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Iron-fortified iodized salt to control iodine-deficiency and iron-deficiency disorders

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Food fortification is the most significant development in the effort to control micronutrient deficiencies[1,2]. Iron deficiency anaemia (IDA) and iodine deficiency disorders (IDD) are the major micronutrient deficiencies of public health importance in India[2,3]. Salt is a universal vehicle for the fortification of iodine / iron as it is consumed at approximately the same levels throughout the year by all normal populations, with very little risk of overdosing. Low-cost technologies for the manufacture of stable iodized salt[4,5] and colour-free iron-fortified salt[6,7] are available. With the introduction of universal salt iodization (USI) as a National Policy, the National Institute of Nutrition (NIN), Hyderabad evolved the concept of fortification of iodized salt with iron (double fortified salt, DFS) for controlling IDD and IDA as 'one intervention controlling two problems' and succeeded in its pioneering work[8]. In view of their antagonistic chemical properties, simultaneous incorporation of potassium iodate (powerful oxidizing agent) and ferrous sulphate (powerful reducing agent) in DFS requires a stabilizer to protect iodine from undesirable interactions with iron that could lead to iodine loss. NIN developed a DFS formulation using Sodium Hexa Meta Phosphate (SHMP), a permitted food additive[9] as a stabilizer for this purpose. NIN-DFS simultaneously provides 35-40 ppm iodine and 1000 ppm iron (Table 1). As a prophylactic measure, DFS provides the entire daily requirement of iodine and one-third of the daily requirement of iron. Daily consumption of DFS over a long period of more than two years is necessary to result in any significant reduction in iron-deficiency anaemia. Edible-grade common salt and food-grade chemicals should be used in the production of DFS. High levels of magnesium or moisture in salt are detrimental to the stability of iodine in DFS[10]. The quality attributes of the chemicals required for NIN-DFS are given in Table 2.

Chemical sources of iodine and iron: analytical methods and stability

The very first studies on the development of the NIN-DFS formulations dealt with ferrous sulphate as the source of iron and involved either potassium iodide (KI) or potassium iodate (KIO_3) as the source of iodine. Though both the sources of iodine were found to be suitable, KI was the preferred choice at the time. This was because the use of KI ensured DFS of good iodine stability even from ordinary salt, whereas the use of KIO_3 required salt of better quality. When KI is used in DFS, the method of iodine estimation involves oxidation of KI to KIO_3 using bromine or chlorine, release of iodine with o-phosphoric acid, and titration of the released iodine with thiosulphate. With KIO_3 as the source of iodine, direct titration is done with thiosulphate, using sulphuric acid. Thus, in the initial experiments with DFS, either KI or KIO_3 was used as a source of iodine, and later only KIO_3 was used. With the introduction of the policy of universal salt iodization (USI) and KIO_3 being specified as the source of iodine for salt fortification as per Prevention of Food Adulteration (PFA) Rules, the method of iodine estimation is required to be in conformity with regulatory protocols. Accordingly, in the studies carried out after 1990, DFS formulations contained only KIO_3 as the source of iodine and the choice of the titration procedure using sulphuric acid was employed for assessment of iodine content in DFS. The use of sulphuric acid in the titration procedure had resulted in inadvertent changes in the methodology after the 1990s, leading to some problems in the estimation of iodine in DFS. However, the errors in the procedure were identified and rectified subsequently.

The initial laboratory-scale studies[8], factory trials[10], community studies in tribal areas[11], residential school studies in urban areas[12] and multicentric stability studies[13,14,16], showed good stability of iodine and iron in DFS beyond 6 months (Table 3). In a double-blind study (1997-98) carried out in residential school children, one batch of salt showed a lower amount of iodine[12] in the samples collected from the kitchen as well as those tested at the time of delivery of the salt. Due to the double-blind nature of

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Table 1. Double fortified salt formulation from NIN

Ingredients	Quantity (g/kg)
Edible common salt*	1000
Sodium Hexa Meta Phosphate	10
Powdered Ferrous Sulphate ($FeSO_4.7H_2O$)	5.08**
Powdered Potassium Iodate (KIO_3)	0.067**

