



## **Enhancing Farmer Income through Value Addition to Rice in Khammam District, India**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. Author WJS has carried out the work and drafted the manuscript. Author JHK has monitored the writing of manuscript. Authors PJMR and YGP overviewed the writing of manuscript. All authors read and approved the final manuscript.*

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### **ABSTRACT**

Rice is the staple food to half of world's population providing more than one fifth of the calories consumed worldwide. Cereal grains are rich sources of phenolic compounds present in cell walls that help in combating many life style diseases occurring due to oxidative stress. Rice has been domesticated more than 10000 years ago but even today the farmers prefer selling freshly harvested paddy at a lower price. Few entrepreneurial farmers have come up with the idea of primary processing the paddy as semi polished and brown rice that can fetch them more profits along with providing health benefits. Each Kg of paddy, white, semi polished and brown rice cost Rs. 17 – 18.50, 46 – 48, 58 – 60 and 65 respectively. Similarly, one Kg of brokens get Rs. 15, bran Rs. 12 during season and Rs. 20 during off season.

The rice without any processing fetched the farmer profit of about Rs. 24400 to 36000 on an average per acre. But if the farmer subjected the rice to primary processing and sold as white, semi polished or brown rice, the profits generated per acre were Rs. 57156 – 66480 Rs. Rs. 82996 – 102400 and Rs. 105910 – 120400 can be generated.

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As can be seen the decrease in processing produced lower quantity of brokens and bran and income from them was comparatively lower than on processed rice indicating that there can be rise in income with minimal processing with added health benefits. There can an increase in profits by 4 to 5 times due to primary processing benefiting the paddy growers. The white, semi polished and brown rice can increase the income of farmer by 76.92, 127.79 and 161.58% per one bag of paddy weighing 75 Kg. There was a significant decrease in brokens and bran produced in semi polished and brown rice that actually fetch less prize than the actual produce. The growing awareness of consumers towards health foods, improved eating habits and health consciousness is expanding brown rice market at higher compounded annual growth rate (CAGR) compared to overall rice market.

**Keywords:** Rice; free radicals; value addition; primary processing and income generation.

## 1. INTRODUCTION

Rice is the most important staple food for a large part of the world's population providing more than one fifth of the calories consumed worldwide by the humans. It is grown in at least 114 countries with global production of 645 million tons and Asian farmers contributing about 90% of this total produce. It contains appreciable quantities of nutrients like protein, fat, dietary fiber, minerals like iron, potassium, zinc, etc. [1].

Rice has shaped the culture, diets and economics of millions of people around the world. For more than half of the humanity "rice is life" and due to its importance, the United Nations declared 2004 as the International year of rice (adopted on December 16, 2002; [www.fao.org/ag/irc](http://www.fao.org/ag/irc)).

Domestication of Asian rice (*Oryza sativa* L) variety by humans started more than 10,000 years ago resulting in a series of rice culture developments over the millennia and making it the most important staple food crop for more than half of world's population [2].

Historians believe that *indica* variety of rice was first domesticated in the foot hills of the Eastern Himalayas, stretching from Burma, Thailand, Laos, Vietnam to Southern China whereas *japonica* variety was domesticated from wild rice in Southern China and was later introduced to India. Perennial wild rice appeared around 1400 BC in Southern India after it was domestication in the Northern plains and spread to all the fertile alluvial plains watered by rivers. The term 'rice' may be derived from the Tamil word '*arisi*' [3].

The inseparable link of agriculture with climatic variables, impact of climate change on agriculture and food security has been at the forefront of the research and policy agenda in

recent times [4] as climate change will have an economic impact on agriculture including changes in farm profitability, prices, supply, demand, trade and regional comparative advantages [5].

The multi-faceted interactions between humans, microbes and the rest of the biosphere increased the concentration of greenhouse gases like CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O in the atmosphere causing global warming along with a cascading consequence that include shift in abiotic factors like rainfall pattern, melting of ice, rise in sea level, depletion of ozone layer, rise or fall in temperature, salinity, osmotic stress, floods, drought and so on [6].

Rice is already growing in areas where temperature has reached optimal for its growth and any additional increase in day or night temperature or exposure to high temperature during sensitive stages effects the rice yields [7]. It is estimated that the increasing temperature would reduce rice production by 41% at the end of this century. This change can potentially introduce greater sensitivity to previously unaffected developmental stages like panicle initiation, spikelet differentiation, gametogenesis and flowering stage [8].

