Rice Fortification in Andhra Pradesh:

Pioneering an Innovative Blending Process to Improve Nutrition Outcomes

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Executive Summary

Andhra Pradesh, a coastal state in Southern India, has a high burden of vitamin and mineral deficiencies leading to night blindness, anaemia and various birth defects. To combat malnutrition, in early 2018, Andhra Pradesh announced its plans to distribute fortified rice through government feeding programs in three districts in the first phase and later scale it up to the entire state.

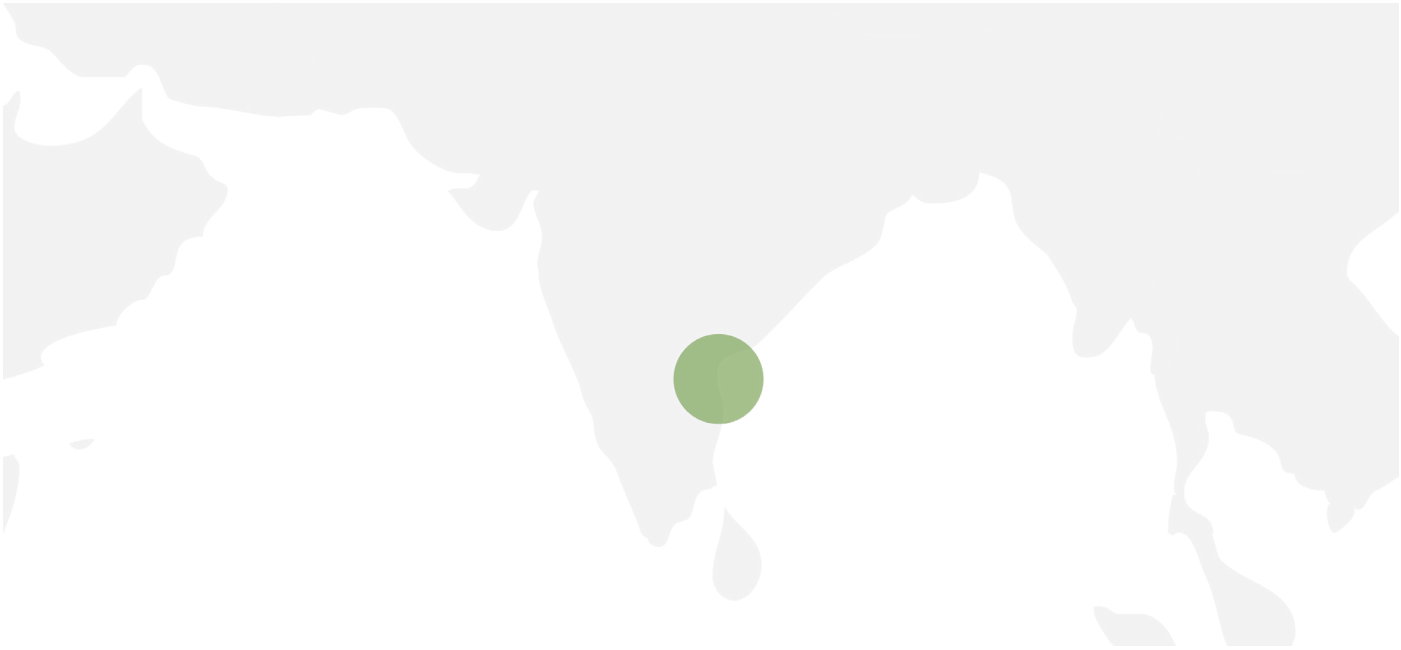
Currently, the rice fortification program includes a batch blending system to blend fortified rice kernels with regular rice. However, there are shortcomings with the batch blending system, which created the need for a new system. To support this effort, Sight and Life, in partnership with Tata Trusts and the Government of Andhra Pradesh, has pioneered an innovative, cost-effective blending process, called continuous blending. This is the first of its kind in India and the first time a continuous blending process is being employed to fortify rice for large-scale government programs. Table 1 shows the difference between batch blending and continuous blending.

