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Working paper

# RICE VALUE CHAIN FOOD LOSS ANALYSIS: CAUSES AND SOLUTIONS

*Case studies in the small-scale agriculture and fisheries subsectors*

## *State of Andhra Pradesh – India*

*Manuscript*

# Rice value chain
# Food loss analysis: causes and solutions

Case studies in the small-scale agriculture and fisheries subsectors
*In the State of Andhra Pradesh, India*

*Manuscript*

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## Summary


Food loss and waste is observed across commodities globally. Food losses do not merely reduce food available for human consumption but also cause negative externalities to society through costs of waste management, greenhouse gas production, and loss of scarce resources used in their production. This study is an initiative to drive innovations and promote dialogue between the stakeholders across the food supply chain (FSC) to generate solutions that would lead to curbing this problem.

The objective of this study is to identify main causes of food loss in the rice supply chain and suggest potential solutions to mitigate these losses. A field case methodology has been used for conducting this study. It is a one-moment recording, not a state or national subsector study. It is a uniform methodology formulated by FAO based on four ('S') elements, **Screening** (secondary research from documents, reports, and expert consultations), **Survey, Sampling, Synthesis (**root cause analysis and solution finding). The study also evaluates the suggested solutions on their technical and economic feasibility, social acceptability and environmental impact to create a concrete proposal for a food loss reduction program. The proposal is further discussed and validated in a one day workshop with stakeholders from public and private sector the outcomes of which are presented in this report.

Andhra Pradesh (AP) is an agrarian state which has a premier position in the country with a major contribution in agriculture, horticulture, dairy, poultry, and fisheries. Around 60% of the state's population is employed in agriculture and related activities. Andhra Pradesh is also popularly known as the 'Rice Bowl of India' as it ranks third in terms of rice production and second in terms of productivity; contributing 7% of national rice production.

To assess the food losses, field case studies were performed in the selected FSCs in east Godavari and Nellore districts because they contribute to approximately 60% of paddy production in the state, and the existence of the entire value chain that helps to give a holistic picture. The rice supply chain in the state is highly organized and complex. It flows either through the public distribution system or through private markets. Paddy supply chain comprises of multiple actors and factors which could lead to potential food losses. In the value chain following actors play a major role: *Farmers* as the producers of paddy, village level aggregators (VLAs), rice processing industries, warehouse managers, distribution agents and retailers.

The key factors affecting the food losses in the rice value chain can be categorized at farmer level (mechanized harvesting), transporter (transportation of paddy or milled rice), millers (milling and processing), warehouses (storage) and retailing. At the farmer level crop varieties, good agricultural practices, rainfall during cultivation and harvest, the timing of harvest/post-harvest operations, and the method of harvesting were observed as food loss risk factors which if managed efficiently will lead to a reduction in losses. Mechanized harvesting and threshing is one of the critical loss points (CLP), where farmers surveyed reported a loss of 7-10%. Similarly, during storage at mills and CWC warehouses, the qualitative losses for the rice range between 2-4 % and these are exacerbated by the intake of paddy with higher moisture content for mechanical drying and processing. The study covers the economic and social impact of these losses. Also across the food supply chain, various factors like machinery utilized, use of chemicals, fuels, land, water etc. that affect the environment are also considered in detail in the report.

Given the significant role that food loss reductions could have toward sustainably improving food security, it is important to have economically viable, environmental friendly and socially acceptable solutions. The study suggests some potential interventions to mitigate the food losses across the critical loss points. It includes a food loss reduction strategy, taking into consideration suitability and economic viability of solutions and expert insights. First and foremost intervention suggested is the formation of farmer producer organizations that would be engaged in the end-to-end linkage in the supply chain. Another initiative is capacity building of the farmers and labourers. Since the major loss is observed at mechanized harvesting stage it has been suggested that the training has to be imparted to the combine harvester operators. Other important solution proposed is to use better combine harvesters which would facilitate deep cutting. To mitigate the losses at the storage level, the utilization of hermetic storage or silos is proposed. A stakeholder meeting was conducted to appraise the findings of the report and key action points were identified to address the food loss in rice subsector.

## Glossary:

| Names | Description |
|---|---|
| AGMARK | Agricultural Marketing |
| ANGRAU | Acharya N. G. Ranga Agricultural University |
| AP | Andhra Pradesh |
| APCSC | AP State Civil Supplies Corporation |
| APEDA | Agricultural and Processed Food Products Export Development Authority |
| APSWC | AP State Warehousing Corporation |
| ARS | Agricultural Research Stations |
| ASCI | Agriculture Sector Skill Council of India |
| B2B | Business to Business |
| BPL | Below Poverty Line |
| Broken rice | Damaged white rice, broken during processing |
| CAGR | Compound Annual Growth Rate |
| CER | Constant Exchange Rate |
| CMR | Custom Milled Rice |
| CWC | Central Warehousing Corporation |
| DMI | Directorate of Marketing and Inspection |
| DRR | Directorate of Rice Research |
| ECA | Essential Commodities Act |
| EG | East Godavari |
| EIC | Export Inspection Council |
| ePDS | Electronic Public Distribution System |
| ePOS | Electronic Point of Service |
| FCI | Food Corporation of India |
| FMCG | Fast Moving Consumer Goods |
| FSSAI | Food Safety and Standards Authority of India |
| GAP | Good Agricultural Practices |
| GoI | Government of India |
| HOD | Head of Department |
| Husked Rice | Rice from which only the husk has been removed |
| IIRR | Indian Institute of Rice Research |
| KVK | Krishi Vigyan Kendra |
| MANAGE | National Institute of Agricultural Extension Management |
| MAO | Mandal Agriculture Officer |
| MLS | Mandal (Block) Level Storage |
| Milled Rice | Rice from which the pericarp has been completely removed by passing through special tapering cylinders |
| MSP | Minimum Support Price |
| NFSM | National Food Security Mission |
| NSDC | National Skill Development Corporation |
| Paddy | Rice which has retained its husk after threshing |
| PDS | Public Distribution System |
| Parboiled rice | Rice that has been partially boiled in the husk |
| QCC | Quality Control Cell |
| RKVY | Rashtriya Krishi Vikas Yojana |
| SBD | Solar Bubble Dryer |
| SCDA | Supervisory Control and Data Acquisition |
| SRI | System of Rice Intensification |
| SRPP | Special Rice Development Program |
| VLA | Village Level Aggregators |

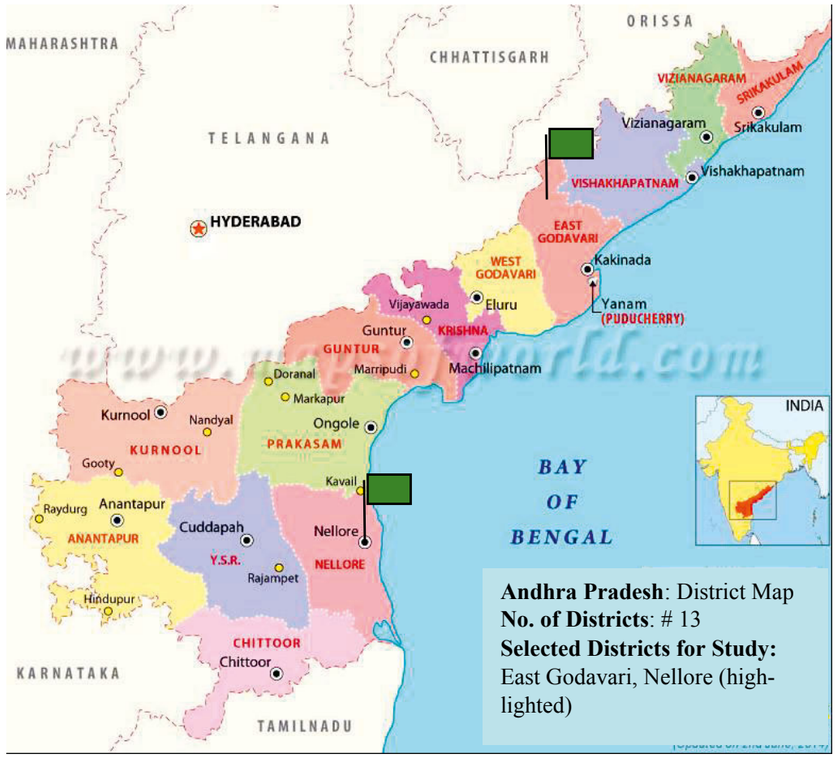


# 1. RICE – INTRODUCTION AND BACKGROUND

## a. Status and importance of the Rice Subsector; developments over the last 15 years

Rice is a food crop of national importance in the Indian economy. Globally[i], India is the second largest producer after China. Andhra Pradesh (AP) is located in the southeastern part of the subcontinent with the eastern boundary of the state being a 970 km coastline along the Bay of Bengal. Agriculture, dominated by the production of food grains, is a major sector of the state's economy in terms of value. AP is one of the leading rice-growing states in the country. The state's rivers, particularly the Godavari and the Krishna, account for its agricultural importance.

In AP, rice is cultivated in an area of 2.4 million hectares with an average productivity of 3.4 MT/ ha (2014-15), behind only Punjab (3.7 MT/ha). Andhra Pradesh (AP) ranks third in India in terms of rice production contributing 7% of national rice production and a share of 1% in the global market[ii]. AP[iii] is also a rice surplus production state, with production in excess of the state's consumption.




The districts in the deltaic regions of Krishna-Godavari and Coastal areas (Nellore) are the major producers of rice. The study has been conducted in the districts of East Godavari and Nellore as they account for 25% of cultivated area and 31% rice production of the state. The rice supply chain is highly organized and marketing of rice is done through public distribution system (PDS) and the private channels. Informal trade or storing for self-consumption is minimal, and most of the produce is marketed after milling. The major cultivation season of paddy in East Godavari district is Kharif with sowing in June and harvesting in October; the other growing season being Rabi with sowing in December and harvesting during April or May; whereas, in Nellore, the seasons are early Kharif (April-August) and Rabi (October –March).

In the last 10 years (Chart 1) the cultivated area for rice has shown a decrease of 1% whereas the production and productivity shows a CAGR of 2 %. The state's rice production witnessed major dips in FY 2009-10 and FY 2012-13 due to drought years; and in FY 2011- 12 due to the phenomenon of crop holiday, a form of protest by the farmers against the negative incomes of the past years when they collectively decide to leave the land unsown for the season to get their demands heard.

Several other factors like a shift in cropping pattern from paddy to high-value non-cereal crops, low productivity and increasing paddy cultivation costs, labour shortage, unattractive market prices and erratic climatic conditions etc. also affect the crop production.

According to the data from Agricultural and Processed Food Products Export Development Authority (APEDA), approximately 2.5 million MT of non-basmati rice was exported from different ports of AP

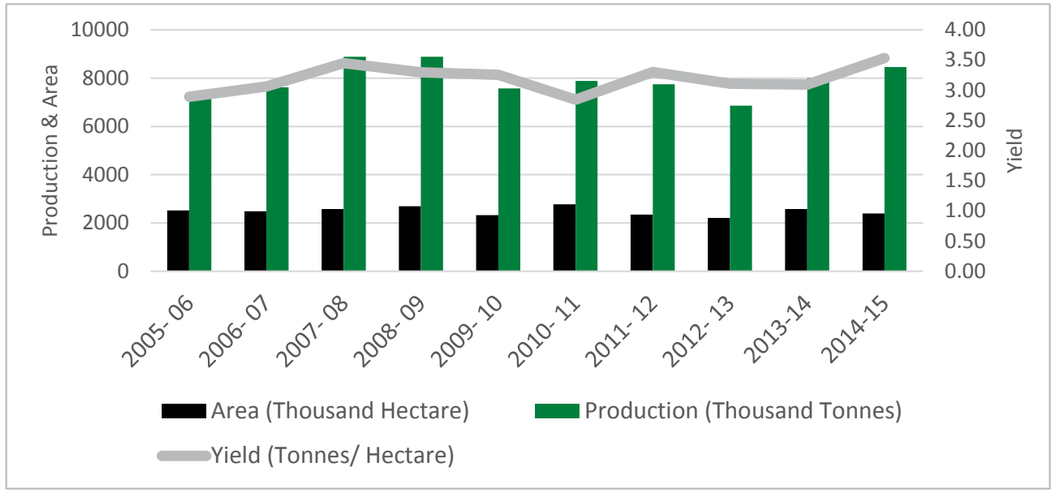



*Fig. 1 Rice Production and Yield in Andhra Pradesh*

and an estimated 2 million MT from the combined states of AP and Telangana is exported from these ports.

## Output I- 1a: Andhra Pradesh Production Information of Rice Subsector: Actors and Product Flow

In AP, almost entire paddy (~98%) is marketed and the organized market (farmers-aggregators-millers-wholesalers-retailers) dominates the value chain with distribution carried via the government and the private channels. The role of different actors in the rice supply chain is as follows:

***Producers:*** In AP, approximately 80% paddy cultivation is done by farmers with small and marginal landholding (land holding size < 2 ha). Tenant farming is predominant, a practice where farmers with medium and large landholdings (land holding size > 5 ha) lease out their lands to multiple farmers (tenants) who cultivate paddy and share a percentage of profit with the landlord. The farmers store ~2% of their produce in anticipation of fetching a better price. However, depending on the market situation, the farmers may or may not obtain a better price. Usually, in the latter case, the farmers consume the produce. No paddy is stored by farmers for seeds in AP.

***Government Procurement Centres:*** These centers operate at the village level and act as aggregation points to procure paddy and pulses depending on seasonality. Usually, one center caters to 3- 4 villages. However, this is not a preferred mode of paddy sale by the farmers, as this system involves the farmers to transport paddy from farm to the centre, and the price of their produce is determined based on moisture content and grain size of the produce. Apart from procuring paddy directly from the farmers and getting it custom milled, a substantial quantity of rice is procured through processors wherein the millers procure paddy directly from farmers, convert it into rice and deliver the same to FCI and state government agencies (SGAs).

***Village Level Aggregators (VLAs)****:* VLAs are private agents or traders working on behalf of the private mills. The VLAs are involved in the collection of paddy directly from the paddy farms, and transport the produce to the mills, usually within 10 km radius of the village. Their commission, approximately 5%, does not affect the profit margin of the farmers, because the commission is paid out of the millers' revenue. This is a preferred system over the Government procurement centres due to the above advantages and the price being determined by the prevailing market rates rather than a sampling method based on moisture and grain size.



***Transporters:*** Transport of paddy as well as milled rice is done by 3rd party private players. Transport of paddy is mostly locally done via trucks and tractors, it is done both interstate (trucks) and intrastate using trucks and rail network, for the export purpose, both shipping and air routes are utilized.

***Processors (or) Millers***: The processing factories are central to the functioning of the government and the private channel for rice. Millers procure paddy from farmers through their intermediaries or local agents or aggregators, transport the produce to the mills, carry out the milling process and also store it. Under the government mandated Custom Milled Rice (CMR) policy, all registered private millers are required to participate in the CMR policy, thus undertaking milling for both the government system (~40%) and the private sector (~60%).

***Food Corporation India (FCI) and Central Warehouse Corporation (CWC):*** In AP region, for handling the procurement of rice, FCI operates 131 depots with a total capacity of 1.6 million MT. Out of which, 36 are FCI owned and the rest are hired. FCI is responsible for stocking food grains and distribution. During times of surplus production, the surplus amount from Central Warehouse (Central Warehouse acts as an agent of the government for purchase, sale, storage and distribution of agricultural produce, seeds, manures, fertilizers, agricultural implements and notified commodities) is transferred to the Food Corporation of India (FCI) warehouses. Similarly, during deficit production of rice in the districts, the stock from FCI warehouses is moved to the Central Warehouse.

**A view of CWC warehouse from outside (bottom left) and storage (bottom right)**

***Public Distribution System (PDS) and Fair Price Shops****:* PDS is the national level government controlled system of distributing rice to beneficiaries, people below poverty line, through fair price shops. Also referred to as rations shops, these are the retail outlets owned by the government and are concentrated in the rural areas. They sell rice, along with other essential commodities like wheat, sugar and kerosene oil to beneficiaries at highly subsidized rates. Rice is sold at USD 0.02 per kg (INR 1/ kg) to USD 0.15 per kg (INR 9/ kg) at these shops.

