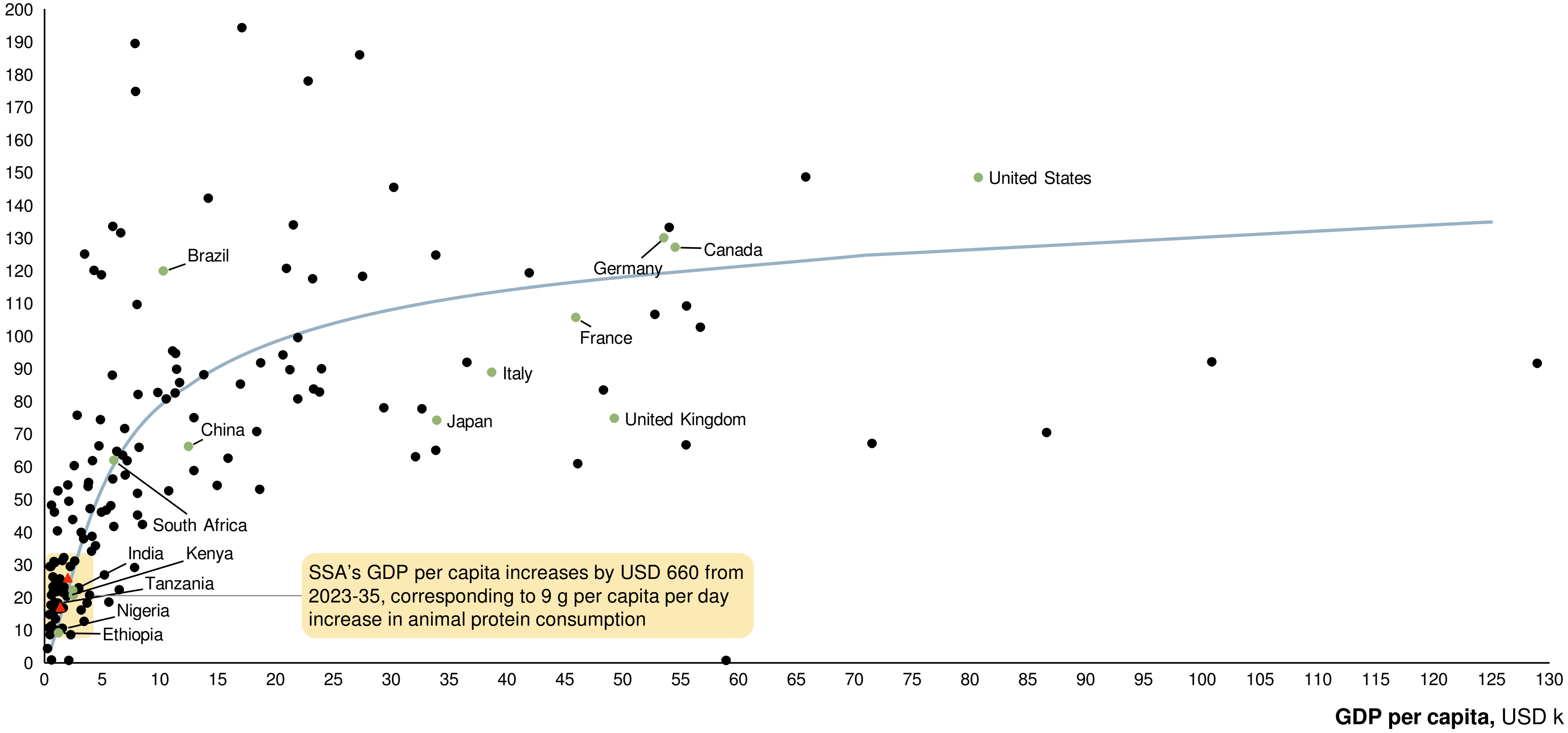
1. Price of end-product in comparison to benchmark
2. Consumer preference for end-products for human consumption, buyer preference for humanitarian, animal feed and global ingredients
3. Protein content in end-product in comparison to benchmark
4. Digestible Indispensable Amino Acid Score, a protein quality method measuring the amounts of amino acids absorbed by the body and the protein's contribution to human amino acid and nitrogen requirements

