



# Methods to improve the sustainability and nutrition of school dinners for both planetary and population health

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## **Chair**

Prof. Maria Bryant  
*University of York*

## **Discussant**

Prof. Charlotte Hardman  
*University of Liverpool*



# **Co-Designed Menu Swaps to Improve Nutrition and Environmental Sustainability of Primary School Meals in Socioeconomically Deprived Settings: Early Findings from the FixOurFood Intervention**

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# Why School Meals Matter

## School meals as a leverage point for healthier and sustainable diets

- 1 in 4 children rely on school meals daily
- School meals influence diet quality and food preferences  
Menu design influences  
environmental impact



*Particularly important in socioeconomically deprived areas*

# FixOurFood cohort: Observations





# What We Observed in Schools

## Baseline Findings from FixOurFood School Observations

- 18 primary schools across Yorkshire
- 3,526 lunch plates photographed and analysed
- Frequent selection of meals with:
  - High saturated fat
  - High carbon footprint
- Limited fibre-rich plant-based uptake

***Highlighting the need for healthier, lower-carbon menu options***



## Aim of the study

To develop and evaluate co-designed menu swaps to improve nutrition and environmental sustainability of primary school meals in Bradford, UK.

### Reformulate high-impact meals

#### Improve:

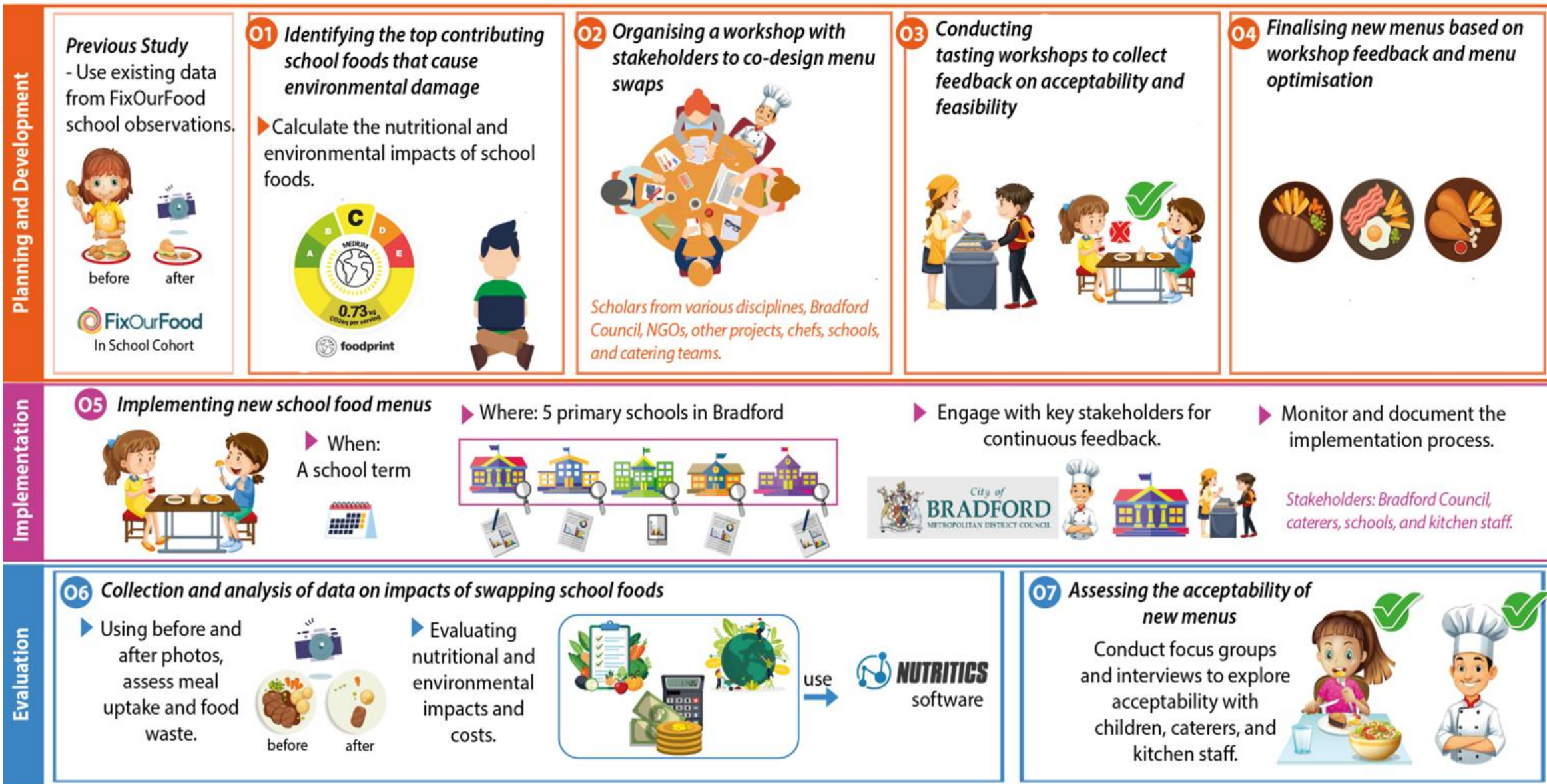
- Saturated fat
- Fibre
- CO<sub>2</sub>e



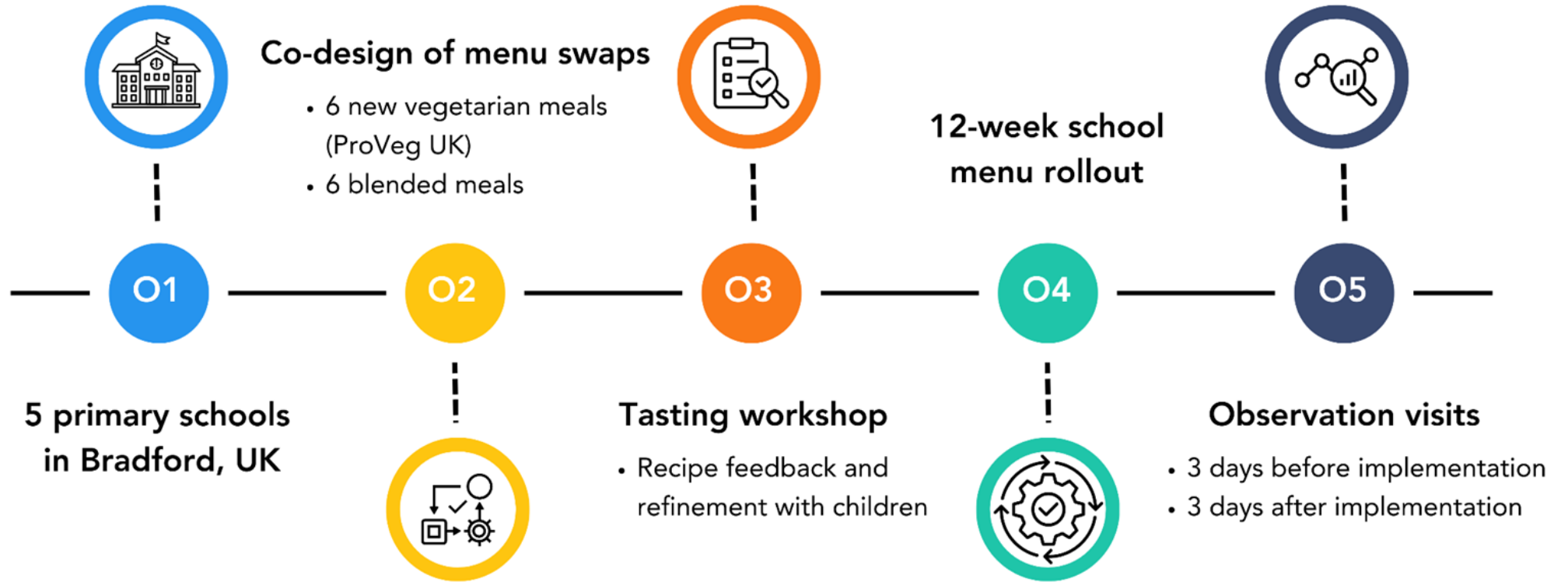
#### Maintain:

- Cost feasibility
- Child acceptability

# Study Design Overview



# Simplified Study Design



# Co-Design Workshop

## Stakeholders:

- Local authority
- School caterers
- Researchers

## Selection criteria:

- Popularity in school menus
- Environmental impact (CO<sub>2</sub>e)
- Practical feasibility for caterers