**A consumser's credentials being authenitcates for purchase of rice under**

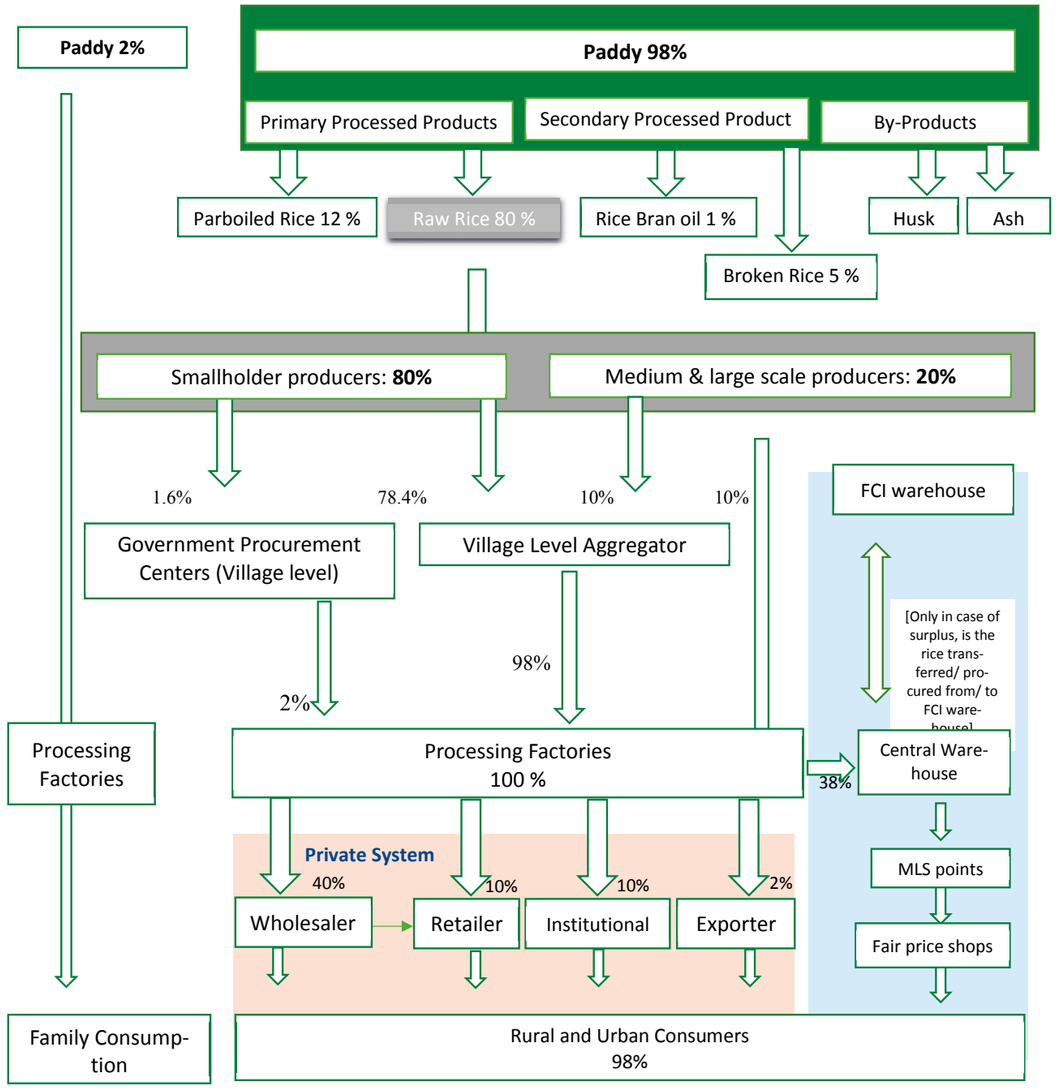
The retail price varies with the subsidy scheme and the targeted audience. Generally, the subsidy schemes have lowest rates for Below Poverty Line (BPL) beneficiaries. These rates are much below the prevailing market prices which are in the range of USD 0.4-0.5 per kg (INR 25- 30/kg).

**Case Study I: ePDS system at Nellore**

Electronic Public Distribution System (ePDS) and Electronic Point of Service (ePOS), introduced in India in 2015, are implemented across fair price shops in Nellore along with a CRM system called "supply management system". Mr. Narsimha Rao manages one such fair price shop in Harinathapuram, Nellore. ePDS is an online software application catering to the Ration cards management, allocation and seeding of Aadhaar (Unique Identification Number (UIN)) data. In ePDS, processes involved in the distribution of Essential Commodities (ECs) to the BPL families are automated so as to bring efficiency, accountability and transparency to the PDS.

He further explains that when ePOS system was put into effect, names of all cardholders were seeded with UIN. Replacement of old ration card system with new online fingerprints for customer identification has increased operational efficiency and stopped leakages. The field staff are able to add new shops in ePDS and tag the ration cards to the concerned shops. The allocation to each shop is calculated in the system based on the distribution of the shop and the closing balances of the previous month. The details of shop wise allocation are linked to eSeva (services to citizens using ICT tools).

## Output I- 1b: Andhra Pradesh Production Information of Rice Subsector






Paddy is the basic farm output that is processed to give de-husked rice or rice as the primary produce. The table below provides the data for products, by-products from milling of paddy and their economic value for AP

## Output I- 1b: State Production Information of Rice Subsector

| **Year 2014-15; CER USD= 65 INR** | **Annual Production/year (million MT)** | **Cultivated Area (million ha)** | **Average Yield (MT/ha)** |
|---|---|---|---|
| Raw Material Paddy | 12.2 | | |
| Raw Material (Rice) | 8.4 | 2.4 | 3.4 |
| Average Annual Growth over the last 10 years | 2% | -1% | 2% |
| Average cost of production (USD / tonne) | 219 | *NA* | |
| | **Farmer storage** | **Marketed** | *NA* |
| Percentage of production | 2% | 98% | *NA* |
| | **Volume (million MT/year)** | **Value (million USD/year)** | **Value (USD/MT)** |
| Rice | 8 | 3,231 | 385 |
| Parboiled Rice | 1 | 582 | 447 |
| Broken Rice | 1.5 | 366 | 244 |
| Rice Bran | 0.5 | 12 | 24 |
| Rice Bran Oil (crude) | 0.1 | 37 | 366 |
| Husk | 3 | 863 | 288 |
| Fly Ash | 1 | 46 | 51 |

### Intermediary Products and Byproducts

The different intermediary products and byproducts and a brief about their value chain in the state is as follows.

**Parboiled rice:** Parboiled rice is referred to as rice processed after giving boiling/heating treatment to paddy. The supply chain is similar to that of raw rice, where the farmer sells to the miller through the agents or aggregators and the millers after processing can directly sell in the open market or sell to the government under the CMR scheme, which mandates 68% recovery from paddy. Due to harder grain and resistance to pest attack, it is preferred by FCI for storage. The FCI currently transports the rice to Kerala through rail and road, and is also considering the sea route for transport.

Due to parboiling, the rice gets harder and results in higher milling yield with lesser breakage and more oil content in bran, containing more vitamins and minerals than in polished rice. Hence, parboiled rice fetches a higher market value than raw rice. However, parboiled rice requires more energy to achieve the same degree of milling. Some mills in AP produce parboiled rice in addition to raw rice and export to other states like Kerala, Tamil Nadu etc. or overseas to other countries.

**Broken rice:** Broken rice obtained as part of rice milling, is further processed to various other products and consumed. Higher % of broken kernels or rice reflects the qualitative loss in rice grains. Depending on the mills, the percentage of broken rice varies; for traditional steel huller mills, broken rice @ 10-12 kg/ quintal of paddy is obtained; whilst for modern mills with rubber roll shellers, 6-8 kg of broken rice is obtained from 1 quintal of paddy. If the paddy is not dried optimally to 18% moisture, the probability of broken kernels during milling increases.

Broken rice is sold at a price lower than the raw rice, the primary product of processing. The broken rice is sold at mill gate or on the open market. This is further processed to rice flour, vermicelli, semolina, and poultry feed. In addition, blending is also done by various millers as per customer demand, which involves mixing predetermined amount of broken rice with raw rice, and sold at a lower price. The broken rice market is unorganized. The local cottage and small scale industries further process it to other value-added products, package and distribute it to the local markets. These units, therefore, incur losses during cleaning, packaging, distribution and storage. In the organized market, few players

especially the large-scale millers have tapped this market, and are also exporting to Africa, Thailand and various South East Asian countries as branded products.

The brokens can be of several fractions and of different sizes as follows:

- Large broken kernel: 50-75% of the whole kernel size
- Medium broken kernel: 25-50% of the whole kernel size
- Small broken kernel: less than 25% of the kernel size, cannot pass through a sieve with 1.4mm diameter holes
- Chips: fragments of a kernel which pass through a sieve with 1.4mm diameter holes

**Rice bran/oil:** Rice bran, obtained as a by-product from rice is a high-value product. The bran contains approximately16- 18% rice bran oil and is further processed through solvent extraction for refining. In the extraction facility, the bran oil is extracted as the chief product and the de-oiled cake is used for cattle feed or in the soap manufacturing and waxes/ gums or for coating candy, fruits etc. as it prevents moisture loss and shrinkage. The rice bran oil accounts for a higher economic value due to its health benefits which include the ability to lower cholesterol and aid in weight loss, boost the immune system, increase cognitive strength, prevent cancer, and lower allergic reactions.

**Husk:** Husk is the bulky by-product obtained during rice milling (about 20-22% of total paddy milled), is a rich source of silica and fiber, and used in glass manufacturing. But it has a considerable fuel value for different industries and is used as a fuel in process industries to produce steam or electricity. Later its ashes are used as manure as it contains a considerable amount of silica.

**Demographic of the subsector**

The absolute population of producers, traders or wholesalers engaged in rice supply chain at the state level across the age groups could not be determined during the study. At the producer level (excludes land title owners), most of the labourers are contract workers at the village level and hence no record of their employment is maintained. At the trader level viz. primary processing at mills, women and men are equally employed. However, women's role is restricted to cleaning and winnowing only. There is limited participation of women in processing and marketing.

The age disaggregated absolute data has been difficult to compute due to non–availability of any reference published data points. The below percentages are provided based on the field level observations during the study, and are not a representative of the State.

| Number, sex, age of | Female | | | | Male | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | 15- 30 | 30- 45 | 45+ | Total | 15- 30 | 30- 45 | 45+ | Total | |
| Producers | | | | 55% | | | | 45% | 100% |
| Traders | | | | 1% | | | | 99% | 100% |
| Wholesalers/ Retailers | | | | 10% | | | | 90% | 100% |

Out of approximately 6,500 rice mills in Andhra Pradesh, the majority of the mills are modernized. The large units are highly advanced with milling capacity as high as 2,000 MT per day. The distribution channels (wholesale and retail) operate via the government and the private systems through the fair price shops and the hypermarkets/supermarkets/*kirana* stores respectively, the density of which depends on the rural or urban areas as provided in the below table.

| Level of Operations | Small | Medium | Large[3] |
|---|---|---|---|
| | 5% | 70% | 25% |
| Trade/ wholesale | Rural: At block and District level only Urban areas: Across | Model: B2B or cash and carry outlets | Model: B2B or cash and carry outlets |
| Retail Operations | Rural areas dominated by presence of Government-owned Fair price shops and *kirana* stores | Urban Areas dominated by supermarkets | Urban Areas dominated by hypermarkets |

[3] Number of employees/ workers: Small <10, Medium: 10- 50, Large >5



## Output I- 1c: Food Safety Management Mechanisms

Different quality and safety standards are prescribed for the domestic and export market for rice. For the domestic market in particular, standards prescribed by Agricultural Produce (Grading and Marketing Act), 1937 and Food Safety and Standards Authority of India (FSSAI) standards are followed. According to FSSAI the rice should conform to the following standards:

| | | |
|---|---|---|
| (i) | Moisture- | Not more than 16% by weight (obtained by heating the pulverized grains at $130^0$C-$133^0$C for two hours). |
| (ii) | Foreign matter - (Extraneous matter) | Not more than 1% by weight of which not more than 0.25 %. By weight shall be mineral matter and not more than 0.10 %, by weight shall be impurities of animal origin. |
| (iii) | Damaged grains | Not more than 5% by weight |
| (iv) | Weevilled grains | Not more than 10% by count |
| (v) | Uric acid | Not more than 100 mg per kg (ppm) |
| (vi) | Aflatoxin | Not more than 30 µg per kg (ppb) |

FSSAI standards do not set limits for heavy metal and arsenic. Arsenic is not considered a potential threat so far for the domestic market.

At farm gate, paddy is procured based on the moisture level and the purity percentage. For domestic rice market, there is no mechanism or procedure to check for the pesticide residues, metal contaminants in paddy and hence is not considered as a grading parameter. Limits for pesticide residue levels are however strictly followed for the export market. The institutions involved in monitoring and implementation of standards are listed as follows:

1. ***Food Corporation of India:*** The Quality Control (QC) wing inspects the stock regularly during storage to monitor the quality by carrying out physical and chemical analysis to ensure the quality standards prescribed by GoI and FSSAI. This is done through a network of laboratories throughout the state. The senior Q.C. Officers undertake frequent visits to FCI warehouses for inspection. Periodical disinfestation measures are also undertaken to ensure the health of the grains. Rice samples are drawn through joint sampling system and lots strictly conforming to Uniform Specifications of Government of India standards are henceforth issued to PDS.

***Non-Issuable (DAMAGED) Food grains and Their Disposal:*** The grains which do not conform to PFA (Prevention of Food Adulteration Act & Rules, 2004) and cannot be upgraded by reconditioning are considered unfit for human consumption and categorized as 'Non-Issuable grains'. The use of these grains is categorized into 5 groups based on the presence of sound grains/ broken/ slightly damaged grains, weevilled grains, discolored and chalky grains and contamination of the sample.

In 2014-15 upto January, 2015, 2,262 MT of grains (wheat and rice) were reported to be non-issuable at FCI warehouses in the Andhra Pradesh out of 1.18 million MT stocks held, which is less than 1% (India stat: State/Region-wise Stocks of Food grains Accrued as Damaged/ Non-Issuable in Food Corporation of India (FCI) in India).

| | % of sound grains | Category for which stock is fit | Parties eligible to purchase |
|---|---|---|---|
| 1 | 70-85 | Cattle feed | Manufacturers/direct consumers of cattle/poultry feed with processing plant and machinery registered with FCI |
| 2 | 55-70 | Poultry feed | |
| 3 | 30-55 | Fit for industrial use (except for inedible starch) | Starch/manure manufacturers registered with FCI |
| | | Contaminated stocks fit for inedible starch | Only starch manufacturers registered with FCI |
| 4 | 10-30 | Manure | Manufacturers/direct consumers of manure and manufacturers registered with FCI |
| 5 | <10 | Dumping | |

2. ***Quality Control Cell (QCC):*** QCC lab, located at Hyderabad, ensures the quality of food grains during procurement for storage and distribution and conducts surprise inspections at procurement centers, food storage depots, rail heads, rice mills and fair price shops

3. ***AP Civil Supplies & CWC Warehouses:*** Quality Inspectors at procurement agencies belonging to AP Civil Supplies are responsible to ensure food safety by conducting quality tests on the inbound lot of paddy and rice. Quality inspectors at CWC warehouse perform quality check of rice in terms of moisture content, broken percentage, stones etc. During storage, the CWC ensure the adherence to the defined standards by regular quality checks, fumigation and pesticide sprays.

4. ***APEDA recognized laboratories****:* APEDA recognized laboratories are entrusted with residual analysis of pesticides and microbiological analysis in rice and rice products to ensure the prescribed limits as defined by Food safety and standards (Contaminants, Toxins and Residues) Regulation, 2011.

5. ***Rice Mills/Processors:*** Registration of mills with Government is mandatory. Voluntary standards by major processors are maintained. Some of the measures taken up by the millers to ensure good quality are (a) paddy procurement from selected regions to maintain a consistent superior quality, (b) maintaining authorized laboratory to ensure that the quality is up to the standards, (c) utilization of modern machinery to ensure the quality of rice, (d) cooking test of the processed rice, (e) regular fumigation and (f) quality tests for all consignment before transporting to market.

