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Challenges and Opportunities for Research and Action Towards Nutrition Security

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The year 2019 is a landmark year for nutrition science in India, celebrating the centenary of the National Institute of Nutrition, (NIN) a premier institute of nutrition research of the Indian Council of Medical Research in India, the 100th birthday of Dr. C Gopalan, an outstanding nutrition scientist who served as the Director of NIN, Director General of ICMR, and Founder President of the Nutrition Foundation of India and the Golden Jubilee of the Nutrition Society of India. It is indeed a privilege and pleasure to deliver the C Ramachandran Memorial Lecture at Nutrition Foundation of India this year and I express my deep gratitude to NFI for giving me this honour.

Nutrition Security Vs Food security

Many people equate Nutrition Security with Food security. However, nutrition security goes beyond food security and its more appropriate definition is: "Physical, economic and social access to an age-appropriate balanced diet, safe drinking water, environmental hygiene, and primary health care for all". Awareness, particularly among women is important to utilise these. Challenges for achieving nutrition security in a resource-poor country are numerous. These include:

- Food security at national level Vs household level, intra-household and intra-individual differences;
- Problem of agriculture productivity with sustainability, post-harvest losses, environmental degradation, global warming;
- Double burden of malnutrition and ill health: under-nutrition and risk of communicable diseases, along with epidemic of over-nutrition and non-communicable diseases;
- Inequity - gender, social, economic;
- Lack of nutrition literacy and consequently sensitivity at all levels;
- Inability to appreciate the enormity of the cost of malnutrition;
- Challenges in basic research;
- Mechanism of action of nutrients;
- Cross talk between genes, nutrients and microbes.

Agriculture productivity and demand supply

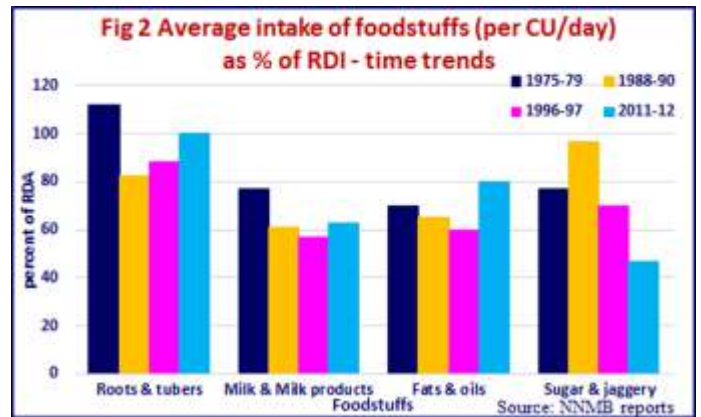
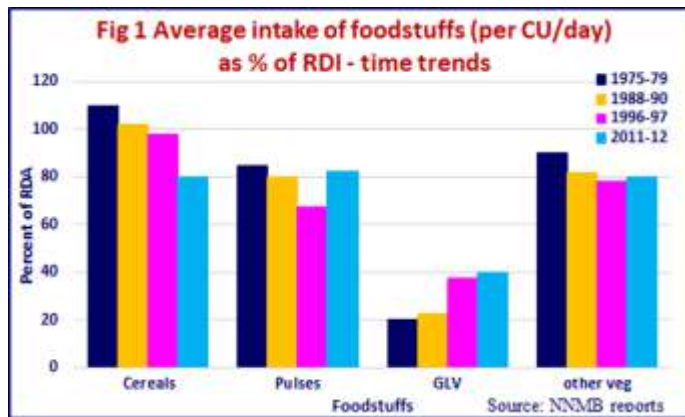
Agriculture productivity as judged by Gross Value Added (GVA) per worker is extremely low in India (715), compared to China (2632), EU area, (37155), and the USA (6945)¹. The challenge is to increase farm productivity in resource efficient ways, without harming the environment. This is an opportunity to develop green methods of farming (use of vermicompost, bio-pesticides) rather than increase the use of chemical fertilizers and pesticides, though judicious use of these may be necessary. Water and power are precious resources and their efficient use is needed. Apart from technology constraints, malnutrition among agriculture workers can also affect productivity. This aspect needs attention.