*Development of candidate menu swaps*



# Recipe Reformulation

12 redesigned recipes



## 6 vegetarian swaps

- Whole-food plant-based and low in dairy



## 6 blended meals

- Reduced meat proportion
- Fibre enrichment

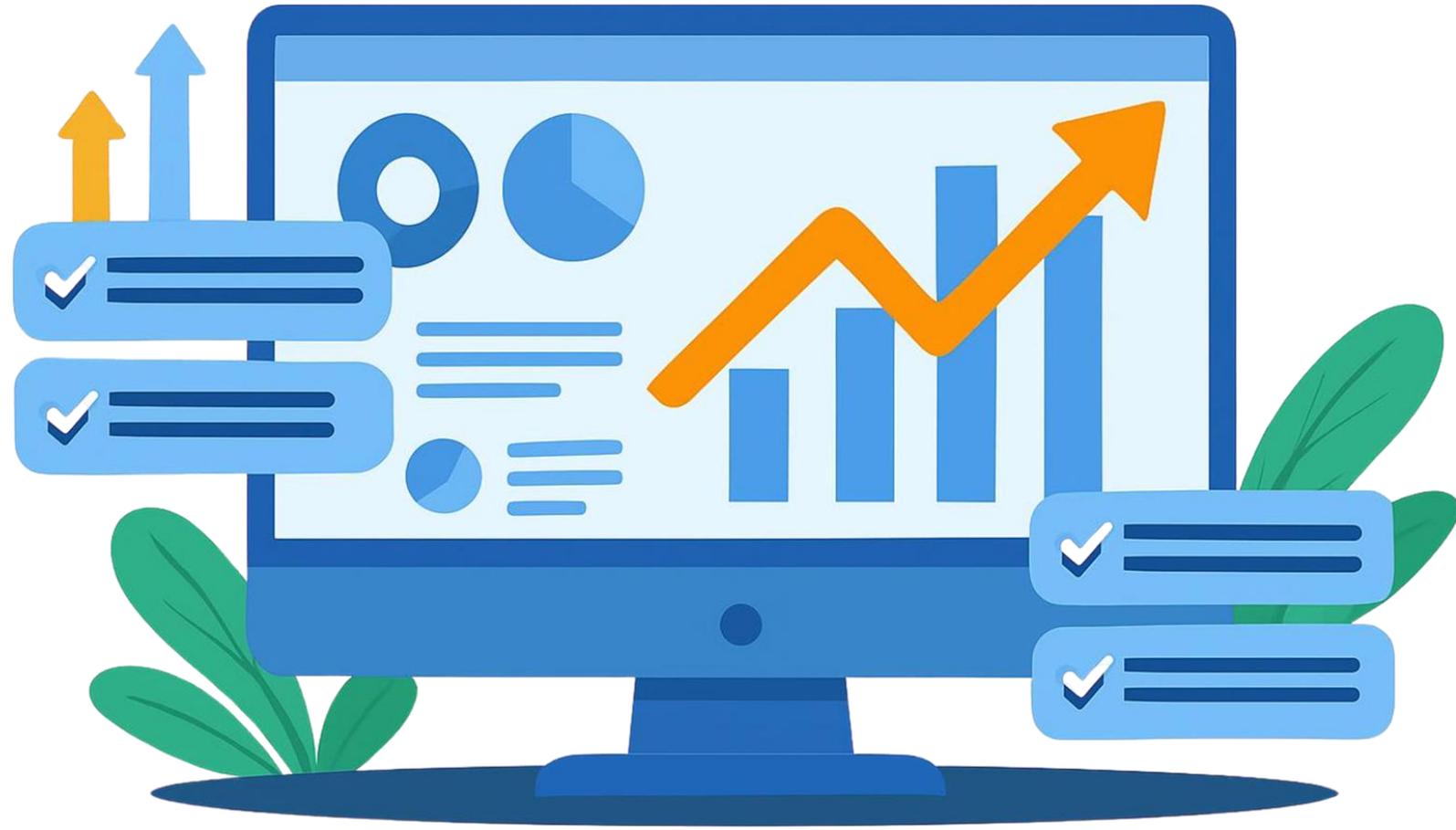


## Nutritional & Environmental Analysis

- Nutritics software (Research Edition v6.12)
- Ingredient-level reformulation
- Carbon footprint (CO<sub>2</sub>e) calculation
- Cost analysis using supplier data



# Results



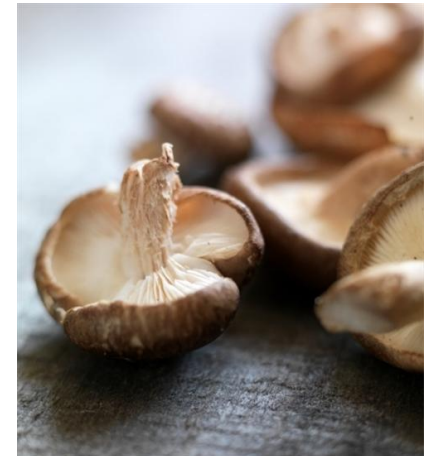
## Matched recipe comparisons: percentage changes between baseline and new recipes

Recipe Pair (Original → Revised)	Saturated Fat (%)	Dietary Fibre (%)	Carbon Footprint (%)	Cost (%)
Tuna Melt Hot Baguette → Coronation Chickpea Sandwich	-84	+267	-79	-41
Chicken Korma → Curry Club Dal with Crispy Chickpeas and Coriander Yoghurt	-66	+334	-16	-55
Mac & Cheese → Creamy Cauli Mac “N” Cheese and Peas	-79	+154	-40	+63
Homemade Cheese & Onion Pasty → Indian-Style Sausage Rolls	-60	+42	-38	-40
Chilli & Rice → Loaded Mexican Wedges	-53	+200	-84	+10
Braised Sausage → Cowboy Sausage and Beans	-89	+127	-77	+38
Beef Burger in a Bun (blended)	-61	+45	-9	-24
Mild Chicken Curry (blended)	-38	+144	-34	-16
Spaghetti Bolognese (blended)	-25	+1	-31	-20
Meat Lasagne (blended)	-16	+24	-23	-13
Chicken Pie (blended)	-1	+112	-29	-30
Cheese & Tomato Pizza (blended)	-20	+19	-16	0

# Nutritional Improvements

## Vegetarian swaps

- Sat fat: -53% to -89%
- Fibre: up to +334%



## Blended meals

- Sat fat: -1% to -61%
- Fibre: up to +144%

# Environmental Impact

## Vegetarian swaps

- CO<sub>2</sub>e: -16% to -84%

*Strongest reductions in plant-based swaps*

## Blended meals

- CO<sub>2</sub>e: -9% to -34%

*Blending = incremental but scalable strategy*



*Plant-forward reformulation substantially lowers environmental impact*

## Cost Implications

Some meals ↑ cost (+10% to +63%)

- Vegetarian meals
- Due to ingredient substitutions

Others ↓ cost (up to -55%)



*Improvements possible without consistent cost increases*

# Acceptability (Tasting workshop)

- 34 children



- Age 6–11

- Hedonic liking scale



## Welcome, Taste Detectives!

Today you will help us explore 6 exciting new dishes. After tasting each one, tell us how much you liked it using fun faces!

At the end, you'll choose your favourites. There are no right or wrong answers — just your honest taste.

Let's begin!



Dishes



## Liking Assessment

- Smiley Face Scale
- Bucket Activity
- Preference Ranking

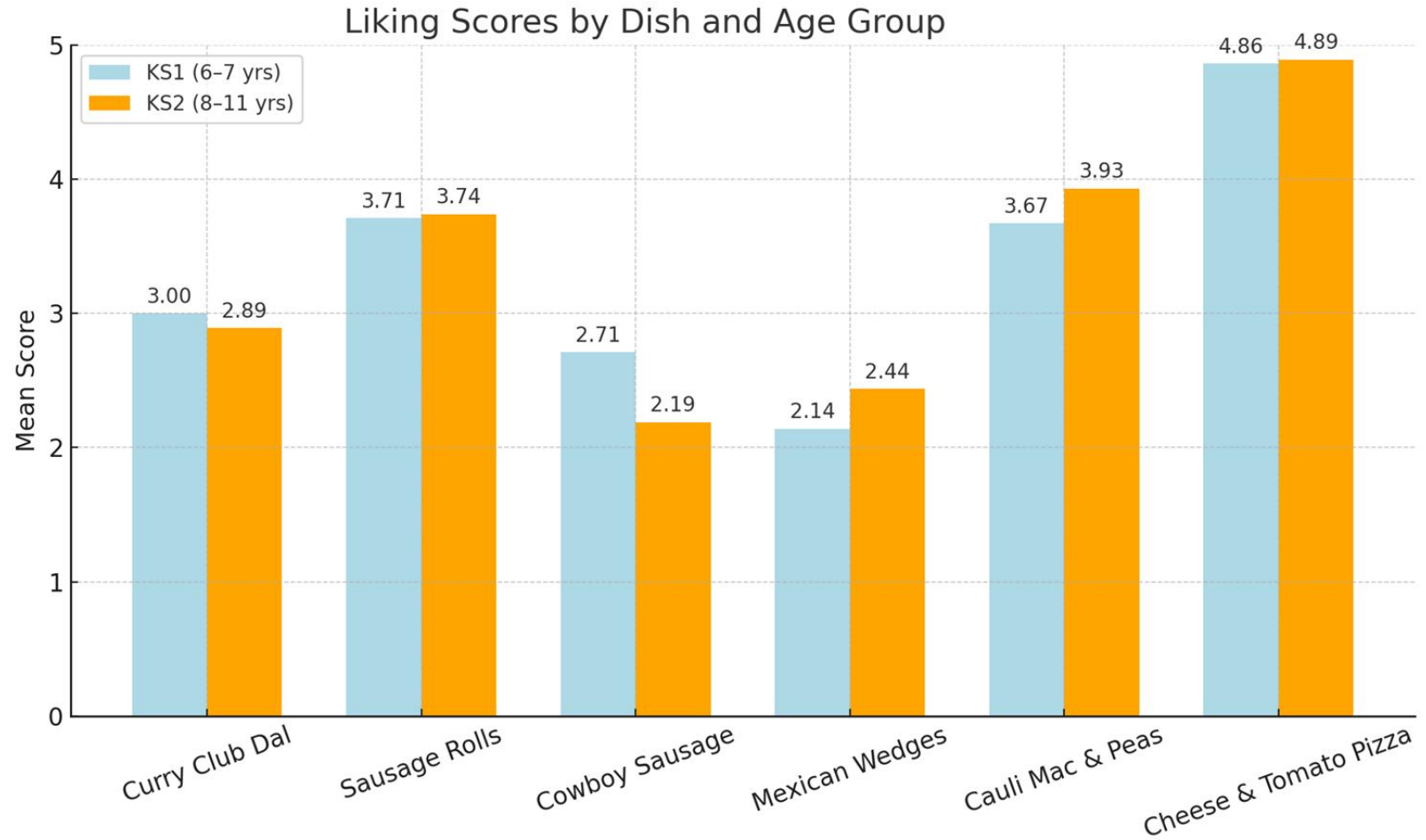
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## Fruit Kebabs

