

How to include millets in menus to maximize both nutrition and likeability

Smart Food brief 2

Summary

This is the first known scientific study on introducing millets into a school feeding program that tested both acceptance and nutritional impact.

Study Results

- The millets-based meals formulated in this study were **nutritionally superior** to fortified rice-based meals being served in the schools.
- **50% more growth** than the growth of the control group, observed in just 3 months in the children being fed the millets-based meals as compared to those eating fortified rice-based meals. (*see table A, page 4)
- The children rated the meals **4.5 or higher out of 5 for taste**; this included even little millet served as rice. (*see table B, page 4)

Urgent Call to Policy Makers

Lessons learnt from the study can help achieve more impactful schemes. The following are recommended:

1. **Follow guidelines on how to incorporate millets** into feeding schemes so as to maximize nutritional/health benefits and acceptability
2. **Create a level playing field** for the pricing and availability of millets (e.g. through the Minimum Support Price [MSP], Public Distribution Scheme [PDS] and feeding programs [MDMs, ICDS])
3. **Select millets by variety and ensure whole grain,** to maximize nutrition
4. **Promote millets** in positive fun ways, through flagship programs such as Eat Right India

Guidelines for Including Millets in Menus

To maximize the impact:

1. Understand and target the specific nutritional needs of the consumers
2. Select the millets highest in the required nutrients
3. Select the variety of millet with the highest nutrient value (eg; Iron levels can double based on which variety is selected)
4. Ensure the millets are whole grain and not polished
5. Custom-design menus taking into account:
   - -> Combinations of foods that increase bioavailability
   - -> A major proportion of millets (60% or more) to have impact
   - -> A variety of foods for a balanced diet
   - -> Preparation and cooking methods to retain the nutrition and increase bioavailability
   - -> Equipment and cooking skills
   - -> Cultural sensitivities and taste.
6. Include an edu-tainment component (an awareness program that is fun/enjoyable)
7. Train the cooks or suppliers on the cooking methods.

A Smart Food initiative undertaken by:

Akshaya Pātra™ Unlimited food for education

ICRISAT International Crops Research Institute for the Semi-Arid Tropics

CGIAR

smart food® Good for you - the planet - the farmer®

The Study - Acceptance and Nutritional Impacts of Including Millets in the Menu

This brief is based on the study published in the journal *Nutrients*:

Anitha S[1], Kane-Potaka J[2], Tsusaka TW[2,3], Tripathi D[4], Upadhyay S[5], Kavishwar A[4], Jalagam A[1], Sharma N[4] and Nedumaran S[1]. 2019. Acceptance and impact of millet-based mid-day meal on the nutritional status of adolescent school going children in a peri urban region of Karnataka State in India. *Nutrients* 11:1-16. doi:10.3390/nu11092077

[1] *International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad 502324, India*
[2] *ICRISAT, Lilongwe 1096, Malawi*
[3] *Organization for Advanced and Integrated Research, Kobe University, Kobe 650-0047, Japan*
[4] *Akshaya Patra Foundation, Bengaluru, Karnataka 560022, India*
[5] *United Nations Children's Fund (UNICEF), Lilongwe 30375, Malawi*