Projections of production of major food crops in India²

According to decadal projections of demand versus supply and availability of different food crops, cereal production in India can meet the demand of 284 million tons (MT) up to 2030. After years of low production necessitating import of pulses, estimated pulse production in the current year is 24-25 million tonnes which is sufficient to meet the demand (Table 1). India is the largest global producer of milk and second largest producer of vegetables and fruits. This may ensure supply to exceed demand at the national level for these foods, up to 2030. However, the actual availability falls short of

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demand due to post-harvest losses estimated (during 2010) to be 24% for vegetables, 20% for fruits and 5% for milk. Added to this is the problem of inequity in distribution with the ‘haves’ grabbing the most and leaving the ‘have-nots’ out due to the problem of affordability. Thus the challenges are: prevention of loss through post-harvest value addition, and social intervention to ensure access for the poor through channels like the Public Distribution System.

increased. Despite economic constraints some improvement in diets can be achieved through nutrition education to bring about behavioural changes in eating habits.

Food and nutrient consumption trends in India

Diet surveys also show that often even within the same family the diets of infants and children is poorer than those of the adults, suggesting ignorance of the care giver. In the same family inter-individual differences in macro- and micro-nutrient malnutrition is not uncommon. Many apparently healthy or even obese individuals suffer from micro-nutrient deficiencies, particularly anaemia- one of the most challenging nutritional problems of public health concern.

Diet surveys in 10 states of rural India, conducted by the National Nutrition Monitoring Bureau (ICMR), between 1975-77 and 2011-12, show a progressive decline in the consumption of cereals from 110% of RDA in 1975-77, to 74% of RDA in 2011-12. Since RDA is calculated, taking into consideration changes in physical activity patterns, shift to sedentary life styles over time cannot be invoked to explain the decline in cereal consumption. The intake of other foods like pulses, vegetables, green leafy vegetables (GLV), and milk and milk products which was low even to start with, continued to be low (Figs 1 and 2).

Contribution of major diseases in India to DALYs lost

Along with foods, there was a systematic reduction in intake of nutrients as well. Figures 3 and 4 show that the micro-nutrient gap is greater than the protein gap. If adequate calories are consumed protein requirement can be met though quality will still be a problem. Indian diets are qualitatively deficient in micro-nutrients, particularly calcium, iron and vitamins like vitamin A and some B vitamins like riboflavin, folic acid and vitamin B12. Green leafy vegetables (GLV) are good source of vitamin A (β carotene) as well as minerals. They are easy to grow and available throughout the year. There is no reason why intake of green leafy vegetables cannot be

A recent report³ shows that in India, between 1990 and 2016, there has been a significant shift in disease burden from pre-transition diseases (communicable, maternal, neonatal and nutrition) to post-transition non-communicable diseases and injuries (Table 2), as judged by Disability Adjusted Life Years Lost (DALYs)³.

Malnutrition tops the list of risk factors causing disease burden

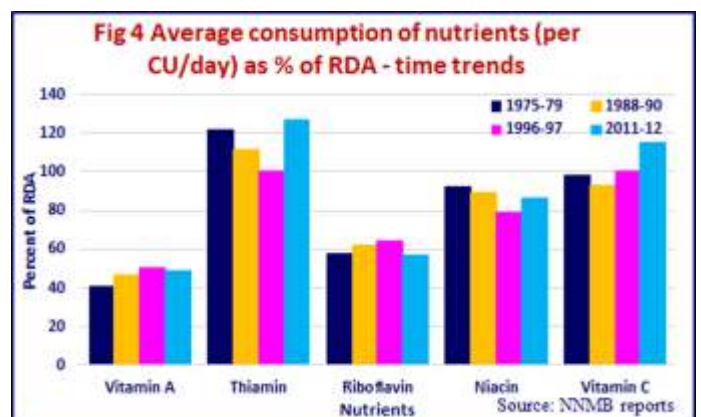
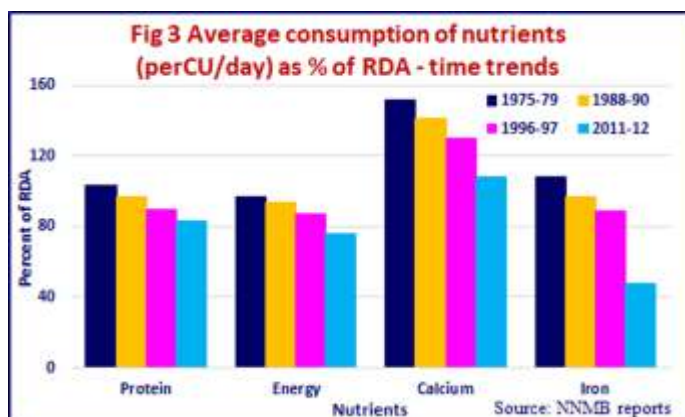