TABLE 1: Rice fortification batch blending vs. continuous blending

BATCH BLENDING	CONTINUOUS BLENDING (used in Andhra Pradesh)
Additional process used after milling, with equipment added to the process	Done at the time of milling using existing equipment
Additional equipment: batch blender, one or two doser(s), weighing sensors, pneumatics, hoppers, supporting structure, software programming, control panels and extra civil construction	Additional equipment: a doser and a hopper Existing equipment: Length/ indented graders in a mill, which are generally used to separate broken rice, are being used as blenders. Set controls for FRK to match the blend ratio of 1:100 with the rice flow; >95% of dosing accuracy and the blend coefficient of variation within FSSAI prescribed limits of +/- 15%
High fixed costs which increase with the size of the mill: for a medium-scale mill of 8-10 MT/hour capacity, it would cost ~USD 100-120K	Low fixed costs: ~USD 1-1.2K, irrespective of mill capacity/ size. i.e 100 times cheaper than the batch blending system
Limited by the capacity of the blender, requires more floor space, more civil construction and high operational costs (~$USD 10000-12000 per annum)	None of these limitations exist. Negligible operational costs: $100/annum

This technical brief includes a step-by-step guide for operationalizing rice fortification, using the continuous blending model. By conceptualizing and operationalizing this model, in a short period of time, we have been able to provide 60 million meals with fortified rice to schoolchildren and pregnant and lactating women in Andhra Pradesh. Building on these successes, Sight and Life endeavors to optimize and expand activities using the continuous blending model, working in partnership with Tata Trusts and state governments in improving nutritional outcomes in India.

Context



Andhra Pradesh, a coastal state in Southern India, has a very high burden of vitamin and mineral deficiencies leading to night blindness, anemia and various birth defects. Vitamins and minerals are required to ensure good health, increase the ability of the body to fight infections and help in physical growth and brain development.

To combat this high burden of malnutrition in the country, the Prime Minister's office launched the **National Nutrition Mission** where staple food fortification has been stated as one of the most cost-effective approaches to control vitamin and mineral deficiencies[1]. Among the various staples available in Andhra Pradesh, rice is the most effective vehicle to reach the poorest and only one of two staples, which when fortified well, can carry a range of minerals and vitamins. It is delivered to the most nutritionally vulnerable population through the government's three food supplementation programs:

1. Mid-day Meal scheme (MDM)
2. Integrated Child Development Scheme (ICDS)
3. Public Distribution System (PDS)

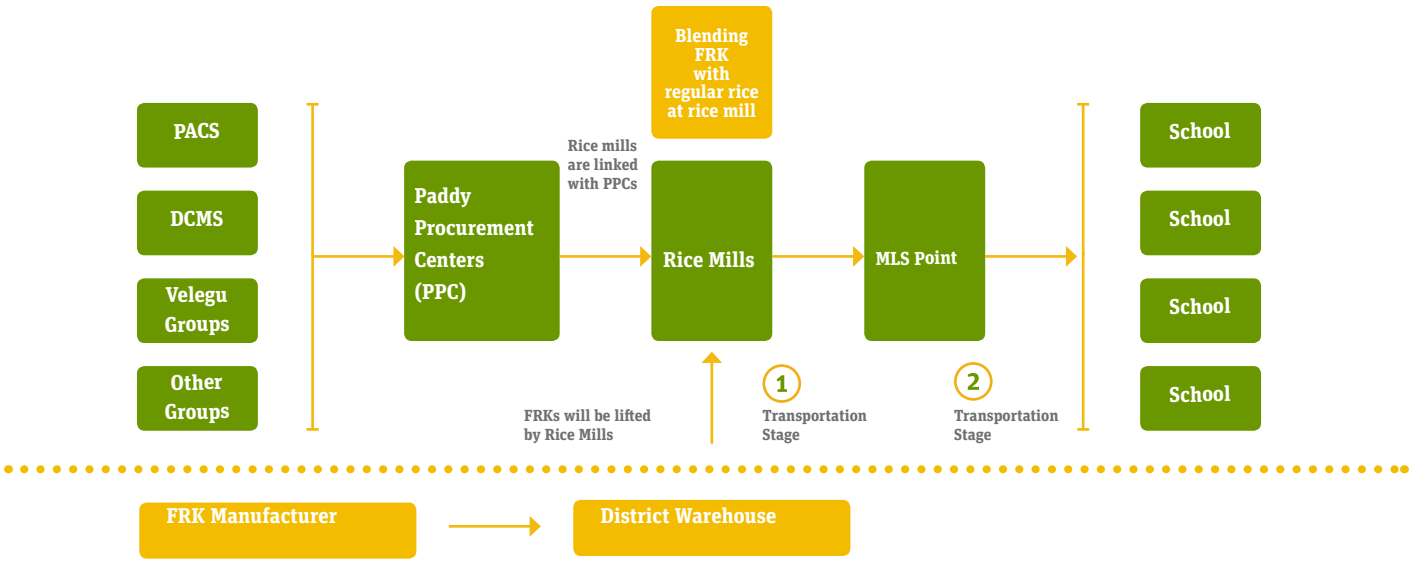
The Food Safety and Standards Authority of India (FSSAI) developed specifications for fortified rice after expert consultations which included strong clinical evidence from leading academic institutions in India. Since then, rice fortification has gained momentum and currently four states have drawn up plans to start implementing it through MDM, ICDS and PDS.

