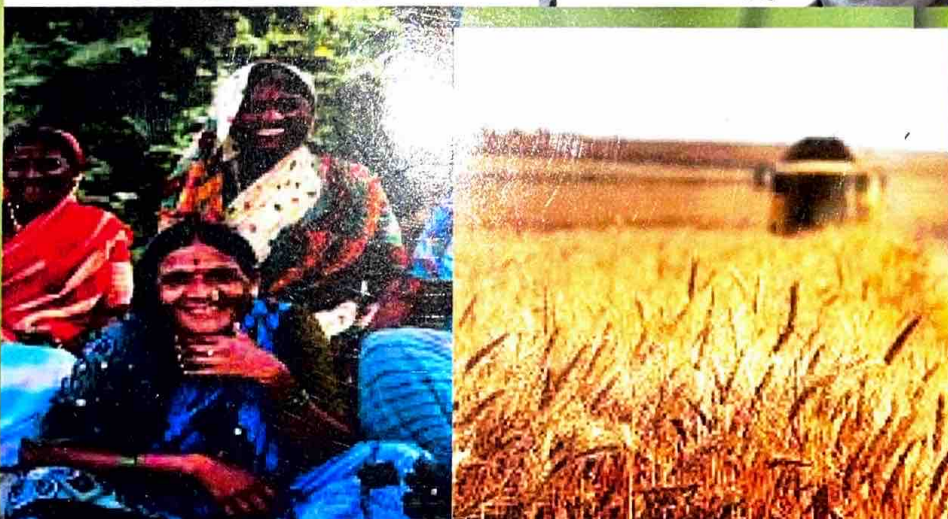


INDIAN ECONOMY PROBLEMS & PROSPECTUS



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CHAPTER 3

ARSENIC CONTENT IN RICE CROPS: A CAUSE OF CONCERN

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ABSTRACT

Arsenic is a toxic trace element, denoted by the symbol As. It is not usually found on its own. Rather, it is bound with other elements in chemical compounds. These compounds can be divided into two broad categories. Organic arsenic: mainly found in plant and animal tissues. Inorganic arsenic: found in rocks and soil or dissolved in water. This is the more toxic form. Both forms are naturally present in the environment, but their levels have been increasing due to pollution. For a number of reasons, rice may accumulate a significant amount of inorganic arsenic (the more toxic form) from the environment. This chapter highlights the arsenic content in rice crops and measures adopted recently to overcome the problem.

Keywords: Organic arsenic, inorganic arsenic, accumulate and environment

1.0 INTRODUCTION

Arsenic has been in food as long as humans have been consuming food. Arsenic is a natural component found in our earth's crust. The arsenic concentration of Earth's crust is just 1 to 1.8 mg/kg. It is toxic in its inorganic form and studies have found inorganic arsenic in many rice varieties and rice-based products. Because Arsenic exists in soil and water, incorporation into most plants and food, including rice, is inevitable. Arsenic is present in a wide array of foods, including flour, corn, wheat, fruit, poultry, rice and vegetables, as well as beer and wine, fruit juices and water. Chronic exposure to inorganic arsenic can elevate the risk of cancer of various organs, as well as skin cancer. In epidemiological studies observing the effects of poor water quality, particularly in developing countries, scientists have found that high oral exposure to arsenic over time causes adverse health effects.

2.0 CONCERN BY FOOD AND DRUG ADMINISTRATION (FDA)

The inorganic arsenic is more hazardous and causes long-term health effects. Rice contains inorganic arsenic. According to the 2016 FDA risk assessment report on arsenic in rice, here are the average concentrations of inorganic arsenic in rice and rice products: 92 parts per billion (ppb) in white rice, 154 ppb in brown rice, 104 ppb in infants' dry white-rice cereal, 119 ppb in infants' dry brown-rice cereal (FDA, 2016). (1 ppb = one part per billion, or one microgram or one millionth of a gram of substance per litre of water.) This is equivalent to one drop of water in a swimming pool, adding a pinch of salt to a 10-ton bag of potato chips, or three seconds in a century) Due to high amounts of arsenic content, children should not feed too many rice products, as it can negatively affect their immune system. A study surveyed arsenic in various rice varieties from different parts of the world to determine the effect of arsenic exposure on rice. The American long grain rice had the greatest arsenic levels. The rice from India, Pakistan and Bangladesh had less arsenic than American rice.