**Quality testing lab (left), cooking test (middle) and rice color sorting at Srilalitha Enterprise, Peddapuram, EG**

6. ***Export Inspection Council:*** EIC, either directly or through the Export Inspection Agencies renders services in the areas of:

    - Certification of quality of export commodities through installation of quality assurance systems (In-process Quality Control and Self-Certification) in the exporting units as well as consignment-wise inspection,
    - Certification of quality of food items for export through installation of Food Safety Management Systems in the food processing units as per international standards,
    - Issue of different types of Certificates such as Health, Authenticity etc. to exporters under various product schemes for export,
    - Issue of Certificates of Origin to exporters
    - Laboratory testing services



| Controller | Control | Actual Situation in the FSC | | Responsible agent |
|---|---|---|---|---|
| Government regulation and requirements | National food safety/ quality standards | Exists and applies to the whole FSC | True | Quality Inspector- AP Civil Supplies, Quality Inspector- FCI |
| | | Exists but not rigorous | | |
| | | Doesn't exist | | |
| | Frequency of checking (None, Low, Medium, High) | Harvest | None | |
| | | Transport | Low | |
| | | Storage | Medium | Quality Inspectors at CWC and FCI |
| | | Process | Low | Inspectors of Consumer Affairs, AP Food and Civil Supplies |
| | | Market (Regulated- Fair price shops) | Low | Inspectors of Consumer Affairs, AP Food and Civil Supplies |
| | | Market (Non- PDS but with MSP norms) | None | Collectors, Agricultural Marketing department |
| | Obligatory registration of the food processing/ preparation unit | Exists | Exists | Commissioner- Civil Supplies, District Commissioner |
| | | Doesn't exist | | |
| FSC actors | GHP/ GAP/ HACCP/ voluntary standards | Voluntary standards by processors like moisture test for stock, scientific construction of facility, health of machine, pest control etc.<br>GAP, GHP are voluntary in India and not mandated by Government. Thus, these are referred to and not completely adopted by rice mills especially by modern mills. | | Quality team at mills |
| | | Standards exist only for Export Markets as per Codex Alimentarius Commission | | Export Inspection Council |
| Food safety management system | Identification of potential hazards | Physical contaminants: Dust and particulate matter from milling equipment and storage bags<br>Chemical contamination: Pesticide residues or chemical residues from polishing<br>Biological contamination: Insect pest, mycotoxin | | |

India's food safety standards are stricter for the export market than the domestic market and are lagging as far as food safety inspections at farm gate are concerned.

### b. Inventory of activities and lessons learnt from past and on-going interventions in subsector rice losses

To optimize the supply chain along the production, procurement and distribution to retail points, the state government has adopted several initiatives and streamlined the value chain process postharvest. The key interventions are enumerated as follows:

**Minimizing loss at harvesting:** Adoption of non-lodging, non-shattering varieties like MTU 1064, MTU 7029 and harvesting at the optimum stage helps to optimize higher yield at harvest. Such varieties released by Rice Agriculture Research Stations in the region are popularized by the Krishi Vigyan Kendra (KVKs - primary link for farmers to know about latest agricultural technology development and serve as Farm Science Centres for diffusion of location specific technologies with minimum time gap between development and transfer to the end users) of through extension services.

**Subsidy schemes for mechanized harvesting:** Schemes under Rashtriya Krishi Vikas Yojana (RKVY) provide a subsidy of USD 15,384 per unit of machinery. Such subsidy schemes have promoted at a large scale mechanization to address labor shortages.

**PPP Mode of paddy procurement**: The private millers are engaged by the government to procure, transport, process and store paddy/rice on behalf of the government. The process has well-defined protocols to ensure market discipline, substantially improving the efficiency of the supply chain.

**Minimum Support Price (MSP) for paddy**: Year-on-year, the government has been revising upwards the Minimum Support Price (MSP) for paddy, and ensuring strict mechanisms to procure rice from farmers at or above MSP. For *Rabi* season (2015-16), the MSP for Common Grade rice was fixed at USD 216.92 and USD 223.07 per MT for Grade A rice. The initiative has incentivized farmers to sell their entire produce.

**Rodent Control Programme**: In the coastal districts of Krishna, Guntur, East Godavari and West Godavari paddy crop cultivation is carried out throughout the year followed by summer pulses and thus the environment is congenial for rodent breeding. The main objective of implementation of Rodent Control Programme in paddy fields is to reduce the yield losses due to rodents and also to produce quality food grain. The activity is undertaken and monitored by the Block (Mandal) level officers in the farmer fields.

### c. The process of policy making and current policy framework or national strategy on subsector losses (if any), and brief description/ assessment of the level and extent of current implementation

Rice, a food security crop for the country, has always been the focus crop for the Central and State government. Policies have been designed to address various bottlenecks across the supply chain. The key policies relevant to paddy post- harvest supply chain are as follows:

1. **Farm mechanization and post-harvest:** In the AP State Action Plan 2015-16, the component of mechanization at harvesting has been integrated with the Agriculture Plan. The policy aims to provide implements to farmers in groups (Rythu Mitra Groups, JLG etc.) under the scheme of RKVY and to individual farmers under Normal State Plan (NSP).
2. **Weather based crop insurance scheme**: With growing importance of climate smart agriculture, various weather based insurance schemes covering paddy for both its growing season- *Kharif* and *Rabi*, are announced and revised from time to time. The schemes cover for not only production but also the post-harvest losses and is assessed at farm level. Coverage is available upto a limited time (2- 3 weeks) post-harvest, when the crop is harvested and left to dry on fields and is affected due to natural calamities. Unseasonal heavy rains in November-December (post-harvest) as seen in the last few years has been washing away farmer produce especially in Andhra. The policy thus helps to minimize the economic loss of farmers even in post-harvest. In AP, the districts rich in paddy cultivation like East Godavari, West Godavari, Guntur and Krishna are made as Village Insurance units for the other crops. The government subsidizes the programme by capping the premium percentage, 2.5% in case of paddy.
3. **Decentralized Rice procurement policy**: The policy was launched in 2012, and mandates the state to undertake responsibility to procure food grains, store it scientifically and distribute it through the PDS, thereby by-passing the FCI which was previously involved in direct procurement. Earlier, the paddy procured by the state government was sent to the rice mills and the rice was stored in the Food Corporation of India (FCI) warehouses and later supplied to the public distribution system (PDS) shops. The policy has helped to achieve self-reliance and economize on the warehouse space. On ground, the scheme has improved the distribution efficiency in the supply chain and reduced the losses at farm level as well as storage, as most of the processes are now taken care of by the organized channel.
4. **Procurement under Custom Milled Rice (CMR) policy**: This policy outlines the quality guidelines and the scientific design to be adopted for unloading, storage and processing of rice by the private mills. Under Custom Milled Rice (CMR) policy, millers are required to mill rice for the Public distribution system (PDS). The millers are required to obtain dehusked or milled rice at67kg of rice or 68 kg of parboiled rice for every 100 kg of paddy provided to them. The initiative involves the participation of the private sector and has well-defined protocols to ensure the market discipline.
5. **National Food Safety and Quality Policy**: Agmark drives the Food safety, quality and grading criteria. On ground implementation is effective only for grading criterion for the domestic market. The standards of Agmark have been defined by Directorate of Marketing and Inspection (DMI).

### d. Relevant institutions and their role in terms of policy, organizational structure, mandate and activities in the small and medium subsector industry sector

Government's Agriculture and allied departments are involved in supporting and controlling the paddy supply chain system, as paddy is a commodity under the Essential Commodity Act (ECA), an Act of Parliament of India, which ensures the delivery and on time supply of selected commodities to consumer. The list of the major institutions in AP involved in Paddy/ Rice FSC is as follows:

| Institution/ Department | Type | Role/ Mandate Activities |
|---|---|---|
| Department of Agriculture and Cooperation | Central Government | Responsible for formulating and implementing national policies and programmes to achieve rapid agricultural growth |
| Department of Agriculture, Govt. of AP | State Government | Provides agriculture extension and training to farmers, introduction of HYV, supply of quality inputs, regulating the supply |
| Consumer Affairs, Food and Civil Supplies | Central Government | Promotes Consumer Affairs and in protecting the Consumer Rights in the State. The Department with a view to protect the rights of Consumers, to increase awareness among the consumers to enable them to protect themselves and safe guard the interest of consumers is focusing on various aspects. |
| AP State Civil supplies Corporation | State Government | Promote, improve, develop counsel and finance production, purchase, storage, processing movement transport distribution and sale of food grains, foodstuffs and any other essential commodities and to establish laboratories for the purpose of ensuring quality control |
| FCI | Central Government | Distribution of food grains through PDS, maintaining buffer and operational stocks to ensure national food security, regulating market price and price support operations to consumers |
| Central Warehousing Corporation | Central Government | Provides storage and handling, offering services in the area of clearing & forwarding, handling & transportation, procurement & distribution, disinfestation services, fumigation services and other ancillary activities. |
| AP State Warehousing Corporation | State Government | Provides storage facilities for food grains and other agriculture commodities, seeds, manures and fertilizers to minimize losses and deterioration in storage. The scheme also aims to enable farmers to have easy and cheap credit facilities from banks against pledge of the warehouse receipt |
| Indian Institute of Rice Research (IIRR), Hyderabad (erstwhile AP) | Central Government | Rice research institute coordinating testing, technology transfer and consultancy services. |
| ANGRAU | Autonomous Agriculture Research Inst. | Agriculture research, education and training |

## e. Overview of the most important FSCs in Rice subsector, selection of FSC

Rice productivity in Nellore and East Godavari are above the national average and these districts have the major milling facilities of AP, thus constituting the existence of the entire value chain for rice in the selected geography. Also, the selected districts fall under two different agro-climatic zones. East Godavari in the Godavari agro-climatic zone, receives rainfall varying from 800-1000 mm and constitutes 14.8 % rice area of the state. Nellore, on the other hand, falls under the Southern agro-climatic zone of the state with rainfall varying from 700-1000 mm and constitutes 9.8 % rice area.

The major varieties used in East Godavari district are Cottondora Sannalu (MTU-1010) (IET 15644), Vijetha (IET-13967), MTU 1064, Triguna (IET-12875), Swarna (MTU 7029) and Sravani (NLR-33359),(IET-14876), Somasila (NLR-33358), (IET-13932), Swathi (NLR-33057), (IET-11582), Vedagiri (NLR-33641), (IET-14328) are the main varieties for Nellore.

Table I-2a lists the main FSCs in the subsector by the geographical location, final product and market for the final product. Based on the information from Table 1-2a, the Tables I-2b and I-2c have been completed by assigning a score of **1 (low), 2 (medium) or 3 (high)** to the factors in the columns for each FSC in the rows.

### OUTPUT I-2a. FOOD SUPPLY CHAINS IN THE RICE SUBSECTOR

| FSC # | Geographical area of production | Final product | Volume of final product (tonne/year) FY 2014- 15 | Number, age and sex of smallholder producers | Market of final product, location, buyers | Project support |
|---|---|---|---|---|---|---|
| 1 | East Godavari | Rice | 1.56 milion | 80%+ of paddy producers are small and marginal producers- with ~55% workforce being female field labourers in the 20- 40 age group | AP (wholesale and retail shops) | Minimum Support Price, Decentralized Procurement Scheme<br><br>[Parboiled rice when processed for food security, follows decentralized procurement scheme] |
| | Nellore | | 1.03 million | | | |
| 2 | East Godavari | Parboiled Rice | 234,000 | | AP, Kerala & Tamil Nadu | |
| | Nellore | | 154,000 | | Kerala & Tamil Nadu | |

**By-products of rice:**

The key intermediary products obtained during rice processing are broken rice, rice husk and bran which are traded in niche markets outside the state, and are of not much importance at the state level.

| FSC by-product # | Geographical area of production | Final product | Volume of final product (tonne/year) FY 2014- 15 | Market of final product, location, buyers | Project support |
|---|---|---|---|---|---|
| 1 | East Godavari | Broken Rice | 187,587 | AP | No direct support schemes available.<br><br>Processing of rice bran is covered under small scale or cottage industries, and are covered under various credit linked capital subsidy schemes |
| | Nellore | | 123,120 | AP | |
| 2 | East Godavari | Rice Bran | 62,529 | AP | |
| | Nellore | | 41,040 | AP | |
| 3 | East Godavari | Rice Bran Oil | 11,255 | AP & other states | |
| | Nellore | | 7,387 | AP & other states | |



## Output 1-2b Importance of Food Supply Chains (from I-2a) in Andhra Pradesh

Rice: The staple food contributing significantly to national food consumption as well as nutrition. Total value generated for milled rice produced in the state is 3,230.78 million USD contributing approximately 62.91% to the rice economy (share of rice in the value of all products) of AP.

Parboiled rice: Produced for export to overseas markets and other states and generates 581.24 million USD for the state contributing 11.32% to the rice economy.

Since the economic contribution of rice and its value as staple food across the state was observed to be the highest and entire value chain (farmers to retail) is present in the state, FSC for rice was selected for the study.

| FSC # | Product | Economic Importance | Generation of foreign exchange | Contribution to AP food consumption | Contribution to AP nutrition | Impacts on environment and climate change |
|---|---|---|---|---|---|---|
| 1 | Rice | 3 | 2 | 3 | 3 | 3 |
| 2 | Parboiled Rice | 2 | 2 | 2 | 2 | 2 |

## OUTPUT I-2c. Economic Importance of Food Supply Chains for smallholder actors

Rice is the primary product obtained after processing of paddy and information in Output I-2c is captured only for rice. The entire FSC of other products either do not exist in the selected geography or are scanty. Rice is the major crop cultivated in the geography across two seasons in a year in most of the areas, thus is a significant contributor to the income of the farmers; both female (including contract workers) and male. Most of the land holdings are owned by men and only nominal ownership lies with women. Men drive the production and influence the decision making. Women are mainly employed as farm labourers and engaged only in the transplanting and intercultural operations during crop production. The women get paid USD 4.3 per day whereas men were paid USD 4.6 per day for different activities during cultivation. The wage disparity exists as transplanting and intercultural practices are not perceived as labour intensive activities.

The VLAs are engaged in trading of various commodities, mostly dominated by men, who get ~65% income contribution from paddy/rice. For mills, rice contributes significantly to the income share of the engaged labour force. Women at mills are engaged only for winnowing and cleaning and are paid USD 4.62 – 5.38 per day (8 hr. shift). On an average, the women are engaged for approximately 200 days per year, and contribute USD 924-1056 annually to household income. The distribution channels (wholesale/retail points) are engaged in the trade of various products like cereals, pulses Fast Mover Consumer Goods (FMCG) FMCG commodities, of which rice is one, which varies with the market, and can be generalized to be of a medium scale.

| FSC # | Sex | Percentage of produce by | | Contribution to income generation (% share of annual income) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Smallholders | Other | Farmers | VLAs | Processors | Wholesalers | Retailers* |
| 1 | Female | 20 | 20 | 60-100 | - | - | 90 | 70 |
| | Male | 80 | 80 | 80-100 | 65 | 60 | 90 | 70 |

* the data is for PDS system only as the private retailers have wide range of commodities and the percent share of rice could not be determined

## OUTPUT 1-3b.Preliminary screening of food losses in the selected FSC

Preliminary screening of the food losses along the FSC identifies harvesting and threshing as critical loss points (CLPs) followed by storage losses. Other stages of the value chain like drying, transportation, quality testing, and milling and short term storage were observed to be low loss points (LLPs).