# Acceptability Results



*No major rejection patterns observed.*

# Menu Finalisation Before Implementation

- Minor recipe revisions made based on **tasting workshop feedback**, in collaboration with **FM Catering** and **ProVeg**, particularly for lower-scoring dishes
- Final **12 revised recipes** combined with **8 remaining dishes** to create a full menu
- **Two-week rotating menu** with **two daily main meal options**
- Menu optimisation conducted by the **SNEAK team**

## Menu Architecture (SNEAK)

- Modelling of over 3.6 million menu combinations across 10 school days
- Optimised for nutrition, carbon footprint and cost

# Final menu implemented across five Bradford primary schools

and fresh fruits served daily

## Bradford Primary School

1<sup>st</sup> Dec, 15<sup>th</sup> Dec, 18<sup>th</sup> Dec, 12<sup>th</sup> Jan

### WEEK 1

MON	<b>Chicken Pie</b> (Red Tractor Accredited) Pieces in a rich Gravy with Vegetables, topped with a Golden Pastry lid	<b>Coronation Chickpea Sandwich</b> (Mashed chickpeas are mixed with mild curry spices, mango chutney, and a touch of sweetness from raisins to make a tasty, protein-packed sandwich filling)	Assorted Jacket Potatoes	<b>Chocolate Sponge &amp; Chocolate Sauce</b> (Homemade, light Chocolate Sponges, served with Chocolate Sauce)
TUES	<b>Homemade Beef Burger in a Bun</b> (Red Tractor Accredited) Beef & Spinach Burger, served in a White Bun with Baked Potato Wedges	<b>Loaded Mexican-Style Wedges</b> (Golden roasted sweet potato wedges are topped with a rich, gently spiced tomato and bean sauce, melted cheese, and sweetcorn)	Assorted Jacket Potatoes	<b>Banana Muffins</b> (A fluffy Vanilla Sponge, with Bananas & drizzled with Icing)
WED	<b>Roast Meat Dinner</b> (Red Tractor Accredited) Gammon, Turkey or Pork served with Yorkshire Pudding, Roast Potatoes & Veggie Gravy	<b>Spaghetti Marinara</b> (A Tomato and mildly spiced Sauce combined into cooked Spaghetti, topped with Cheese)	Assorted Jacket Potatoes	<b>Fruity Flapjack</b> (A Sweet Bar made with Oats, Golden Syrup & Butter with Fruit)
THURS	<b>Classic Cheese &amp; Tomato Pizza with Coleslaw &amp; Salad</b> (Wholemeal 50/50 Base topped with a lightly spiced Sauce, and topped with Mozzarella/Cheddar Cheese)	<b>Spaghetti Bolognese</b> (A rich Tomato sauce with Soya Mince, Peppers and Herbs)	Assorted Jacket Potatoes	<b>Pears &amp; Ice Cream with Syrup</b> (Vanilla Ice Cream with Trained Pear Slices, with a Chocolate flavoured Syrup)
FRI	<b>Mild Chicken Curry</b> (Red Tractor Diced Chicken cooked in a mild spiced Indian style curry sauce)	<b>Golden Cheese Flan</b> (Mature Cheddar Cheese & Egg Based in a Pastry Case, served with Seasoned Potatoes)	<b>MSC Battered Fish Fillet</b> (MSC Battered Fillet of Fish, served with Baked jacket Wedges)	<b>Strawberry Sponge &amp; Custard</b> (Homemade, light Strawberry Sponge with a Strawberry Jam layer, served with Custard)

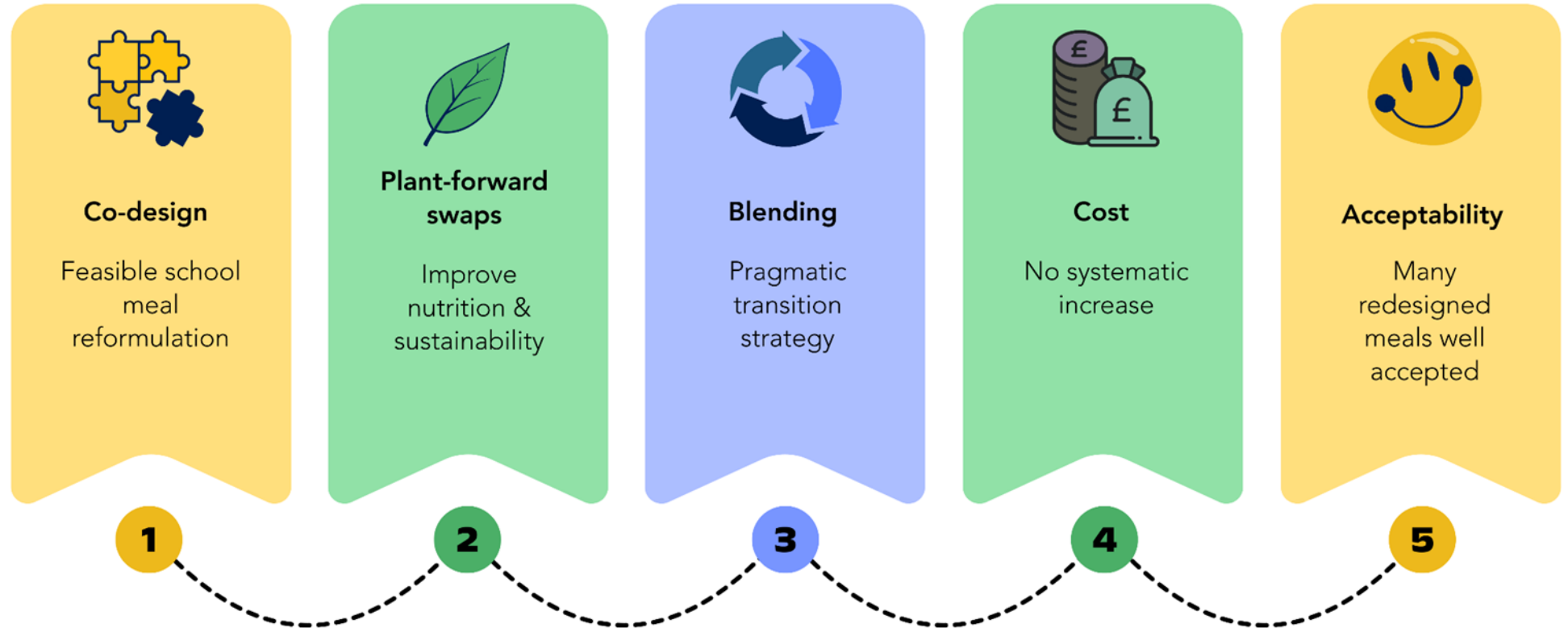
## Bradford Primary School

5<sup>th</sup> Jan, 19<sup>th</sup> Jan

### WEEK 2

MON	<b>Pork &amp; Carrot Meatballs in a Tomato &amp; Herb Sauce</b> (Red Tractor Accredited) Pork & Carrot Meatballs with homemade Tomato & Herb Sauce served with Pasta or Baked Bread	<b>Curry Club Dal with Chickpea &amp; Coriander Yoghurt</b> (This hearty dal is made with red lentils, chickpeas, tomatoes, and warm spices, then served with fluffy rice and a cool, fresh coriander yoghurt sauce)	Assorted Jacket Potatoes	<b>Strawberry Sponge &amp; Custard</b> (Homemade, light Strawberry Sponge with a Strawberry Jam layer, served with Custard)
TUES	<b>Red Tractor Accredited Beef Mince in a rich Tomato Sauce with Herbs &amp; Garlic, layered with Pasta Sheets and a Creamy Cheese Sauce, served with Garlic Bread</b>	<b>Vegetarian Sausage &amp; Beans</b> (Tender vegetarian sausages soaked with a mild bean, tomato & veggie in a smoky sauce)	Assorted Jacket Potatoes	<b>Banana Muffins</b> (A fluffy Vanilla Sponge, with Bananas & drizzled with Icing)
WED	<b>Cottage Pie</b> (Red Tractor Accredited) HMC Chicken Breast, served with Yorkshire Pudding, Roast Potatoes & Veggie Gravy	<b>Indian Style Sausage Rolls</b> (Flaky golden puff pastry is filled with a tasty blend of minced potatoes, chickpeas, lentils, and peas, seasoned with gentle Indian spices and garlic)	Assorted Jacket Potatoes	<b>Fruity Flapjack</b> (A Sweet Bar made with Oats, Golden Syrup & Butter with Fruit)
THURS	<b>Creamy Chicken Pasta &amp; Crusty Bread</b> (Red Tractor Accredited) diced Chicken in a homemade Creamy Sauce with Crusty Bread, served with Penne Pasta	<b>Mexican Style Burrito</b> (Rice, Sweet Potato, Beans & Vegetables seasoned with Mexican spices & baked in a Tortilla wrap)	<b>Classic Cheese &amp; Tomato Pizza with Coleslaw &amp; Salad</b> (Wholemeal 50/50 Base topped with a lightly spiced Sauce, and topped with Mozzarella/Cheddar Cheese)	<b>Pears &amp; Ice Cream with Syrup</b> (Vanilla Ice Cream with Trained Pear Slices, with a Chocolate flavoured Syrup)
FRI	<b>MSC Battered Fish Fillet</b> (MSC Battered Fillet of Fish, served with Baked jacket Wedges)	<b>Creamy Cauli Mac "N" Cheese &amp; Peas</b> (Soft pasta and sweet peas are mixed in a smooth, cheesy cauliflower sauce and baked until golden and bubbly)	Assorted Jacket Potatoes	<b>Chocolate Sponge &amp; Chocolate Sauce</b> (Homemade, light Chocolate Sponges, served with Chocolate Sauce)