TABLE 1 PULSE OUT PUT (Mil. Metric ton)

Crop year*	Kharif	Rabi	Total
2013-14	5.99	13.25	19.25
2014-15	5.73	11.42	17.15
2015-16	5.53	10.82	16.35
2016-17	9.42	13.53	22.95
2017-18#	8.71	16-16.5	24.7-25.2

Department of agriculture, cooperation and farmer's welfare: All India crop situation 2018* Jul-Jun #forecast
1st advance estimates

TABLE 2 TRANSITION IN DISEASE BURDEN

Disease	DALYs lost		Deaths	
Year	1995	2016	1995	2016
Communicable, maternal, neonatal	60.9	32.7	53.6	27.5
Non-communicable	30.5	55.4	37.9	61.8
Injuries	8.6	11.9	8.5	10.7

ICMR, PHFI, Institute of health metrics: India, Health of the Nation's states an evaluation report (2017)

alcohol and drug use in that order³.

India has done better in reducing mortality indicators than under-nutrition

The National Family Health Surveys (NFHS surveys), between 1992-93 and 2015-16 show, that India has achieved considerable progress in reducing infant, under-five, and maternal mortality rates (Table 3). Under-nutrition in children has also come down, but to a much smaller extent. During the same period there was very little reduction in under-nutrition in children under 3 years of age. Wasting (wt/ht) showed no change. (Table 3). Maternal mortality rate also showed a reduction of 42% (SRS Survey), between 1997-98 and 2011-13 (Table 3). The question is; why is the problem of under-nutrition so resistant to solution? Complex questions cannot be answered simplistically, but one of the important reasons is neglect of women's health.

Some critical indicators of women's health

Tables 4 describes some of the critical indicators of women's health⁴. Lower sex ratio reported in NFHS4 (2015-16) as compared to NFHS3 (2005-06) clearly indicates that in India females are killed or allowed to die. Biologically the female has a higher survival rate than the male. Though female literacy has increased over the years, gender

disparity persists. Marriage of girls before the age of 18, and fertility rates have declined. Under-nutrition as assessed by BMI is almost the same in both the sexes (about 20%). There is an alarming increase in overweight in both the sexes. Women tend to be more overweight than men. The reasons for this, need to be examined. Anaemia is a serious problem in women as well as children (above 55%) and shows no signs of decline over the years. Almost 23% of men are also anaemic.

It is interesting to note that despite a marked increase in institutional births, from 39% during 2005-06 to 79% during 2015-16, the parameters of antenatal care are poor. Thus in 2015-16 only 21% women had full antenatal check-up, and about 30% had consumed iron folic acid for 100 days during pregnancy. This may suggest that women go to government or private institutions only for delivery. The Government gives incentives in cash and kind for institutional delivery and this can be an inducement for delivery in hospitals. However, frequent antenatal check-ups may be difficult for the women due to accessibility- distance of the institution from the village.

The challenge of low birth weight (LBW)

Among all the countries of the world, South Asia has the highest incidence of low birth weight- higher than Sub Saharan Africa. Among the South Asian countries, India has a higher incidence of

TABLE 3 TRENDS IN REDUCTION IN MORTALITY AND MALNUTRITION

Parameter	NFHS 1 (1992-93)	NFHS 2 (1998-99)	NFHS 3 (2005-06)	NFHS 4 (2015-16)	Reduction between 1992-93 and 2015 16 (%)
Infant mortality (deaths/1000 births)	79	68	57	41	51.9
U5 Mortality (deaths/1000 live births)	109	95	74	50	45.9
Nutrition status U3yrs Ht/age %-stunting	52	45	48	38	15.7
Nutrition status U3yrs, Wt/age %- Under weight	53	47	42	36	13.1
Nutrition status U3yrs Wt/Ht % Wasting	17	15	20	21	+0.4
Year	1997-98	2001-03	2007-09	2011-13	
Maternal mortality rate SRS Survey	398	301	212	167	42

ICMR, PHFI, Institute of health metrics: India, Health of the Nation's states an evaluation-report (2017)

