

Socioeconomics

Diagnostics of Sorghum and Pearl Millet Grains-based Nutrition in India

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Introduction

About 26% of the Indian population is deficient in calories and 28% in protein (Chand et al. 2003). The deficiency is most acute among the poor. The magnitude of micronutrient [iron (Fe) and zinc (Zn)] deficit is particularly alarming among children, women of reproductive age, and pregnant and lactating women (Sharma 2003). Current efforts to combat micronutrient malnutrition in the developing world focus on providing vitamin and mineral supplements to pregnant women and young children, and on fortifying foods during processing (Per Pinstrup-Andersen 2000). The introduction of crop varieties selected and/or bred for increased Fe and Zn will complement these efforts. Micronutrient-rich sorghum [*Sorghum bicolor* (L.) Moench] and pearl millet [*Pennisetum glaucum* (L.) R. Br.] cultivars are being bred by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) to address micronutrient deficiency in the semi-arid tropics with funding support from HarvestPlus. An understanding of the dietary contribution to nutrient intake in major sorghum and pearl millet production/consumption regions would help in quantifying the micronutrient deficiency for better targeting sorghum and pearl millet cultivars. This paper summarizes the contribution of sorghum and pearl millet toward intake of nutrients in major sorghum and pearl millet growing regions in India.

Data and Methodology

We used household data drawn from the 55th National Sample Survey (NSS) conducted in 1999–2000. The NSS contains information on per capita monthly consumption of various food and nonfood commodities in quantity and value terms. As part of the sample design, each state of India was divided into 5–10 regions, referred to as National Sample Survey Organization (NSSO) regions. The entire country was thus divided into 77 regions. For the present study, we selected five regions spread across the states of Andhra Pradesh, Karnataka and Maharashtra which contribute 86% to sorghum production and ten regions spread across the states of Gujarat, Haryana,

Maharashtra and Rajasthan which account for 84% of pearl millet production.

Information on consumption of food items in the major sorghum and pearl millet producing districts was culled and aggregated by income groups to generate estimates for the selected growing regions with rural and urban population as weights. Quantities of different food commodities consumed were converted into their nutrient equivalents using nutritional composition figures from Gopalan et al. (2000).

Results and Discussion

Grain consumption and nutrient intake. The annual per capita consumption of sorghum (rural + urban) in India was about 5.0 kg. However, among the major sorghum-producing regions, consumption was highest (75.2 kg year⁻¹) by rural consumers in the inland central region of Maharashtra (ICM), accounting for 48% of the total per capita cereal consumption followed by the inland eastern region of Maharashtra (IEM), and the inland northern region of Karnataka (INK) (Table 1). In terms of nutrient intake, sorghum accounts for about 35% of the total intake of calories, protein, Fe and Zn in the dominant production/consumption regions of ICM, IEM and INK (Table 2).

The annual per capita consumption of pearl millet in India was about 3.5 kg, accounting for 2.5% of the total cereal consumption. However, this statistics does not reflect the consumption pattern in regions where pearl millet is cultivated and consumed. Among the major pearl millet producing regions, per capita consumption was highest (92 kg year⁻¹) by the rural population in the western region of Rajasthan (WRR), followed by the dry areas of Gujarat (DAG). In both these regions, pearl millet accounts for more than 50% of the cereal consumption (Table 1). The other major pearl millet consuming regions are inland central Maharashtra, inland western Maharashtra, inland northern Maharashtra, Saurashtra, the northern plains of Gujarat and northeastern Rajasthan. In these regions, pearl millet contributes about 20–40% of the total energy and protein intake. Its contribution of

Table 1. Per capita consumption of sorghum and pearl millet in major producing regions of India.

Region	Rural		Urban	
	Consumption (kg year ⁻¹)	Proportion of all cereals (%)	Consumption (kg year ⁻¹)	Proportion of all cereals (%)
Sorghum				
Maharashtra				
Inland Western	32.0	25.0	18.7	17.0
Inland Central	75.2	48.0	41.8	29.3
Inland Eastern	72.4	50.2	13.4	11.6
Karnataka				
Inland Northern	67.6	49.0	39.2	31.6
Andhra Pradesh				
Inland Northern	22.6	14.8	3.2	2.5
Pearl millet				
Gujarat				
Saurashtra Region	49.6	38.9	14.9	12.8
Dry Areas	69.7	62.8	33.4	34.5
Northern Plains	39.0	26.2	7.6	5.7
Maharashtra				
Inland Northern	25.8	19.8	7.8	7.2
Inland Western	37.6	29.4	3.8	3.5
Inland Central	44.4	26.5	8.2	6.8
Rajasthan				
Western Region	92.0	52.0	12.7	8.5
North Eastern	27.1	15.3	0.9	0.7
Haryana				
Eastern Region	2.6	1.8	0.5	0.4
Western Region	8.1	5.8	0.6	0.5

micronutrients (Fe and Zn) is higher, varying from 30% to 50% (Table 2).