Methodology

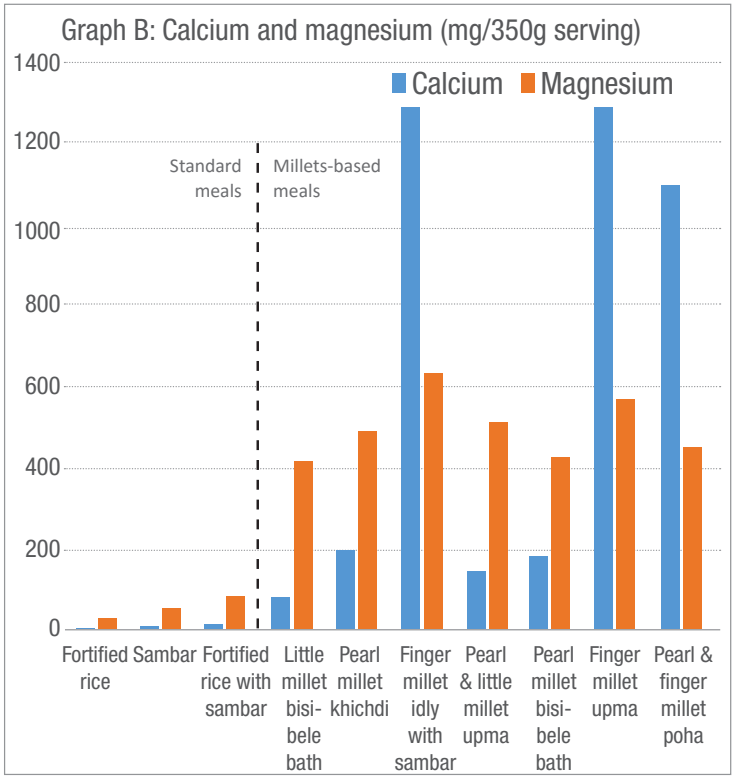
Approximately 1,500 adolescent school children from two schools were provided with a millet-based mid-day meal for three months. Children from two other schools fed the standard fortified rice and sambar (a watery pigeonpea and vegetable stew) mid-day meal were the control group for comparison. Ten percent of the children were tracked for their growth (using anthropometric measurements), and sensory evaluations were also noted every month to see how the children were liking each of the millet meals. This scientific study was undertaken in peri-urban Bengaluru in India by International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and Akshaya Patra Foundation.

The household dietary assessment, conducted before the start of the feeding program, indicated that fortified rice was a major staple occupying 70% of the weight of their diets – where it was eaten in different forms including as blended rice (steam cooked or toasted), and boiled rice with or without lemon juice, tamarind juice or tomatoes. The remaining 30% of the meal comprised of sambar.

The baseline result suggests that the children largely depended on mid-day meals for their daily calorie intake and other nutrient requirements. The data showed that the meals consumed by adult household members provided 50-60% of the required calories, 50% of protein, 40-50% of iron, 60% of calcium, and 40-50% of zinc. The bulk of calories came from rice,

Laboratory tested nutrition composition of final meals: The typical school meal of fortified rice and sambar compared to millet based meals.

(Varieties used: Pearl millet *Dhanshakti*; Little millet *Phule Ekadashi*; and Finger millet used a range)



*Note: **Idly:** steam cooked fermented savory cake; **Bisi-bele bath:** millet-lentil hot meal; **Upma:** millet-vegetable meal; **Khichdi:** millet-yellow lentil hot meal; **Poha:** flattened millet-vegetable meal

protein from pigeonpea and other pulses such as chickpea and green gram, calcium from finger millet and legumes, and iron from vegetables. For the adolescent children aged 10 to 15 years the nutrient intake was slightly better compared to that of adults as the former were consuming the lunch provided at school. However, it is still not sufficient to meet the Recommended Dietary Allowance (RDA) for their age. The diet diary data shows that adolescent children, depending on their age, were receiving 61-83% of required calories, 65-97% protein, 64-76% iron, up to 41% calcium and 74-91% zinc.

Although the average number of food groups consumed was four, the consumption of vegetables and milk products was neither regular nor in adequate quantities. As a result, the nutrient intake of the sample children – in both control and intervention groups – was found to be low. In particular, iron and calcium intake were far from the RDA. This is because the two main sources of calcium were consumed in small quantities. Only 10% of the children consumed finger millet though it was regularly consumed by the parents or adults at home, and milk was only consumed at school once a day.

For the intervention group, meal recipes were formulated to include 60% or more of millets. Other than millets, the recipes contained one or more legumes, such as dehulled green gram, pigeonpea, and groundnut. The recipes also contained vegetables such as carrot, capsicum, and green peas.

Priorities for future research

Priorities for future research that will contribute towards more impactful millet-based meals – for both feeding programs and for commercial products are:

A. **Clinical testing** to provide more detailed and accurate nutritional and health benefits, including areas of nutrition, gut microbiome and bioavailability