**NaCl (≥99.0%), Moisture (1.5%), Magnesium (<0.1%).*
*** Expected iodine content: 40ppm & iron content 1000 ppm*

Table 2. Quality attributes of chemicals required for NIN-DFS

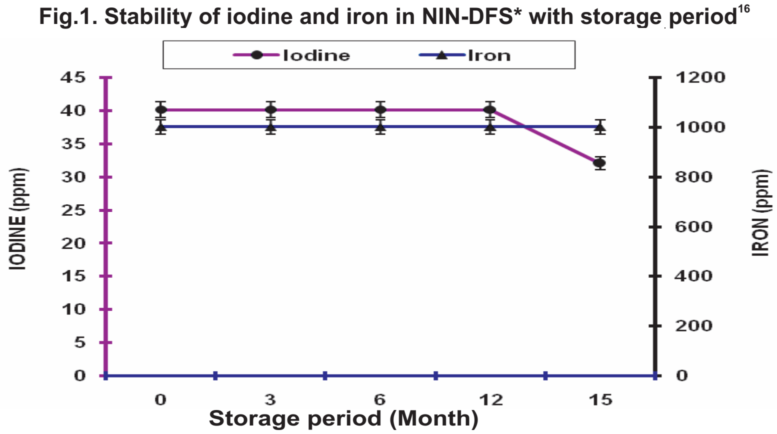
Parameter	Chemicals		
	SHMP	$FeSO_4\ 7H_2O$	KIO_3
Colour and appearance	Colourless fine glossy powder	Light greenish powder	Colourless crystalline powder
Solubility in water	1g in 1.7ml	1g in 1.5 ml	Soluble in 30 parts of water
pH (5% solution)	5.6 to 6.6	3 to 4	Neutral
Purity	P_2O_5 content: 66 to 68%	98 to 100%	Not less than 99.8%
Grade	Food Grade		

the study, no corrective measures could be taken during the study and therefore more detailed investigations were carried out later. A series of large-scale multicentric DFS stability studies showed that the method of iodine estimation using sulphuric acid, usually applied to iodized salt, did not yield consistent results[13,14]. The reasons for these inconsistencies, irrespective of the type of common salt used, were: very low pH of DFS in water resulting in iodine loss and large variations in duplicate values before the addition of KI; also, the interference by sulphuric acid resulting in persulphate formation with ferrous sulphate leading to very high iodine values through interaction with the added KI[15]. With the modified method[15], where o-phosphoric acid replaced sulphuric acid in iodine estimation with a change in the sequence of addition of reagents, iodine stability was demonstrated beyond 15 months (Figure 1). This was confirmed independently in different laboratories[16]. In the entire series of studies, in no instance was there any problem as regards the stability of iron in DFS (Table 3).

Production

DFS is produced by a dry mixing method, involving a batch mixing process or a continuous process[10]. The production process consists of (a) addition of premix and (b) blending of salt. Premix can be added to salt either manually or automatically. The premix (40 ppm Iodine and 1000 ppm Iron) is prepared on a batch basis for the batch mixing process and on shift/daily basis for the continuous process. In the batch process the premix prepared manually is divided into approximately 10 equal aliquots. From the top of the ribbon blender, the aliquots are added manually from left to right over the horizontal plane of the blender into salt in the rotating ribbon blender (1-2 minutes). Automatic addition of premix depends upon the type of dosifier, and the synchronization system to be used, and on each blender's mechanical structure, which varies from factory to factory. After the quantitative addition of premix to the bulk of salt in the ribbon blender, the blending is done for 15 minutes so as to ensure uniform distribution of iodine and iron in salt. The blender is stopped and the DFS is discharged into double-lined high-density polyethylene (HDPE) bags for further packing in 1 kg low-density poly ethylene (LDPE) pouches. In the continuous process, the calculated quantities of premix (40 ppm Iodine and 1000 ppm Iron) and salt, from different hoppers, are loaded by an automatic system into the ribbon blender and blended for a set time period, depending upon the blender capacity. DFS is collected continuously in HDPE bags. After ensuring satisfactory levels of iodine (40 ppm) and iron (1000 ppm) and their uniform distribution, DFS is packed in 1kg or 0.5 kg LDPE pouches. The pouches indicate that they contain DFS by means of a printed message as per the specifications of the Standards of Regulatory Authority[17].

Fig.1. Stability of iodine and iron in NIN-DFS* with storage period[16]



Initial iodine* 40 ± 3 ppm and iron 1000 ± 50 ppm

Transportation, distribution and cost

Large-scale production of DFS (9 to 60 metric tons) has been successfully carried out in factories[10-14]. Packing of DFS in 0.5kg or 1kg LDPE pouches and long-distance transportation by road (a) from Valinokkam to Hyderabad[10], (b) from Hyderabad to remote tribal areas of Rampachodavarm[11], (c) from Chennai to Hyderabad[12], (d) from Chennai to Hyderabad, Bhubaneswar, Dibrugarh, Delhi, Surat, and Mumbai[13], and (e) from Bhubaneswar to Delhi and Hyderabad[16] was successful. DFS was distributed for over two years to households periodically in 1kg pouches in the community[11], while it was supplied in 50kg sacs in the residential schools study[12]. Thereby the operational feasibility of supplying DFS was confirmed (Table 3). DFS is affordable, and is currently priced at Rs.8.60 per kg, which is about Rs.2.00 per kg more than Iodized Salt (IS)[18].