3.0 MAGNITUDE OF THE PROBLEM

Arsenic in rice content in Bangladesh has attracted much attention since recognition in the 1990s of its wide occurrences in well-water in that country. Since this time, significant progress has since been made and the number of people exposed to arsenic exceeding the Bangladesh drinking-water quality standard has decreased by approximately 40%. Despite these efforts, it was estimated that in 2012 in Bangladesh, about 19 million people were still exposed to arsenic concentrations above the national standard of 50 $\mu\text{g/L}$ and 39 million people above the WHO provisional guideline value of 10 $\mu\text{g/L}$. In a highly affected area of Bangladesh, 21.4% of all deaths in the area were attributed to arsenic levels above 10 $\mu\text{g/L}$ in drinking-water. A research report recently prepared by the Indian Council of Agriculture Research (ICAR) is set to cause alarm in Punjab and Haryana. The report submitted last week establishes that Punjab and Haryana feature among the 12 states in the country where groundwater contains arsenic beyond the permissible limit. The report further points to the fact that a large quantity of this contaminated water is used for agriculture, thus entering the food chain. The report further suggests that vegetables and other crops grown in the contaminated belt in the two states have high level of Arsenic. "Excessive tapping of groundwater through shallow tube wells for irrigation, particularly in rabi/summer crops, is a major cause for arsenic contamination in crop produce. It may adversely impact human, animal and environmental health," reads the report. The report claims that while there is no direct link between high arsenic content and cancer, "it is a major reason for many other

diseases in humans and animals through the food chain". Rice can accumulate As in several-fold higher levels than other cereal crops such as wheat and maize. In Punjab, high arsenic content has been found in vegetables like cauliflower, lady's-finger and even paddy. Rice is one of the most severely affected crop plants with As contamination as compared to other crop plants like wheat and maize. The reason being the cultivation method of rice that is flooded as compared to non-flooded for wheat. This leads to the development of reducing conditions in soils that in turn result in predominance of As(III) over As(V). Further, rice is one of the most efficient silica accumulators among all crop plants and As(III) too enters through silicic acid transporters in rice (Ma et al., 2008; Norton et al., 2010). These factors contribute to As accumulation in rice grains in quantities greater than recommended safe limits (Zhao et al., 2010). The situation becomes of even grave concern considering the very high rice consumption rate in As contaminated South east Asian countries ranging from 250 to 650 g of rice per day per person (Arslan et al., 2017). It is imperative to understand the mechanisms of As uptake and translocation by rice. West Bengal is among the States with the highest concentration of arsenic in groundwater, with as many as 83 blocks across seven districts having higher arsenic levels than permissible limits

4.0 RAMPANT USE OF PESTICIDES

Renowned economist Sucha Singh Gill, Director General, Centre for Research in Rural and Industrial Development (CRRID), Chandigarh, said that Punjab farmers have been following the wheat and paddy cycle for the past many years and using more than the required pesticides to save their crop. "In this mad rush for a bumper crop, the farmers have polluted the soil. Successive governments have failed to check this menace. Many crops grown in Punjab have been rejected for export to European countries due to high chemical content. Arsenic in these crops will further ensure that our farmers are never able to enter the well-paying markets of Europe," said Gill. In 2014, the Central Ground Water Board (CGWB) collected 50 groundwater samples from Punjab. Arsenic contamination — more than 0.05 milligrams per litre (mg/l) — was found in six districts. These include Gandiwind (Amritsar district), Patti (Tarn Taran), Jhunir (Mansa), Dhilwan (Kapurthala), Ropar and Fazilka. In fact, 30 more blocks in 13 districts of Punjab have arsenic contamination ranging between 0.01 and 0.05 mg/l. The same report suggests that Punjab should replace water-guzzling crops like boro-rice and vegetables and replace these with wheat, coarse cereals, oilseeds and pulses that accumulate less arsenic. "Promoting agro-forestry on farm bunds, direct seeded rice, creating farm ponds, minor irrigation tanks, installation of deep (more than

80m depth) tube wells and other steps should be taken to reduce arsenic in the food chain," states the report.