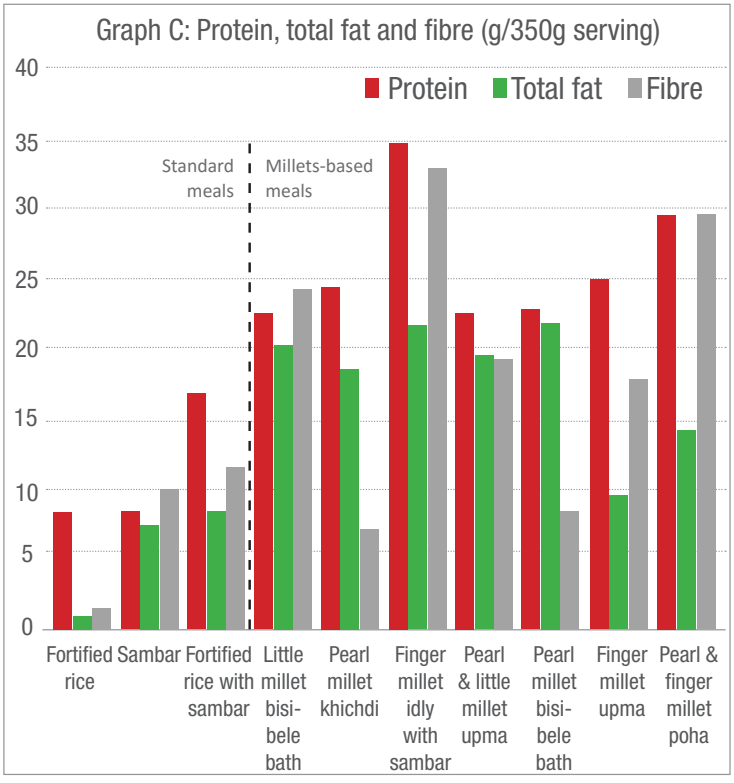
B. **Applied studies of other geographical/cultural areas** that have different taste preferences so as to build a repertoire of suitable recipes

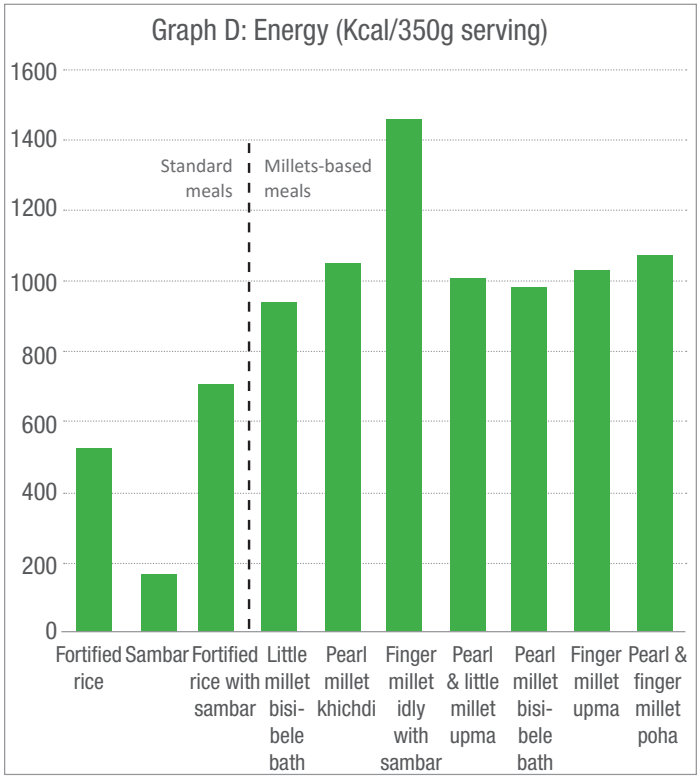
C. Design and **evaluate the effectiveness of different approaches to edu-tainment programs** in schools and for consumers around nutrition and millets, in order to build knowledge and a positive modern image around millets

D. Studies on **how different forms of processing and cooking can affect** nutritional composition and bioavailability

E. All commonly available **varieties of millets tested for their nutritional composition**

F. **Understand the effect of different technological interventions and policy changes** on improving millet production and consumption and its subsequent impact on the environment and farmer livelihoods in different agroecologies.





Comparing composition of meal nutrition

The millets-based meals had significantly higher nutritional content compared with the fortified rice and sambar that is typically served. This was identified through laboratory testing and the comparisons shown in Graphs A-D.

Note that rice was not served at all during the three months, and on some days little millet was served as a rice.

Nutrition indicators reveal improvements in just 3 months

Eating millets-based meals led to significantly faster growth in the children. This increase was double that obtained with fortified rice and sambar meals.