The below table indicates the quantitative and qualitative loss points along with the extent of losses across the various steps in the FSC. The description of the losses and the associated causal factors have also been captured based on the findings of the field study.

| FSC # Rice | | | |
|---|---|---|---|
| **Step in the FSC** | **Expected Loss Points (CLP/LLP)** | | **Comments/ Remarks** |
| | **QNT** | **QLT** | |
| **Harvesting and Threshing** | CLP, 6 % | LLP ,<1% | Gaps in technical know-how on usage of machines and lack of on-time availability of machines<br>At the farm level, 30- 35 bags of paddy (each bag weighing 75 kg of paddy) is harvested per ha, and loss is approximately 2- 3 bags. |
| **Drying** | LLP, 0.2% | | Open and manual drying exposes the grains to feeding by birds, and admixture of dust/ stones, contributing to grain breakage during milling. |
| **Transportation** | LLP, 0.5% | _ | Paddy is transported from farm to mill and losses occur as pilferage during loading/ unloading. |
| **Quality Testing (Miller level)** | _ | _ | Sample lots are drawn for quality testing. If quality is found below the standards, the entire lot is rejected. |
| **Milling** | LLP, <0.1% | | Mills are modernized and operate using rubber hullers, minimizing the losses caused due to milling. |
| **Storage (At Mills)** | LLP, 0.2-0.5 % | CLP, 3% | -Quantitative and qualitative loss observed, % depending on the duration of storage. The % has been calculated basis the storage time for 6 months or more and the level of hygienic conditions for storage.<br>-For a medium sized mill with a storage capacity of >5000 MT of rice; for one season, the mill stores 20,000- 25,000 bags for Government channel (each bag weighing 50 kg); and 120,000 bags for the private channel (each bag weighing 25 kg).<br>Loss of approximately 240-600 (0.3%) bags for Government channel and 60-75 (0.3%) bags for the private channel observed. |
| **Transportation** | _ | _ | No loss during transportation of rice (plastic bags packing) |
| **Storage at CWC warehouses** | | CLP, 2-3% | -Depending on the duration of storage, quality loss occurs due to sub-optimum storage conditions leading to discoloration, grains breakage, moisture loss<br>-In CWC warehouse with a storage capacity of ~30,000 MT of rice; storing 400,000 rice bags (50 kg bag), 7,000 to 10,000 bags of rice are lost due to improper storage conditions. |
| **Storage at MLS points** | _ | _ | Stock turnover ratio is within 20 days, thus no storage loss at this point observed |
| **Storage at FCI Warehouse** | LLP, 0.2 % | _ | % obtained directly from representative officials, and not on the basis of observation. [Restricted entry into FCI warehouse premises for observation] |
| **Distribution (Fair Price Shops)** | LLP, 0.01-0.05 % | _ | Pilferage at the time of distribution has been observed. The loss at Fair price shop minimal due to e- Public Distribution system (e- PDS) in place. |
| **Distribution (Wholesale/Retail)** | - | - | Pilferage losses occur only when sold in unpackaged form |



## 2. THE FOOD SUPPLY CHAIN – SITUATION ANALYSIS

### a. Description of the selected subsector supply chain, its location, an estimate of the quantities of products, and when the case study took place

The study was conducted in East Godavari and Nellore districts of AP during May to July, 2016. The preliminary survey was conducted in May followed by detailed survey in June in East Godavari; whereas, in Nellore, the study was done in July. The scheduling of the field visits was as per the seasonality of FSC viz. late harvesting threshing of Rabi rice, peak months of milling activities in May, June, July respectively. Cultivation season of paddy in East Godavari district is Kharif (June-October) and Rabi (Dec-April) whereas in Nellore, the seasons are early Kharif (April-August) and Rabi (October –March).

In the surveyed areas, the rice supply chain is highly organized and both the ***public distribution system*** (PDS) and the ***private channels for marketing exist***. Large farmers directly supply their paddy to the mills reducing their middlemen cost whereas the smallholder farmers sell their produce to mills via village level aggregators (VLAs). The mills after processing supply to government warehouses or to the wholesalers.

The region comprises of small (<0.5 MT/day), medium (0.5-2500 MT/day) and large (>2500 MT/day) mills. The small mills are engaged at the village level where they offer milling services to clients who use the milled rice for household consumption whereas the medium and large mills cater to the milling needs of government and commercial market.

The percentage recovery of rice and other intermediate and by-products from paddy across the FSC is provided in the below table.

OUTPUT II-3a (INTERMEDIARY) PRODUCTS AND CONVERSION FACTORS IN THE FSC

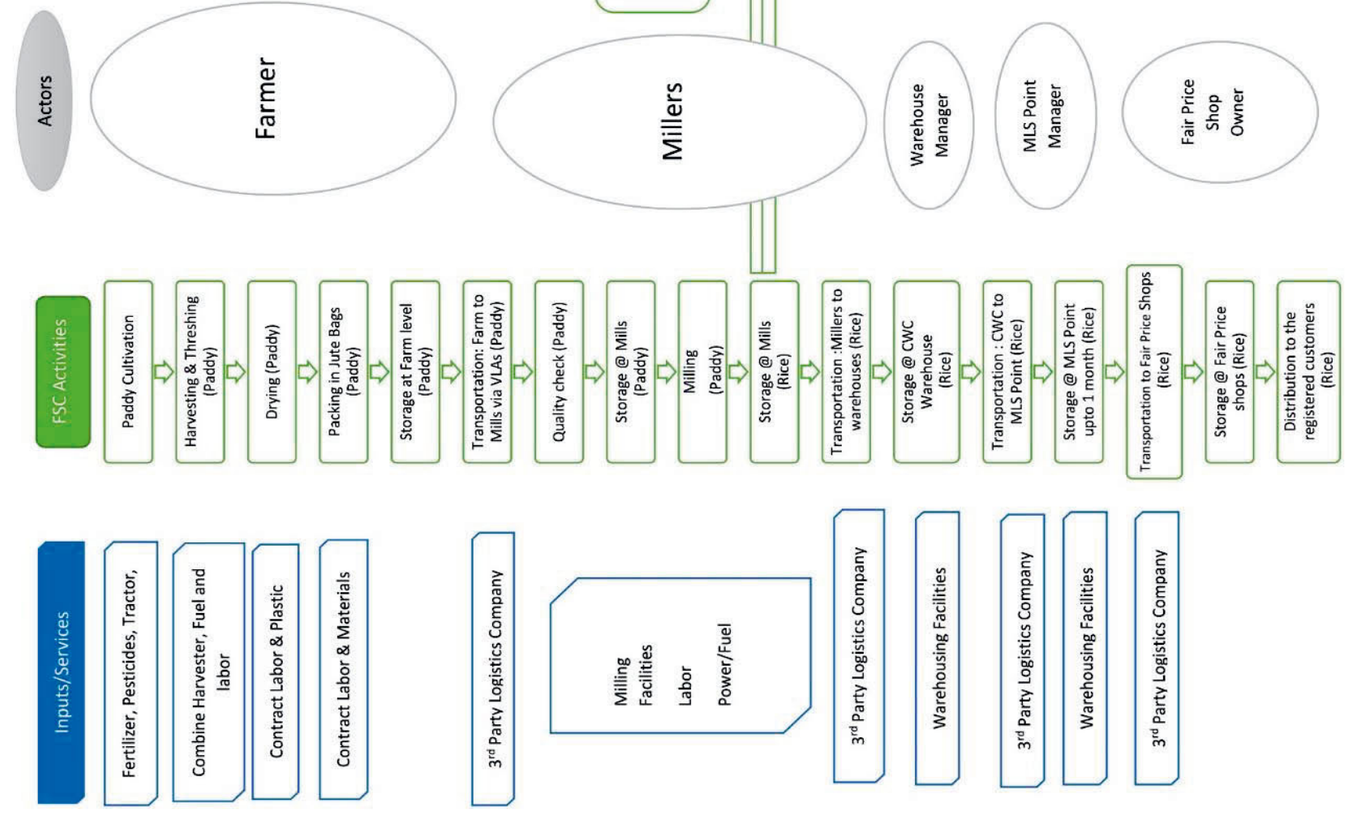
| **Activity in the process** | **Duration** | **Product out** | **Weight from 100 in Kg** | **Error (± %)** | **Conversion Factor in %** |
|---|---|---|---|---|---|
| Milling-Polishing | These steps are continuous processes | Rice | 60 | 5 | 60-65 % |
| Milling-De husking | | Rice husk | 20 | 5 | 20-25 % |
| Milling-De hulling | | Rice Bran | 6 | 2 | 4-6 % |
| Milling-Grading | | Broken Rice | 12 | 4 | 12-16 % |
| Milling-Grading | | Waste Rice | 2 | 3 | 2-8 % |

The description of the flow of the products across the various steps in the FSC along with the services provided and the duration of each activity is provided in the below table. The FSC starts from the village level and ends at retail points. The entire process of production (120 days) is followed by processing (within a month) and storage for future consumption which extends to a year or more.

Referring to the lot of paddy entering a particular rice mill with the production of rice and other intermediaries, the table below shows the flow of products along the FSC.

## OUTPUT I-3a: FLOW DIAGRAM OF THE SELECTED FSC

A pictographic representation of the value chain of rice is shown below:




## OUTPUT II-3B DETAILED DESCRIPTION OF THE FOOD SUPPLY CHAIN - BASICS

| FSC stage | Location East Godavari | Months of the year | | Main Products | Qty. (tonne) | By- Products | Qty. (tonne) | Duration (Days) | Services |
|---|---|---|---|---|---|---|---|---|---|
| | | From | To | | | | | | |
| Primary production | Dwarapudi | Jul | Oct | Paddy | 912,500 | | | 120 | Irrigation, Transplantation, Weeding |
| Harvest | | Nov | Nov | | | Straw | | 10 | Combine harvester |
| Post-harvest handling | | Nov | Nov | | | | | 4-5 | Labour |
| Storage | | Nov | Dec | | | | | 10-12 | Warehousing |
| Transportation | | Dec 1st week | | | | | | 7 | Transport |
| Milling | Peddapuram | Dec | Mar | Rice | 620,500 | Husk | 182,500 | 15 | Milling Services |
| | | | | | | Bran | 36,500. | | |
| | | | | | | Broken Rice | 109,500 | | |
| | | | | | | Waste Rice | 18,250 | | |
| Storage | Rajahmundry | Dec | Jun | | | | | 180-360 | Storage at warehouses |
| Market sales | | Throughout Year | | | | | | 360 | Sale |
| **FSC stage** | **Location Nellore** | **Months of the year** | | **Main Products** | **Qty. (tonne)** | **By Products** | **Qty. (tonne)** | **Duration (Days)** | **Services** |
| | | **From** | **To** | | | | | | |
| Primary production | Varigonda | Oct/Nov | Feb/Mar | Paddy | 61,320 | | | 150 | Irrigation, Transplanting, Weeding |
| Harvest | | Mar | Mid-Mar | | | Straw | | 10-15 | Combine harvester |
| Post-harvest handling | | Mid-Mar | April 1st week | | | | | 4-5 | Labour |
| Storage | | April | Aug | | | | | 6 | Warehouses |
| Transportation | | April | | | | | | 7 | Transport |
| Milling | Nellore | Mar | May | Rice | 41,080 | Husk | 12,264 | 15 | Milling Services |
| | | | | | | Bran | 2,452.8 | | |
| | | | | | | Broken Rice | 7,358.4 | | |
| | | | | | | Waste Rice | 1,226.4 | | |
| Storage | | Mar | Aug | | | | | 180-360 | Storage at warehouses |
| Market sales | | Throughout year | | | | | | 360 | Sale |

It was observed that in rice value chain following actors play a major role: Farmers as the basic supplier of paddy, VLAs, rice processing industries, warehouse managers, distribution agents, and retailers.

- **Farmers:** Primary stage of the rice supply chain is managed by the farmers who supply paddy to the rice processing companies, both directly and through intermediaries. Typically a farmer handles cultivation, harvesting, threshing, drying and packing of paddy.
- **Operators of combine harvesters:** Harvesting operations are manual as well as mechanical. Manual harvesting is more prevalent during the *Kharif* season when rice is cultivated under rain fed conditions whereas, during *Rabi* season under irrigated condition, mechanical harvesters are deployed for harvesting the paddy crop.

  Manual harvesting is done by both men and women. Mechanical harvesters are preferred as they help to address the crisis of labour availability during peak agriculture season. Though mechanization has a positive impact on the farmer, the people engaged as agriculture labour are facing a challenge as their livelihood is being replaced by machinery.
- **Labourers:** The labourers are engaged in production, drying and packaging during cultivation of paddy, loading, unloading during transportations and various operations during milling and processing of paddy. Transplantation of rice is completely women driven activity. Men are seldom involved in transplantation. Women involvement can also be seen in weeding and drying. Harvesting is mostly mechanized and the operators of the machines are men. Most of the post-harvest practices are male dominated and women are only involved in cleaning and sometimes in packaging.
- **Village Level Aggregators (VLAs):** VLAs play an important role in rice value chain as they are responsible for the procurement of paddy for the government as well as the millers. They buy paddy from various farmers in the village and sell it to the millers at a predetermined price. A single village has one or two aggregators who collect the produce from the entire village. They are also responsible for transportation of the harvested paddy from field/farmer storage to the processor. Though the transportation charges are included in their commission, the VLA is accountable for the physical transfer of the product. It was observed during the visits that aggregation is a male dominated activity. Only men play the role of VLA in the region.
- **Transporters:** They take care of the transport of paddy from village to mills, mills to market, warehouses and from warehouses to FPS. Transport of rice from one state to another is done by either using trucks or rail network.
- **Processor/Miller:** The processor is the pivot of the supply chain where value addition in primary product occurs. The miller handles the following activities

  i. ***Procurement:*** The processor procures paddy from farmers through village aggregators from multiple villages. In the case of procurement under CMR policy, the government allocates specific regions and quantum to be processed to each miller based on the processing capacity. The allocated amount of paddy is then procured by the processor through VLA and processed.

  ii. ***Quality Testing At Mills:*** Quality lab of mill/processing factories conducts the quality test on the transported paddy. Tests evaluate paddy in terms of moisture level and uniformity of grains, based on which the grains are divided into Common Grade and Grade A. For the purpose of testing, samples are collected randomly using a poking rod which is inserted in the gunny bags, pull out a sample and conduct the test as per recommendation of quality standards by FSSAI.



  iii. ***Processing/Milling:*** Paddy is cleaned to remove unwanted matters like mud, stones, chaff etc. This cleaned lot is then fed to de-husker where with the help of rubber roller, the husk is separated. The brown rice is then taken to huller where polishing is done by mild friction created within the polishing chamber. The resulting polished rice and bran are separated and collected.

  iv. ***Packaging:*** Rice is packed in 50Kg and 25Kg bags for PDS and private sales respectively.

  v. ***Storage:*** The millers store rice that goes to private markets under the brand of the mill.

  vi. ***Transportation:*** Millers transport rice to CWC warehouses through third part transporters whereas wholesalers send vehicles to mills for procuring rice for sale.

- **Warehouse Manager (FCI and CWC)**: They are in charge of organizing the safe and efficient receipt, stockpiling, maintenance and dispatch of the products.
- **Fair Price Shop (FPS) Owner**: Fair price shop owners take delivery of stocks from authorized nominees of the State Governments to ensure that essential commodities are available within the first week of the month and sold to beneficiaries.

### b. Description of the existing marketing systems of the selected subsector supply chain, for small-scale producers

The marketing systems for rice follows two channels viz. the Government system (Public Distribution System-PDS) and the private channel (wholesaler and retailer).

**Government System:** The government allots fixed quantum of paddy to be milled to every registered processor in the state. The millers procures paddy at MSP during the season and processes it. After processing, the miller transports rice to MLS points/CWC warehouses and/or FCI warehouses. Government also allocates specific quantity of rice to different Fair Price Shops to be sold to consumers at highly subsidized rates. The fair price shop owners procure the allotted quantity from MLS point and distribute it to the consumers.

**Private Market System**: The entire produce is not sold at the same time. Some farmers after harvesting store the paddy anticipating an increase in prices. For the private channel, the millers procure the paddy at differential prices taking advantage of the market dynamics and accordingly vary the rates of rice at wholesale points. The usual model followed by the rice in this system is that the rice processors procure the paddy from farmers and sell it to wholesalers who in turn sell it to the retailers. Some of the large processors have their own franchise through which the business is operated. In contrast, some large retailers like Big Bazaar have developed backward integration through which they have established direct procurement from villages and sale to urban customers. The prevailing retail market rates are USD 0.54-0.62 / kg (INR 35- 40) for the common grade rice and goes up to USD 0.92 /kg (INR 60).

### c. FSC actors' involvement and their benefit, including job creation and income generation; economic data of the FSC; environment-related inputs and factors of the FSC

Involvement of men and women along the FSC is dependent on the type of activity being conducted at different stages. All the persons involved in different activities across the value chain are in the working age group of 21-50 years. At the primary production stage, the activities of land preparation, fertigation, and pesticide sprays are done by men. The equipment used by men in carrying out these activities are tractors (land preparation), diesel operated pump sets (irrigation) and hand sprayers (pesticide sprays). However, the activities like nursery raising, transplantation of paddy are done by women. Harvesting is male dominated activity and is conducted by employing third party operators (combine harvesters). The crop is harvested in presence of the farmers. The involvement of women post-production activities are limited to cleaning at the mills and wholesale levels whereas they are engaged in sales in retail stores and large market chains like Big Bazaar, Spencer etc. and to some extent in rural *kirana* (traders of consumer goods) stores.

