ICAR – Central Tuber Crops Research Institute
Sreekariyam, Thiruvananthapuram – 695017, Kerala.

Eat Healthy Stay Healthy

ICAR-CTCRI NEH Programme

RAINBOW DIET CAMPAIGN

An Extension Strategy for Scaling up Biofortified Tuber Crops Varieties

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ICAR-Central Tuber Crops Research Institute | ICAR-CTCRI NEH Programme

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Chapter 1

Tuber Crops in Food and Nutritional Security

1. 1. Tropical tuber crops

The tropical root and tuber crops like sweet potato (*Ipomoea batatas*), cassava/tapioca (*Manihot esculenta*), yams (*Dioscorea* spp.), taro (*Colocasia esculenta*), tannia (*Xanthosoma sagittifolium*), and elephant foot yam (*Amorphophallus* spp.) are popular secondary staples which can provide viable options for ensuring food, nutritional security, lessening hunger and combating malnutrition. In India, the tubers are long served as secondary food staples and delicious vegetables in ethnic food, which attracted commercial dimension in recent years.

The tropical tubers are the ancient food sources and are often regarded as relics of primitive agriculture. As self-grown crops of rain forests, they served the human beings as staples along with meat in primitive era. During the organized cultivation, tuber crops offered sustained food security to under-served tribals and others living in fragile, disadvantageous conditions. As underground food producers, these crops withstood the adverse soil and climatic conditions as well as other biotic and abiotic stresses through their inbuilt survival mechanisms. Later, the wide niche of tropical tubers shrunken with advancement of civilization due to diversified culture including food habits. Currently tuber crops, the third most important food sources provide 6% dietary calorie of the global population consisting mostly small, marginal farmers and tribal community.

1.2. Nutritional composition of tuber crops

The tropical tubers are reservoir of dietary energy (86-300 kcal/100g), micronutrients [(Fe 0.2-3 mg/100g, Zn 0.3-2mg/100g)], vitamins (Vit. E 0.2-2mg/100g), antioxidants (β-carotene and anthocyanin) and dietary fibres (Lebot, 2009). Most of these crops are source for functional foods due to low glycemic index (44-54), slow digestible and resistant starch.

Among tuber crops, sweet potato has wide nutritional diversity from low-glycemic index to high levels of β-carotene and anthocyanin content. The TIME magazine has selected sweet potato as one of the 25 best inventions of 2016 for its ability to combat vitamin A deficiency in a natural way, withstand drought and tolerance to viral diseases (Times.com, 2016). The National Aeronautics and Space Administration (NASA) has selected sweet potatoes as a candidate crop to be grown and incorporated into the menu for astronauts on space missions due to their unique features and nutritional value.

1.2. Production scenario of tuber crops

Tuber crops like cassava and sweet potato are ranked among the top ten food crops produced in developing countries in terms of volume of production. Cassava is cultivated in 23.77 million ha and spread over the continents of South America, Africa, and Asia, producing 281 million tons of tubers. The average productivity of cassava in the world is 11.22 t ha^{-1}. Similarly, sweet potato is grown in Asia, Africa, America, Europe and Oceania with area, production and productivity of 11.91 million ha, 175 million tons of tubers and 10.58 t ha^{-1} respectively (FAOSTAT, 2016).

Cassava and sweet potatoes are the two important tuber crops cultivated in India with 0.204 and 0.130 million ha area under cultivation with 4.55 and 1.47 million tons annual production, respectively (FAOSTAT, 2016).

In India, about 70 - 80 % of the total cassava produced is used as raw materials to produce starch (including modified starch forms), sago, fried chips, flour etc., whereas 20-30% is directly cosumed. Human consumption of cassava tubers is mainly confined to Kerala and tribal areas.

1.3. ICAR - Central Tuber Crops Research Institute, Thiruvananthapuram

The tuber crops research in India is largely undertaken by ICAR – Central Tuber Crops Research Institute (ICAR-CTCRI), Thiruvananthpuram with support from its Regional Centre at Bhubaneswar and All India Coordinated Research Project on Tuber Crops (AICRP-TC) centres spread throughout India. The ICAR-CTCRI, a premier institute under the Indian Council of Agricultural Research, New Delhi is the one of the institutions in the world dedicated exclusively for research on tropical root and tuber crops.