In early 2018, Andhra Pradesh joined this group by announcing its plans to distribute fortified rice in three districts in the first phase and later scale it up to the entire state. The Andhra Pradesh Ministries of Agriculture and Information Technology, Panchayati Raj and Rural Development invited and discussed with Tata Trusts a plan to explore and support rice fortification. Providing critical nutrients through rice is also aligned with Andhra Pradesh's State Nutrition Mission 2016-2026[2]. Sight and Life was brought in as a technical partner, by Tata Trusts, to steward the program.

Methods of Rice Fortification

Figure 1 below outlines the procurement, milling and supply-chain of rice in Andhra Pradesh, and the point of fortification. Paddy is procured by Paddy Procurement Centers and transferred to the rice mills where the paddy is milled to rice and delivered to the district level warehouses. Every month, as per allotments, the rice is distributed to the Mandal Level Stockpoints (MLS) (Transportation stage 1) and from there to the Fair Price Shops (FPS)/ schools/ ICDS centers/ Hostels (transportation stage 2). The figure also provides a glimpse into how the Fortified Rice Kernel (FRK) supply chain is integrated into the existing rice supply chain.

FIGURE 1: Rice Supply Flow

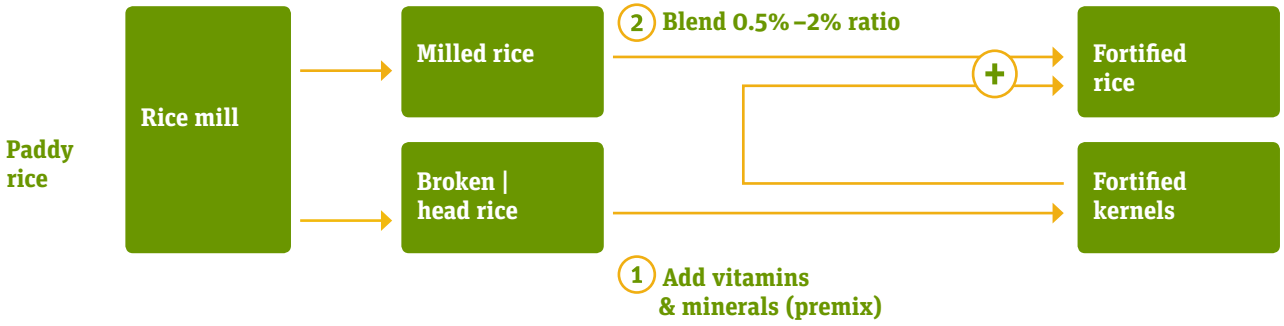


Fortification of rice is a two-step process:

- Step 1: producing fortified rice kernels (FRKs)
- Step 2: blending FRK with regular rice.