When paddy rice is stored at the household level, women's involvement is extended to movement of bags from field to storage point at home and maintenance of the stored paddy. The storage conditions at the household level are moderately good to poor in various households. The storage at different levels

in FSC i.e. millers, state and central government warehouses are operationally handled by men and they perform loading, unloading of paddy/rice, stacking of bags, sprays for pest management whereas women are engaged in cleaning and winnowing activities. The storage conditions in the mills and government warehouses are equipped with good storage conditions. The storage is done in jute or tarpaulin bags.

At the marketing stage, the involvement of women is more in terms of the main activities of sale in both the public and private channels. Fair Price Shops are the major retail places with moderate storage space and conditions. Rural shops, as well as organized, retails chains like Big basket, Big Bazaar, Spencer and More are also involved in retail sales.

In the activities performed by women, in general, their wages are 20-22 % lower than the men for comparable activities in the value chain. A high percentage of the women engaged in aforementioned activities are contract labours. The access of women in FSC to technology and decision making in terms of selection of varieties for cultivation, different cultivation activities and marketing were observed to be minimal during the study. Also, it was observed that in rural areas, men are the head of household and control the income earned by women in the family whereas, in urban areas, women have comparatively greater control on their income.



## OUTPUT II-4: DETAILED DESCRIPTION OF THE FOOD SUPPLY CHAIN – SOCIAL STRUCTURES

| FSC STEPS | Involvement of women | | Involvement of men | | Who is mainly involved: Men, women, children | Organization level of FSC actors | Gender/Social Patterns: Observations and remarks that explain the chosen qualifiers and/or give additional information |
|---|---|---|---|---|---|---|---|
| | Girls | Adult women | Boys | Adult men | | | |
| | Qualifier[1] | Qualifier | Qualifier | Qualifier | | | |
| Primary production | | 3 | | 3 | Men and women | Household | Labor intensive activities are handled by men |
| Harvest | | | | 3 | Men | Private | Harvesting in the selected districts is highly mechanized (60%) and men operate the machinery |
| Post-harvest, handling | | 2 | | 2 | Men and women | Household | Loading of bags handled by men. Women are involved only in stitching of the bags |
| Storage | | 2 | | 2 | Men and women | Household | Storage at farmer level is very low (2%) and is handled by men and women both |
| Transportation | | | | 3 | Men | Private | Transportation is male dominated and is done by village aggregators using tractors, trucks or lorries |
| Agro-processing | | 3 | | 3 | Men and women | Private | Processing is handled by private millers and is well mechanized. The machines are operated by men whereas women are involved in cleaning activities |
| Storage | | 3 | | 3 | Men and women | Private and Government | Physical labor like loading, unloading of paddy/rice is done by men, while women are involved in cleaning and winnowing |
| Transportation | | | | 3 | | Private | Transportation from mills and government warehouses is again male dominated and is done by village aggregators using tractors, trucks or lorries which are hired on contract basis |
| Wholesale | | 3 | | 3 | Men and women | Private | Sale of the packed product as well as loose rice to consumers handled by both men and women. Women are also involved in cleaning activities |
| Retail | | 3 | | 3 | Men and women | Private | Sale of the product is handled by both men and women, cleaning by women and loading/unloading of the stock by men |
| Qualifies for equipment, conditions, access to services and training; 4: excellent; 3: good; 2: moderately good; 1: bad | | | | | | | |

## OUTPUT II-5: DETAILED DESCRIPTION OF THE FOOD SUPPLY CHAIN–ECONOMICS

Maximum value addition in the price of rice occurs at the miller's level for both the marketing systems. With rising cost of production, the farmer has been realizing lesser margins. Rice being a staple food crop, the government intervenes through various input subsidies for fertilizers, seeds and credit to subsidize the crop production costs.

Two scenarios have been presented below to understand the economics of the FSC:

i. Farmer sells to millers under PDS system:

Farmer receives the price for paddy at MSP, and the miller also receives government fixed rate for processing and the rice is sold through fair price shops at highly subsidized rate. Thus the value added margin at every step is not a true representation of the economics of the FSC. The MSP for 2014-15 *Rabi* season was fixed at USD 216.92 per tonne of paddy.

ii. Farmer sells to millers for the private trade system:

For the private market, the miller varies the sale price for paddy with respect to the demand-supply market conditions. At market prices above the MSP, the farmer benefits. The miller bears the processing expenses and transport and sells at prevailing market price. The miller may also store the rice in anticipation of rising price.

In the current market scenario, the farmer realizes higher price in the latter option as the prices paid to the farmers are higher (USD 231 per tonne).

**Scenario 1: PDS system; Farmer sells to millers at MSP**

| FSC stage | Main Products | Cost of production (USD/ton) | Value of products (USD/ton) | Value added/margins (USD/ton) |
|---|---|---|---|---|
| Primary Production | Paddy | 171 | Production at farmer level | |
| Harvest | | 34 | | |
| Drying | | 3 | | |
| Sale to Miller Point (MSP rate) | | | 217 | 9 |
| Transportation | | 4 | At Miller level, Price paid to Miller which is fixed by Govt. | |
| Storage | | | | |
| Agro-processing | | | | |
| Transportation | Rice | | | |
| Storage at CWC | | 1 | | |
| Market sales | | | 15-154 | Prices are subsidized by Govt. |

**Scenario 2: Private market system; Farmer sells to millers at market price**

| FSC stage | Main Products | Cost of production (USD/ton) | Value of products (USD/ton) | Value added/margins (USD/ton) |
|---|---|---|---|---|
| Primary Production | Paddy | 171 | | |
| Harvest | | 34 | | |
| Drying | | 3 | | |
| Sale to Miller Point (Market price; Market price> MSP) | | | 231 | 23 |
| Transportation | | 2 | | |
| Agro-processing | | 18 | | |
| Market sales | Rice | | 385 | 174 |

## OUTPUT II-6a: DETAILED DESCRIPTION OF THE FOOD SUPPLY CHAIN-ENVIRONMENT

Across the FSC, various factors like operation of equipment, use of chemicals, fuels, land, water etc. affect the environment. These factors are as follows

- **Tools, Equipment, Facilities:** A wide variety of equipment and products are required in operations of a particular farm. The rice industry has witnessed a drastic cut in labour needs due to mechanization (tractors, combine harvesters); further labour reductions are expected as automation and digitalization lead to more efficient production. Mechanization at drying and storage level is still at a very nascent stage. There is a large scope for improvement in terms of infrastructure development at farmer level storage.
- **Chemicals:** Different pesticides used during cultivation and storage are listed in the table below. Farmers usually spray more than the optimum need for management of disease pests, which then either remain as residues in the product or runs off with the run-off water and affects the soil and water streams.
- **Energy:** Rice milling industry is one of the most energy consuming industries. A typical processing unit involves dehusking, dehulling, polishing and sorting. The major energy consuming equipment in the rice milling units are boilers and steam distribution, sorter, polisher, blowers, pumps, conveyers, elevators, motors, transmission systems, weighing, etc.
- **Water:** Water consumption is as high as 3000 liters for the production of 1 kg of rice. Major water consumption in rice chain were observed at production and processing stage. At production level, rainwater and irrigation water are necessary for rice growth in two ways: to maintain soil moisture and – in wet irrigation – to maintain the standing layer of water over the paddy field. In the selected regions, the crop is grown using irrigated water. An advantage being, part of the water used in wetland farming percolates back to ground reestablishing the balance in the water table. However, the flooded irrigation is a major source of GHG emissions and ads to the salinity of soil over the years. Water is utilized at processing for cleaning the paddy, to produce steam and to boil rice. Usually, the used water is discharged into open fields without treatment. This further leads to ground water pollution.

| Production | | Quantity | Unit |
|---|---|---|---|
| **Tools, Equipment, Facilities** | Tractor (for small to medium farms) Diesel operated | 1 | Per ha |
| | Combine Harvester Thresher (small to medium farms), Diesel operated | 1 | Per ha |
| **Materials** | Seeds (Varieties for medium to long duration) | 15 | Kg/ acre |
| **Chemicals** | Fertilizers | | |
| | i. Nitrogen (basal and top dressing) | 120 | Kg/acre |
| | ii. $P_2O_5$ (basal dose) | 60 | Kg/acre |
| | iii. $K_2O$ (top dressing for long duration varieties) | 40 | Kg/acre |
| | **Fungicides:** Carbendazim, Edifenphos 50 EC, Tricylozole, Hexaconazole **Insecticides:** Profenofos, Monocrotophos, Acephate Buprofezin, Carbofuran, Cartap hydrochloride | 10-12 | Sprays per season |
| | **Weedicides:** Pre and Post-emergent (0- 10 DAT) Pretachlor/Oxadiazil/Butachlor/Phyzosulfuron/ Ethoxysuluron/Visphyricivax, | 1-2 | Applications per season |
| **Energy** | Diesel (Tractor + Irrigation pump set) Consumption varies with area of operation, no. of irrigations required) | 7-10 L | Per ha |
| **Water** | Crop Paddy consumes the maximum amount of water (Irrigation + milling) | 3000-4000 | L/Kg of rice |
| **Land** | Gross cropped area (GCA) for Paddy in AP | 86,14,768 | Ha |
| **Storage (Millers, warehouses)** | | **Quantity** | **Unit** |
| **Tools, Equipment, Facilities** | Captive storage with use of pallets for elevation, ventilators, plinth, stack size and rodent traps | Varying capacity ranging from 50 – 250 MT (small) to above 2000 MT (large) | |
| **Materials** | Gunny bags (for Government procurement and private), Plastic bags (for private channel only) | 1<br>1 | 75 Kg (jute bags)<br>50 Kg (plastic bags) |
| **Chemicals** | ○ Fumigants Dichorvos (DDVP) to be sprayed once in 20- 30 days<br>○ To control stored grain insect pests (weevil, beetle, borer etc.)<br>i. Deltamethrin 2.5% WP sprayed once in 3 m<br>ii. Malathion sprayed once in a fortnight | 3 L for 100 $m^2$ area on floor and open spaces not on bags<br><br>Deltamethrin @1200 g/ ha<br><br>1 L/270 $m^3$ | |
| **Energy** | Electricity consumption is minimal and is limited to general administration of the warehouses, activities like spraying are done in daylight conditions | NA | |
| **Transportation from Farmer to Mill; and Mill to Warehouse** | | **Quantity** | **Unit** |
| **Tools, Equipment, Facilities** | Lorries/ Trucks (Diesel operated); Rail tracks for intra-district and intrastate transport | 17 MT | Load (FCI), varied for private purpose |
| **Energy** | Diesel for transportation; Consumption varies with distance | 4 km/L | Trucks |
| **Processing** | | **Quantity** | **Unit** |
| **Tools, Equipment, Facilities** | Dryer, Hullers, Rollers, DE stoner, Boilers, Conveyor belts, Sorter, Polisher and Packaging machine | Varying capacity | |
| **Materials** | Raw material paddy | | |
| **Chemicals** | Chalk for rice polishing | | |
| **Energy** | ○ Rice husk for boiler and/ turbine system<br>○ Additional Thermal energy to meet balance requirement | 437.5 | kWh/ t of paddy |
| **Water** | - | - | - |
| **Wholesale/ Retail** | | **Quantity** | **Unit** |
| **Tools, Equipment, Facilities** | Store premises | Varies with area of store | |
| **Energy** | Electricity consumption for running of store | NA | |



## *OUTPUT II-6b: FACTORS FOR THE ENVIRONMENTAL ASSESSMENT*

The factors considered for environmental assessment were grouped in farming practices (land preparation, soil quality, water use efficiency and GHG emission) and processing activities (water use and reuse, utilization of by-products, energy efficiency). The water use in cultivation was observed to be a major challenge as the cultivation in East Godavari is done in continuously waterlogged fields leading to increased emission of GHG gases especially methane ($CH_4$). Another source of GHG emissions and other pollutants like dust and smoke are the processing operations at both the small scale and large mills. As far as the reuse of byproducts from processing is concerned, the larger mills were observed to operate more efficiently, like the use of rice husk in the boiler for energy generation, transport of fly ash to brick kilns etc.

The GHG emission is dominated by the methane emissions from the paddy field and other field emissions (mainly Nitrous Oxide) also contribute significantly. Second largest emissions occur during parboiling because the heat is sourced by burning the rice husk. Due to incomplete combustion, a fraction of the carbon is released as methane, which is 25 times more potent as a GHG than carbon Methane emissions occur on an area basis and the higher the yield, lower the emissions per MT of the final product.

| Factors | Description | Details |
|---|---|---|
| Production system | Rainfed and Irrigated | Both the productions systems are used |
| Land preparation practices | Intercultural operations (like puddling) | Disturbs the soil structure affecting the soil micro fauna |
| Soil quality and land degradation | ▪ Nutrient Depletion<br>▪ Soil erosion<br>▪ Application of Pesticides | ▪ Usually, water logged farming is practiced in these areas. During draining along with the water the nutrients are also drained out of the soil leading to nutrient deficiency in the soil.<br>▪ Waterlogging leads to soil salinization. -<br>▪ Run off from farm contaminates the soil, thereby degrading the soil health disturbing the soil micro fauna. |
| Fertilizer manufacture and utilization | ▪ Fertilizers containing Nitrogen, Phosphorus and Potassium are commonly used for paddy cultivation. | ▪ Fertilizer run-offs into streams, canals or ponds results in algal bloom leading to eutrophication<br>▪ Application of fertilizer causes ground water pollution as part of fertilizer accumulates in the soil or is lost as run-off, increasing the nitrate level of soil and water.<br>▪ Application of fertilizers also significantly contribute to greenhouse gases as they emit $N_2O$<br>▪ Moreover, the manufacture of fertilizer is also very energy intensive |
| Water regime | ▪ Water intensive crop<br>▪ Water pollution | ▪ Double cropping system depletes the water table.<br>▪ The water discharged from field & processing units is untreated. This water further seeps into the water table and contaminates it. |
| Sources of GHG emission and particulates | Paddy cultivation and milling Units and Combine Harvesters | GHG ($CH_4$, $N_2O$) emission: 9-12%<br>Particulates: Smoke and dust from mills and loading- unloading |
| Utilization of residues in the supply chain | Biomass rice husk is used to fuel the boilers | Bioenergy which reduces the dependency on fossil fuel, reducing $CO_2$ emission. |
| | Fly ash generated is sent to brick kilns or road construction | |
| | Water used in production of electricity | Though observed at few mills, this reduces the release of refuge in to groundwater reducing the environmental impact |
| Re-use of food losses | High recovery % of rice from paddy and less broken rice | Broken rice is further processed to rice flour or rava at smaller mills |

## 3. THE FOOD LOSSES – STUDY FINDINGS AND RESULTS

### a. Description of the FSC: risk factors

Paddy cultivation and the various activities associated with it to ensure the supply of the end product to consumers was observed to involve multiple actors and factors which could lead to potential food losses. The specific risk factors i.e. parameters and variables associated with critical and low loss points across the rice value chain are listed in Output II-7.