TABLE 4 SELECT CRITICAL INDICATORS OF WOMEN'S HEALTH

Indicator	NFHS-3, 2005-6	NFHS-4,2015-16
Sex ratio	1000	991
Women 15-49 yrs who are literate %	55.1	68.4
Men who are literate %	78.1	85.7
Women aged 20-24, married before age 18	47.4	26.8
Fertility rate	2.7	2.2
Women underweight BMI <18.5	35.5	22.9
Men underweight BMI < 18.5	34.2	20.2
Women overweight BMI >25	12.6	20.7
Men overweight	9.3	18.6
Anaemia 6-59 months old	69.4	58.4
Anaemia women aged 15-49	55.3	53.0
Anaemia men aged 15-49	24.2	22.7
Full antenatal checkup	11.6	21.0
Iron folic acid consumption for 100 days during pregnancy	15.2	30.3
Institutional births	38.7	78.9
Children fully immunised	43.5	62.0
Children <3, breast-fed within 1 hr	23.4	41.6
Children <6 mts, exclusively BF	46.4	54.9
Children 6-8mts, Compl feeding + BF	52.6	42.7

International Institute Of Population Sciences National Family Health Survey-4, 2015-16. India fact sheet-

LBW (28%) than some neighbouring countries such as Bangladesh (22%), Nepal (18%), and Sri Lanka (17%), but LBW rates in Pakistan are higher than in India (32%)⁵. LBW/prematurity, top the list of causes of neonatal mortality, followed by infections, birth asphyxia/trauma and other causes⁶. It is interesting to note that while between 2000 and 2015, mortality due to infections, birth asphyxia/trauma and other causes came down markedly, mortality due to low LBW/prematurity actually went up (Table 5). Maternal malnutrition is the major cause of LBW; others are maternal age, premature birth, lack of antenatal care, infections and too much physical work. These are all correctable and should be addressed without delay.

Consequences of Low Birth Weight

Some of the important consequences of LBW are:

- High morbidity - greater neonatal and infant mortality. 6-10 times higher perinatal mortality.
- Adverse future pregnancy outcome in the daughters.
- Slower growth rate - stunting. Early intervention can reduce the disadvantage.
- Impaired physical and mental performance.
- Foetal origins of adult diseases. (development origins of adult diseases)

TABLE 5 MORTALITY RATES FOR NEW-BORNS BY CAUSES

Cause	2000	2015
Low birth wt/prematurity	12.3	14.3
Infections	11.9	4.0
Birth asphyxia/ trauma	9.0	2.2
Other causes	10.1	5.4

Million deaths study, Changes in cause-specific neonatal and 1-59-month child mortality in India from 2000 to 2015 Lancet 2017

Foetal origin of adult diseases (Developmental origin of adult diseases)

According to this hypothesis first enunciated by Barker, those born with low birth weight due to intra-uterine growth retardation (IUGR) are more susceptible to life style associated diseases like Type II diabetes, hyper-lipidaemia, hypertension and cardiovascular diseases (CVD) in later life. Their bodies have higher fat content-lean fat babies^{7,8}. Currently this is one of the most researched areas in the field of nutrition. It suggests that in a country like India which is in a state of economic transition, a considerable degree of the dual burden of disease mentioned earlier can be attributed to under-nutrition in early life, and indulgence in later life.

Micro-nutrients and foetal programming

Micro-nutrients influence gene function by interacting with nuclear receptors (e.g., vitamins A and D) or through epigenetic mechanisms (e.g., folate, vitamin B12). This impacts numerous cellular processes, particularly during foetal development. Epigenetics are genomic changes that may alter gene expression, but do not involve alterations in the primary DNA sequence [DNA methylation, post-translational histone modifications and RNA based mechanisms including the ones controlled by non-coding RNAs (miRNAs)]. They are transferred across generations. The first thousand days after conception is the window of opportunity for health. Since most pregnancies are unplanned, the peri-conception, time and the adolescent years of girls are important. In fact there should be a life-cycle approach to nurturing female health and nutrition.

Micronutrient deficiencies (hidden hunger) of public health concern

Among nutritional deficiency disorders, iron deficiency anaemia, zinc deficiency, iodine deficiency disorders, vitamin A deficiency,

and deficiencies of B-vitamins (particularly B2, and folic acid) have been well recognized. Vitamin B12 deficiency was ignored since its daily requirement is only 1µg and it was assumed that even vegetarians can get it through microbial association. Vitamin B12 occurs naturally in animal products and some algae like Spirulina. However, in recent years vitamin B12 deficiency has become more common and this is a matter of concern.