Source: Press search; expert interviews

Agenda

Animal protein demand | With higher GDP per capita, animal protein demand per capita per day is projected to grow in SSA from 17 g in 2023 to 26 g in 2035

Animal protein consumption across all countries globally[1], g per capita per day, 2023



SSA's GDP per capita increases by USD 660 from 2023-35, corresponding to 9 g per capita per day increase in animal protein consumption

As expected, animal protein demand tends to grow with increasing incomes

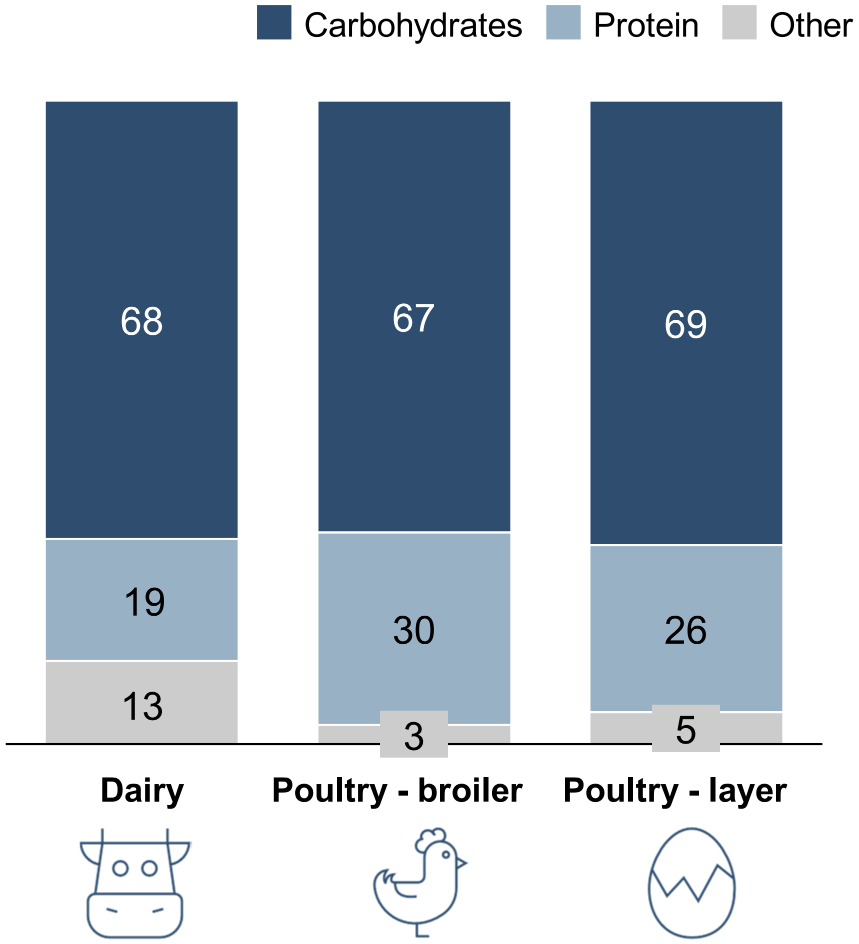
To model the growth in SSA, we assumed demand grows according to this curve as GDP per capita increases (left shows the aggregate change, but this was done on specific protein categories to get category demand growth)