# Key Messages



*Menu reformulation represents a realistic pathway towards healthier and more sustainable school food systems.*

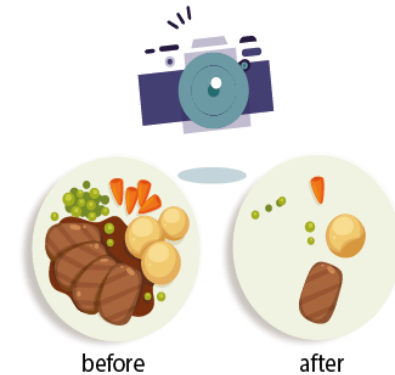
## Next Steps

### Real-world feasibility



**Implementation** of new dishes across 5 schools

Follow-up **menus analysis**



Follow-up **acceptability** - catering interviews, focus groups with children



# Acceptability of new school menus for population and planetary health: a proof-of-concept study

SUNDUS MAHDI<sup>1</sup>, Zeynep Caferoglu Akin<sup>1,2</sup>, Nicola Nixon<sup>1</sup>, Louise Padgett<sup>1</sup>, Bob Doherty<sup>3</sup> & Maria Bryant<sup>1,4</sup>

<sup>1</sup>Department of Health Sciences, University of York, York, UK

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<sup>3</sup>Department for Business & Society, University of York, York, UK

<sup>4</sup>Hull York Medical School, University of York, York, UK

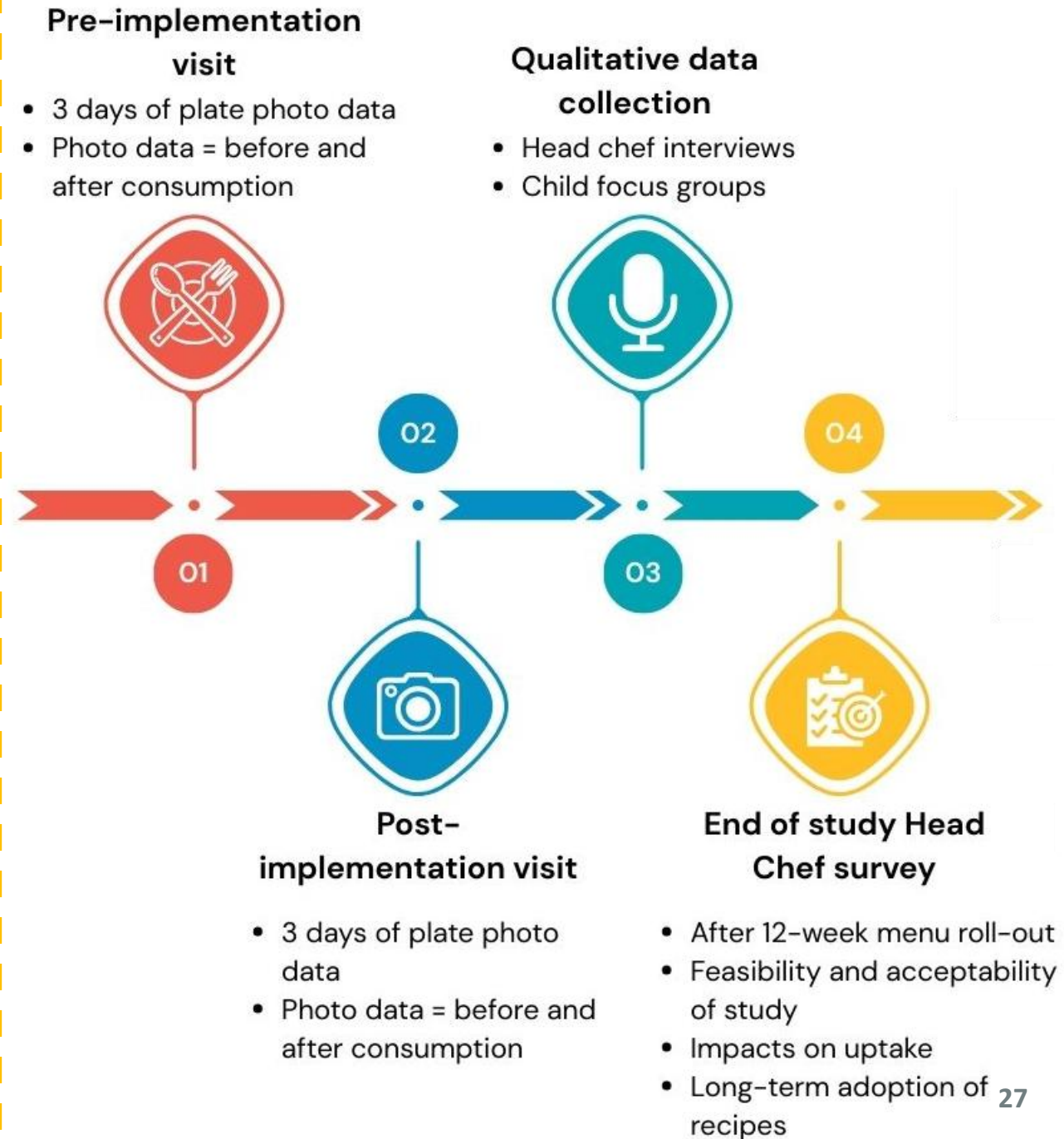
# Aims and Methods

## Aims

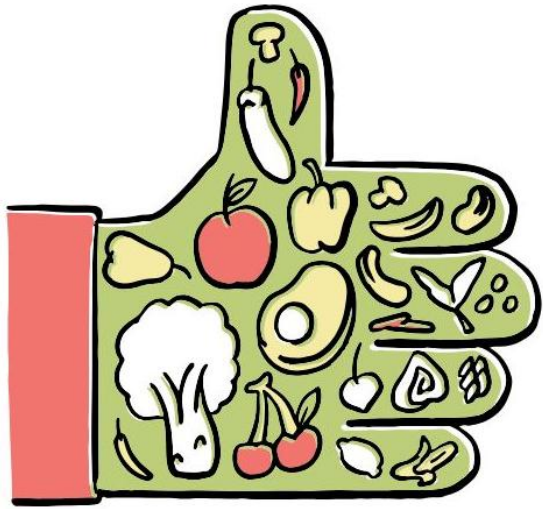
Evaluate the acceptability of healthier and more sustainable new menus among school children and head chefs.

## Sample

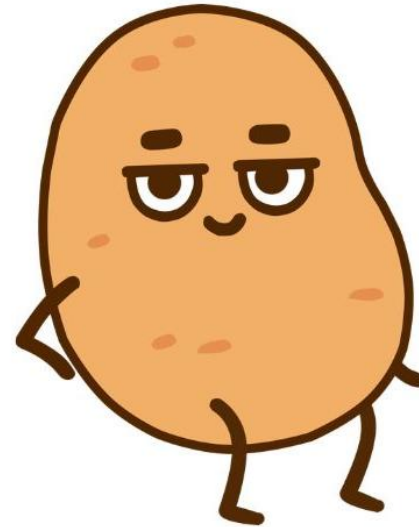
5 primary schools were selected via Bradford City Council. 2 rural and 3 urban.



## Results: Perceptions and Acceptance of the New Menu



Child preferences and attitudes



Safe options

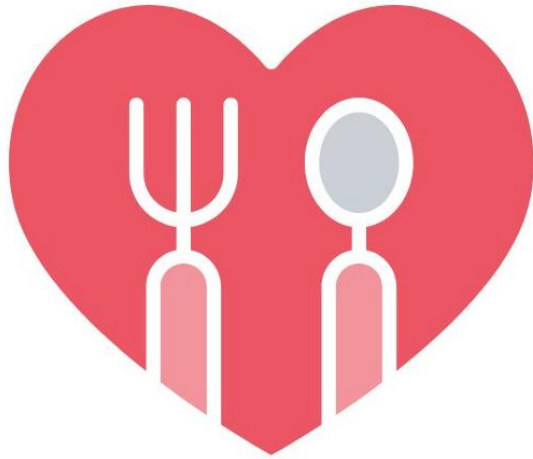


Visual appeal and noticeable changes to menu

I love trying new things, but when my concern is a child is not eating it that's when I'm like, "No, no, we draw a line under that now" ...maybe just cut back on your lentils and just give them a bit more meat for the protein [Head Chef]

I normally eat the same things until something comes up on the menu that looks really nice [Pupil]

## Results: Nutritional and Environmental Value



Health outcomes: healthier, more energy and allergy considerations



Sustainability: Good for the planet but waste implications



Understanding importance of new menus

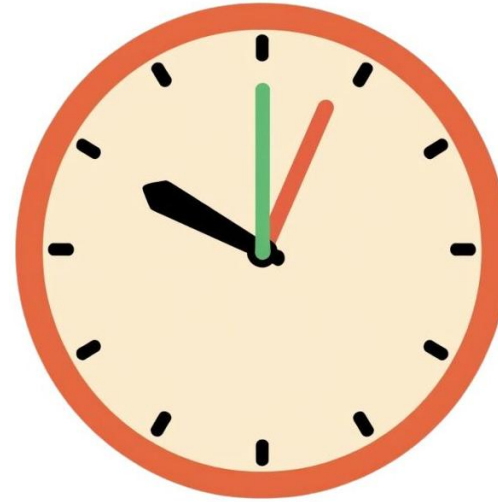
I think because of all this as well, they're all mothers [kitchen staff], so they want to see how to hide things like that, I will start doing it with my grandchildren, so that they will eat more veg, and those sauces are a gamechanger [Head Chef]