(*) Children who were consuming millet-based meals showed an average increase in height of 1.5% and average increase in weight of 5% from the time of the baseline measurement. The rice consuming control group showed an average increase in height of 1% and average increase in weight of 3% from the baseline. Therefore, the intervention group showed a 66% increase in height and 50% increase in weight compared to the control group. This eventually led to a significant increase in Z-scores (Δ) for height and BMI, while the children in the control group showed no significant increase in Z-scores for the same (see Table A).

Sensory evaluation shows high likeability

The overall mean acceptability of all millet-based recipes ranged between 4.5 and 4.7 out of 5 (5 is the highest scale point of acceptance) in 94-98% of the children depending on the recipe (see Table B). There was no wastage of food during the intervention period, further reinforcing its acceptability.

Table A: Growth of children after 3 months.

	Height for Age Z-Score			BMI for Age Z-Score		
	Δ [End line – Baseline]	t-statistic	p-value	Δ [End line – Baseline]	t-statistic	p-value
Treated (n = 136)	0.074	5.204	0.000	0.166	2.817	0.003
Control (n = 107)	0.044	0.384	0.351	-0.004	-0.028	0.511

Table B: Sensory evaluation of different millet meals.

Name of the food item	Taste (Mean ± SD)	Appearance/ colour (Mean ± SD)	Smell (Mean ± SD)	Overall acceptability (Mean ± SD)	Overall acceptability with above average scale point
Little millet bisi-bele bath	4.8 ± 0.6	4.4 ± 0.8	4.5 ± 0.9	4.7 ± 0.7	98%
Pearl millet khichdi	4.5 ± 1.0	4.3 ± 1.0	4.4 ± 1.0	4.5 ± 1.0	94%
Finger millet idly	4.7 ± 0.8	4.5 ± 0.9	4.6 ± 0.7	4.7 ± 0.8	98%
Little millet rice with rasam (Indian soup)	4.5 ± 1.1	4.4 ± 0.9	4.5 ± 0.9	4.6 ± 0.9	96%

Lessons Learnt and recommendations

The team collated a variety of lessons on how to maximize the benefits of introducing millets into the school feeding program. These include:

1. **Understand and target the specific nutritional needs of the consumers**
2. **Select millets based on the biggest nutritional needs:** Each type of millet has a different nutritional composition; so you need to know what nutritional or health issues you are targeting and select the millets accordingly. If all of these micronutrients are important, design menus with a combination of these millets.
3. **Select millets by variety**: Varieties of each millet can have a wide variation in micronutrient levels; hence selecting the right variety matters. (For example, the iron content can be doubled just by the variety selected).

   Select millets based on data disaggregated by variety rather than by taking an average of varieties: Averages are misleading when used for this purpose, given that the range can vary widely. The majority of tabulated nutrition composition data for millets presents only one variety or averages the nutrition level. Note that ICRISAT has tested different millets and commonly available varieties for their nutritional composition, and compiled a detailed nutrition composition table by type and variety. This is a new study and data is undergoing publication. The millets used for this pilot study were selected based on this new data.
4. **Ensure the millets are wholegrain and not polished:** Pearl and finger millets along with sorghum are naked grains and do not need dehulling. Small millets need to be dehulled and are often also polished. Polishing will reduce the nutrients and fibre.
5. **Design the menus taking into account these five key factors**:

→ Specific combinations of foods are critical to ensure bioavailability of the nutrients.

For example, a few rules of food combinations:

- **To absorb iron:** Vitamin C-rich food is needed, e.g., capsicum, orange, lemon
- **To absorb calcium:** Vitamin D is needed, e.g., coming from early morning sunlight or select foods high in vitamin D
- **To improve the quality of protein:** Combine millets and legumes. The proportion of essential amino acids in millets and legumes complement each other; so when combined, they provide a higher quality of complete protein[1].

→ Balancing the whole menu and diet is necessary as no one food provides all the nutrients needed. When adding millets, the full meal as well as the food on which the other meals for the day are based, need to be known and recipes designed accordingly.

→ How the millets are prepared and cooked can significantly change nutrient levels as well as bioavailability. For example, sprouting and fermentation can reduce phytates and increase the absorption of nutrients.

→ Equipment and cooking skills need to be available.