1. Excl. extreme outliers

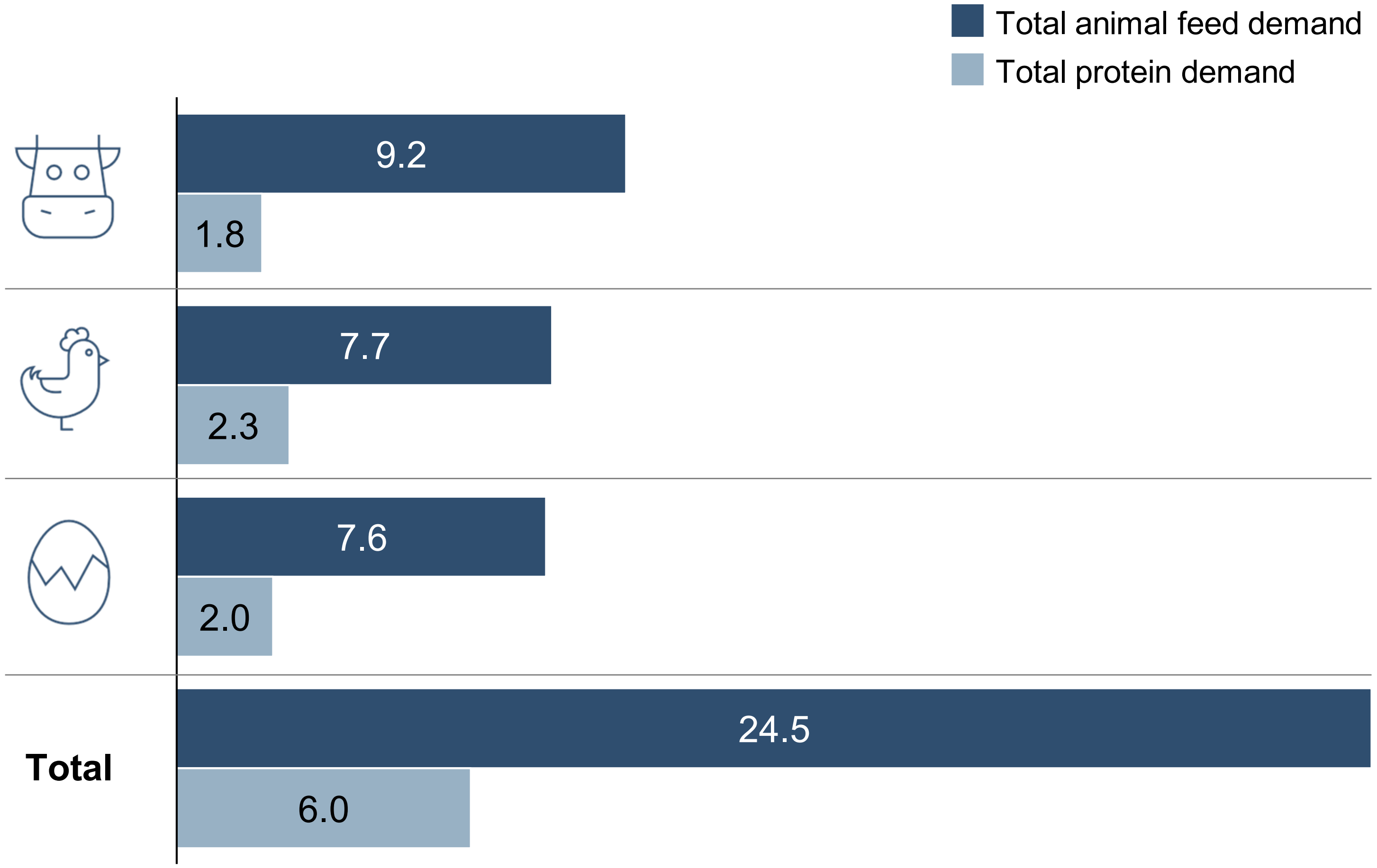
Source: FAOSTAT; World Bank; World Population Review; International Monetary Fund

Animal feed demand | From the total animal feed demand for dairy and poultry in 2035, ~6 mn tonnes (20-30%) needs to come from protein