I think they have made it a lot healthier, because you can't see in this picture, but they've added, like, some greenery onto the loaded wedges [Pupil]

## Results: Implementation Feasibility and Kitchen Logistics



Cost implications



Staffing and labour: impact on preparation time, adequate team & resource constraints



Implementation and recipe difficulty

...in this kitchen I'm the only cook here, there's only me doing it, whereas other kitchens there's more staff, there's two cooks and things like that. So some days there's been that much prep I've not even had time to do anything else [Head Chef]

Really easy. Again, the burgers... they're not... it wasn't difficult to follow. There's obviously more to do. But, yeah, really easy, found it really easy to do [Head Chef]

## Results: Stakeholder Engagement and Impact



Impact on- and methods to increase- meal uptake



Collaborative decision making, taster sessions and parent and chef involvement



Study support and acceptability

I don't like it. I don't like the fact that I wasn't given any input into it at all and sort of told, "This is what you're doing," basically, "You don't have a choice," and I don't like that because obviously I know better than [caterer] and even the Head what the kids will and won't eat [Head Chef]

I think that would be better in case if you order and you don't like it, you can try it first in a little pot [Pupil]

## Results: Adaptability and Long-term Integration



Tweaks to recipes and preparation techniques



Long-term adoption of new recipes



Menu architecture, recipe, and lunchtime service improvement

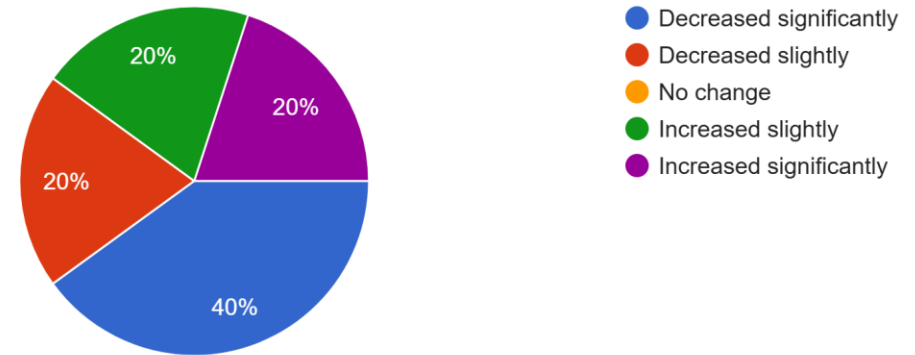
At the moment the lentils that you are putting into like the lasagnas and the cottage pie and things like that I think is far too much; you're taking away too much meat. Maybe do 75% meat, 25% lentils [Head Chef]

I want like pizza day to be on Thursday and then burger day to be on Friday [Pupil]

# Survey: New Menu Child Acceptability

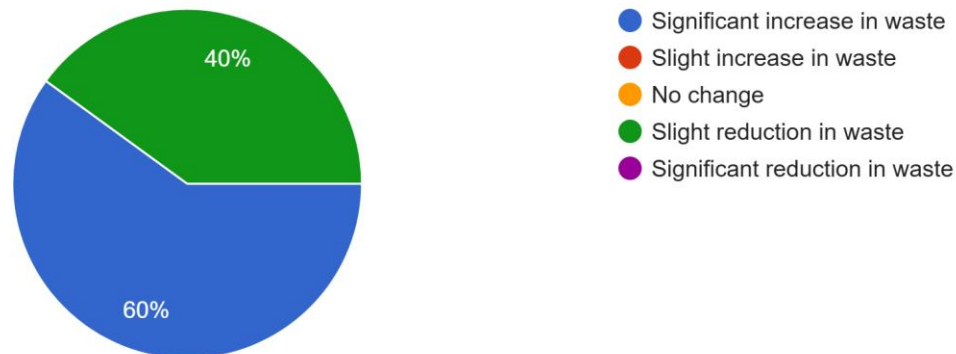
To what extent did child acceptability/liking of the new menu choices change over the new menu period?

5 responses



Did you notice a change in the volume of food waste over the new menu period?

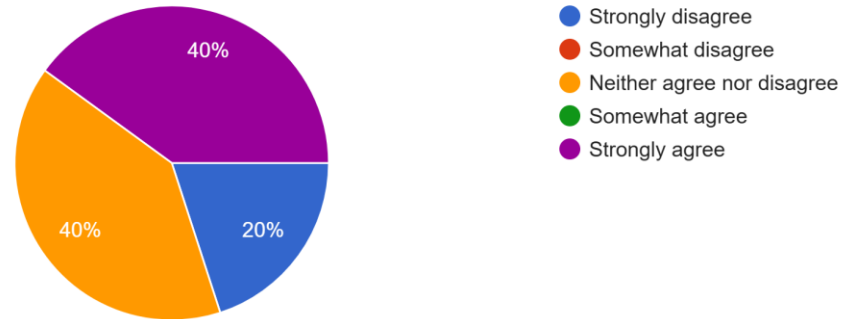
5 responses



# Survey: New Menu Head Chef Acceptability

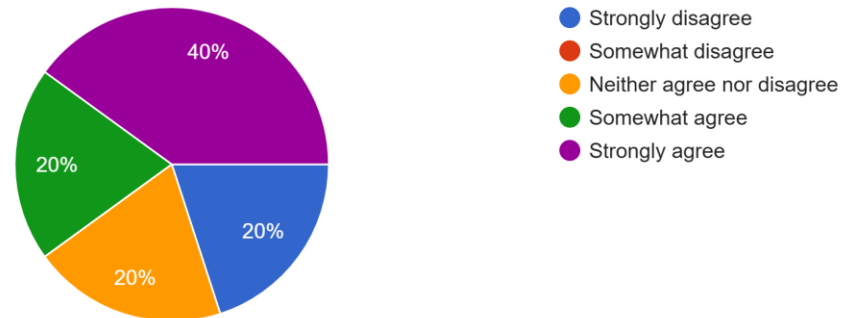
Participating in the study has inspired us to make healthier and more sustainable changes to our catering.

5 responses



We are likely to continue using at least some of the new meals now that the work with FixOurFood has ended?

5 responses



Cauli mac n cheese

Burger

Indian sausage roll

Mild chicken curry

# Discussion



One size does not fit all



Risk avoidance



Blended recipes > New recipes



Tasting opportunities



Ordering systems and decision making



Intervention fidelity and unintended consequences

## Future learnings

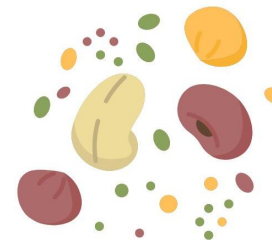
Optimal post-implementation data collection period

Allergies to legumes

Over-representation of chickpeas and lentils

Involvement of kitchen team in decision making during intervention design and implementation

Menu architecture to consider preparation time & child routine





# Acknowledgments



Prof Bob Doherty and Katherine Denby (FoF leads); Prof Maria Bryant (FoF in Schools lead); Dr Sundus Mahdi; Dr Nicola Nixon; Rob Oxley; Michelle Scaife; Prof Sarah Bridle; Dr Alana Kluczkovski; Prof Jeff Brunstrom; Dr Annika N Flynn; Dr Taro Takahashi; Dr Wendy Burton; Louise Padgett; Dr Belinda Morris; Sophie Stewart; Katie McGinty; Paul Davison; Nichola Harris; Alex Jemison; Polly Higginson.





# Children's acceptance and liking of novel UK-grown beans in primary schools:

## A quasi-experimental evaluation of the BeanMeals intervention

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<sup>1</sup>Department of Psychology, University of Liverpool, UK

<sup>2</sup>Environmental Change Institute, University of Oxford, UK



BeanMeals is researching **systemic innovation** in the food system using two novel common bean varieties ('Capulet', a navy bean; and 'Godiva', a blonde kidney bean)

- ✓ Developed for UK growing conditions
- ✓ Quick-cooking
- ✓ High soluble fibre, gluten-free and low glycaemic index
- ✓ N-fixing



## University of Warwick harvests beans fit for British summer

By Rosie Eaton  
BBC CWR

8 September 2023



Prof Eric Holub, pictured with Warwick Crop Centre research fellow Rosanne Maguire, said seed was being harvested to produce food on a farm next year

**University researchers have celebrated the first commercial harvest of a homegrown bean.**

The UK has traditionally had to import most of its beans used in products due to growing conditions.

However scientists at the University of Warwick have been working to create a variety that could be planted by British farmers.