The ICAR-CTCRI has developed 67 varieties in all tropical tuber crops; standardized agro-techniques of various tuber crops in different agro-ecosystems in India including North-Eastern region; resource conservation technologies including *in vivo* and *in vitro* protocols for quality planting material production; integrated management packages for tuber crops pests and diseases; value added food and industrial products from tuber crops and computer simulation models/ information systems for crop management. The Institute has a strong out-reach programme for transferring tuber crops technologies for various user group. Owing to its good work conducted in the last five decades, ICAR-CTCRI has received several recognitions at the national and international level.

1.4. Biofortified tuber crops varieties from ICAR-CTCRI

The biofortification work conducted at ICAR-CTCRI has resulted in development of seven anti-oxidant rich varieties. Six sweet potato varieties rich in β-carotene (Bhu Sona, Sree Kanaka, Bhu Kanti, Bhu Ja, Gouri and Sree Retna) and anthocyanin (Bhu Krishna) along with one variety of purple yam (Sree Neelima) (Fig. 1 a & b).

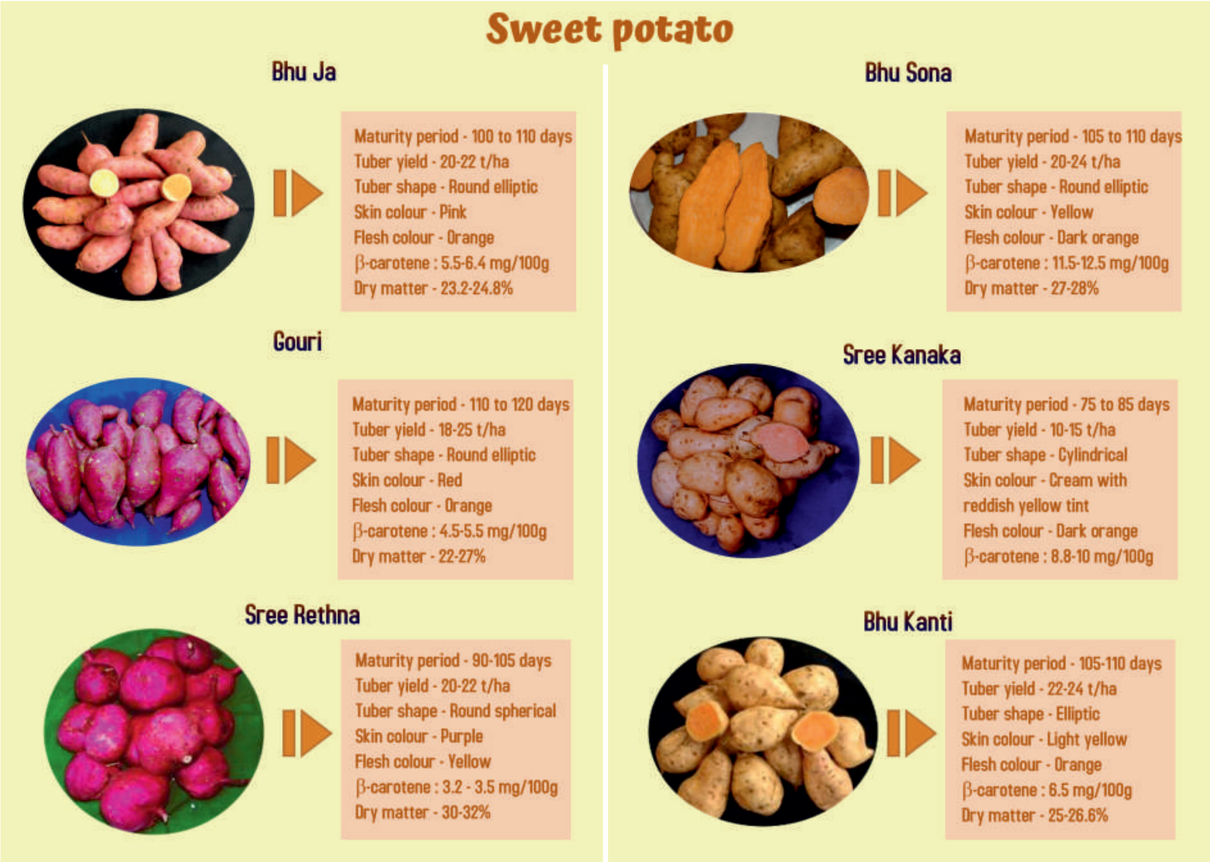

Fig. 1 a. β-carotene rich sweet potato varieties released by ICAR-CTCRI

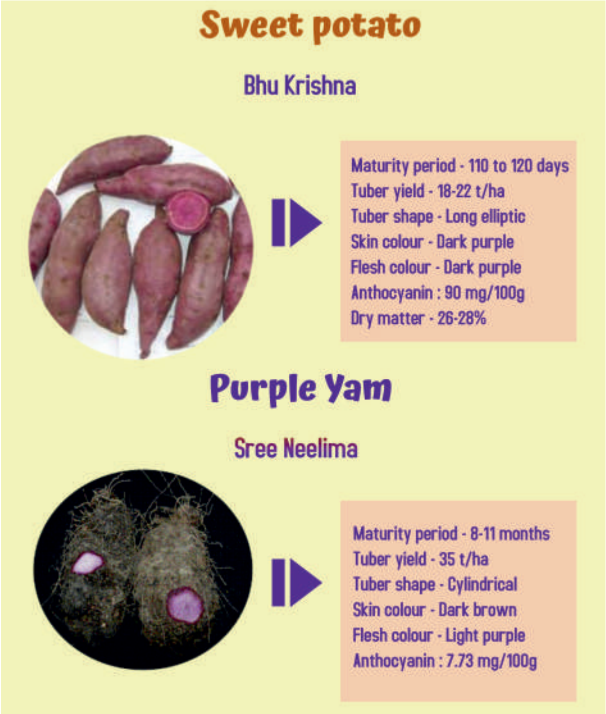