Nutritional composition of animal feed, %



Total protein demand in animal feed in 2035, mn tonnes

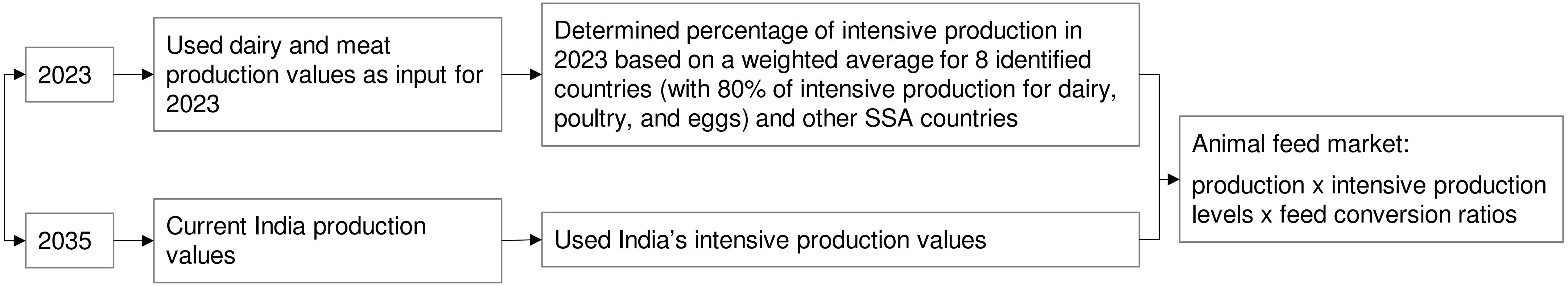


Source: FAOSTAT; expert interviews; press search

Animal feed market | Animal feed market demand methodology

Calculated value | **Animal production levels** | **Share of intensive production** | **Animal feed market size**

Methodology



2023 → Used dairy and meat production values as input for 2023 → Determined percentage of intensive production in 2023 based on a weighted average for 8 identified countries (with 80% of intensive production for dairy, poultry, and eggs) and other SSA countries

2035 → Current India production values → Used India's intensive production values

→ Animal feed market:

production x intensive production levels x feed conversion ratios

Assumptions

Animal production levels:

- Meet 50% of India's dairy production
- Meet 100% of India's poultry and eggs production

Share of intensive production:

- Used 50% of India's intensive and semi-intensive production values for dairy in 2035
- Used 100% of India's intensive production values for poultry and eggs
- Intensive production change between 2023-35
  - Dairy
    - Intensive: 10%-11%
    - Semi-intensive: 11%-29%
  - Poultry: 36%-80%
  - Eggs: 38%-80%

Animal feed market size:

Feed conversion ratios

- Dairy (kg feed per litre)
  - Intensive: 0.5
  - Semi-intensive: 0.2
- Poultry (kg feed per kg meat): 2.5
- Eggs (kg feed per kg eggs): 2