Bio-availability, acceptability and bio-safety

By use of a dual-radioisotope technique it has been shown that, in humans, the mean iron absorption after a rice-based meal with DFS was 6.1% whereas, after a similar meal with control salt, iron absorption was only 3.9%; urinary iodine excretion with the consumption of

Table 3. Distribution of DFS with adequate iodine and iron in various studies

	STUDY					
	Laboratory (8)	Factory (10 -14)	Community (12)	Residential school* (13)	Multicentric stability (14)	Multicentric stability (15)
Period	1981-84 1997	1984, 1996	1989-92	1997-98	2001-03	2004
Salt produced (MT)	0.1	20	60	9	6	0.5
Salt supply (Kg)	1	50	1	50	1	0.5
Study period (Year)	1	0.5	2	2	2	0.5
Samples tested (n)	300	500	1500	12*	1440	720
Adequate iodine: 15 ppm (%)	100	100	91-98	100 in 2 batches ** & 50 in 1 batch **	76**	100
Adequate iron: 850-1100 ppm (%)	100	100	100	100	100	100

** Main emphasis on iron impact. ** Sulphuric acid method for iodine estimation. Figures in parentheses indicate the respective reference numbers.*

DFS was equivalent to that for IS[8]. Commonly consumed foods prepared with DFS showed no difference in the sensory properties from those prepared with unfortified salt[10]. DFS was well accepted by the community in daily cooking without any problem[19].

The maximum tolerable daily intake (MTDI) of SHMP through foods is 70mg/kg body weight[9]. For an individual with a body weight of 60kg, the MTDI of SHMP will be 4200mg, which is equivalent to 1260mg of phosphorus for food grade SHMP (purity as P_2O_5: 67-68%). From a daily intake of 10g DFS, the amount of SHMP consumed would be 100mg, which is equivalent to 30mg phosphorous. Thus, in adults, the daily intake of phosphorus through the consumption of DFS is only 2.4% of the MTDI for SHMP as well as for phosphorus. In children this percentage will be even lower. Nevertheless, the bio-safety of the daily consumption was evaluated, and the results confirmed that long-term ingestion of DFS causes no apparent impairment of calcium and phosphorus balances in rodents and is safe for daily use[20]. The haemoglobin-regenerating ability of a diet containing DFS was compared with that of a diet containing unfortified salt, using a depletion-repletion rodent model for a period of 9 months. The results revealed that the iron-deficient animals regenerated haemoglobin up to anaemia-free levels by the end of 4 weeks. Long-term feeding of DFS resulted in the haemoglobin level reaching 15g/dL with no untoward effect with respect to the integrity of bone and the histopathology of various tissues[20]. Also, daily consumption of DFS over two years showed that SHMP as a stabilizer in DFS did not alter the calcium and phosphorus homeostasis in children[21].

Efficacy and impact

A two-year community study in the tribal areas of Andhra Pradesh revealed the operational feasibility of distribution of DFS along with IS and its acceptability in the community. No untoward effects associated with DFS consumption were observed during the study period. The total prevalence rate of goitre decreased from 28% to 13.7% in the DFS group and from 25.8% to 16.1% in the iodised salt user group; the mean T4 levels were approximately the same as the initial levels (7.3-7.6 μg/dL) in DFS and IS areas, whereas it decreased significantly ($P<0.001$) from 7.8 to 6.6 μg/dL in the control area. Median urinary iodine excretion levels (μg/L) sample size given in parentheses, increased significantly from 116 (104) to 155 (67) ($P<0.02$) in the DFS area and from 59 (89) to 160 (92) ($P<0.01$) in the IS area, whereas in the control area there was no significant ($P>0.05$) difference between the initial 101 (102) and final 97 (54) values[11]. With regard to the effects of DFS on the prevalence of anaemia, the impact was not uniform, and the increase in haemoglobin was statistically significant only in certain age groups. The mean gain in haemoglobin in the DFS group relative to the control group was 0.42g/dL at the end of two years (Table 4). The possible factors responsible for the relatively small impact of DFS on haemoglobin status in the tribal population include high prevalence of malaria and the consumption of large quantities of tamarind and wild tubers, which are known to inhibit iron absorption[22]. It was therefore decided to undertake studies to assess the impact of DFS, particularly on haemoglobin status, in communities in which these confounding factors do not operate.