Figure 2 below demonstrates this process.

FIGURE 2: Rice Fortification Process



Reproduced from Scaling Up Rice Fortification in Asia, 2015.

Existing Method: Batch Blending

Currently, rice fortification programs in India use a batch blending system to blend FRK with the rice procured for the PDS program. The simple set-up of machinery and the process is briefly explained below.

FIGURE 3: Batch Blending Process

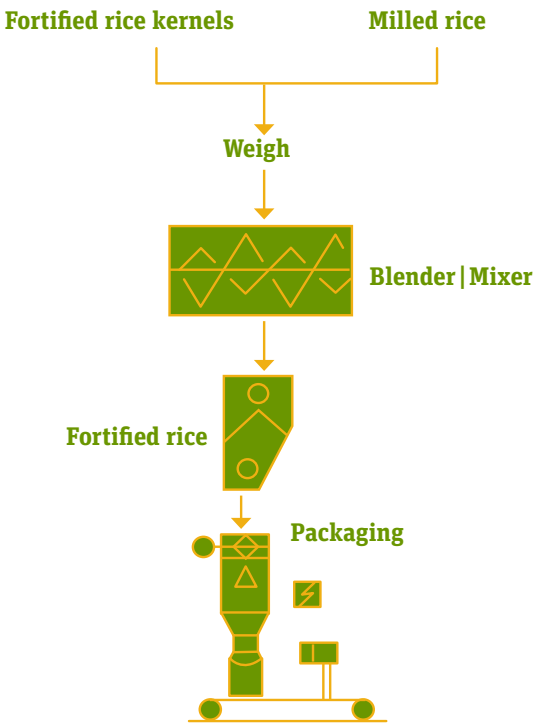


Image by S1 Grafik Design

Two hoppers which supply rice and FRK are fitted above the blender. First, the rice is weighed (say 100 Kg) and fed to the blender.

Second, the FRK is weighed (say 1 Kg) and added to the content.

So, the FRK falls on the rice as a layer. The blender is used to mix these two layers to get a uniform mixture.

This represents the simple form of the existing batch blending. Various other equipment like weighing sensors, supporting structures, elevators, pneumatics, control panels, civil structures etc. are also used to complete the process.

The idea for the innovative new blending method was prompted by the question:
What happens if we feed FRK directly to the rice flow? Will that result in an uniform mix?

Designing the innovative new method: Continuous Blending

This initial curiosity paved the way for several other related questions:

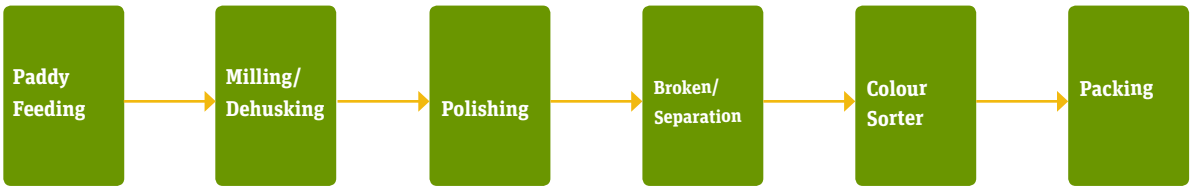
1. How do we ensure uniform rice flow?
2. How do we measure the flow?
3. How do we match the FRK flow to 1/100th of rice flow?

Even if the other aspects are operationalized, it would still not solve the issue of distribution of FRK within the rice layer as it would continue to be seeded above the layer or into rice which is flowing.

All of these questions were answered, one by one in a systematic manner to arrive at the existing innovative solution: the continuous blending of rice with FRK at the rice mill.

To understand the existing method, a brief understanding of the flow of rice at rice mill is demonstrated in Figure 4.