The high temperature at the flowering stage of rice can result in failure of pollination due to poor theca dehiscence and increased sterility thereby resulting in a significant decrease in number of seeds and grain yield [9]. The high temperature stress during grain filling stage reduces the assimilate supply from shoot to grain, shortens grain filling duration and ultimately affecting the grain yield. Also, there can be reduced utilization of additional non-structural carbohydrates in the sink, despite increased assimilate supply from leaves and reduction in starch metabolism enzymatic activity [10].

There are also changes in life style due to globalisation and industrialisation that is causing oxidative stress leading to imbalance between reactive oxygen species and antioxidant defences of the body. This alterations of the normal redox state of cells can cause toxic effects leading to development of chronic life style diseases that affect the health and wellbeing of individuals throughout the life [11].

The overload of these free radicals cannot gradually be destroyed and get accumulated in the body causing oxidative stress causing chronic and degenerative illness such as cancers, autoimmune disorders, aging, cataract, rheumatoid arthritis, cardiovascular and neurodegenerative diseases [12].

All cereal grains contain unique free phenolic compounds with significant amount of insoluble phenolic compounds bound to polysaccharides of cell walls preventing oxidative damage of lipids and low-density lipoproteins, inhibiting platelet aggregation, reducing the risk of coronary heart diseases and cancers caused by reactive oxygen species [13].

As rice is one of the most produced and consumed cereals in the world, it has an important role in the relation between the diet and health. There are several compounds with antioxidant activity in brown rice including phenolic compounds, tocopherols, tocotrienols and  $\gamma$ -oryzanol [14]. The light brown rice consists of soluble total phenols between 38 to 60% [15]. The phenolic compounds are mainly present in the pericarp of rice and milling reduces the concentration of them in the grain [16]. The concentration of total phenolics in the grain has been positively associated with the antioxidant activity and reduction of oxidative stress [17].

Nutritionally brown rice was found to be superior than white rice due to higher content of dietary fiber and micronutrients required by the body in the outer layers that otherwise removed by polishing. The increase in fiber content helps in combating the life style diseases [18].

Although a lot has been said about the health benefits of brown rice and how rice has been of our diets for centuries together, the profits associated with selling brown rice to white rice have not been discussed. The awareness on cost economics can benefit the farmers to enhance their income in the present context of global warming, unpredictable weather conditions and rampant pest attacks. In this context, the present study made an attempt to analyse the monetary benefits associated with selling of primary processed rice by farmers.

## 2. METHODOLOGY

Farmers who are selling primary processed rice in Khammam district were selected randomly to analyse the economics using a simple questionnaire with details on amount of broken, bran and grain obtained due to primary processing as part of on field trails at Krishi Vigyan Kendra, Wyr, Khammam Dt.

The farmers were growing 38 – 40 bags of paddy per acre, when processed as white rice 47 – 49 Kg were obtained that were Rs. 46 – 48 per Kg. Similarly, semi polished rice yielded 49 – 51 Kg at sold at Rs. 58 – 60 and brown rice yielded 53 – 54 Kg sold at Rs. 65 per Kg. These costs of selling each of these mentioned varieties have been analysed and tabulated. Plate 1 displays the white, semi polished and brown rice below.



Plate 1. Types of primary processed rice

### 3. RESULTS AND DISCUSSION

From the time that rice was domesticated for cultivation, it was used in diverse ways and consumed in many forms providing energy along with income to Indian farming community (Directorate of Economics and Statistics, 2008). Table 1 shows the various quantity of products obtained by primary processing of rice.

Usually a farmer in one acre of land produces around 38 to 40 bags of paddy, each weighing cumulatively 75 Kg. Each bag of paddy gives white rice of 45 – 47 Kgs, brokens of 5 – 6 Kgs and bran of 4 – 5 Kgs, semi polished rice of 49 – 51 Kgs, brokens of 3 – 4 Kgs and bran of 2 – 2½ Kgs whereas brown rice of 53 – 54 Kgs, brokens of 2 – 2½ and bran of 0 – 1 Kg after storage for 6 – 12 months. Brown rice is dehulled and used resulting in minimal bran production.