A randomized double-blind study was therefore, carried out for a period of two years among children belonging to backward communities in residential schools in and around Hyderabad to assess the impact of consumption of DFS on haemoglobin status, urinary iodine excretion and calcium phosphorus homeostasis. None of the beneficiaries complained of any side effects on consumption of DFS over a period of 18 months[12]. The median urinary iodine excretion levels (μg/L) increased significantly ($P<0.001$) from 68 (91) to 108 (76) in the DFS group and

Table 4. Mean increase in haemoglobin in DFS subjects as compared to CS subjects

Study	Subjects		Mean increase in hemoglobin (g/dL) in DFS over CS
	DFS	CS	
Tribal community	606	676	0.42
Residential school	353*	280*	0.72

**Number of students followed up throughout the study* from 70 (85) to 452 (75) in IS group. There was a fall in haemoglobin both in the DFS and IS groups, but to a lesser extent in the DFS group[12] DFS improved the haemoglobin levels of anaemic children and was able to reduce the prevalence rate of anaemia significantly, from 42% to 30%. However, in the IS group, the decrease in the prevalence rate of anaemia was not significant (from 53.7% to 47.4%)[23]. Covariate analysis to understand the variations in the initial haemoglobin with respect to gender, age, and school, showed that the mean increments of haemoglobin at the end of the study, after adjusting for the differences in initial hemoglobin, were significantly higher in the DFS group (P<0.01) as compared to the IS group. The mean (95%) rise in haemoglobin levels in the DFS group relative to the IS group was 0.72 (0.43-1.01) g/dL (Table 4), which is well within the range of global experience[24].

High-power Committee on DFS

The Union Ministry of Health & Family Welfare, India, constituted a Technical Committee under the Chairmanship of Dr. M. K. Bhan, Secretary, Dept. of Biotechnology, Govt. of India, on "Formulations of guidelines for use of double-fortified salt as a measure to reduce prevalence of anaemia" (letter No. Z 28020/16/2005-CH/PH dated 14th July 2005). The Committee examined the evidence on different DFS formulations and approved only NIN-DFS for the public health programme for controlling IDA and IDD in the country[24] based on convincing evidence on formulation, acceptability[8,10], stability[8,10,16], process[10,17], salt quality and sensory evaluation[10], factory production and transportation,[10-14] community acceptance[11,12], safety evaluation[20,21], bioavailability[8], efficacy and impact[11,12,22], and ultra-structure[25]. A comparison with other DFS formulations showed that NIN-DFS is the only formulation that has been proved to be stable and acceptable, and had the desired impact[26]. DFS specifications are notified under the Prevention of Food Adulteration Act[27].

Roadmap

DFS, the result of two decades of untiring pursuit by scientists at NIN, is a simple solution for a complex problem. The roadmap consists of three phases: Phase I: Preliminary activity, Phase II: Development of the Technology, and Phase III: Follow-up activity. NIN-DFS has passed through the first two phases successfully. Phase I proved that DFS is a product of low-cost high-impact technology to alleviate the ill effects of IDA and IDD in the population. In Phase II, the following have been achieved: (i) NIN has transferred DFS technology, free of charge, to several salt manufacturers (e.g . Prince International Health Care (P) Limited at Bhubaneswar and Bangalore, Christy Friedgram Industry at Tiruchengode, Ankur Chemfoods at Gandhidham, Tata Chemicals Limited at Mithapur, Gujarat Heavy Chemicals Limited at Chennai, and AP Foods at Hyderabad) by signing memorandums of understanding (MoUs) requiring the manufacturer to supply at least 20% of the produce to the public distribution system at prices fixed by the Government for supply to the population below the poverty line; (ii) Specifications for DFS have been notified under the Food Safety and Food Standards Act of India; and (iii) The Prime Minister's Office on April 2011 issued instructions for the introduction of DFS in ICDS, MDM and PDS, and recommended that the government may take up an IEC campaign[28]. In Phase III, (i) the Director, NIN, apprised the media about DFS including its present status at the 'Press Meet' held on 4th May, 2011 at NIN; (ii) Efforts are being made by NIN to accelerate the production of DFS; (iii) DFS is being supplied at Orissa in the open market and in MDM programmes of Karnataka, Chhattisgarh, Jharkhand and Haryana; and (iv) NIN has writen to the Secretaries of the Women Development and Child Welfare Departments as well as to the Health Departments of all the States and Union Territories in the country, advocating the introduction of DFS in the nutrition programmes of their respective States and Union Territories. Effective implementation of the IEC campaign is the need of the hour; this is being done by NIN through its website and also by sending communications to the concerned departments of all the States & Union Territories in the country. NIN is proud to present DFS as a gift to the nation and rededicate itself to the service of the nation and its people.