### OUTPUT II-7: FOOD LOSS RISK FACTORS

FL = parameter a × variable x;
FL transport (%loss) = a (%loss/hour) × x (hours of transport);
FL Storage (% loss) = a (% loss/month) × x (months of storage)

| Variable | Unit | Parameter - relation to food losses-Contributing to Low loss | Value of variable (observed in the case study) |
|---|---|---|---|
| Variety | Name | Non-Shattering Varieties | Both Shattering and Non-shattering varieties |
| Good agricultural practices | Yes/No | Yes | Selection of High yielding varieties from established sources, irrigation, proper doses of fertilizers, pest management and harvesting techniques |
| Rainfall during cultivation | mm | 175-300 | 318.7-768.1 (East Godavari)<br>331.3-661.4 (Nellore) |
| Optimum Temperature during cultivation | $^0$ C | 20-40$^0$ C | 26-38$^0$ C |
| Harvest technology | L/M/H | High level of mechanization | Medium |
| Operation of combine harvesters | L/M/H | High skill level of operator | Low |
| Processing Technology | L/M/H | High output processing | High output processing |
| Good maintenance practices at mills | L/M/H | High-Regular maintenance practices | Medium and High quality |
| Packaging materials | L/M/H | High Quality | Medium and High quality |
| Packaging practices | L/M/H | High Quality | High quality |
| Transport practices | L/M/H | High Quality | Medium Quality |
| Transport duration | Short/Long | Short | Short (1- 3 hours) |
| Good Storage Practices | L/M/H | High level of implementation | Medium and High level |
| Storage Duration | Short/Long | Short | - Short (paddy)<br>- Long (milled rice) |
| Price Incentive for better Quality (optimum moisture content, no immature grains, no discoloured grains) | Yes/No | Yes | Yes |
| Knowledge of FSC actors | L/M/H | High | Low to Medium knowledge level |
| Consumer access to the product | L/M/H | High | High |

Legend: Y/N = yes / no; L/M/H = low / medium / high



The key variables affecting the food losses in the rice value chain can be categorized at farmer level (post-harvest operations), transporter (transportation of paddy or milled rice), millers (milling and processing), warehouses (storage) and retailing. At the farmer level crop varieties, good agricultural practices, rainfall during cultivation and harvest, the timing of harvest/post-harvest operations, and the method of harvesting were observed as food loss risk factors which if managed efficiently will lead to a reduction in losses. Most of the mills present in the selected geographies utilize modern machinery. Transportation distance and duration for the primary (paddy) and the end (Milled rice) products are short were observed to be of short duration. Good storage practices are followed at the miller, government warehouse, and marketing channels.

### b. Critical Loss Points: type and level of food losses in the subsector

An overview of the food losses in milled rice subsector is provided in Output III-10. The critical loss points are summarized in Output III-3b

*Output III-3b: Critical loss points and level of losses*

At harvesting and threshing, farmers reported that they lose 2-3 bags per ha against the yield of 28-30 bags per ha. Likewise, during storage at mills, some of the surveyed mill owners mentioned that the qualitative storage losses for the paddy ranges between 2-4 % and these are exacerbated by the intake of paddy with higher moisture content for mechanical drying and processing. The below table has been derived by computing average of the responses received. Thus, the loss percentages are indicative and not uniform across all mills. Losses of CWC has been derived based on our discussion and observations in the surveyed geographies.

| Critical Loss Points | Product | Type of loss | Percent Loss |
|---|---|---|---|
| Harvesting and Threshing | Paddy | Quantitative | 7 - 10 |
| Storage* at Mills | Paddy | Qualitative | 3 |
| Storage at CWC warehouse | Paddy | Qualitative | 2 - 3 |

* The storage losses reported are based on the data provided by representatives and are for long term storage (6 months or more)


**Food loss points in Rice FSC**

**Case Study II: Harvesting & Threshing Losses**

Subarao, a farmer from Nalluru, owns 5 acres of land, all of which is under paddy cultivation. The average yield per acre is around 3.75 MT in Kharif season and 2.25 MT in Rabi. Until recently Subarao harvested paddy manually, but now he uses combine harvesters for harvesting and threshing activities. Scarcity of farm labour and high labour cost have driven this change. Subarao says that he paid USD 61 per acre and it took 2 days to harvest one acre and now he has cut down his cost to USD 49 per acre and harvesting is complete in 1.5 hours. The combine harvester is supplied by a 3rd party service provider who charges rent on an hourly basis. Although Subarao is happy that mechanization has improved farming he has concerns about the operational efficiency of the machine. It has been observed that while harvesting/threshing the machine doesn't ensure complete separation of grains from straw. The farmer has observed that around 225 kg of paddy per acre is lost during machine harvesting. Also compared to manual harvesting, combine harvester is harsh on the crop which results in higher percentage of broken. Despite the fact that there are certain drawbacks in mechanization the farmer still prefers to use it as he perceives it to be the more economically viable solution.

## III-8a: QUALITY SCORING OF FOOD PRODUCTS

The quality scoring of the rice grain was been done on a scale of 0 – unfit for consumption (to be discarded) and 9 – fit for consumption. The reasons and symptoms of the poor quality of grains during observation of samples at the miller level are listed in Table III-8b. The market value of the paddy (USD 215 per tonne) and for milled rice (USD 385 per tonne) are the reference points of reduction in market value of the food products.

| **PRODUCT:** | **Paddy/Rice** | |
|---|---|---|
| Quality score | Description of the quality | Percentage reduction of market value |
| **0** | High pesticide residues | - |
| **1** | Immature and green coloured grains | - |
| **2** | Presence of foreign matter or weevilled grains beyond prescribed limits | 2 % |
| **3** | Damaged grains | 1 % |
| **4** | Moisture exceeding 16 % | 2 % |
| **5** | Discoloured grains | 0.5 % |
| **6** | Presence of admixture beyond permissible limits | 0.5 % |
| **7** | Polished rice- Common Grade | - |
| **8** | Polished Rice – Grade A | - |
| **9** | Superfine grains with no impurities/residues | - |

* No Quality check for pesticide residues done at the miller level. The quality checks for pesticide residues are done for export purpose only. It is assumed here that products with higher quality scores have lower pesticide residues.

The first point of quality check is the arrival of paddy for processing at mills. The millers pay a lower price for the inbound stock when (a) there is high moisture content (>16%) in grains and (b) grains are immature and green colored. The mills do take paddy for processing if the moisture level is > 16% (optimum is 14%) but the price to farmers is reduced by 2% (USD 4.3 per tonne) due to the additional cost involved for drying by the millers. Additional quality checks are carried out when the stocks arrive at warehouses for storage. Moisture is the only criteria checked for stock intake for processing at the miller level, but inspectors from central (FCI) and state (CWC/MLS points) government also conduct frequent checks for chemical contaminants at governmental storage points during storage time and suggest preventive or curative measures to minimize losses in stored paddy or milled rice.



## III-8b: QUALITY ANALYSIS OF SAMPLED UNITS

Load tracking has not been conducted in this study. The challenges of the critical stages which did not allow for load tracking is provided below:

a. Harvesting and threshing: Tracking is not feasible as mechanized harvester cum thresher were being used in the field, thus no sampling can be conducted before the event as it is a standing crop in the field.

b. Milling: The processors follow a continuous process of milling; each mill catering to several villages.

c. Storage at Miller or Government warehouse: Rice is stored for longer term (at least 6 months), this limits the study of load input and output for the sample.

## OUTPUT III-10: SUMMARY RESULT MATRIX OF FOOD LOSSES

The results of food loss assessment in rice value chains are summarized in Table III-10. The percent reduction in the market value at each stage is derived from the value of primary (paddy- USD 215 per tonne) and end products (rice- USD 385 per tonne).

### c. The causes of these losses and identified (potential) loss reduction measures

Higher losses in rice occur at the stages where less skilled actors are involved, who have low or no perception of the economics of the losses and are not able to minimize or eliminate the losses. At several stages across FSC, the losses can be reduced by the capacity development of the actors and simultaneous supervision of the activity by the skilled actors.

**Farmers:** Farmers are the first link in the supply chain of the rice and perform production related activities. Harvesting and postharvest operations (drying and packaging) of paddy are the keys to reducing losses down the supply chain as the quality of the product after milling is dependent on moisture content and mature grains. When the activities done at farmer level are not done efficiently, their effects trickle down to processing and storage. However, high losses occur at these stages due to

- Timing of harvesting during the day
- Rains at crop maturity
- Shattering of grains due to very dry panicles and/or type of varieties
- Failure in complete separation of panicles from the rice straw due to variations in operating efficiency of the combine harvesters
- Skill level of operators of combine harvesters
- Spillage of grains during drying or scattering of grains by birds or cattle
- Inclement weather during drying (grains reabsorb moisture leading to fissure of grains)
- High moisture content (>14%) in the packed rice
- Excessive use of pesticides for disease management may lead to pesticide residues leading to rejection at a later stage in FSC

**Warehouse operators:** The storage losses were not very high as the storage is a short duration (3 days-1 month) for distribution purposes and better management practices are being adopted by millers and government (CWC and FCI) warehouses for long term storage. The causes of losses identified are

- Moisture loss especially during long term storage,
- Poor storage infrastructure, ventilation, poor stacking or no stacking, and
- Inadequate method of insect, rodent, and pathogens (fungal) control measures

In the present study, the storage losses were less due to low storage (2%) at farmer level and better management practices in organized storage operations.

Poor storage conditions like high temperature, high humidity and poor aeration at the warehouses contribute to more losses. The losses can also be attributed to physiological activity in grains leading to discoloration and breakage of rice. It was observed that most of the surveyed warehouses followed good storage practices (platform at raised level, good ventilation, proper stacking on wooden pallets, regular sprays to ward off insects and other pests) leading to low losses. The reasons observed for qualitative losses in stored rice are mainly biological (Pest attacks-weevils, *Aspergillus, Penicillium*) and physiological (respiration). As testing for chemical contaminants is not done at farmer and miller stage during sale or purchase of paddy/ rice, the actors in the early stages of FSC are less concerned about the chemical contaminant residue.

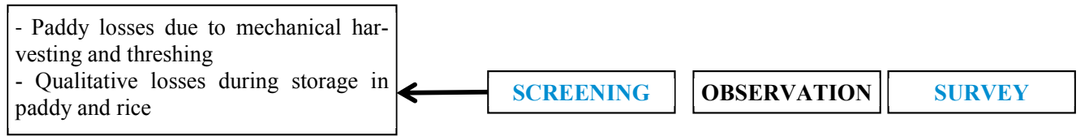


OUTPUT III-10: SUMMARY RESULT MATRIX OF FOOD LOSSES

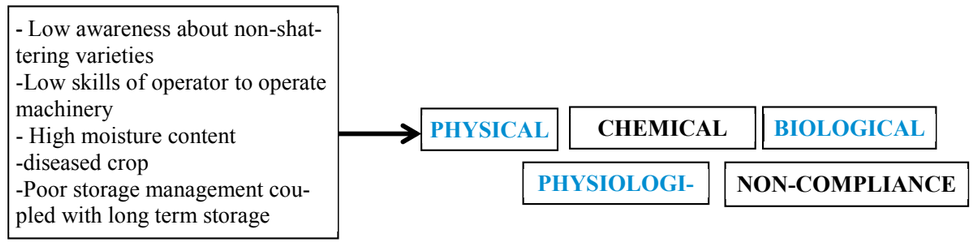
| FSC Stage/Process/Product | Type of Loss (Qnt./ Qlt.) | % loss in this process (Quantity) | %age of the product that incurred quality loss in this process | %age of product that goes through this stage | %age loss in the FSC | Cause of loss/ Reason for low loss | Reduced market value (%) | CLP /LLP | Destination of food loss | Impact/ FSC Actors affected (men/women) | Loss perception of FSC actors (men / women) | Suggested Solutions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Harvesting and Threshing (Paddy) | QNT | 6 | - | 100 | 6 | -Grain shattering -Leftover grains -Machine efficiency | N/A | CLP | Birds, stray cattle | Farmers | Concerned | Capacity building |
| Drying (Paddy) | QNT | 0.2 | - | 100 | 0.2 | Dispersal of grains | N/A | LLP | Birds, stray cattle | Farmers | Less concerned | n/a |
| Transportation (Paddy) | QNT | 0.5 | - | 100 | 0.5 | Spillage during loading/Good transport management practices | N/A | LLP | Garbage | Farmers | | n/a |
| Storage @ mills (Rice) | QNT/ QLT | 0.3 | 3 | 21 | 0.6 | Physiological activity in grains/ Good management practices at storage points | 0.3 | CLP | Cattle feed | Mill owners | Concerned about qualitative losses | Hermetic storage |
| Storage @CWC warehouse (Rice) | QNT/ QLT | 0.2 | 2 | 62 | 1.2 | | 0 | CLP | Cattle feed | Government | | |
| Storage @FCI warehouse (Rice) | QNT/ QLT | 0.2 | <1 | 15 | 0.03 | | 0 | LLP | Cattle feed | Government | | |

## OUTPUT IV-1: CAUSE FINDING DIAGRAM

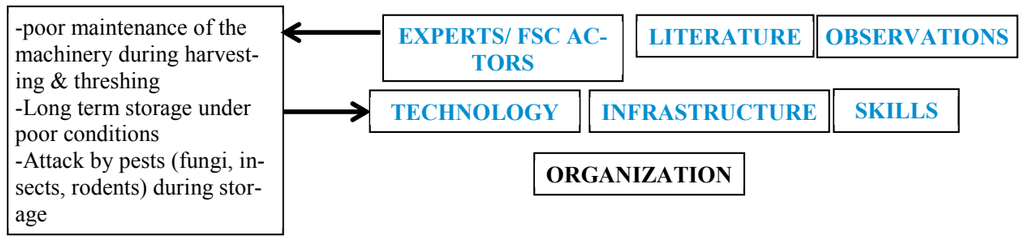
1. Food loss assessment methods have revealed a batch of food products containing critical *losses or product of low quality*.



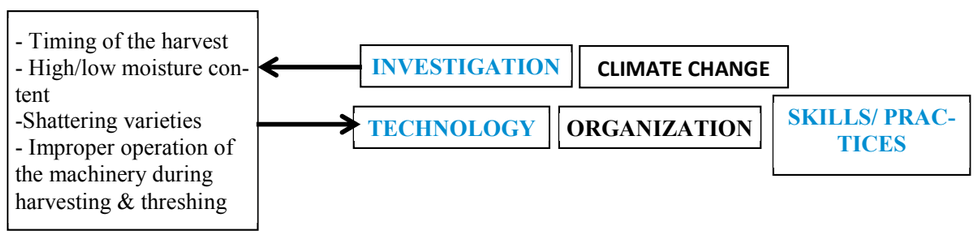

2. Identify and describe the *symptoms* that lead to this quantitative/quality loss.



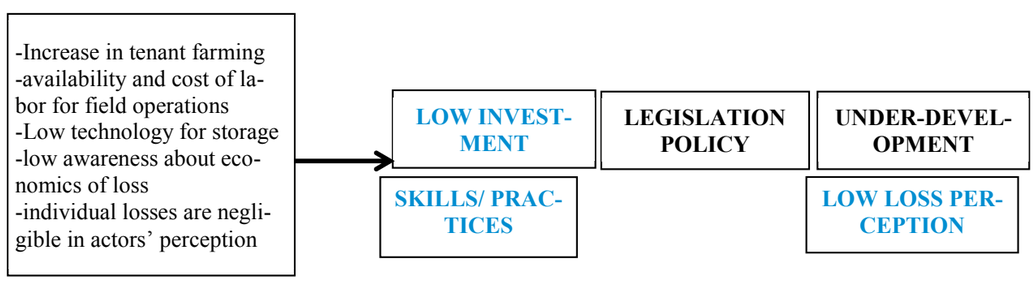

3. Verify the possible *causes* by consultation of experts and literature, and by on-site investigation.




4. Identify the *real cause* of the low quality and subsequent food loss.




5. Find the underlying *reason* for the cause, why the problem hasn't been solved yet.






### d. Low Loss Points, and good practices leading to low food losses

The low loss points were observed at different steps across the value chain and specific practices account for the low losses.

**Drying:** Sun drying at farmer level is done in the open field where paddy is spread on a plastic sheet. It is done for 2-3 days depending on the weather. During rains, the plastic sheet is collapsed and covered with another sheet to protect grains. At miller level, drying, if required, is done using machine dryers which are more efficient and helps to keep the losses low.

**Transportation:** Post-harvest transportation of paddy at different stages (from farmers' fields to mills) as well the transport of rice (from mills to public or private distribution chains via warehouses) is one such LLP accounting for 0.5 % losses. The reasons for the low losses during transportation are the short distances which the transporter need to cover to reach mills and along with the good transportation practices (packaging, loading, unloading and quality checks at miller points to ensure requisite moisture levels) adopted for long distance transportation.

**Milling:** The losses at milling were low because of the modern machinery being utilized at most of the mills. This is backed up by the strict quality checks (moisture % and immature grains) of paddy being carried out during taking the paddy stock in for milling.