B-vitamins, homocysteine metabolism and health

Apart from the well-established functions of B complex vitamins (haemopoiesis, co-enzymes role), vitamins B2, folic acid, B6, and B12 are needed for homocysteine (HC) metabolism. Homocysteine is a sulphur amino acid whose metabolism stands at the junction of two pathways: remethylation to methionine (DNA synthesis), which requires, vitamin B2, folate and vitamin B12 and trans-sulfuration to cystathionine, which requires pyridoxal-5'-phosphate⁹. Hyper-homocysteinemia is a potential risk factor for disorders like neural tube defects (NTD), and congenital heart disease (CHD)¹⁰. Deficiencies of folic acid, vitamin B12 and B6 have been shown to raise serum HC levels. Recent studies from Pune highlight the magnitude of vitamin B12 deficiency in populations, particularly pregnant women. They also suggest that raised HC levels may also be associated with pre-eclampsia during pregnancy (Sadhana Joshi, Dr Rajammal Deva Das Oration in Annual Conference of Nutrition Society of India, 2018). Vitamin B-complex deficiencies and their health consequences have to be investigated through more research studies.

The problem of vitamin D deficiency in Indian population

Vitamin D is synthesized on exposure of the skin to ultra violet rays from sunlight from Vitamin D precursor 7 Dehydro cholesterol. Since vitamin D is synthesised in the skin from its precursor 7-dehydro-cholesterol on exposure to mid-morning sunlight, it was assumed that there cannot be vitamin D deficiency in a tropical country like India where there is so much sunshine. However, in recent years the problem of vitamin D deficiency has been reported in all age and occupational groups¹¹. This can be attributed to change in lifestyle, clothing, and calcium deficiency.

Vitamin D regulates Ca and P homeostasis. Calcitriol enhances the active transport of Ca in small intestine, stimulates synthesis of calcium binding protein in mucosal brush border. Parathyroid hormone (PTH) alone or in combination with calcitriol or estrogen or both mobilises the Ca and P from bone to maintain normal blood levels. In addition to the well understood classical functions of vitamin D, it has been observed to perform non-classical functions in non-classical target organs.

Non-classical target organs and functions of Vitamin D

Some of the non-classical functions of vitamin D are: regulation of hormone secretion, immune function and cellular proliferation and differentiation. Non-classical target organs are: adipose tissue, skin, muscle, pancreas, thymus, breast and colon. Vitamin D deficiency is associated with hypertension, diabetes, psoriasis Crohn's disease, multiple sclerosis, and prostatic and colonic cancer. This is an important area for future research.

Diet, gut micro-biota and health- pro-biotics and pre-biotics

Human metabolic functions and health are controlled not only by the person's genes but also by the micro-organisms, particularly the gut micro-flora. Diet can modulate the composition and metabolic activity of the human gut micro-flora (micro-biome). This in turn can impact human health¹². Thus microbes can influence cholesterol metabolism, blood glucose homeostasis, insulin sensitivity, and obesity and demonstrate anti-hypertensive and anti-carcinogenic properties by way of regulating host metabolic pathways and gene expression. The gut micro-biome, has potential involvement in neurological disorders impacting behaviour and mood. Microbes (bacteria, yeast) which when administered in adequate amounts confer a health benefit to the host are referred to as Probiotics. They are selected from the strains most beneficial for the host such as Lactobacillus, Bifidobacterium and yeast. Prebiotics are dietary substances like inulin and oligo-fructo-saccharides that are not absorbed from the small intestine and are fermented in large intestine by colonic bacteria, to promote the growth of beneficial probiotic microbes. Pre-biotics are present naturally in fruits, vegetables, onion, garlic, chicory, legumes, nuts, seeds, and most vegetables high in soluble fibre. The subject of gut microflora, probiotics and prebiotics is a relatively new and important area of research.

Functional foods and nutraceuticals

The Functional Food Centre (FFC, USA) defines functional food as "natural or processed foods that contain known or unknown biologically-active compounds; these foods, in defined, effective, and non-toxic amounts, provide a clinically proven and documented health benefit for the prevention, management, or treatment of chronic disease". Nutraceuticals are a distinct set of food-derived chemicals which are responsible for the functional attributes of foods. This is yet another fertile area for research in food and nutrition. It would be interesting to find out if some of the healthy foods mentioned in Ayurveda and other ancient forms of medicine based on empirical evidence can fulfil the criteria of functional foods.