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The authors are nutrition scientists from the National Institute of Nutrition (NIN), Hyderabad, India. B. Sesikeran, Director, NIN. S. Ranganathan, Retired scientist from NIN.

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NUTRITION NEWS

- The XXXXIII Annual National Conference of the Nutrition Society of India will be held at the National Institute of Nutrition, Hyderabad, on 11th and 12th November 2011. The theme of the Conference is "Economic Transition in Nutrition – Life Style Diseases & Health and Nutrition Wellness".

- Two pre-conference workshops on "Methods of assessing nutrient-gene interactions" and "Methodology of nutrition assessment and body composition" will also be conducted parallelly on the 10th of November 2011.

- Apart from this, two symposia are also being arranged during the conference. Symposium I: Bone Health and Nutrition and Symposium II: Chemical Basis of Nutrient Function.

- Further details of the conference may be accessed from the website: www.nutritionsocietyindia.org.

Reviews and Comments

Restoring Millets and Pulses to their Rightful Place in Indian Diets

C Gopalan

Millets and pulses had traditionally occupied an important place in the Indian dietary system. Finger millets (ragi), pearl millets (bajra) and sorghum (jowar), along with a variety of other "coarse grains" such as barley and maize were consumed as staples or adjunct staples by millions of people in this country. Pulses and legumes too were traditionally part of Indian diets in all parts of the country. However, per capita availability and consumption of millets and pulses have been on the decline in the decades since the Green Revolution, commencing in the 1960 (Table 1 & 2).

Millets

The Green Revolution succeeded in bringing about a remarkable augmentation in the production of wheat and rice. It saved the country from the threat of large-scale famines. However, it has had its deleterious side effects. The near-exclusive emphasis on rice and wheat production during the Green Revolution resulted in significant acreage being diverted to the cultivation of these two food grains. Over the last 50 years, the share of 'coarse grains', which include pearl millet, sorghum, maize, finger millet, barley and five other millet species known as 'small millets', has registered a 25.3% decline in terms of total area under cultivation, from 38.83 Million Hectares (MHA) in 1949-50 to 29.03 Mha in the year 2004-05. Production figures for millets show a flat trend over the decades, even as the population continued to grow at a rapid rate. This contrasts sharply with the overall rise in production of cereals

Consequently, per capita availability of millets has declined steeply (Table 2). Millets are grown almost entirely only in rainfed areas, where there are no other means of irrigation. A total annual rainfall of approximately 300 to 400 mm is sufficient to support the cultivation of most millets. The geographical distribution of millet cultivation has traditionally depended on the habitat, the total rainfall, and the local dietary habits. They can be grown as food for human consumption or as fodder, and as either a primary crop or an allied crop in combination with oilseeds, pulses, spices and condiments, so that the farmer need not rely entirely on the millet crop. However, in spite of rich inter/intra-species diversity, wide climatic adaptability, wide adaptability to a range of soil conditions, and no dependence on artificial irrigation, the cultivation of diverse millet species/varieties has been falling. In a way, a lack of institutional support for millet crops, in contrast to the institutional promotion of rice and wheat, continues to shrink the millet-growing acreage. A fallout of this policy has been that even traditional millet consumers have switched to rice or wheat exclusively, with millets no longer forming part of their food basket. This call for the restoration of millets to their rightful place in Indian diets is not based merely on the argument that they were once traditional foods for millions of Indians, nor is it a call to replace rice and wheat with millets. It is a call to promote dietary diversity by adding millets along with rice/wheat to the household diet. Careful analysis has shown that millets have nutritive values comparable to those of rice and wheat, as regards both proximate principles and micronutrient content, as can be seen in Table 3[1].

Table 1. Time trends in production of food grains cereals, pulses , rice, coarse cereals

	1961	1971	1981	1991	2001	2006
Cereals	69.3	96.6	119	162.1	185.7	195.2
Coarse cereals	13.1	16.1	15.7	18.6	14.3	15.7
Pulses	12.7	11.8	10.6	14.3	11	13.1
Population in millions	433	539	675	832	1015	1103

Production figures are in million tonnes. Comparison between pre-Green Green Revolution (1971) and post-Green Revolution (1981 and beyond).