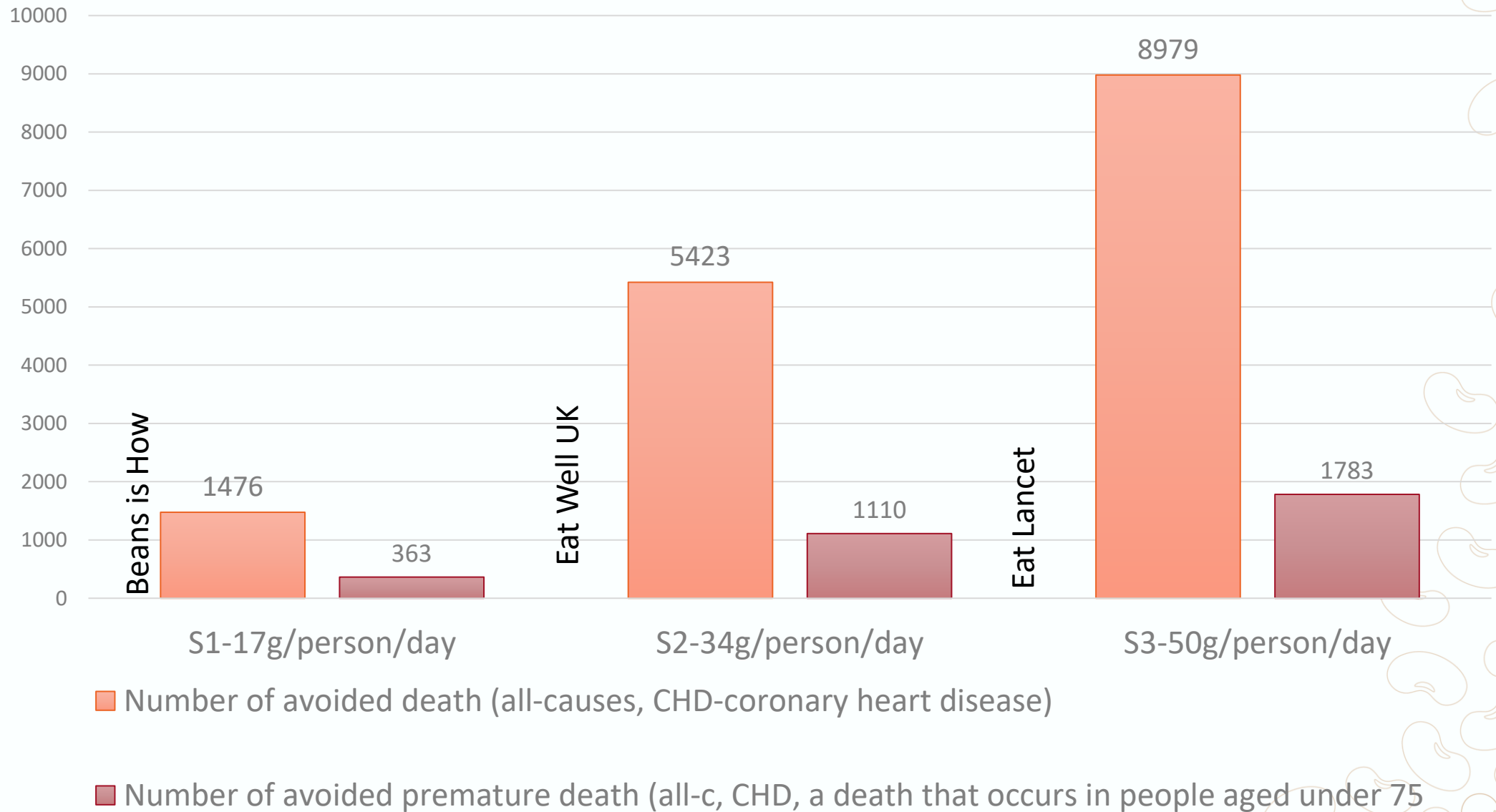
The first commercial crops of the Godiva and Olivia beans have been grown by a private firm in Lincolnshire.

# Four research themes

1. Determine how to promote healthy diets with bean-based meals low in fat, salt and sugar
2. Assess how to produce and supply bean-based foods and ingredients
3. Estimate health, environmental and enterprise benefits/trade-offs of scaling UK beans
4. Understand how to design and implement 'fork to farm' systemic innovation

Case study in Leicester and Leicestershire (6 primary schools)

# Public Health Outcome if upscaling bean consumption in the UK From CURRENT 8.5G/PERSON/DAY



# BeanMeals intervention



Bean-based school meals



Bean-based education

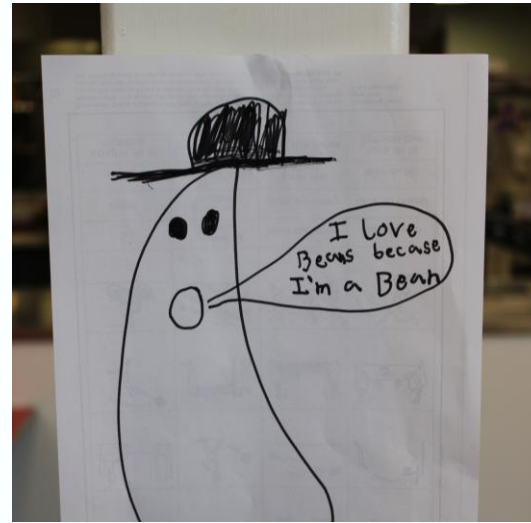


Staff training



# BeanMeals on the menu

Over 5 months, school cooks were provided with UK-grown beans and trained to prepare and offer them in new meals



## Whole school food approach:

- Introductory assemblies
- Dining hall and classroom posters
- Stickers and small rewards for tasting bean-meals
- BeanMeals t-shirts, hoodies and aprons worn by lunchtime staff, researchers and bean ambassadors
- Bean-taster sessions (3 schools)



# Bean-based education



- Activities were delivered to Year 5 children only and included:
  - Bean-focused lessons (sensory, growing, cooking, climate-friendly meals)
  - Farm visit (sub-sample)
  - Cook and eat sessions (2 schools only)
  - Bean-based educational game (2 schools only)

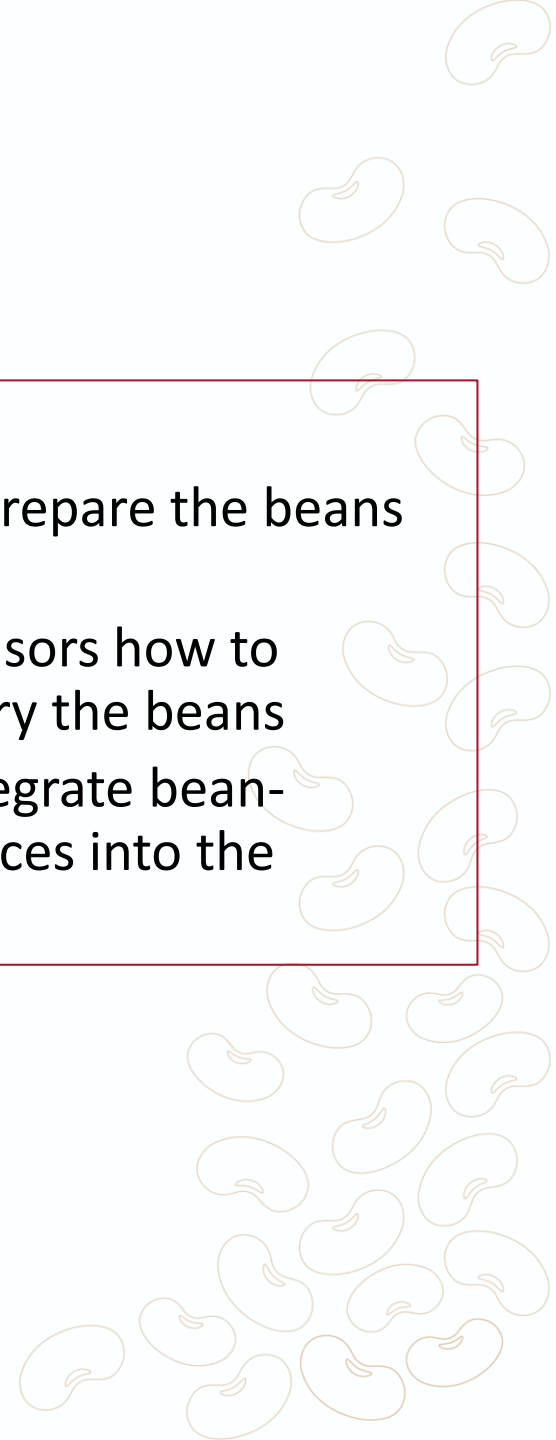
*Beantopia: a game to consolidate classroom learning co-designed with children*



# Inclusion of school catering service and all school staff

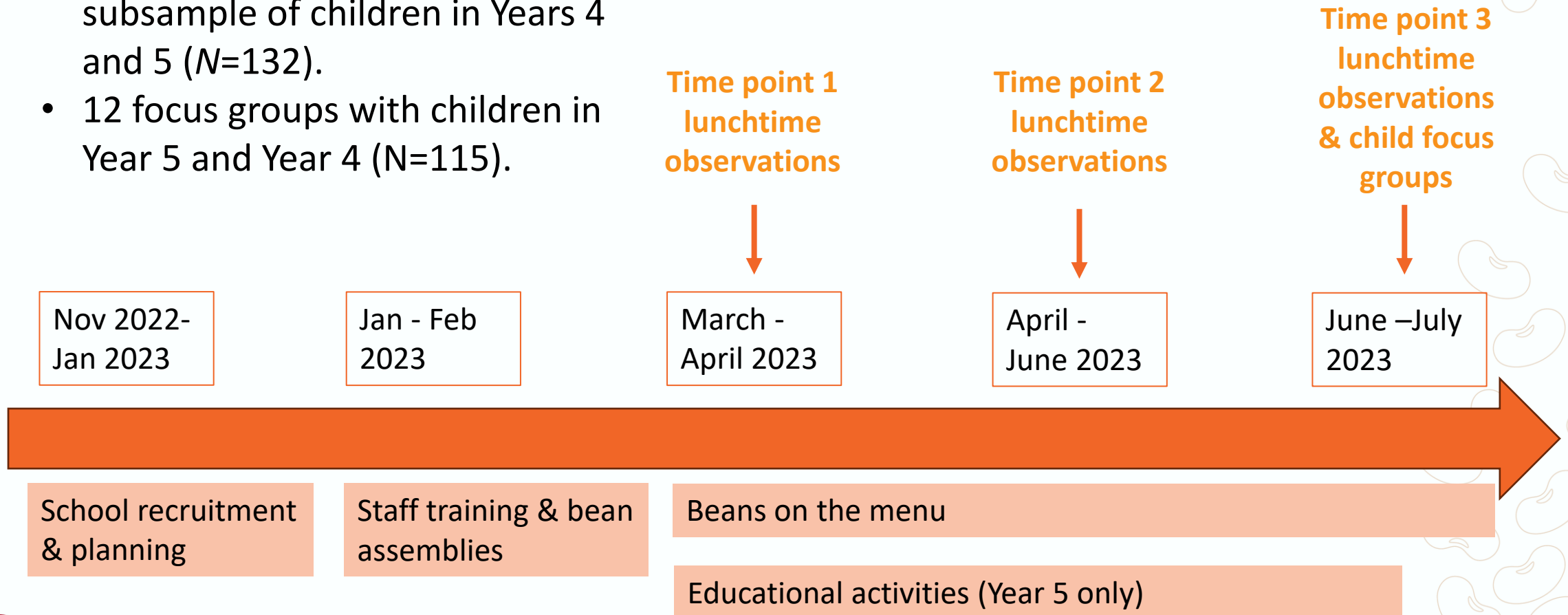


- Staff training included:
  - Training cooks how to prepare the beans and recipe ideas
  - Training midday supervisors how to encourage children to try the beans
  - Training teachers to integrate bean-focused learning resources into the curriculum