Fig. 1b. Purple fleshed sweet potato and purple yam varieties released by ICAR-CTCRI

Chapter 2

Micronutrient Malnutrition in India

2.1. Micronutrient Malnutrition

Micronutrient malnutrition or Hidden hunger is a term used to refer to diseases caused by dietary deficiency of vitamins or minerals, caused by inadequate intake or absorption of micronutrients for maintaining good health and development. Along with inadequate intake, various diseases and increased micronutrient needs not met during pregnancy and lactation also lead to micronutrient deficiencies (Muthayya *et al.,* 2013). Various micronutrients and their functions in human body are described in Box 1. and Fig. 2.

Box 1. What are Micronutrients?

Micronutrients are the vitamins and minerals obtained through specific foods in small quantities. Humans must obtain micronutrients from food since our body cannot produce them. Right balanced diet ensures healthy metabolism, growth and physical fitness.

- ✓ Vitamins – vitamin A, provitamin A (β-carotene), vitamin B1, vitamin B2, vitamin B6, vitamin B12, biotin, vitamin C, vitamin D, vitamin E, folic acid, vitamin K, niacin and pantothenic acid.
- ✓ Minerals – elements of copper, iodine, iron, manganese, selenium and zinc together with the macro elements calcium, magnesium, potassium and sodium.