In one of my early studies[2], I had shown that the rise in blood glucose levels is much less with a ragi-based diet than with a rice-based diet. Millets are noted for their low glycaemic index. Although the reasons for the recent sharp escalation in the prevalence of diabetes mellitus in India are multifactorial and include lifestyle changes in addition to dietary changes, one may speculate about whether adding millets to the food basket as a measure of dietary diversification, if not as a staple, would help in stemming the rising prevalence of diabetes. If the current falling trend in millet availability and consumption is to be reversed, the issue has to be addressed simultaneously on two fronts....boosting production and, creating demand, both supported by millet-promotion policies.

Boosting production

This requires both *appropriate technology* and *incentives*-

***Appropriate technology*:**

The International Crop Research Institute for the Semi-arid Tropics (ICRISAT), with its headquarters in Hyderabad, has been producing germplasm and seeds for improved varieties of millets in addition to pulses and legumes, all of them suitable for areas with limited availability of water. The Institute develops hybrid strains that are pest-resistant and improve the yield per hectare. It has been working with farmers in various parts of India and the world to promote the cultivation of these new strains. The scientists at the Institute have also taken up bio-fortification of some of the millets and pulses to make them more nutritive. Improving yields is particularly important if the farmer is to be persuaded to take up the cultivation of millets.

***Incentives*:**

The cultivation of millets would reduce

Table 2. Time trends in estimated per capita availability of cereals, coarse cereals and pulses (grams/per day)

Year	Total Cereals	Coarse cereals*	Pulses
1961	438.5	82.9	80.4
1971	491.2	81.8	57.4
1981	483.0	63.7	43.0
1991	533.8	61.3	47.1
2001	501.2	38.6	29.7
2006	484.9	39.0	32.5

Per capita availability computed taking into account the data on net availability ie production, import / export and wastage. *While rice/wheat consumption is universal, coarse cereals are consumed only in some remote regions and tribal areas in the country; therefore percapita availability of coarse cereals does not reflect the actual dietary practices in most of the country.

Table 3 . Nutritive values of some importent cereals and pulses

	Protein (g)	Fat (g)	Minerals (g)	Crude Fiber (g)	Carbo-hydrate (g)	Energy (Kcal)	Calcium (mg)	Phospho-rus (mg)	Iron (mg)
Rice raw, milled	6.8	0.5	0.6	5	78.2	345	10	160	0.7
Rice, par-boiled, milled	6.4	0.4	0.7	0.2	79	346	9	143	1
Wheat whole	11.8	1.5	1.5	1.2	71.2	346	41	306	5.3
Bajra	11.6	5	2.3	1.2	67.5	361	42	296	8
Barley	11.5	1.3	1.2	3.9	69.6	336	26	215	1.6
Jowar	10.4	1.9	1.6	1.6	72.6	349	25	222	4.1
Ragi	7.3	1.3	2.7	3.6	72	328	344	283	3.9
Bengal gram dal	20.8	5.6	2.7	1.2	59.8	372	56	331	5.3
Black gram dal	24	1.4	3.2	0.9	95.6	347	151	385	3.8
Green gram dal	24.5	1.2	3.5	0.8	59.9	348	75	405	3.9
Red gram dal	22.3	1.7	3.5	1.5	57.6	335	73	304	2.7
Rajmah	22.9	1.3	3.4	4.8	60.6	346	260	410	5.1
Soyabean	43.2	19.5	4.6	3.7	20.9	432	240	690	10.4

All values are as per 100g of edible portion

the small farmers' vulnerability to drought and climate change while increasing crop diversity and value. This in itself is sufficient justification for beginning to promote millet production and consumption. With the Food Security Bill soon to be passed in India, it would be the appropriate time to ensure that millets make a comeback in Indian diets. Whether this should be done through direct incentives to farmers or the setting up of cooperatives to process the millets and bring them to market, or other innovative strategies, policy makers should seek out measures to make the cultivation of millets of good quality an attractive option to the farmers in rainfed regions. This requires conscious policy decisions and a strong political will. At present, the heavily subsidised prices at which rice and wheat are offered through the public distribution system, and the relatively high prices of millets and coarse grains act as a disincentive for families to even supplement their diets with millets. While offering rice and wheat at very low prices (and even free) is done with the laudable intention of ensuring food security to economically weak households, it would make the task of promoting millet consumption even more difficult. Market prices play a big role in diverting both area under consumption and end use. The recent news report that wheat is being diverted to cattle feed in many parts of the country is a case in point.