Source: Press search; expert interviews

Animal feed market | Soy deficit methodology page

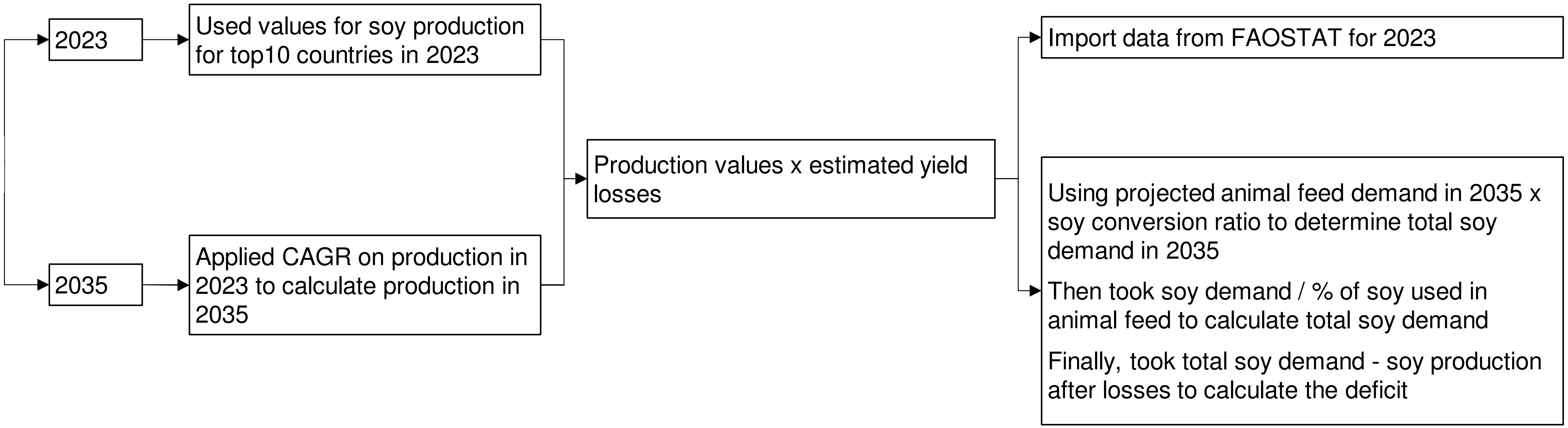
Calculated value

Total soy production

Soy production accounting for yield losses

Soy deficit

Methodology



2023

Used values for soy production for top10 countries in 2023

2035

Applied CAGR on production in 2023 to calculate production in 2035

Production values x estimated yield losses

Import data from FAOSTAT for 2023

Using projected animal feed demand in 2035 x soy conversion ratio to determine total soy demand in 2035

Then took soy demand / % of soy used in animal feed to calculate total soy demand

Finally, took total soy demand - soy production after losses to calculate the deficit

Assumptions

- 12% CAGR for production increase from 2023-35 based on FAOSTAT production increase from 2010-23

- Yield losses in 2023: 60%
- Yield losses in 2035: 30-50%

- Soy conversion ratio: 0.26
- Soy used in animal feed: 0.85

Source: Press search; expert interviews

Market size | We used a specific approach and set of assumptions for the market and investment sizing per market segment

Market		Market sizing	Investment size
Sub-Saharan Africa consumer market		Premium meat mimic and plant-based dairy are substitutes for conventional protein, assuming: ▪ Effective consumption for 2035 based on analysis of animal protein demand growth ▪ Growth in market formalisation based on median income growth ▪ Split in technology for premium meat mimic based on the expected global split in 2035 ▪ Price parity with current conventional meat prices in 2035 Mass meat alternatives, sports nutrition products, and fortified foods are supplements to diets, assuming: ▪ Target population based on income levels by 2035 (i.e., mass market for meat, high-income for sports nutrition, and urban high-and-middle-income for fortified foods) ▪ Current prices for sports nutrition in the US, mass market meat alternatives in Rwanda, and fortified foods in SSA	Average investment for a mid-size facility to produce protein ingredient and end-products
Sub-Saharan Africa humanitarian food aid		Alternative to current milk powder in ready-to-use therapeutic and supplementary food, assuming: ▪ Constant total volume for ready-to-use foods as average 2020-24 ▪ Expected price for fermented mycoprotein for a local player in 2035 Substitution of corn-soy blend in food aid and fortification in school feeding with biomass fermented protein, assuming: ▪ Constant total volume for general food aid and school feeding as and average of years 2020-24 ▪ Expected price for fermented mycoprotein for a local player in 2035	Average investment size for a mid-size fermentation facility to produce the protein ingredient
Sub-Saharan Africa animal feed	**Livestock**	BSF is a substitute for soybean meal in livestock feed, assuming ▪ Share of brewery waste, farm waste, and large scale sources of organic waste can be captured by BSF players ▪ Waste to BSF conversion ratio of 5% ▪ Average market price for soybean meal (assuming BSF is at price-parity)	Average investment size for a mid-size BSF production plant
	Pet food	BSF is a substitute for animal protein in pet food ▪ Sub-Saharan Africa share of global pet food market is ~1.6% ▪ 53% of the pet food market is dry pet food that can be substituted by BSF ▪ Average market price of global BSF pet food	
Sub-Saharan Africa supplying inputs to global novel alternate protein market		Fava beans could be exported out of sub-Saharan Africa to be processed into protein isolate abroad ▪ Sub-Saharan Africa could export enough fava beans to supply one or two 20 k tonnes of isolate production facilities ▪ Sub-Saharan Africa share of total global plant-based ingredients market would be 0.4-0.8% ▪ Average export price of fava beans from Ethiopia	Average investment size to set up fava bean farm in sub-Saharan Africa

! More details on the methodology in appendix

Investment size | The investment size is based on a mid-sized commercial facility