# Study design and measurement

- Lunchtime observations - subsample of children in Years 4 and 5 ( $N=132$ ).
- 12 focus groups with children in Year 5 and Year 4 ( $N=115$ ).



# Lunchtime observations

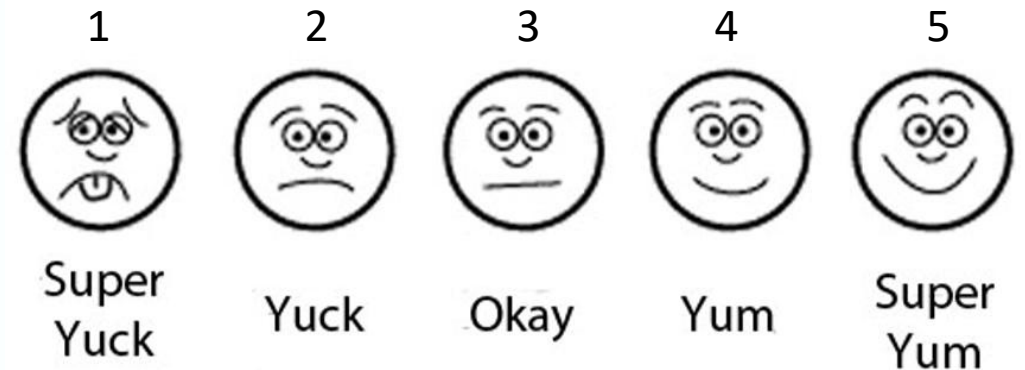


Percentage of meal consumed was measured using pre-post meal photographs.

Liking using child-friendly ratings (5-point scale “super yuck” – “super yum”).

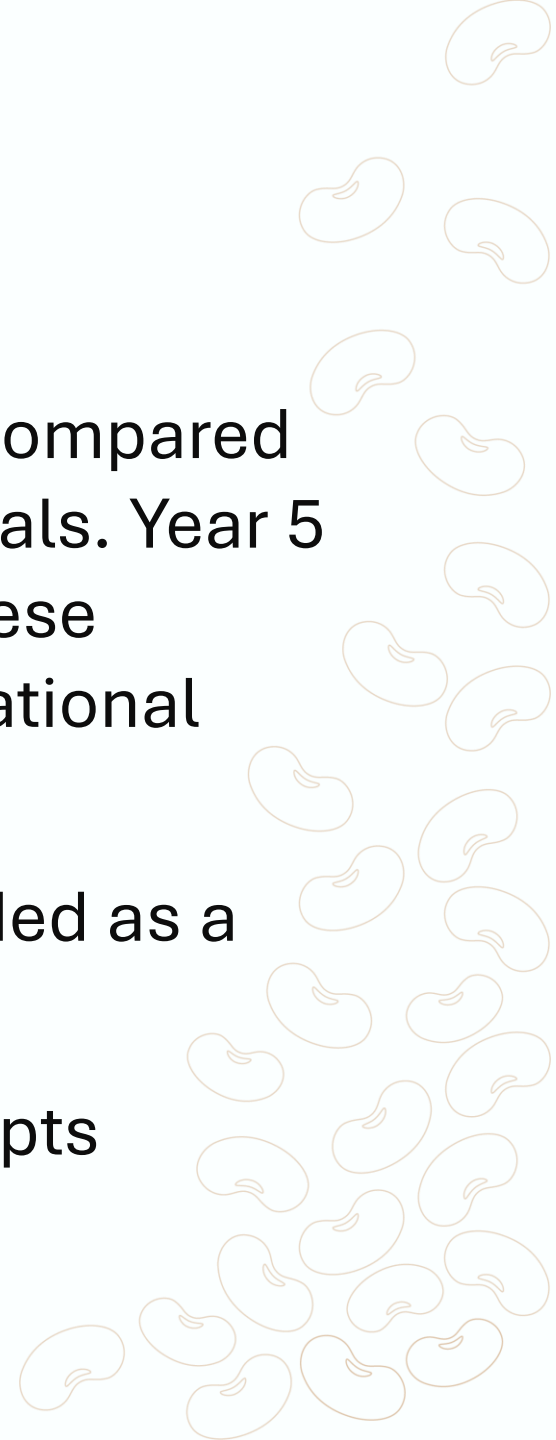
Used existing method for processing and coding consumption estimates from digital images  
Marcano-Olivier et al. (2019). *Public Health Nutrition*, 22(10), 1745-1754.

Circle one of the faces below to show how yummy or yucky your meal was today.



# Analysis

- Mean percentage meal consumption and liking was compared between the bean-meals and standard non-bean-meals. Year 5 children were also compared to Year 4 children on these outcomes to identify any additive effects of the educational activities.
- Linear mixed effects models in R with “school” included as a random effect.
- Thematic analysis conducted on focus group transcripts





primary schools



different bean-based meals served



lunchtime observations



children had the opportunity to try a bean meal



families took part in cook-and-eat sessions



local authority caterers

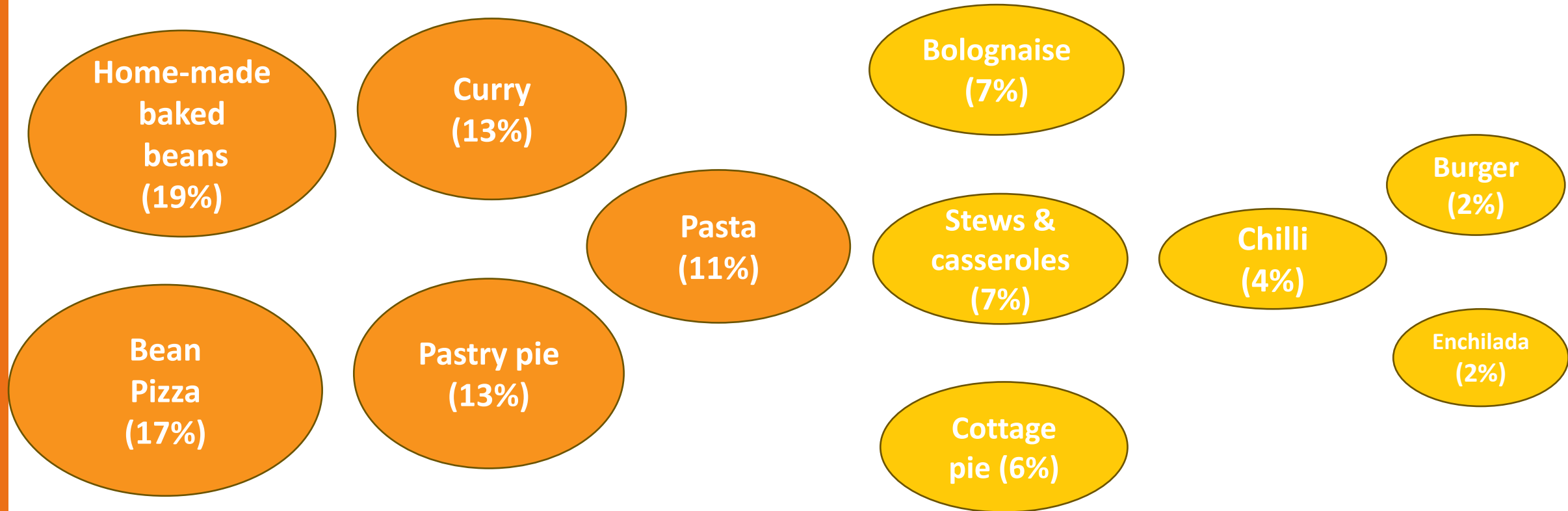


year 5 pupils took part in sessions covering bean investigation, food systems, cooking with and growing beans