FIGURE 4: Flow of Rice at the Mills



In the existing flow of operations, paddy/ rice travels through various machinery and bucket elevators. The milled rice, after milling, goes through a separator where the paddy and rice are separated by a gyratory motion. The separated milled rice moves to the bucket elevator and the paddy again goes to the de-husking machine. The rice is fed to the polisher where the bran is removed. From the polisher, the rice is fed to either a sifter or indented (length) grader for separating the broken grain. After the broken rice is separated, the rice goes to the silos for storage or sent for packing.

What is the Continuous Blending Model?

In the continuous blending design, FRK is fed in to the rice flow after the polisher.

- The rice from the 'polisher' passes through a cylindrical pipe and is fed to the 'bucket elevator' which takes it to the 'broken separator (sifter/ length grader)'. For this model, rice mills with length grader/s are only selected.
- At this stage, FRK is dropped on the 'rice-flow' matching to 1/100th of rice flow. FRK is fed to the top layer of the rice flow but not distributed within the layer.
- The mixture gets its first impact from the moving buckets and gets dispersed in the bucket elevator.
- By employing this method, we are able to achieve more than 75% of the homogeneity in distribution.
- Then this rice is passed through the length graders, where the mixture is blended for a period of ~2 minutes, thus achieving a blending homogeneity of more than 80% at the rice mill, without utilizing any blenders but only the existing equipment of the rice mills.

FIGURE 5: Continuous Blending Process

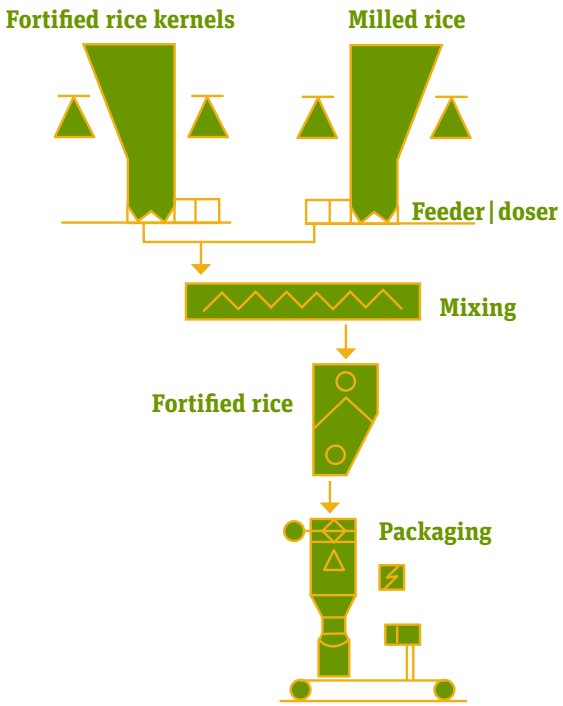


Image by S1 Grafik Design

The only extra investment incurred is the dosing equipment with a small hopper, made of stainless steel, which costs approximately Rs 80,000 ($1000-1200).

By effectively utilizing the existing buffer hopper/s, we can control the rice flow manually. The rice flow was calculated by filling the rice bags for a period of 5 min, 10 min and 15 min and calculating the flow per minute. For example, when we calculated the rice flow at a rice mill we got 835 Kg/ 10 min, on average, which means the rice flow rate is 83.5 Kg/ min or 5000 MT/hr.

Hence, we calibrated the FRK flow at 835 grams per minute or 50 kg per hour.

The continuous blending process offers is an innovative solution to improve rice fortification and support government programs in Andhra Pradesh, and has many addition advantages including:
the system that uses the equipment is already available in the rice mill to achieve the required homogeneity (>80%); there is no need to install a costly new blender; this method only requires a one-hundredth of the investment, compared to batch blending; the technology is extremely affordable and easy-to-implement; the method is adaptable and can be undertaken at any mill with any capacity, unlike batch blending where the capacity of the blending is limited by the capacity of a blender; and it is more easily scalable, since the blending is continuous. The only current disadvantage identified is that if the flow is disturbed, it needs to be calibrated all over again. Thus, care needs to be taken not to distrupt the flow.