5.0 ARSENIC ACCUMULATION

A recent publication by researchers at the School of Environmental Studies (SOES), Jadavpur University, reveals not only rise in arsenic contamination of paddy plants from ground water in West Bengal, but also that concentration of 'arsenic accumulation' depends on the variety of paddy and its stage in the crop cycle. The study titled 'Arsenic accumulation in paddy plants at different phases of pre-monsoon cultivation', published earlier this year in the peer-reviewed scientific journal *Chemosphere*, highlights the processes and dependencies of arsenic trans-location in rice from contaminated irrigation water. Samples for the study were taken from the Deganga block in the State's North 24 Parganas district, an area that's worst affected by ground water arsenic contamination. Researchers have developed and commercialised a rice variety that is resistant to arsenic. Several studies have shown that arsenic from groundwater and the soil can enter the food chain through paddy.

6.0 ARSENIC-RESISTANT RICE CULTIVATED IN WEST BENGAL

The new rice variety, Muktooshi also called IET 21845, was developed jointly by the Rice Research Station at Chinsurah coming under West Bengal's Agriculture Department and the National Botanical Research Institute, Lucknow, over several years. A gazette notification for the commercial use of Muktooshi was made by West Bengal last year. Bijan Adhikari, one of the scientists who worked on developing the variety, said that the State government's decision to make the seeds available for cultivation came after successful trials in both the wet season and dry season in different blocks of the State. The trials were done in areas with arsenic contamination in groundwater, particularly in Nadia, North 24 Parganas, Bardhaman and Murshidabad. "During our multilocal trials, we found that this variety uptakes very less amount of arsenic from soil and water in comparison to other varieties of rice. The variety yields 5.5 metric tonnes per hectare in the Boro season and 4.5 to 5 metric tonnes per hectare in the Kharif season, respectively," said Mr. Adhikari. Work on developing the variety started in 2006 and by 2013 the scientists were successful. Pradip Kumar Das, a farmer at Birnagar in Nadia district who cultivated the variety in over four hectares (30 bighas of land), said that the yield was satisfactory despite a dry spell. "In Nadia, arsenic contamination is a major health problem. So far about 150 farmers are cultivating the variety and it is going to increase in next few years," Mr. Das said. He said the rice was long and

thin, and aromatic. Across the State, thousands of farmers have started cultivation, even in areas where arsenic in groundwater is not an issue, because of the aroma and the yield.

7.0 METHOD OF REDUCING ARSENIC FROM RICE

Yes. Basmati rice from California, India or Pakistan are the best choices, as they have about one third of the inorganic arsenic compared to brown rice from other regions. Washing and cooking rice with plenty of clean water can help reduce the amount of arsenic present. This method works for both white and brown rice, with one study showing it has the potential to remove up to 57 percent of the toxic element. To reduce the arsenic in your rice, first give it a good rinse. Place the grains in a fine mesh strainer and pour water over them until it runs clear. Cook the rice in excess water, at a ratio of one cup of rice to six cups of water, and drain any extra leftover once the grains are tender. The most efficient way is to cook the rice the "pasta way" or more scientifically known as "the parboiling method", Alternatively rice can be soaked for 48 hours before cooking, the water can be poured off and rinsed every 8 to 12 hours.

8.0 CONCLUSION

Arsenic in rice is a real concern, but that doesn't mean that we should cut this staple grain out of our diet. Let's be more choosy with the type and origin of your rice, always rinse and cook it with excess water, and be aware of how much you're consuming. If you find yourself serving most meals with rice as a base, try looking at other whole grain alternatives to round out your dishes and keep your arsenic consumption to a minimum.

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