The cost of under-nutrition

Some of the adverse consequences of under-nutrition (UN) are:

- Illnesses may be more severe in undernourished children; over one-third child deaths associated with under-nutrition;
- Children who were under-nourished between conception and two years of age (1000 days) follow a lower trajectory of physical growth and mental development; these in turn may affect productivity and national development;
- Economic cost of UN high and are either direct due to- increase in the burden on health care or indirect due - loss of productivity.
- Anaemia has been computed to be associated with a 2.5% drop in adult wages

The World Bank and Nutrition report, updated in September 2018 states:

"Malnutrition is one of the world's most serious but least-addressed development challenges. Its human and economic costs are enormous, falling hardest on the poor, women, and children". According to a group of economists including three Nobel laureates (the Copenhagen Consensus 2004) investment in nutrition is one of

the 'best buys' that developing countries can make for economic growth.

Approaches for combating dietary micronutrient deficiencies are:

- Pharmaceutical supplementation (Anaemia prophylaxis programme, Massive dose vitamin A supplementation programme)
- Food fortification (salt, wheat flour, milk, oil) or addition of micro-nutrient powder to cooked food. Iodised salt is a success story. Iron fortified iodised salt (double fortified salt) needs promotion.
- Food-based approach: Dietary diversification through nutritionally sensitive and environmentally sustainable agriculture.

Food-based approach for micronutrient security

Unlike supplementation or fortification, which can address the deficiency of only select nutrients, dietary diversification is a more holistic and balanced approach with little or no danger of toxicity. It demands creating an enabling environment of awareness, and ensuring access at affordable cost to a variety of micronutrient-dense foods, and knowledge of right infant and child feeding practices. Besides access to micronutrient-dense foods, access to safe drinking water, a disease free environment and health care outreach are also important to ensure optimum absorption and utilisation of nutrients.

Nutritionally sensitive and environmentally sustainable agriculture to increase access to micronutrient-dense foods.

In vegetarian diets, vegetables and fruits, besides pulses and millets are richer sources of micro-nutrients, than cereals like rice. Among vegetables, green leafy vegetables are naturally well-endowed with micro-nutrients like minerals, pro-vitamin A (β -carotene), folic acid and vitamin C. Orange and yellow vegetables like carrots and fruits like, mango, papaya are rich sources of pro-vitamin A, besides vitamin C. Citrus fruits, guava and Indian goose berry (amla) are rich in vitamin C. Besides preventing scurvy, vitamin C also facilitates iron absorption. Pulses and millets are well-endowed with micro-nutrients minerals and B-complex vitamins. Finger millet (ragi) is one of the richest sources of calcium. Nutritionally-sensitive farming implies promoting vegetables, fruits, pulses and millets in a mixed cropping system with cereals, fodder grass and other cash crops. Prof. MS Swaminathan urges setting up of genetic gardens of plant food varieties whose germplasm is naturally enriched with vitamins and minerals. Bio-fortification utilising conventional breeding, marker-aided breeding and genetic engineering can help to develop micro-nutrient-rich plant foods, by enriching the germ-plasm. While the first two are non-controversial, genetic engineering where genes are transferred within species or plucked out and introduced from unrelated species has raised questions of safety. Some examples of the engineered plants are:

Conventional or marker aided breeding include initiatives of Harvest Plus programme of Consultative Group for International Agricultural Research (CGIAR) include development of zinc-rich rice and wheat, iron-rich beans and pearl millet and vitamin A-rich sweet

potato, cassava and maize. Research initiatives in Genetic Engineering has resulted in the development of Provitamin A- rich golden rice, high-folate rice, lettuce, tomato and high protein potato (developed in India). Farm-based approach to combat hidden hunger include Leveraging agriculture for nutrition in South Asia coordinated by the MS Swaminathan Research Foundation.

Some of the problems encountered in promoting nutritionally-sensitive and environmentally-sustainable agriculture are small size of land holdings, resistance among farmers to shift away from traditional cropping pattern, agriculture being viewed as source of income, or to export and at best to quench hunger and get protein and lack of awareness regarding importance of eating nutritious food.

Experience of Dangoria Charitable Trust in promoting farm and food based approach to improve dietary diversification and mothers' understanding of health and nutrition

Since over a decade, my colleagues and I in the Dangoria Charitable Trust (DCT), have examined the feasibility of land diversification from traditional crops like paddy and sugar cane to vegetables, fruits, millets and pulses and linking agriculture intervention with health and nutrition education¹³⁻¹⁶. The location was villages of Medak district in the South Indian state of Telangana (formerly part of integrated Andhra Pradesh). Since the first 1000 days are important for laying the foundation for good health and nutrition, the target group was families with a pregnant woman and/or a child under-24 months of age. Fortunately most families had some land either their own or leased. Seeds and seedlings of nutritionally-endowed vegetables like green leafy vegetables, beans, okra were distributed. Some interested women were trained and given seeds and sachets to raise saplings of drumstick, papaya and creeper spinach (bachalkura). These saplings were later purchased from them at Rs 5/ each and used as planting material and this gave them some income. Organic methods of farming like vermi-compost and botanical pesticides (decoction of neem seeds and chilli garlic) were promoted. One self-help group has established a unit for preparing neem seed powder and sells it with proper labelling explaining its use as pesticide and fertiliser.