**Storage:** Quantitative losses during storage is another LLP accounting for 0.3 % loss. The low losses were observed due to

- Introduction of decentralized procurement of paddy and rice,
- Good storage practices e.g. storage of rice at raised levels, proper ventilation, specific stacking (bags placed alternately), and
- Regular fumigation and pesticide sprays to ward off pests (weevils, *Aspergillus*, *Penicillium* and rodents).

**Marketing and distribution:** The low loss points were also observed at fair price shops, which work as a central point for distribution of rice among other commodities. They receive rice at the end of each month and distribute 90-95% of the stock within 10-15 days of receiving. The quantitative losses at this stage were observed to be 0.01-0.05 % at FPS which occur only due to spillages as all distribution sale is done in loose packets. For wholesale and retail chains, most of the sale happens in sealed bags (tarpaulin/ plastic). Though some sale happens in loose packs also, the cleaning, winnowing and restocking of the spilt grains are more efficient at private channels. In addition, the short storage duration and better management of storage facilities for private channels make this an LLP.

As per the decentralized policy and CMR policy of paddy procurement from farmers, private millers have been engaged and accorded with the critical role of procuring directly from farmers, thus plugging the inefficiencies in the system owing to farmer transporting the produce to mills or storage at farmer level. The millers bring in the efficiency of the private sector and add maximum value to the produce. They are kept on a tight leash by the government by mandating for fixed recovery percentage of rice from the paddy procured, leaving a minimum margin for millers to siphon off produce; Moreover, the target numbers of recovery can be obtained only by modern mills, thus reducing the milling loss. Further to this, with the support of online systems like ePDS, the upstream movement of the stock from miller to government warehouse at the state and the central level is tracked and monitored displaying transparency and efficiency in the system. This intervention has significantly led to the contribution of LLP in the state of AP.

## 4. THE FOOD LOSS REDUCTION STRATEGY-CONCLUSIONS AND RECOMMENDATIONS

### a. Impact of food losses in the selected FSC

The major impact of the food losses is the economic impact for different actors in the value chain. In economic terms, overall loss for different actors in rice value chain is 7 %. The impact on smallholder farmers is higher as the major losses observed are at harvesting and threshing level. This impacts the overall income of the household. The female members of the household are also affected as they have to manage food with less economic resources.

Though the losses in economic terms are also there at the stages of transportation as well as storage, however, the actors in this value chain like transporters, village aggregators and warehouses are not affected directly by the prices of the product at these stages don't vary based on the quantity lost. For example, the price of transportation is fixed for a quantity of rice and is variable only for the distance to be covered to reach the destination. Likewise, for warehouses (which are mostly under government control), the prices are a variable of the duration of storage, fixed at the beginning of storage and not on the quantity that comes out of the storage for transportation to different destinations.

### b. Required inputs and cost-benefit analysis of the food loss reduction measures (for 10 year implementation) identified at the critical loss points; social implications.

**Food loss reduction measures:**

The interventions which can be used to reduce losses at CLP and help lower the negative impact on the environment are as under:

**Harvesting and Threshing**

1. ***Combine Harvester:*** Currently, the combine used in the Andhra Pradesh have an inbuilt engine and take around 40-180 mins to harvest one acre of paddy field costing 2,400 rupees per hour. In most cases, the harvesters used perform shallow cutting which results in residual grains that are wasted. The introduction of advanced combine harvesters into the system which would enable deep cutting will help save the losses during harvesting and threshing.

2. ***Capacity Building*** of farmers and operators of combine harvesters: Due to untimely harvesting at high moisture content, the grains need excessive drying before processing, leading to higher storage losses. Capacity development program should focus on master trainers from each rice producing village to sensitize them about harvesting at the right maturity period of paddy, specific moisture content required for harvesting and strict monitoring for the mechanical harvesting. Operators of combine harvester can be trained on improving the efficiency of machines. In addition, capacity building efforts will also cater to train farmers on good agriculture practices (GAP) for paddy cultivation.

**Processing**

3. ***Single polished or brown rice in PDS:*** Rice is main food among south Indian adults, providing at least half of the total calories consumed. Currently, the rice consumed is double polished rice which contributes to high glycemic load (GL). Higher dietary GL is positively associated with type 2 diabetes risk. In the traditional south Indian diet, carbohydrates were typically derived from 'under milled' grains such as hand pounded, which has been replaced by polished 'white rice' (refined grain, 8% polish). Although this has led to increase in rice yield (due to modern milling technology) and lowering storage losses it reduces the nutritional value of the cereal. This is a major concern as most of the current day population are victims of either malnutrition or diabetes and coronary artery diseases. In order to help save this situation, a potential solution suggested in the consultative workshop is the distribution of brown rice through public distribution system. While most consumers' prefer polished white rice, education regarding health benefits may help this population switch to brown or undermilled rice. One significant constraint that hinders distribution of brown rice is that it is more susceptible to pest attack. The introduction of better pest control mechanisms tailor made for brown rice will help in increasing its shelf life. Implementation of this intervention would mitigate the burden of the health hazards in the state.



**Storage**

4. ***Hermetic storage*** at farmer level (Superbags-50 kg) or commercial cocoons (5 - 1000 MT) for milled rice at warehouses and mills is a viable solution. where either can be used to provide air tight conditions for stored grains.

5. ***Metallic (galvanized steel) or concrete silos:*** Improved infrastructure like ***metallic (galvanized steel) or concrete silos*** for rice storage could provide a solution for the warehouse operators. Small metallic silos technology for smallholder farmers is already being implemented in many countries as an effective solution and efficient method of reducing post-harvest grain losses. Since the storage losses observed at the farmer level (in the study) are very low (2%), no solution has been proposed for this stage.

   FCI has developed a plan to pilot the steel silos for storage of rice in Bihar and based on the success will expand to other states including AP.

| **Projected Construction of Silos in Andhra Pradesh (Phase III)** | |
|---|---|
| **Centre** | **Capacity in MTs** |
| Srikakulam | 100,000 |
| East Godavari | 100,000 |
| West Godavari | 100,000 |
| Krishna | 50,000 |
| Total | 350,000 |

6. ***Farmer Producer Organizations:*** To create and promote economically viable, democratic, and self-governing Farmer Producer Organizations (FPOs).The FPO's should provide end to end linkage. This will enable farmers to enhance productivity through efficient, cost-effective and sustainable resource use as well as obtain higher returns for their produce, via better access to the markets. This can be achieved through fruitful collaboration with academia, research agencies, government, civil society and the private sector. These FPO can function on 5 point agenda:

   i. Capacity Building: Strengthening farmer capability through agricultural best practices for enhanced productivity.

   ii. Quality Inputs: Ensuring access to and usage of quality inputs, credit and other services at affordable prices for enhanced production.

   iii. Storage: Invest and operate community storage and drying facilities.

   iv. Value Addition: Facilitate tie up with processors for value addition of the produce.

   v. Market Linkage: Facilitating access to fair and remunerative markets including linking of farmers to marketing opportunities through market aggregators

### OUTPUT IV-2a: BUDGET CALCULATION FOR FOOD LOSS REDUCTION

We considered different solutions and strategies to control food losses at the critical loss points i.e. harvesting-threshing (quantitative) and storage (Quantitative and Qualitative). The major challenges faced by us in assessing the solutions are the low loss perceptions of the actors, thus not realizing and exhibiting concerns for the loss points. This was aggravated at the farmer level by their lack of knowledge about the methods to reduce the losses. Likewise, the mill owners are happy as long as they

are making a profit. The two interventions proposed hereunder are based on the economic considerations, inclusiveness and positive environmental impact. The cost-benefit analysis of the proposed solutions has been done for the two districts under study.

Considering a sustainable environment friendly intervention, we are proposing for use of solar powered portable training kits, which will also help to address power outage in villages in a greener way and an uninterrupted smooth training. Additionally, the other solution proposed viz. hermetic storage is also an eco-friendly technology involving no hazards to storage operators, consumers, and non- target organisms. This technology also limits the use of insecticidal admixture procedures or fumigations.

## OUTPUT IV-2a.1: LOSS REDUCTION AT HARVESTING AND THRESHING STAGE

In the study, the quantitative losses were observed to be maximum (6%) at harvesting and threshing using combine harvesters. We propose the capacity building of farmers and machine operators to reduce the losses by 30 % at this stage. For each village, one master trainer will be selected, and the training will be provided to them by ARS, KVKs. The master trainer will focus on the training of the farmers in these villages with the aim of educating the farmers about type and name of varieties to use to minimise or eliminate shattering of grains

a. Timing of the harvest in terms of specific time periods in a day, grain maturity
b. Moisture Assessment of the grains before harvesting

In addition, the training for the operators of combine harvester will be focused on the maintenance of the machine for better operational efficiency and reduce harvesting and threshing losses. The calculations for the capacity building efforts are shown in the table below:

| | Item | Value | Unit | calculation |
|---|---|---|---|---|
| a | Product quantity | 4,979,286 | tonne/year | Total paddy produced in East Godavari and Nellore |
| b | Product value | 215 | $/ton | |
| c | Loss rate | 6% | % | |
| d | Anticipated loss reduction | 30% | % | |
| e | Cost of intervention (training of trainers) | 149,840 | $ | (No. of Villages * No of Training per Village *Cost of training) |
| f | Depreciation | 10 | years | |
| g | Yearly costs of investment | 14,984 | $/year | e / f (for 4 months) |
| h | Yearly costs of operation per season (training of farmers) | 280,950 | $/year | (Cost of training* No. of Villages * No. of training per season) |
| i | Total yearly costs of solution | 295,934 | $/year | g + h |
| j | Client costs per ton product | 0.059 | $/ton | i / a |
| k | Food loss | 298,757 | ton/year | c * a |
| l | Economic loss | 64,232,789 | $/year | k * b |
| m | Loss reduction | 89,627 | ton/year | k * d |
| n | Loss reduction savings | 19,269,836 | $/year | m * b |
| o | Total Client costs | 295,934 | $/year | a* j = i |
| p | Profitability of solution | 18,973,902 | $/year | n - o |



## OUTPUT IV-2a.2: BUDGET CALCULATION FOR FOOD LOSS REDUCTION BY HERMETIC STORAGE

The quantitative losses (0.2 - 0.3%) during storage are low loss points in the present study, however, the factors affecting the quantitative losses are also leading to qualitative losses which is a critical loss point at 3%. We are proposing hermetic storage of rice by the use of Cocoons, with a life cycle of 15 years for commercial storage at various points for a longer duration (6 months - 1.5 years). The calculations are done for one cocoon for 5 MT of rice.

In addition to reducing the quantitative loss, the hermetic storage eliminates the use of pesticides, thereby, eliminating the harmful effects of chemicals used.

**5 MT cocoon (Source: IRRI Knowledge bank)**

The initial investment costs are higher than conventional storage, however, both tangible and intangible benefits are manifold. The major ones are as follows

a. The original storage moisture content can be maintained because the grain cannot absorb moisture from outside. This will reduce qualitative losses.
b. The damage caused by pests can be reduced as there will be no oxygen, so any pests inside the cocoon are quickly killed.
c. No chemical sprays are needed to control insect attack thus benefiting the environment from harmful effects of insecticides and reduce the cost of pesticides and labour cost for its spray.
d. It suppresses aflatoxin and other grain-infecting moulds.
e. As the grain gets sealed off from the air, rodents cannot smell the grain. This reduces attacks from rodents.

The calculations for the hermetic storage of rice are given in the table below and are based on per unit cost provided by the representative from Grain Pro.

| Intervention: Hermetic cocoon (No subsidy provided by Govt.) | | | | |
|---|---|---|---|---|
| | **Items** | **Value** | **Unit** | **Calculation** |
| a | Product quantity | 8,400,000 | ton/year | Annual AP rice production |
| b | Product value | 385 | $/ton | |
| c | Loss rate | 3.3% | % | Quantitative and Qualitative |
| d | Anticipated loss reduction | 80% | % | As per empirical data of pilot projects |
| e | No. of 5 MT cocoons required | 1,680,000 | Units | |
| f | Cost of intervention | 1,663,200,000 | $ | Cost of cocoon($ 1,100); Further Discount of 10% on cocoon price due to bulk purchase |
| g | Depreciation | 15 | years | Life cycle of a hermetic cocoon |
| h | Yearly costs of investment | 110,880,000 | $/year | f / g |
| i | Yearly costs of operation | 2,307,692 | $/year | Negligible, Considered as an organic approach to storage; Only Labour charges in stacking considered(Assumption: Labour charges =500 Rs per person per day, 30 working days are spent on restacking and 10,000 storage points across the state |
| j | Total yearly costs of solution | 113,187,692 | $/year | h+i |
| k | Client costs per ton product | 13 | $/ton | j/a |
| l | Food loss | 277,200 | ton/year | a*c |
| m | Economic loss | 106,722,000 | $/year | l*b |
| n | Loss reduction | 221,760 | ton/year | l*d |
| o | Loss reduction savings | 85,377,600 | $/year | n*b |
| p | Total Client costs | 113,187,692 | $/year | j |
| q | Profitability of solution | (27,810,092) | $/year | o-p |



| Intervention: Hermetic cocoon (50% subsidy provided by Govt.) | | | | |
|---|---|---|---|---|
| | **Items** | **Value** | **Unit** | **Calculation** |
| a | Product quantity | 8,400,000 | ton/year | Annual AP rice production |
| b | Product value | 385 | $/ton | |
| c | Loss rate | 3.3% | % | Quantitative and Qualitative |
| d | Anticipated loss reduction | 80% | % | As per empirical data of pilot projects |
| e | No. of 5 MT cocoons required | 1,680,000 | Units | |
| f | Cost of intervention | 831,600,000 | $ | Subsidized @ 50%; Cost of cocoon($ 550); Further Discount of 10% on cocoon price due to bulk purchase |
| g | Depreciation | 15 | years | Life cycle of a hermetic cocoon |
| h | Yearly costs of investment | 55,440,000 | $/year | f / g |
| i | Yearly costs of operation | 2,307,692 | $/year | Negligible, Considered as an organic approach of storage; Only Labour charges in stacking considered(Assumption: Labour charges =500 Rs per person per day, 30 working days are spent on restacking and 10,000 storage points across the state |
| j | Total yearly costs of solution | 57,747,692 | $/year | H + i |
| k | Client costs per ton product | 7 | $/ton | j/a |
| l | Food loss | 277,200 | ton/year | a*c |
| m | Economic loss | 106,722,000 | $/year | l*b |
| n | Loss reduction | 221,760 | ton/year | l*d |
| o | Loss reduction savings | 85,377,600 | $/year | n*b |
| p | Total Client costs | 57,747,692 | $/year | j |
| q | Profitability of solution | 27,629,908 | $/year | o-p |

## OUTPUT IV-2a.3: BUDGET CALCULATION FOR FOOD LOSS REDUCTION- SILOS

Another bulk storage solution used globally is the storage in metal silos. Though at present, metal silos are being used for storing grains like maize and wheat, for rice, the use is not yet widespread. The economics provided here is for the storage of grains in metal silos with a capacity of 50,000 MT. The project cost is estimated to be USD 482323 for development steel silos consisting four bins of 12,500MT of capacity each. The land of about 7 acres would be required for the development of bulk storage.

| Description | Amount (USD) |
|---|---|
| Land & Site Development | 1,077 |
| Building and Civil Works | 2,224,046 |
| Plant and Machinery | 1,487,615 |
| Electrical Automation and Other utilities | 442,308 |
| Preliminary & Pre-operative expenses | 336,569 |
| Contingency | 207,754 |
| Total Cost | 468,585 |
| Taxes | 13,738 |
| Total Capital Cost | 482,323 |

The metal silos can be used for several years with proper maintenance and have following advantages over bag system of storage currently being practised in India.

1. This method requires less ground space, which is important if space is not available or if its cost is high like at ports.
2. Easy it is to maintain optimum storage conditions for the grain, by controlling the temperature, insects, mould, birds, which in long term storage facilities could result in an important economic loss.
3. Lower costs than that incurred from using warehouses, which entails the automation of the grain transport equipment. The loading, as well as the unloading, can be completely automated using a Supervisory control and data acquisition (SCADA) system and at a lower cost.