Market	Novel AP opportunity	Technology	**Investment size,** USD mn	Description of investment size
Sub-Saharan Africa consumer market	① Premium plant-based meat mimic	Plant-based	15-30	Mid-sized facility that can produce protein isolates and extrusion for plant-based products; average production between 5,000 and 10,000 tonnes annually
	② Biomass fermented meat mimic	Fermented	30-50	A realistic mid-size facility of 200 litres; average production between 3,000 and 5,000 tonnes annually
	⑥ Mass market plant-based meat mimic	Plant-based	0-15	A mid-size facility based on current conventional dairy farm sizes; average production between 5,000-10,000 tonnes annually
	⑦ Plant-based milk mimic	Plant-based	15-30	
	⑨ Plant-based value-added dairy mimic	Plant-based	15-30	
	⑬ Plant-based sports nutrition	Plant-based	15-30	
	⑳ Plant-based fortified consumer foods	Plant-based	15-30	
	㉑ Biomass fermented fortified consumer foods	Fermented	30-50	A realistic mid-size facility of 200 litres; average production between 3,000 and 5,000 tonnes annually
SSA humanitarian food aid	㉕ Biomass fermented therapeutic foods	Fermented	30-50	
	㉙ Biomass fermented fortified general humanitarian food aid	Fermented	30-50	
	㉝ Biomass fermented fortified school feeding	Fermented	30-50	
Sub-Saharan Africa animal feed	㊲ Insect-based pet food	Insect-based	15-30	A mid-size facility, based on current players; average production between 5,000 and 1,000 tonnes annually
	㊶ Insect-based animal feed	Insect-based	15-30	
Sub-Saharan Africa providing inputs to global novel AP consumption (human and animal)	㊹ Insect-based pet food (global)	Insect-based	15-30	A mid-size facility with an average production of 10,000-20,000 tonnes annually
	㊼ Plant-based ingredients (global)	Plant-based	0-15	A commercial scale fava/mung bean farm or aggregation from small scale farms to produce and export 70,000-160,000 tonnes annually
	㊿ Biomass fermented mycoprotein (global)	Fermented	N/A	Market not sized given the high level of uncertainties around biomass fermentation capacity

Source: Press search; expert interviews; Good Food Institute

SSA consumer market | To project novel alternate protein demand for the SSA consumer market, we projected future growth of 5 main categories

Market	Key assumptions
Premium meat mimics	• Countries are split into income groupings from the World Bank (upper-middle, lower-middle, and low income) • Lower-middle formal market share in 2023 is based on Kenya's formal market share[1] • Upper-middle and low-income formal market share in 2023 is based on the ratio of refrigerator ownership using the lower-middle formal market as the index • Formal market share is grown from 2023-35 using median income growth
Mass market meat alternatives	• Determine SSA population that are considered mass market (<USD 700 income and above the poverty line of USD 2.25 per day)[2] for lower-middle income countries • Adjust population share for upper-middle and low-income countries based on the refrigerator ownership ratios • Decrease population considered mass market based on median income growth
Dairy mimics	• Select countries that are considered high dairy-consuming: Kenya, Ethiopia, Nigeria, Tanzania, Uganda, Rwanda, Zambia, Zimbabwe • Determine the share of the formal market in 2023 for each country and make assumptions on which countries would be similar where limited data exists • Grow formal market share from 2023-35 based on median income growth
Sports nutrition	• Consider upper-middle and lower-middle-income countries only (not low-income countries) • Take a share of population considered high-income in 2035 (using inverse population of mass market population from meat alternatives sizing)
Fortified consumer foods	• Consider upper-middle and lower-middle income countries only (not low-income countries) • Take a share of population considered high-income in 2035 (using inverse population of mass market population from meat alternatives sizing)

1. Gatsby/UK Aid report study on meat end market trends
2. Using Kenya National Bureau of Statistics (KNBS) data

Source: Expert interviews; Gatsby/UK Aid; KNBS

SSA consumer market | Detailed market segment share of consumption and alignment to novel AP products (1/2)

🟦 Mass market for novel alternate protein ⬜ Premium market for novel alternate protein x 2035 est. market size (mn tonnes) x Novel alternate protein opportunity number