Creating demand:

Incentivizing the farmers and improving yields and area under cultivation cannot by itself put millets back in the food baskets of Indian families. Efforts to improve production, yield and nutritive value have to be supplemented by efforts to boost demand through education and promotion. The demand for millets can rise only if their consumption is seen as desirable by most sections of the population. This requires *information dissemination, conscious re-positioning including pricing strategies.*

***Information dissemination*:**

For decades Indians, including those in the middle and lower income groups, have been moving away from millets and have been consuming rice and/or wheat exclusively, especially, as mentioned earlier, because of the subsidised prices at which the latter are offered. Even in the rural and tribal areas, families have moved largely to rice or wheat as their staple food grain. There has to be a sustained promotional campaign by the Central government as well as State governments to promote the consumption of millets at least as an adjunct cereal in family diets. These efforts should be made at the rural level through the existing health and nutrition support networks as well as at the urban level through educational pamphlets and wall charts in government hospitals and primary health centres. The nutritive values of the various locally available cereals should be listed in a manner that can be assimilated by all levels of potential consumers. The print and electronic media should be requested to co-operate in this millet promotion mission. With rising literacy levels and television penetration, these efforts can yield good results.

***Conscious repositioning*:**

Unfortunately, millets have come to be viewed as “the poor man's food”, although the reality is very different today (for instance, some millets are priced at more than Rs.30 per kilogram as against the price of rice in the public distribution system at one or two rupees a kilogram, or even free). Millets should therefore be “re-positioned” in the collective consciousness of the average Indian as an “aspirational food”. It has been suggested, for instance, that the term “coarse grains” be replaced with the terminology “nutricereals”. The move towards popularizing millets is already beginning to take place in a small way, with major food companies coming out with multi-grain flour, bread and biscuits. The middle class is consuming these in ever larger numbers, and the market for these products is said to be growing far faster than that for the wheat- or rice-based products. The new generation of better educated, upwardly mobile Indians is more diet-conscious and willing to experiment with variety. In other words, these food companies have shown that millets can be marketed as health-promoting aspirational foods that are convenient as well as beneficial. They have shown that a strong demand can be created through dissemination of a health message, and easy availability of the items in the form of already familiar foods (flour, bread and biscuits). As demand picks up, the effects will inevitably flow back down the chain, raising the production of millets and also the acreage. Also, as prices stabilize (either through market forces or through policy initiatives) other sections of the population too may begin to add such products to their diets. It could create an opening for a flourishing rural industry.

Practical issues:

There are practical issues that may stall the wider use of millets. Millets generally take a longer time to cook, which could be a problem with the rising domestic fuel prices. The shelf-life of millet flours is reported to be quite short, making them unsuitable for introduction in the public distribution system. Also, for the palates of a generation raised on wheat and rice, the taste of millets may be difficult to get accustomed to. This was found to be the case in some midday meal centres, where the children expressed their preference for rice/wheat instead.

The solution is not to retreat, but to regroup and advance. As pointed out, this can be done by devising newer recipes and more convenient forms of millet foods (including ready-to-eat), all supported by strong health messages, financial incentives and pricing policies. The cultivation of millets is an ecologically friendly process, with a minimum of irrigation, fertilisers and pesticides; it avoids soil depletion and is sustainable because even semi-arid acreage can be put to productive and remunerative use. The addition of millets to the Indian household diet would enhance farmers' security, food and nutrition security, and dietary diversity.

Pulses

Pulses and legumes have always formed

part of the Indian daily meal. Dals of various types, often cooked with vegetables, are eaten with rice or chapatis. But, as with millets, pulses too have been a casualty of the Green Revolution. The production of pulses has been stagnant over the past few decades, resulting in sharply lower per capita availability and consumption (Tables 1 and 2). The addition of pulses can ensure the protein quality of the vegetarian Indian diet, because pulses have lysine and essential amino acids that are lacking in wheat. Apart from lysine, pulses are also rich in micronutrients that play an important role in disease prevention and health promotion (Table 3). This is precisely why I had resisted an earlier attempt to promote lysine-enriched wheat into the country as an answer to the insufficiency of pulses in the diets. Such a step would have further reduced the pulse-eating habits of the people and thereby shut off access to excellent quality, highly bio-available micronutrients in a food that has been part of the regional cuisines for centuries.