# BeanMeals schools project in numbers

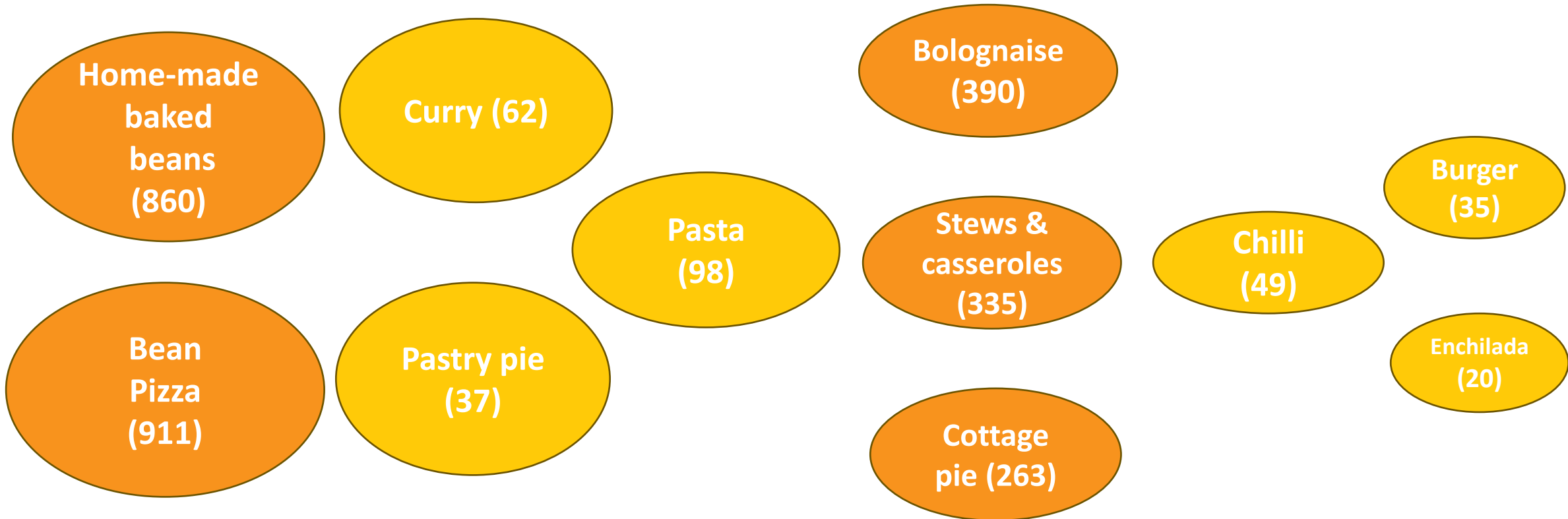


In 36 lunchtime observations across the six schools, there were **54** servings of “bean-meals” comprising of ....



Percentages indicate the proportion of servings of the respective bean-meal

# Total number of portions cooks prepared of each dish ...

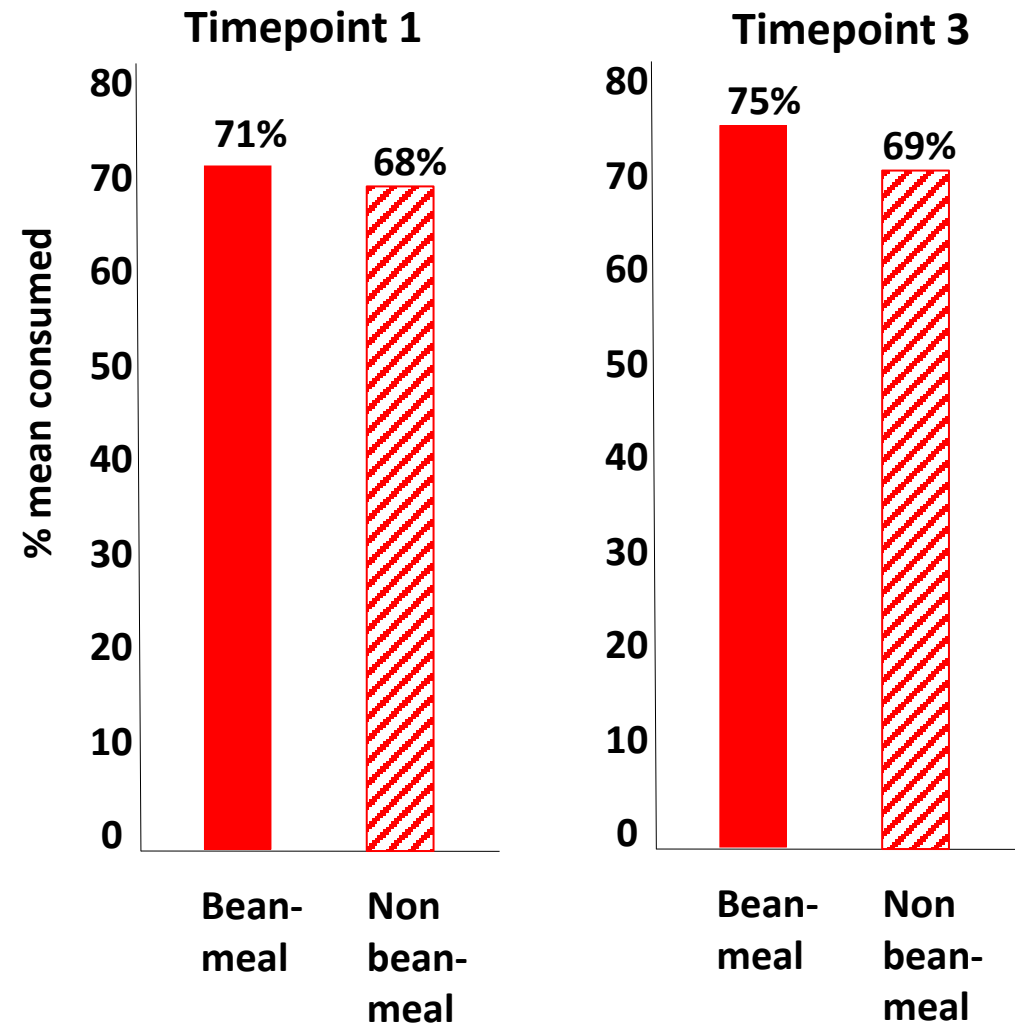


# Consumption

Data shown are from 91 children (Year 4 and 5 only)

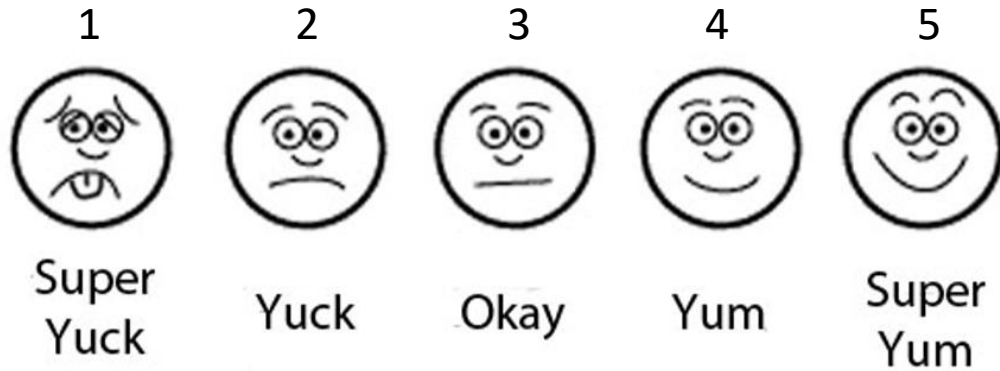
Average bean-meal consumption did not differ significantly from the non-bean-meal at Timepoint 1 (respective mean % consumption (standard deviation) = 71 (26) vs. 68 (22), 95% confidence interval [-6.2, 13.7]) or at Timepoint 3 (75 (24) vs. 69 (26), 95% CI [-4.5, 16.3]).

No significant differences between children in Year 4 and Year 5.



# Liking

Circle one of the faces below to show how yummy or yucky your meal was today.



Liking did not differ significantly at Timepoint 1, but at Timepoint 3 was significantly lower for the bean-meal than the non-bean-meal - though average bean-meal liking remained above the scale mid-point (3="okay").

No significant differences between children in Year 4 and Year 5.

	Bean-meal	Non bean-meal
Timepoint 1	3.89 ( <i>SD</i> = 1.03)	3.69 ( <i>SD</i> = 0.98)
Timepoint 3	3.57 ( <i>SD</i> = 1.28)*	4.17 ( <i>SD</i> = 1.02)

Data are mean liking ratings (with standard deviations in parentheses)

\* Significantly different relative to non-bean meal,  $p = 0.02$

# Children's perspectives of taking part – focus groups

- Children enjoyed the bean-related educational activities particularly the Beantopia game.
- Evidence of increased knowledge and learning about beans and the food system.
- Differed in preferences for the texture of beans. Preferred consuming beans in familiar already-liked meals.
- In general, recognised the importance of being curious and receptive to trying new foods.
- Wanted more taster-based experiences.

*"I learnt that you can make so many things out of beans."*

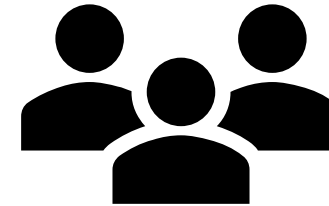
*"I learnt beans were good for you and I learnt that there's lots of different types of beans."*

*"I learnt that farmers work hard to make beans."*

*"I enjoyed when we had to use our five senses."*



*"We had to use our senses. How does it smell? How does it feel? How does it taste."*



*"I enjoyed when we got to try the beans with the meals."*

*"I also enjoyed trying the beans because I never knew that more beans existed, just baked beans."*



*"You can put beans in almost any food and make it taste good."*



# Take home messages

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Beans can easily be added to a variety of school meals ... many positives and some challenges.

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Consumption and liking of bean-meals was generally comparable to regular school meals.

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Children were more likely to accept beans when they were added to already-liked foods.

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Fun and engaging learning activities increased children's knowledge, curiosity and potentially willingness to try beans.

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Staff buy-in is crucial; in school and beyond.

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Valuable interplay between food at school and home – mutually reinforcing strategies.

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# Acknowledgements – WP1 Research Team



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# Transforming UK Food Systems Conference, 23-24 March 2026



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