Scope for improvement:

Even though we took care to ensure uniform flow of the rice, we still anticipate slight differences in the rice flow. Currently these errors are discounted during the process, and we are getting a homogeneity of around 80%. Going forward, if we are able to automate the process of calculating the rice flow for every 5 minutes and allow the dosing equipment to automatically adjust to the rice flow speed, we can achieve better blending homogeneity. This will also avoid the cumbersome process of calculating the rice flow, the FRK flow and the resulting human errors attached to the process. Further research is required on this aspect.

Milestones

A step-by-step guide for operationalizing the continuous blending model at rice mills

The partnership between Sight and Life and Tata Trusts has pioneered an innovative, cost-effective continuous blending process in Andhra Pradesh. This is the first time a continuous blending process is being employed to fortify rice for large-scale government programs. A step-by-step guide for how rice fortification, using the continuous blending model, can be operationalized is as follows:

1. **Selection of the rice mills for dosing and installing dosing systems in the selected rice mills:** We identified around 20 rice mills, suitable for blending, in the three selected districts and prepared a broad operational plan for processes related to blending, based on the requirements and resources available (including time). Three rice mills were selected for the first phase to cover two districts.
2. **FRK Procurement:** We drafted the procurement and inventory plans.
3. **Setting up Blending Equipment:** We scouted, identified and finalized local fabricators who have the requisite knowledge on rice mills, rice mill machinery, the rice production process, procuring the required machinery from a third party and fabricating the required dosing systems. Considering the technical/ operational and quality specifications, a dosing system was designed with minimum modification of machinery and the milling process. Finally, a prototype was developed and tested. After some modifications and adjustments, the final version was prepared.
4. **Preparing and Training on Quality Control Processes:** We prepared Quality Assurance (QA)/ Quality Control (QC) processes for the FRK production and blending processes. We also trained the selected technical assistants and Assistant Managers (Technical) from the branch offices of Andhra Pradesh State Civil Supplies Corporation (APCSCL) on QA/ QC/ Monitoring and report preparation. This way, we tried to integrate the monitoring process with the existing system.
5. **Initiating the project in project districts and monitoring logistics:** We arranged a blending trial with the help of Tata Trusts. The trial was taken up successfully, the system was standardized at first mill and the whole process was documented. The dosing equipment was installed and calibrated in three rice mills. We continued providing regular technical support to ensure continuous running of the system. The process has now been running continuously, for more than a 6 month

period, without any significant technical glitches. The FRK procurement and inventory plan, lifting of fortified rice from the mill, storage at district level warehouse, regular supply to MLS points, etc. are also very important to avoid any operational glitches.

6. **Providing ongoing project management support and building capacity:** Since the start of the project, we have been providing technical, administrative and logistic support whenever required. At the same time, we are building the capacity of rice millers in Andhra Pradesh who want to start manufacturing FRKs by linking them to the appropriate financial and technical assistance.

Impact

The objective of this program and the new innovation is to improve nutritional outcomes in Andhra Pradesh and reduce the burden of micronutrient deficiencies in the state. By conceptualizing and operationalizing the continuous blending model, significant strides have been made in achieving the objective, in a short time period. Some preliminary results include:

Currently 6000 MT of rice is being fortified in this first phase of 6 months, which equals 60 million meals. The fortified rice is currently reaching 0.1 million school children and Pregnant and Lactating Women.

Once the continuous blending model is scaled up beyond the 3 districts, to the rest of the state, we would be able to feed meals with fortified rice to 5.50 m elementary school children (1-8) and 0.37m PLW and 0.32m 3-6 year old children.

Sight and Life endeavours to optimize and expand activities using the continuous blending model, working in partnership with governments for sustainable scale.

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Graphics and Layout by Anne Milan

[1]https://www.india.gov.in/spotlight/poshan-abhiyaan-pms-overarching-scheme-holistic-nourishment
[2]http://www.cbgaindia.org/wp-content/uploads/2016/10/Launching-of-State-Nutrition-Mission-Andhra-Pradesh.pdf