→ Cultural sensitivity and taste preferences are critical elements for food acceptability. A participatory approach to achieve this is recommended, for example:

- Work with local cooks to design recipes
- Understand the common and popular recipes of the community as well as new and modern foods
- Talk to parents and children or customers.

6. **Include an edu-tainment or communications program:** By incorporating this component, it builds a positive image about millets while also building knowledge about their value.
7. **Train the cooks or suppliers on the cooking methods**

[1]Anitha Seetha, Mahalingam Govindaraj, Kane-Potaka Joanna, 2019, Complementary nature of millet-legume combination for amino acid profile, protein digestibility and micronutrients, Cereal Chemistry, September. 10.1002/cche.10227

Comments from the Experts

"Millets are indeed superior cereals in terms of nutrition and also in terms of sustainability. They are ideally suited to address child undernutrition and fit very well in nature-friendly production. Use of millets in various nutrition intervention programs and in PDS will be of great help to address malnutrition and improve health."

Prof Ramesh Chand
Member, NITI Aayog, Government of India

"This study and results are hugely valuable for how we move forward with designing meals for children. We knew millets were nutritious and were advocating for their inclusion in government programs. This study provides more guidance on how to do this."

Dr Raj Bhandari
Medical doctor and government advisor

"Government policy that creates a level playing field for millets versus rice or wheat, is a critical need. It has to be cost effective for more nutritious meals to be served to those who are most in need."

Dr S Nedumaran
Senior Scientist - Economics, ICRISAT

"We worked closely with the school principals and teachers in undertaking this study. They played a key role in advising us on childrens' preferences and how best to communicate with the children to teach them about millets."

Deepti Tripathi
Social Development Professional, Akshaya Patra Foundation

"This initiative also included developing guidelines on how to introduce millets into menus to maximize the nutrition benefits and likeability. This is pertinent now given the renewed interest in millets."

Ashok Jalagam
Smart Food Coordinator for Asia Pacific, ICRISAT

"Making it profitable for farmers to grow nutritious foods like millet has to be a key part of the Doubling Farmer's Income mission. As part of the mission, I emphasize the need for harmonious consideration of 3 principal stakeholders: farmers, consumers, and ecology. We need a wholesome ecosystem system approach for long term sustainability."

Dr Ashok Dalwai
Chair, Committee on Doubling Farmer's Income

"It is very important to recognize the wide difference in all the millets from nutritional value to cooking and processing suitability and taste. IIMR works on all the millets and across the whole value chain from breeding better varieties to undertaking research on product development to operating an incubator for SMEs."

Dr Vilas Tonapi
Director, Indian Institute of Millets Research

"Scientific research is essential to ensure the best solutions. This study has highlighted the need for research ranging from high end genomics that can halve the time needed for breeding the most nutritious millets through to social economics and marketing research that can test the best methods for achieving behaviour change towards more nutritious diets."

Dr Peter Carberry
Director General, ICRISAT

"Product development based on understanding of consumer preferred traits, especially organoleptic properties, linked to scientifically validated health claims is key to sustainable promotion of millets. The Agribusiness and Innovation Platform (AIP) of ICRISAT is working on sustainable millet value chains through innovative product development and its scientific validation."

Dr Saikat Datta Mazumdar
Chief Operating Officer, NutriPlus Knowledge (NPK) Program, Agribusiness and Innovation Platform (AIP), ICRISAT

We have this very elaborate arrangement and network of processes to ensure cooked food is given to children in thousands of schools all over the country; it is only logical for the Government of India and the State governments to introduce millets by making a few policy changes. We can bring in millet-based preparations to a hundred million children. It is a phenomenal opportunity that is available today. If we can introduce millets in the mid-day meal program and make it delicious and memorable, then it is very good for the children, it is very good for the planet and it is very good for the farmer.

***Chanchalapati Dasa**, Vice-Chair, Akshaya Patra Foundation*
Extracted from the upcoming coffee table book"Against the Grain in India"

The study adds up a strong dimension that these neglected and underutilized foods can play a strategic role in improving nutritional status. It gives us a very good idea to utilize millets in traditional recipes, adding an interest and variety in the plate at household level. A lot has to be done to popularize millets as a low cost solution in the fight against malnutrition. The current effort is commendable and scalable with region-specific modifications.