The freshly harvested paddy fetches about Rs. 1300 to 1400 for each bag. The 6 – 12 months stored paddy when processed to white, semi polished and brown rice fetches Rs. 46 – 48, Rs. 58 – 60 and Rs. 65/- per Kg whereas 1 Kg of unprocessed paddy gives the farmer Rs. 17 to 18.5. Similarly, one Kg of brokens was usually sold for Rs. 15 whereas one Kg of bran fetched Rs. 12 during paddy season and Rs. 20 during off season. The brokens gave Rs. 75 – 90, 45 – 60 and 30 – 40 per paddy bag whereas bran gives Rs. 48 – 60, 24 – 30 and 0 – 12 during off season and Rs. 80 – 100, 40 – 50 and 0 – 20 for white, semi polished and brown rice respectively. The white rice fetched between Rs. 2070 – 2256 for 45 – 47 Kgs from 75 Kg paddy bag, whereas semi polished rice gave Rs. 2842 – 3060 for 49 – 51 Kgs and brown rice of Rs. 3445 – 3510 for 53

– 54 Kg as shown in Table 3. The increase in rice yield decreased the by-product production. On an average, the revenue from paddy was Rs. 1350, from white rice Rs. 2390, from semi polished rice was Rs. 3076 and brown rice was Rs. 3529 for the 75 Kg bag including the cost of selling the by-products.

The same has been interpreted for paddy in one acre of land producing 38 to 40 bags which was commonly observed among the farmers considered for the study were discussed below for clearly understanding the need for value addition with primary processing to enhance income generation.

Freshly harvested rice without any processing fetched the farmer an income between Rs. 49400 to 56000 with the cost of cultivation being Rs. 20000 to 25000 per acre. In this context, the farmer gets profit of about Rs. 24400 to 36000 on an average. But if the farmer subjected the rice to primary processing and sold as white, semi polished or brown rice, the income generated per acre were given in Tables 4 to 6. White rice required 2 to 3 times polishing along with dehulling where semi polished rice was subjected to single polishing and brown rice required no polishing.

White rice fetched between Rs. 78660 to 90240 for 38 to 40 bags per acre costing between Rs. 46 to 48 per Kg with average income of Rs. 82156 for 38 bags, Rs. 84318 for 39 bags and Rs. 86480 for 40 bags. The income on brokens and bran also fetched between Rs. 2850 to 3600 and Rs. 3040 to 3840 respectively. On an average the profits of Rs. 57156 – 66480 can be generated.

**Table 1. Generation of edible and by products from paddy**

Products in Kgs	Paddy	White rice	Semi polished rice	Brown rice
Quantity	75.0	45 – 47*	49 – 51*	53 – 54*
Brokens*	–	5 – 6	3 – 4	2 – 2½
Bran*	–	4 – 5	2 – 2½	0 – 1

\* For 75 Kgs of paddy

**Table 2. Revenue generation from produce and by products**

Cost of produce in Rs.	Paddy	White rice	Semi polished rice	Brown rice
Rice	1300 – 1400	2070 – 2256	2842 – 3060	3445 – 3510
Brokens	–	75 – 90	45 – 60	30 – 40
Bran	–	48 – 60* / 80 – 100**	24 – 30* / 40 – 50**	0 – 12* / 0 – 20**
Total amount	1300 – 1400	2273– 2506	2951– 3200	3475– 3582

Brokens per Kg @ Rs. 15 \* Bran per Kg @ Rs. 12 during season

\*\* Bran per Kg @ Rs. 20 during off season

**Table 3. Revenue from one acre of land –Freshly harvested rice**

Cost in Rs.	38 bags	39 bags	40 bags
Rs. 1300	49400	50700	52000
Rs. 1400	53200	54600	56000

**Table 4. Revenue from one acre of land – White Rice**

Cost per Kg Weight in Kg/Bag	38 bags			39 bags			40 bags		
	45	46	47	45	46	47	45	46	47
Rs. 46	78660	80480	82156	80730	82524	84318	82800	84640	86480
Rs. 47	80370	82156	83942	82485	84318	86151	84600	86480	88360
Rs.48	82080	83904	85728	84240	86112	87984	86400	88320	90240
Average	82156			84318			86480		
income in Rs.									
Brokens @ Rs. 15/Kg	2850 - 3420			2925 - 3510			3000 - 3600		
Bran @ Rs. 16/Kg	3040 - 3648			3120 - 3744			3200 - 3840		

Semi polished rice fetched between Rs. 107996 to 122400 for 38 to 40 bags per acre costing between Rs. 58 to 60 per Kg with average income of Rs. 112100 for 38 bags, Rs. 115050 for 39 bags and Rs. 118000 for 40 bags. The income on brokens and bran also fetched between Rs. 1710 to 2400 and Rs. 1216 to 1600 respectively. On an average the profits of Rs. 82996 – 102400 can be generated.