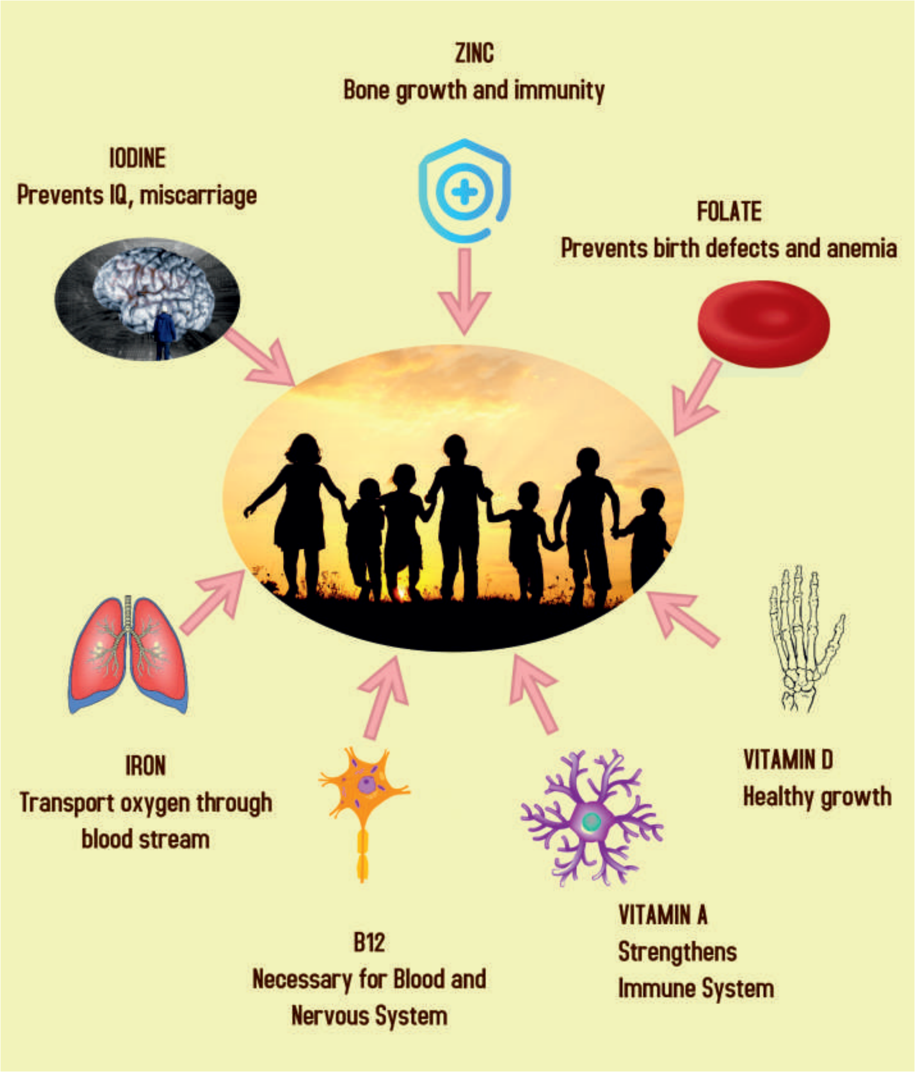

Fig. 2. Specific functions of micronutrients in the human body
(Adapted from Shergill – Bonner, 2013)

While clinical signs of hidden hunger, such as night blindness due to vitamin A deficiency and goiter from inadequate iodine intake, become visible once deficiencies become severe, a large part of its symptoms are not always visible and people are not aware of it. Research indicates that even mild or moderate deficiencies of micronutrients among children can lead to impaired cognitive development, poor physical growth, and increased morbidity and decreased work productivity in adulthood.

Generally iron, vitamin A, iodine and zinc are considered as high public health importance in childhood and adolescence. However, in the recent years, folate, vitamin B12 and vitamin D have also gained significance in maternal and child health research and programmes.

2.2. Micronutrient Deficiency in India

The Comprehensive National Nutrition Survey (CNNS), which collected data on the nutritional status of Indian children between the ages of 0 and 19, indicates that zinc deficiency was found among 19% of pre-school children and 32% of adolescents. Folate deficiency was prevalent among 23% of pre-school children and 37% of adolescents. The prevalence of deficiencies of vitamin B12, vitamin A and vitamin D also hover between 14% to 31% for pre-school children to adolescents (Fig. 3).