Dr Shweta Upadhyay
International Consultant, UNICEF, Malawi

Gut health (microbiomes) is an emerging science and critical for the absorption of nutrients. Millets have pre- and pro-biotic properties and therefore they can naturally help in improving gut health. However, little is known about this area and given that it can influence the final nutritional value of our food, more research is urgently needed.

Dr Rajeev K Varshney
Research Program Director - Genetic Gains, ICRISAT

Our nutrition students were thrilled to be able to undertake the BMI (height, weight, arm length and arm circumference) measurements of the children. Our chefs and students alike have been inspired by the potential of millets and are creating new recipes and testing their nutrition values and undertaking sensory evaluations. So far the results have been very positive.

Priya Arjun
Head, Nutrition and Nutraceutical Research (NNRC)
Ramaiah University of Applied Sciences (RUAS)

It is not enough to say that we are going to add millets in the meal. The type of millet, variety, how it is cooked and foods it is combined with are just some of the key elements that can make a difference to the impact on nutrition and health of the consumer. You can double the amount of iron available just by the variety of millet you select.

Dr S Anitha
Senior Scientist - Nutrition, ICRISAT

Akshaya Patra had been looking for ways to improve the nutrition of the mid-day meals. The millet meals were exceptionally successful and were really liked by the children. We appreciate the state government support and with this positive result, we now hope this will lead to the needed support for nutritious millet-based meals, for the benefit of our future generations.

Ajay Kavishwar
Head of Research, Akshaya Patra Foundation

Our rigorous primary data collection and analysis have delivered evidence of the capability of these climate-smart crops to effectively mitigate the extent of undernutrition in infants and youth, while catering to the palate of diverse consumers. This suggests immense potential of millets and sorghum in contributing to multiple goals under the SDG 2030 agenda.

Dr Takuji W. Tsusaka
Natural Resource Economist, Organization for Advanced and Integrated Research, Kobe University

These results and guidelines developed from the study are equally important for any scheme addressing malnutrition or general healthy diets – whether it is by the government, NGOs or private sector processors or caterers.

Joanna Kane-Potaka
Assistant Director General – External Relations, ICRISAT
Executive Director - Smart Food

> As a teacher, it's my duty to educate children and their parents on the importance of nutrition. I encourage the kids to eat more millet food

> Bisi-bele bath (millet-based) served now is very tasty, better than the rice and sambar we used to eat

> I like the new food served at school. I stopped bringing lunch from home and I'm eating with my friends

Special Appreciation

To the Karnataka Government, and school principals and teachers for their support and guidance. Thanks also to Mount Carmel College and M S Ramaiah University of Applied Sciences, Bengaluru, which supported by providing students from their Nutrition program to assist with the sensory evaluations and anthropometry testing. Thanks to Miruthika Devi and Viney for the data entry.

The **International Crops Research Institute for the Semi-Arid-Tropics** (ICRISAT), a member of the CGIAR system organization, is an international non-profit organization that conducts agricultural research to bring prosperity to smallholder farmers in the drylands of Asia and Africa. Headquartered in Hyderabad, India, ICRISAT has eight country offices in Africa.
See: www.icrisat.org

The **Akshaya Patra Foundation** is the world's largest (not-for-profit run) mid-day meal program serving wholesome food to 1.66 million children from 13,839 schools across 12 states in India. The organisation strives to fight issues like hunger and malnutrition in India.
See: www.akshayapatra.org

The **Smart Food initiative** is a global initiative to bring foods that fulfil all criteria of being good for you, the planet, and the farmer, into the mainstream. The key objective of Smart Food is to diversify staples with Smart Foods, starting with millets and sorghum.
See: www.SmartFood.org; Email: SmartFood@cgiar.org

Smart Food executive council is led by:

Efforts in India are coordinated in association with

@SmartFoodGlobal
@SmartFoodIndia
@SmartFoodESA
@SmartfoodWCA

Smart Food Global
Smart Food Kenya
SmartFoodIndia

Smartfood Global
SmartFood_India

Smart Food Global
Smart Food Kenya

SmartFood India

Citation: ICRISAT, 2019, How to include millets in menus to maximize both nutrition and likeability, Smart Food brief 2, Hyderabad, India.

Writers: *Joanna Kane-Potaka and Parkavi Kumar;* **Photos:** *Liam Wright*; **Design:** *Vengala Reddy Ch and Meeravali SK*; **Editing:** *Smitha Sitaraman*