At various time points during the decades after the Green Revolution, there have been desultory attempts to promote pulse production as part of various Five Year Plans. These did not result in any noticeable improvement because they were not backed by sustained support and focus. Under the Government of India-UNDP Cooperation programme during 1997-2003, pulses were identified as a "priority sector" to be strengthened on a priority basis. After pulses were brought within the ambit of a Technology Mission, their production is beginning to show a rising trend. However, the effects of decades of neglect cannot be reversed in the short term. Now, fortunately, at the highest policy-making levels, it has been recognized that the consumption of pulses is a practical, logical and desirable way to reduce malnutrition and promote health. The government has a pulse promotion policy in place, and has also been resorting to imports to meet domestic shortages. There has also been a move to offer pulses at subsidised rates through the public distribution system, and to ensure that they form part of the school midday meal programmes. But the fact that there is low availability even at the present poor levels of consumption points to the need to augment production, both by increasing acreage under pulses and by improving yields. This, in turn, will require technological inputs as well as financial or other incentives to farmers to grow pulses.

Legumes:

Legumes are the sister food of pulses; they also come in a wide range of varieties and are rich in protein and micronutrients; they too have been experiencing relative neglect over the decades, and are only recently seeing the beginning of a revival, along with pulses. Some of the legumes, like chickpea, have been the focus of intensive study at ICRISAT, and new enriched, high yielding varieties are available to farmers.Fortunately, pulses and legumes have not been perceived as "poor man's food", and therefore may not encounter resistance like millets. However, since pulses are not a staple food, the prevailing high prices will certainly deter many households from adding them to the daily diet. In any household emergency leading to pressure on available purchasing power, pulses may be among the first food items to be omitted, along with vegetables. Any sustainable pulses policy must ensure that optimum quantities of locally consumed varieties of pulses and legumes be made available to the most vulnerable sections of society, possibly through the public distribution system and, of course, in the school midday meal programme. Availability and affordability will lead to acceptance with some encouragement in the form of health education messages and promotion.

Tradition and change

The way forward is through embracing change without forgoing tradition. With the advent of globalisation, new food crops are coming into the Indian market. Soya bean is a valuable and protein rich food crop that is now being grown mostly as a fodder crop in India. Soya is rich in proteins and its flour can be used to make a variety of food items. It can also be eaten as tofu. However, the Indian palate has yet to accept this relatively new food, and it is presently confined mostly to the middle class, who use it as an occasional exotic food item. While we experiment with the new, it would be unwise to abandon the tried and tested food items. The consumption of parboiled rice is one such traditional practice in South India. At a time when the whole of the Andhra region (north of Madras city, as it was then known) was experiencing a large-scale epidemic of beri-beri, in both the wet and dry forms of the disease, the region south of Madras, where parboiled rice was being consumed, was strikingly free of beri-beri. This is because the process of parboiling locks in the thiamine, which is retained even after milling. Indigenous technologies such as these, with proven nutritive value, should be encouraged to continue. As we learn more and more about human nutrition, we realise that diversity of diets will take care of most nutritive deficiencies. Today, there is understandable global concern over food security; the need to ensure dietary diversity is being strongly emphasized. It would be a serious disservice to the national interests to let traditional foodstuffs of proven nutritive value, such as millets and pulses, to disappear from the food baskets of Indian households. Restoring millets and pulses to their rightful place in the Indian dietary system should be taken up as a task of high priority.

The author is the President of the Nutrition Foundation of India

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FOUNDATION NEWS

- Dr Prema Ramachandran attended the meeting taken by the Principal Secretary to the Prime Minister to discuss the promotion of consumption of Iron fortified iodised salt (double fortified salt) on 18.4.2011
- Dr Prema Ramachandran has been nominated to be a member of the Advisory Committee of the National Disaster Management Authority
- Dr Prema Ramachandran has been invited to be a member of the 12th Plan working group on Primary health care, tertiary health care and nutrition

Study Circle Lectures

- Impact evaluations of nutrition interventions to reduce child malnutrition: lessons from a recent review by Ms Ashi K Kathuria (Senior Nutrition Specialist, World Bank) on 27th April 2011.
- Practical issues in nutritional management of hospitalized patients with kidney disease by Ms Rupali Datta (Chief Dietitian, Fortis Hospital) on 30th May 2011.
- Celiac Disease: The Clinician's Perspective by Dr Sarath Gopalan (Deputy Director, NFI); The Nutritionist's Perspective by Mrs Neelanjana Singh (Chief Dietitian, PSRI Hospital) on 29th

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