Brown rice fetched between Rs. 130910 to 140400 for 38 to 40 bags per acre costing between Rs. 65 per Kg with average income of Rs. 132145 for 38 bags, Rs. 135623 for 39 bags and Rs. 139100 for 40 bags. The income on

brokens and bran also fetched between Rs. 1140 to 1500 and Rs. 0 to 640 respectively. On an average the profits of Rs. 105910 – 120400 can be generated.

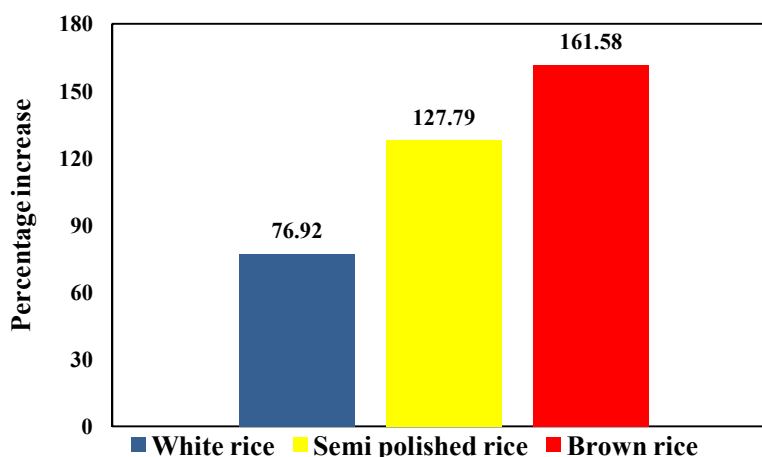
As can be seen in the above tables, with decrease in polishings, the amount of brokens and bran generated too decreased. The income from brokens and bran was comparatively lower than on processed rice indicating that there can be rise in income with minimal processing and more health benefits. There can an increase in profits by 4 to 5 times due to primary processing only benefiting the paddy growers.

**Table 5. Revenue from one acre of land – Semi polished Rice**

Cost per Kg Weight in Kg/Bag	38 bags			39 bags			40 bags		
	49	50	51	49	50	51	49	50	51
Rs.58	107996	110200	112404	110838	113100	115362	113680	116000	118320
Rs. 59	109858	112100	114342	112749	115050	117351	115640	118000	120360
Rs.60	111720	114000	116280	114660	117000	119340	117600	120000	122400
Average	112100			115050			118000		
income in Rs.									
Brokens @ Rs. 15/Kg	1710 - 2280			1755 - 2340			1800 - 2400		
Bran @ Rs. 16/Kg	1216 - 1520			1248 - 1560			1280 - 1600		

**Table 6. Revenue from one acre of land – Brown Rice**

Cost per Kg Weight in Kg/Bag	38 bags		39 bags		40 bags	
	53	54	53	54	53	54
Rs.65	130910	133380	134355	136890	137800	140400
Average income in Rs.	132145		135623		139100	
Brokens @ Rs. 15/Kg	1140 - 1425		1170 - 1463		1200 - 1500	
Bran @ Rs. 16/Kg	0 - 608		0 - 624		0 - 640	

**Fig. 1. Percentage rise in income from selling primary processed paddy**

The percentage increase in the revenue generated was due to primary processing as white, semi polished and brown rice was 76.92, 127.79 and 161.58 on an average as shown in Fig. 1. The farmers selling semi polished and brown rice are few as majority of population still prefer white rice.

The farmers selling primary processed rice reported that 60 to 70% consumers preferred semi polished rice, around 10% brown rice and rest 20% white rice as young children still prefer to eat white rice only. Although a small minority are consuming semi polished and brown rice in this region, demand is picking up in major importing countries and is attracting the interest of innovative farmers to focus on producing brown rice due to increased its nutritional attributes that help combat the prevailing life style disorders.

Although there is substantial increase in the income generated due to primary processing of rice, the farmers end up selling fresh produce due lack of proper storage facilities for 6 – 12 months, increased cost of production, fluctuations in selling price and lack of organised farmer's market.

#### 4. CONCLUSION

The selling of semi processed to brown rice is fetching the farmers better market prizes by 127.79 and 161.58% respectively. The amount of by products like bran and brokens are reduced as they actually fetch less prize than the processed rice in the market thereby improving the crop productivity. Also, increasing preference towards healthy eating habits and growing health consciousness is expanding brown rice market at higher compounded annual growth rate (CAGR) compared to overall rice market. The farmers can be sensitized on the avenues available to them by selling processing rice at higher profits than selling fresh produce. This can be encouraged as a small step in doubling farmers income and help in reducing agrarian distress due to climate change.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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