FCI has already piloted the wheat storage in silos with a positive experience and observed that quality of wheat stocks even after 5 years are excellent, fumigation and insect control is excellent with zero residues. When compared to traditional warehouse, silos are more efficient as evident from the below table

**Comparison of silos and flat warehouses**

| Silos | Traditional Warehousing |
|---|---|
| Erection cost of USD 92-105 per MT | Erection cost of USD 53.8-120 per MT |
| Commissioning with 8-12 months | Completion time 1-2 years and more |
| Mechanical process for bulk handling | Huge manpower cost |
| Small land required | Land requirement 2-3 time that of silos |
| Lower maintenance cost | Regular repair required |
| High degree of automation | No Automation |
| No requirement of multiple bagging | Huge cost incurred in multiple bagging |
| Quality monitoring at all stages with minimum human interference | No such provisions |

As we propose for new interventions, it is imperative to factor the negative impact afflicted on any group of actors due to the solution. This will help to keep the social implications at the minimum. A transition plan should be in place with components detailing on volume of such actors, estimates on damage caused, alternative opportunities along the FSC or scope for diversification to other activities, support in terms of skill development for related job activities, employment opportunity, counselling etc. Such a plan should be backed by Government support and sensitized till the village level machinery. As the impact is foreseen at the village level, sound communication strategy for outreach will play a vital role.

The proposed capacity building programmes emphasize the critical role of training women, to ensure inclusiveness. To ensure greater acceptance of the role of women and the impact the training will generate especially on women, the following approaches can be adopted:



- Integrate gender perspectives in policies, programmes and projects
- Educate public with statistics backed information disaggregated by sex
- Strengthening collaborations with Civil Society Organizations like Women Self Help Groups (SHGs) to be pivotal in driving the efforts to make women come forward
- Gender-linked budget: Will include incentives to encourage participation of women
- Widespread local level campaigning both formal like posters, meetings at village panchayat etc. and informal means like street shows, wall paintings etc.

OUTPUT IV-2b: Assessing social implications of specific food loss solution suggestions

| **(How) Does the suggested solution …** | **Description of the potential impact** | **Gender dimension of the impact (how women and men may be affected differently)** | **Suggestions to mitigate negative impacts** |
|---|---|---|---|
| **Farmer Producer Organizations** | | | |
| 1. …impact the employment situation of FSC actors? | Will make the employment situation more organized | Both men and women will gain better access to inputs and markets | - |
| 2. … increase or reduce the workload of FSC actors? | No impact | | |
| 3. …raise or increase the need for training to apply solutions? | increase the need for training and capacity building | Women participation in FPO should be encouraged. | - |
| 4. …distribute benefits to the FSC actors? (income access and control) | Income of individual farmers will increase | VLA's commission rates may get revised | - |
| 5. …impact dynamics of power in the FSC? (WHO has ownership of solutions?) | Farmers | No impact | Will give more power to producers leading to better opportunities |
| 6. …cause for some actors' exclusion from the FSC activities? | VLA might be excluded as FPO will directly be involved in value addition of rice. | Women can be included as administrators of FPO(s) | Employment of the VLAs in the value chain might be a challenge |
| 7….impact the environment adversely? | Water conservation | No impact | |

| (How) Does the suggested solution … | Description of the potential impact | Gender dimension of the impact (how women and men may be affected differently) | Suggestions to mitigate negative impacts |
|---|---|---|---|
| **Capacity Building** | | | |
| 1. …impact the employment situation of FSC actors? | The training and the technology will provide more employment at village | Will help in involving women for capacity building efforts | - |
| 2. … increase or reduce the workload of FSC actors? | Reduce the workload as new trainers will be developed | Addition of master trainers will also include women members | - |
| 3. …raise or increase the need for training to apply solutions? | Will increase the need for training. Training the trainer model will include key farmers and machine operators | Women trainers will need to be approached separately | Woman trainers will be able to connect to their counterparts in a better way |
| 4. …distribute benefits to the FSC actors? (income access and control) | Income of the farmers will be increased by reducing the losses and for machine operators also by improving operation efficiency. | Management of household economics by women will be better due to increased cash flow and storage owners can improve their operational efficiency with higher income | - |
| 5. …impact dynamics of power in the FSC? (WHO has ownership of solutions?) | Agricultural institutes with government support will own the solution | Women extension workers will play an important role in reaching out to women farmers and workers | Increased engagement of women extension workers |
| 6….take into consideration mobility restrictions of FSC actors? | Movement for training purposes is a very critical phase of the success of solution | Mobility for women trainers will be a challenge | Incentives to women extension trainers for higher engagement |
| 7. …coincide with cultural and social norms and will be culturally and socially acceptable? | Adoption of suggested solutions through trainings will take some time to be accepted | Women trainers will find it challenging to conduct trainings initially | Improve the socio-cultural acceptance of women trainers with the FSC actors |
| 8. …cause for some actors' exclusion from the FSC activities? | Solution is more inclusive and don't exclude any actors from the FSC | Inclusion of women in the training is an integral part of the solution | - |
| 9….impact the environment adversely? | There will be no additional burden on the environmental impact of rice cultivation. | No negative influence on gender | - |



| (How) Does the suggested solution … | Description of the potential impact | Gender dimension of the impact (how women and men may be affected differently) | Suggestions to mitigate negative impacts |
|---|---|---|---|
| **Hermetic storage** | | | |
| 1. …impact the employment situation of FSC actors? | Will reduce the no. of labourers involved in fumigation and sprays | Men being the household head and losing source of income will impact the family | Policy reforms to engage unemployed labour or provide alternative avenues |
| 2. … increase or reduce the workload of FSC actors? | Workload for storage workers will be reduced | Women involved in cleaning activities at warehouses will have more time on their hand due to less cleaning efforts by improving the storage efficiency | Diversifying into other activities or crops will engage these people |
| 3. …raise or increase the need for training to apply solutions? | Will increase the need for training for proper operation of hermetic storage | Women members can also be included in training for monitoring of various parameters in cocoons | |
| 4. …distribute benefits to the FSC actors? (income access and control) | Income of the storage owners will increase as a result of reduced losses | Storage owners can improve their operational efficiency with higher income | - |
| 5. …impact dynamics of power in the FSC? (WHO has ownership of solutions?) | Storage owners/agencies will own the solutions | No impact | Doesn't change the dynamics of power from existing scenario |
| 6. …cause for some actors' exclusion from the FSC activities? | Some labourers will be excluded | Men involved in chemical sprays will be excluded and women as monitors of parameters in cocoons can be included | Diversifying into other activities or crops will be worked out to engage these people |
| 7….impact the environment adversely? | The recommended solution will positively affect the environment by reducing or eliminating the chemicals from storage operations. | Women will not be impacted by the storage solutions | Maintenance of the hermetic cocoons need to done carefully for prolonged life |

| (How) Does the suggested solution … | Description of the potential impact | Gender dimension of the impact (how women and men may be affected differently) | Suggestions to mitigate negative impacts |
|---|---|---|---|
| **Silos** | | | |
| 1. …impact the employment situation of FSC actors? | Will reduce the no. of labourers involved storage handling and management | Number of women involved in cleaning will be reduced | Use of labourers in other activities |
| 2. … increase or reduce the workload of FSC actors? | Decrease the workload of labourers as well as quality inspection team due to automation | No impact | Time availability for staff need to be utilized in other activities |
| 3. …raise or increase the need for training to apply solutions? | Will increase the need for training for proper operation of silos | Women members can also be included in training for monitoring of various parameters | |
| 4. …distribute benefits to the FSC actors? (income access and control) | Income of storage owners will increase | Storage owners can improve their operational efficiency with higher income | - |
| 5. …impact dynamics of power in the FSC? (WHO has ownership of solutions?) | Storage owners/agencies will own the solutions | No impact | Doesn't change the dynamics of power from existing scenario |
| 6. …cause for some actors' exclusion from the FSC activities? | Some labourers will be excluded as a number of activities will be automated | Women can be included as monitors of various parameters for storage in silos | Employment of men labourers in other activities will be a challenge |
| 7….impact the environment adversely? | The recommended solution will positively affect the environment by reducing or chemicals from storage operations and their more efficient use. | Women will not be impacted by the storage solutions | Maintenance of the silos need to done carefully for prolonged life |



**OUTPUT IV-3: SUMMARY TABLE OF FOOD LOSSES, CAUSES AND SOLUTIONS**

| Critical Loss Point | Magnitude of losses in the FSC | | | Cause of loss | Intervention to reduce losses | Loss reduction | | Cost of intervention (USD) | Implications | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % age | Weight (tonne) | USD | | | % age | USD | | Economic | Social | Food security | Environmental and climate change | Policy |
| Harvesting &Threshing | 6 | 298,757 | 64,346,224 | timing of harvest, shattering varieties, machine maintenance | Capacity Building | 30 | 19,303,897 | 951,624 | Increased income | Skilled workforce | Improved | Positive | - |
| Storage | 3.3* | 277,200 | 106,722,000 | moisture loss, pest attacks | Hermetic storage | 80 | 85,377,600 | 113,187,692<br>57,747,692 | Increased income | Reduced labor | Improved | Positive | -<br>Subsidizing purchase of cocoons |
| Storage | 3.3* | 277,200 | 106,722,000 | moisture loss, pest attacks | Metal silos | 50 | 16,431,842 | 482,323.08 | Increased income | Reduced labor | Improved | Positive | Use of silos for storage |

* Includes both qualitative and quantitative losses

## Good Practices observed in the Rice Value Chain:

Insurance schemes to cover Post-harvest loss:

As per the Pradhan Mantri (PM) crop insurance scheme, popularly known as 'Pradhan Mantri Fasal Bima Yojana, launched in 2016, insurance cover has been provisioned to cover post-harvest loss for crops at farmer level. The scheme entails coverage for loss due to cyclones or unseasonal rains till after two-three weeks post the harvest of crops, when the crop is left to dry on the fields. In the state of AP, under the Modified National Agricultural Insurance Scheme (MNAIS), paddy is covered for both the seasons viz. Kharif and Rabi for post-harvest loss. Loss/ damage to the crop in 'cut and spread' condition is considered on an individual basis, thus it is essential that affected farmers should submit claim intimation within 48 hours. The scheme reflects the gradual and increasing emphasis of government on the post-harvest loss.

Decentralized rice procurement policy:

As mandated by this policy, the state government is responsible for procuring paddy directly from the farmers on behalf of the Central Government. Though the policy was launched by Centre in 1996- 97, it was adopted by AP government in 2012. Under this policy, the government is in the process of setting up its own centers in the catchment area of the paddy villages to further increase efficiency in the procurement of paddy. The state government also stores and distributes the food grains under PDS and welfare schemes. This has helped to control losses during transit and increasing food availability and supplying grains more suited to local taste. However, currently, as the government has limited infrastructure for procurement and storage, the model is being implemented in a PPP mode involving the private sector, to drive the supply chain with efficiency.



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| **Expert name** | **Title/ position** | **Institution** |
| Dr. Shaikh N. Meera | Consortium Principal Investigator & Senior Scientist | Directorate of Rice Research, Hyderabad |
| Dr. Amtul Waris | Principal Scientist | |
| Dr. B. Nirmal | Scientist | |
| Dr. S. Krishnam Raju, | Principal Scientist (Rice Pathology) | Agricultural Research Station (ARS), ANGRAU, Maruteru, West Godavari |
| Dr. M. Ramabhadhra Raju | Scientist | |
| Dr. K.V. Seetaramaiah (Breeder at ARS, Maruteru) | Dean | College of Agriculture, ANGRAU, Rajahmundry |
| Dr. B. Suryanarayna | Principal Scientist and Breeder, Rice | ARS, ANGRAU, Nellore |
| Mr. B. Ravi | Mandal Development Officer | Department of Agriculture, Rajahmundry, Government of AP |

Annexure: Itinerary

| Preliminary Visit to East Godavari | | | | |
|---|---|---|---|---|
| **Dates (mm/ dd/ yyyy)** | **Itinerary** | **Address** | **Designation** | **Key Contact Person** |
| **5/6/2016** | Rabi paddy Harvest season: Visit to paddy harvesting farms | Dwarapudi, East Godavari | Farmer & Trader | Bandara Krishna |
| | | Dwarapudi, East Godavari | Farmer | Pokala Bangaraya |
| **5/7/2016** | Visit to Mills | Nalluru, East Godavari | Owner, SRLSN Mill | |
| | Rabi paddy Harvest season: Visit to paddy harvesting farms | Nalluru, East Godavari | Farmer | Penumurthi Subarao |
| | | Nalluru, East Godavari | Farmer | Srinivas |
| **5/12/2016** | Key Informant Interview | Hyderabad | Scientist, IIRR | Dr.Bnirmal |
| | | | Principal Scientist, IIRR | Dr.Amtul Waris |
| | | | Scientist, IIRR | Dr.Shaikh N.Meera |
| **Field Visit to East Godavari** | | | | |
| **Dates (mm/ dd/ yyyy)** | **Itinerary** | **Address** | **Designation** | **Key Contact Person** |
| **6/7/2016** | Key Informant Interview | Mandapeta | M.A.O, Mandapeta | Mr.Ravi |
| | Stakeholder interaction: Farmers, Traders, Commission Agents | Village: Palatodu | Farmer | Srinivas Sharma, A.Krishnamurthy, Y.Satyanand Raju |
| | Key Informant Interview | Rajahmundry | HOD, College of Agriculture | K.V.Seetharamaiah |
| **6/8/2016** | Stakeholder interaction: Farmers, Traders, Commission Agents | Village : Ankapalem | Farmer | P.Subarao, Prasad Rao, R Prasad, G.Satyasai |
| | | | VLA | Satyanaryana |
| | | Village : Adduru | Farmer | B.Ravi, Kameswara Rao |
| | | | VLA | Venkataratnam V |
| **6/9/2016** | Visit to Rice Mills | SVRI, Peddapuram | Director | Sriram |
| | | Srilalita Enterprises,Peddapuram | Executive Director | M. Adishankar |
| | | Sirius rice mills | Manager | - |
| | | Tapeswaram | Owner | Choda Paparao |
| **6/10/2016** | Visit to Central Warehouse | CWC warehouse,Rajahmundry | Manager | Satyanaryana |
| | Visit to Wholesale outlets | Rajahmundry | Owner | Ramakrishna |
| | Key Informant Interview | RARS,Maruteru | Principal Scientist | Dr.Krishnan Raju |



| Field Visit to Nellore | | | | |
|---|---|---|---|---|
| **Dates (mm/ dd/ yyyy)** | **Itinerary** | **Address** | **Designation** | **Key Contact Person** |
| **7/4/2016** | Visit to Mills | Nellore | Sri Radha Krishna Mills | Mr. Kiran |
| | Key Informant Interview | Office of the Joint Director of Agriculture Mini By-Pass Road, Ramamurthy Nagar, | Joint Collector & Addl. District Magistrate | A. Md. Imtiaz |
| **7/5/2016** | Key Informant Interview | Nellore | HOD | Dr.Y. Suryanaryana |
| | Key Informant Interview | SpeakIndia (NGO) | Manager | Mr. Shameer Shaik |
| **7/6/2016** | Meeting with Civil supplies Authorities | District Office, Nellore | Section Officer | P.V.Kondaya |
| | | | Assistant Section Officer | Laxmi Narayan Reddy |
| | | | Quality Supervisor | Sunilla |
| **7/7/2016** | Field visit | Varigonda | Farmer | V.V Govardhan Reddy |
| | | Varigonda | Farmer | Harshavardhan Reddy |
| | | Varigonda | Farmer | Subareddy N |
| | | Varigonda | Farmer | Srinivasulu U |
| | | Varigonda | Farm Labour | Kaushalaya |
| **7/8/2016** | Meeting with stakeholders in Public Distribution System | Harinathapuram, Nellore | Owner, Fair Price Shops | Narsimha Rao |
| | | Gundlapalem, Nellore | Manager, Fair Price Shops | Ravi |
| | | Nellore | Manager, CWC Warehouse | N.P.Reddy |
| | | | MLS Point | Narayan Reddy |
| | | | Manager, FCI Warehouse | |

[i] Rice production in China was recorded as 206 million MT; Rice production in India was recorded as 157 million MT (Year 2014; Source: faostats)

[ii] Global Rice production: 740 million MT; Indian rice production: 120 million MT; AP rice production: 8.4 million MT (Year 2014; Source: faostats)

[iii] Rice production in AP: 8.4 million MT Rice consumption in AP: 7.5 million MT (Year 2013- 14, NSSO, Sathguru calculations)

**SAVE FOOD**
Global Initiative on Food Loss and Waste Reduction
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