Health and nutrition education on issues of food, nutrition, sanitation and common infectious diseases, their causes and management was an important component of the project. Teaching aids included pamphlets in Telugu distributed to all the participants. There has been considerable increase in female literacy in recent years. Even if the mother was illiterate, she was happy to get the pamphlets since there would be someone at home to read it to her.

Both centralised and de-centralised-hands on training programmes were conducted. Baseline and end-line knowledge attitude and practice (KAP) surveys were carried out on the sub-sample of target mothers registered at the ICDS centres, to assess the change in mothers' understanding of health and nutrition including infant and child feeding practices. Household diet surveys were carried out initially and finally. The studies had a duration of 3¹⁴⁻¹⁶ to 4 years¹⁷.

The impact was assessed by examining:

- The acceptance of homestead gardens-crop diversification despite small land holdings;
- Improvement in mothers' understanding of health and nutrition

TABLE 6 IMPACT OF BACKYARD POULTRY ON EGG CONSUMPTION

No of units/Initial and Final survey	Consumption (gms) per capita per week		Frequency per week
	Mean	Mean	Mean
38	Initial May 2012	2.22	2.32
	Final May 2013	3.27***	3.21***
60	Initial March 2013	1.79	1.78
	Final April 2014	4.88***	4.72***

Ind J Nutr Diet 2013

including feeding practices, (KAP surveys);

- Change in household food consumption-frequency per week, g per capita per day.
- Nutrition status of 6-24 months old children (ICDS records).

Besides homestead gardens, backyard poultry (BYP) with high egg-yielding birds were also promoted^{14,16}. Each interested family purchased 4 female birds, and one bird - male or female was gifted.

The salient observations were:

- Remarkable improvement in mothers' knowledge of diet, nutrition, sanitation, feeding practices, common diseases etc.
- Good acceptance of farm technologies and diversification of crops grown on small bits of land
- A significant improvement in weekly frequency and per capita consumption of GLV, was seen in all the studies. While the earlier studies^{13,14} failed to show improvement in vegetable consumption, there was a quantum increase in the frequency (about 30%) and per capita consumption of green leafy (GLV) (179%) and other vegetables (52%), in the recently completed study¹⁵.
- In one of the earlier studies¹³ where we had a control and intervention villages we were able to demonstrate that over the next three years when the cost of vegetables were high, there was no reduction in the vegetable consumption in the intervention villages where homestead gardens were promoted, but in the control villages there was a significant reduction in vegetable consumption over 3 years. This suggests that homestead production at least shielded households against decline in consumption due to increase in the price of vegetables.
- Introduction of backyard poultry with just few high egg-yielding birds resulted in significant improvement in the household egg consumption (Table 6). Data on growth of the children (ICDS data), showed significant decline of about 10% in moderate and severe malnutrition (from about 30 % to 20%). However, every year malnutrition peaked during monsoon months. This is a known phenomenon, attributed to greater morbidity during the rainy season. Improved sanitation in the villages and timely health care outreach may help to prevent this. The experience of the DCT on the impact of homestead gardens and poultry are akin to those of earlier studies from India and abroad¹⁷⁻²⁶. Eminent agriculture scientist Prof. MS Swaminathan (MS Swaminathan Research Foundation -MSSRF), is a strong supporter of what he calls "A farming system model to leverage agriculture for nutritional outcomes" (Farming systems for nutrition-FSN)^{19,20}.

Conclusion

In conclusion, our experience and those of others shows that, with advocacy and education, farmers even with small and marginal land holdings can be persuaded to diversify from traditional crops like paddy and cash crops to horticulture. To convince them to use the home-grown produce for home consumption to enrich their diet, rather than sell it, requires lot of persuasion since the priority of poor farmers is income rather than nutrition security. But this too can be achieved. Even if this approach can meet the vegetable requirement of the family, it is unlikely to meet the micro-nutrient requirement, since in all our studies consumption of pulses and animal products did not increase, the exception being eggs consumption where BYP was promoted. For an overall impact on micro-nutrient security a more holistic approach with inputs in terms of agriculture support, knowhow and do how to produce and consume more millets, pulses and animal products would be necessary. BYP is a promising approach. It is very encouraging to find the marked improvement in the mothers' understanding (KAP) of health, nutrition and sanitation. This demands robust behavioural change communication, which involves reinforcing messages and guidance. The reduction in child under-nutrition seen in ICDS data may be due to better feeding practices. However, for greater impact better sanitation to prevent the monsoon peaks in under-nutrition and purchasing power would be needed.