	Market segment share of population, %		Market segment description	Addressable market for novel AP	Customer profile	Novel AP product	
Total meat market	1.6%	1.6	High-income buying processed meat from modern retail[1]	✓	Convenience-focused consumers who value sustainability and animal welfare so would switch to novel alternate protein	Processed meat mimics (e.g., plant-based burger	1 2
	1.6%	1.6	High-income buying fresh cut[2] meat from modern retail	✗	Meat lovers that value quality and freshness so would not buy processed novel alternate protein	N/A	
	1.8%	1.9	High-income buying all meat from traditional trade[3]	✗	Consumers that prioritise freshness and tradition so would not buy processed novel alternate protein	N/A	
	95%	98	Middle- and low-income meat market	✓	Price-sensitive consumers that also have a protein deficit and therefore open to novel alternate protein as a supplement if priced below conventional meat	Novel texturised vegetable protein – *to be developed*	6
Total dairy market[4]	11%	0.7	Consumers buying pasteurised milk in modern retail	✓	High-income consumers who prioritise sustainability and animal welfare and middle-income consumers who are increasingly health-conscious, with a growing willingness to pay a premium for plant-based alternatives if lactose intolerant	Branded premium plant-based milk	7
	1%	0.3	High income consumers buying value-add[5] dairy in modern retail	✓		Branded premium plant-based yoghurt	9
	3%	0.7	Middle-and low- income consumers buying pasteurised value-added dairy in modern retail	✗	Price-sensitive consumers may switch to plant-based dairy if priced at par with conventional yoghurt, already seen as healthy; this assumes price parity is unlikely by 2035	Affordable processed dairy	
	85%	27	Consumers buying dairy in the informal market (i.e., unpasteurised milk and dairy directly from farmers)	✗	Highly-price sensitive consumer with a strong preference for conventional dairy so would not switch to novel alternate protein	N/A	

1. Sold in the regulated market through retail channels (e.g., supermarkets)
2. Unprocessed meat that is typically slaughtered and sold within a few days
3. Typically, estate butcheries and other licensed channels that are not modern retail
4. For the dairy market we look at high-consuming dairy countries which include East Kenya, Ethiopia, Nigeria, Tanzania, Zambia, Zimbabwe, Rwanda, Uganda
5. Processed dairy products such as yoghurt, cheese, ice-cream etc.

Sources: Kenya National Bureau of Statistics (KNBS); Quantifying appliance access gaps (CLASP); Study on Meat End Market Trends in Kenya; Gatsby, UK Aid; FAOSTAT; World Bank, expert interviews

SSA consumer market | Detailed market segment share of population and alignment to novel AP products (2/2)

▨ Mass market for novel alternate protein ▨ Premium market for novel alternate protein ● x 2035 est. population (mn) ● x Novel alternate protein opportunity number

	Market segment share of population, %		Market segment description	Addressable market for novel AP	Customer profile	Novel AP product
Total sports nutrition market[1]	1.1%	6	High-income consumers within the age range 18-45	✓	Consumers who can afford sports nutrition products, who are physically active and value sustainability so willing to switch to novel alternate protein-based product	Protein powders, meal replacements, protein bars, etc. 13 
	3.9%	20	High-income consumers outside the age range 18-45	✗	Consumers who can afford sports nutrition products, but who are physically less active and less aware of health and sustainability trends	N/A
	96%	550	Middle- and low-income consumers	✗	Price-sensitive consumers who are unlikely to pay for expensive sports nutrition products	N/A
Total fortifi-cation market[1]	1.1%	6	High-income consumers within the age range 18-45	✓	Younger, health-conscious consumers living in urban areas with growing awareness of nutrition trends and are willing to pay a premium	Protein-fortified flours 20 21 
	3.9%	20	High-income consumers outside the age range 18-45	✗	Older consumers who value traditional foods and are likely to stick to established habits	N/A
	96%	550	Middle- and low-income consumers	✗	Price-sensitive consumers who are unlikely to pay a premium for staple foods	N/A

1. Only considers countries classified as upper-middle income and lower-middle income by the World Bank

Sources: Kenya National Bureau of Statistics (KNBS); Quantifying appliance access gaps (CLASP); FAOSTAT; World Bank; expert interviews

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