The study indicated that consumption of both sorghum and pearl millet is significantly affected by urbanization and income. Consumption in the urban areas is about 3–10 times lower than in the rural. There is a negative association of sorghum and pearl millet consumption and income in both rural and urban areas, and the difference between rural and urban consumption levels increases with increase in income.

The intake of iron and zinc appears to be below the recommended dietary allowance (RDA) for an average Indian adult (ICMR 2002), particularly in low-income rural households in sorghum and pearl millet consuming regions. However, fine mapping of micronutrient intake by different groups (pregnant women, children and other vulnerable groups) is required for a precise estimation of the RDA deficit. Such information would help in better targeting micronutrient-dense sorghum and pearl millet cultivars to reduce malnutrition deficiencies.

Unit cost of nutrients from sorghum and pearl millet.

A study of variation in the cost of different nutrients from different sources is important to devise cost-effective nutritional strategies. Pearl millet is the cheapest source of energy, protein, Fe and Zn among all cereals and pulses. For example, the cost of 100 g of protein from pearl millet is Rs. 5.4, which is less than half of the cost for the same amount from rice and pulses (Table 3). Sorghum is also a cheap source of energy, protein, Fe, and Zn after pearl millet. The cost difference is high when sorghum and pearl millet are compared with fruits, vegetables, meat, egg, fish and dairy products.

Conclusions

Both sorghum and pearl millet provide a low-cost solution to combating malnutrition due to micronutrient deficiency. Sorghum and pearl millet provide additional health-related advantages because of their higher level of

Table 2. Contribution of sorghum and pearl millet to nutrient intake in rural India.

Region	Energy (Kcal person ⁻¹ day ⁻¹)	Protein (g person ⁻¹ day ⁻¹)	Iron (mg person ⁻¹ day ⁻¹)	Zinc (mg person ⁻¹ day ⁻¹)
Sorghum				
Maharashtra				
Inland Western	306 (17.0) ¹	9.1 (14.4)	3.6 (15.1)	1.4 (14.4)
Inland Central	719 (35.5)	21.4 (31.6)	8.4 (32.2)	3.3 (31.4)
Inland Eastern	693 (36.3)	20.6 (30.3)	8.1 (33.9)	3.2 (35.2)
Karnataka				
Inland Northern	646 (34.1)	19.3 (32.3)	7.6 (36.9)	3.0 (34.1)
Andhra Pradesh				
Inland Northern	216 (11.8)	6.4 (13.6)	2.5 (24.5)	1.0 (13.5)
Pearl millet				
Gujarat				
Saurashtra Region	490 (26.0)	15.8 (28.1)	10.9 (40.5)	4.2 (35.6)
Dry Areas	689 (37.4)	22.2 (37.4)	15.3 (48.7)	5.9 (44.0)
Northern Plains	386 (19.5)	12.4 (22.9)	8.5 (39.2)	3.3 (30.3)
Maharashtra				
Inland Northern	255 (15.2)	8.2 (17.4)	5.7 (26.3)	2.2 (23.2)
Inland Western	372 (21.7)	8.2 (17.6)	5.7 (26.0)	2.2 (23.9)
Inland Central	439 (21.8)	14.1 (22.8)	9.7 (33.8)	3.8 (33.0)
Rajasthan				
Western Region	910 (40.5)	29.2 (44.2)	20.2 (62.5)	7.8 (55.7)
North Eastern	268 (12.0)	8.6 (11.7)	5.9 (19.2)	2.3 (16.4)
Haryana				
Eastern Region	26 (1.3)	0.8 (1.3)	0.6 (2.4)	0.2 (1.7)
Western Region	80 (4.0)	2.6 (4.3)	1.8 (7.4)	0.7 (6.0)

1. Figures in parentheses are contribution (%) of sorghum/pearl millet to the total nutrient intake from all foods.

Table 3. Unit cost of nutrient intake from selected food commodities in rural India.

Food items	Energy (Rs 1000 Kcal ⁻¹)	Protein (Rs 100 g ⁻¹)	Iron (Rs 100 mg ⁻¹)	Zinc (Rs 100 mg ⁻¹)
Rice	2.9	14.6	79.9	73.6
Wheat	2.5	7.3	19.5	41.9
Sorghum	2.1	7.2	18.2	46.7
Pearl millet	1.7	5.4	7.8	20.1
Pulses	7.2	12.1	43.2	143.3
Milk	15.6	26.6	355.8	298.0
Meat, egg, fish	99.0	144.7	1395.4	698.0
Vegetables	9.5	39.7	39.2	167.2
Fresh fruits	12.4	56.6	52.4	235.5
Dry fruits	6.2	64.7	33.1	56.0

insoluble dietary fiber and more balanced amino acid profile. Thus, dietary diversification toward these crops offers an opportunity particularly for low-income households to improve their nutritional security. Further, fine mapping of micronutrient intake, particularly by women and children, through in-depth household surveys in sorghum and pearl millet production/consumption regions will help in better targeting improved micronutrient-dense sorghum and pearl millet cultivars.

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