The author is retired Director Grade Scientist, NIN, Hyderabad and an Emeritus Scientist of INSA. The article is based on the C Ramachandran Memorial lecture delivered by her on 26.11.2018

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NUTRITION NEWS

NIN Centenary Year: The National Institute of Nutrition, Hyderabad, is celebrating its centenary year (2017-18) with several activities under the theme "Empowering the nation through nutrition".

NSI Conference: The Golden Jubilee Conference of the Nutrition Society of India (50th Annual Conference) was held at National Institute of Nutrition, Hyderabad from 15th to 17th November, 2018. The theme for the conference was "India's Transition from Food Security to Nutrition Security".

Two pre-conference workshops - ABC of Enteral and Parenteral Nutrition and Sports Nutrition- were organized on 15th November, 2018

41st Gopalan Oration on "In search of modifiable susceptibility to diabetes in Indians: Story of a hungry Indian fetus" was delivered by Prof C.S. Yajnik, Director – Diabetes Unit, King Edward Memorial Hospital, Pune on 15th November, 2018.

42nd Gopalan Oration on "50 years of dietary fibre" was delivered by Professor John H Cummings, Emeritus Professor of Experimental Gastroenterology, School of Medicine, University of Dundee, United Kingdom on 16th November, 2018.

30th Dr Srikantia Memorial Award Lecture on "Food and Nutrition Security as Fundamentals of Human Development: National Perspective International Agenda" was delivered by Dr Biplab K. Nandi, Senior Food and Nutrition Officer (Retd), FAO Regional Officer for Asia and the Pacific, Bangkok, Thailand and President, Society for Nutrition, Educational and Health Advancement (SNEHA), Kolkatta (16th November, 2018);

9th Dr. Rajammal P Devadas Memorial Award on Maternal Nutrition and Placental Programming: Implications for Long Term Health" by Dr Sadhana Ramachandra Joshi, Professor and Head, Mother and Child, Interactive Research School for Health Affairs (IRSHA), Bharati Vidyapeeth Deemed University, Pune. (17th November, 2018);

FOUNDATION NEWS

Indian National Science Academy brought out a thematic issue of the Proceedings of the Indian National Science Academy on "Dual Nutrition Burden in India: challenges and opportunities". The issue carries articles contributed by eminent nutrition scientists to document:

- elimination of severe forms of under-nutrition and nutritional deficiencies and reduction in moderate under-nutrition,
- persistence of chronic moderate under-nutrition and anaemia
- rising trends in the prevalence of over-nutrition and obesity in all age groups in India.

The strategies for the prevention, detection and management of both under- and over-nutrition which will enable the country to achieve the nutrition targets of the Sustainable Development Goal by 2030 are discussed in these articles.

Dr. Prema Ramachandran, Director, Nutrition Foundation of India is the Guest Editor for this issue. NFI has contributed two research articles and one review article for the issue.

The Nutrition Foundation of India (NFI) celebrated its Foundation Day on 26.11.2018. Dr Mahtab S Bamji, Retired Director Grade Scientist, National Institute of Nutrition, Hyderabad, and currently INSA Emeritus Scientist, Dangoria Charitable Trust, Hyderabad, delivered the C Ramachandran Memorial Lecture at NFI.

Dr C Gopalan who is considered to be the "Father of Nutrition Sciences in India" celebrated his 100th birthday this year. Nutrition Foundation of India organised the "Dr C Gopalan Centenary Symposium" on 27.11.2018. The theme of this national symposium was "India's Tryst with SDG Nutrition Targets". The symposium was organised in collaboration with the National Academy of Medical Sciences, and was held in the Kamla Raheja Auditorium, NAMS House, New Delhi. Eminent scientists from different parts of the country participated in the symposium and delivered lectures on various aspects of this important theme. The Symposium was transmitted live to other academic institutions through National Knowledge Network; participants from these centres were able to interact with the speakers at NAMS auditorium live and in real time.