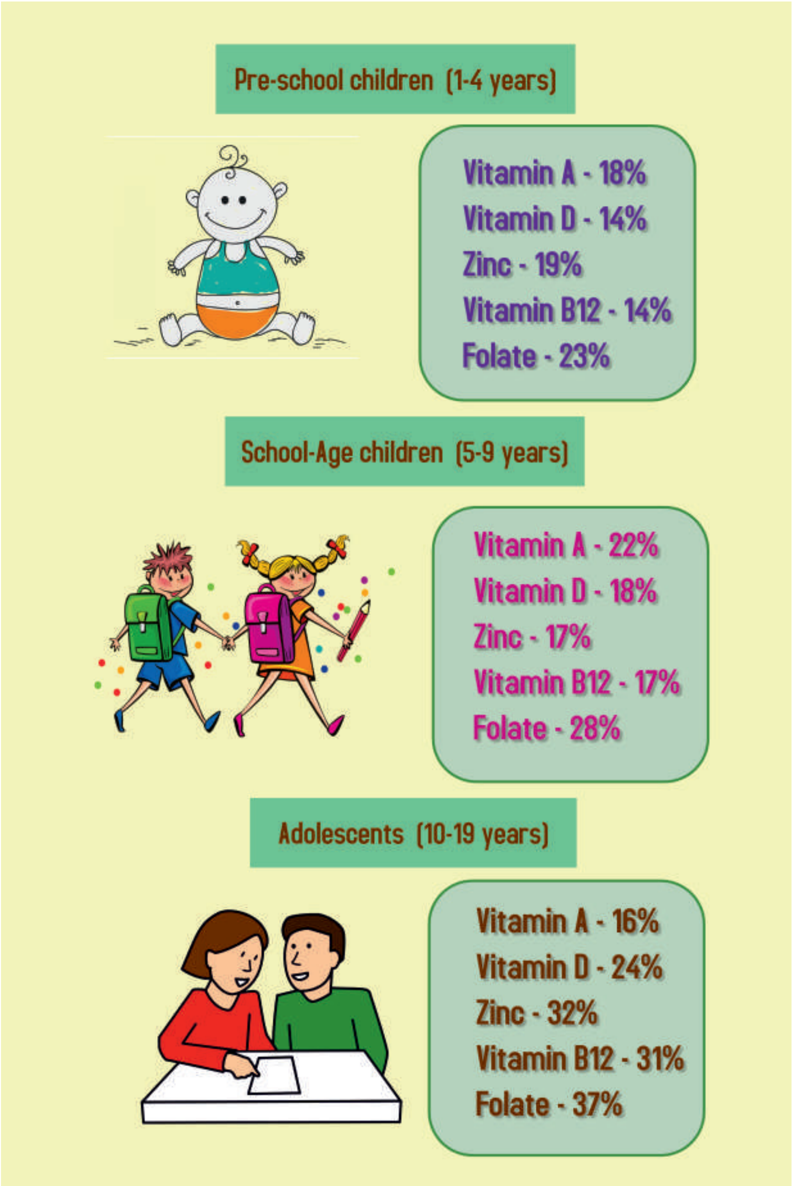

Fig. 3. Prevalence of micronutrient deficiencies across age groups in India (Ministry of Health and Family Welfare, UNICEF and Population Council. 2019)

2.3. Vitamin A deficiency

Vitamin A is an essential micronutrient that is particularly important for immune function.

Vitamin A is critical during periods of rapid growth and inadequate intake can lead to deficiency which, in severe cases, may cause visual impairment (night blindness) and increase the risk of morbidity and mortality from common childhood infections.

The Comprehensive National Nutrition Survey data (Ministry of Health and Family Welfare, UNICEF and Population Council, 2019) shows that the vitamin A deficiency among pre-school children aged 1–4 years was 18%, which is 22% among school-age children (5–9 years) and 16% among adolescents aged 10–19 years. The prevalence of vitamin A deficiency was higher among early adolescents aged 10–14 years (18%), compared to late adolescents aged 15–19 years (13%).

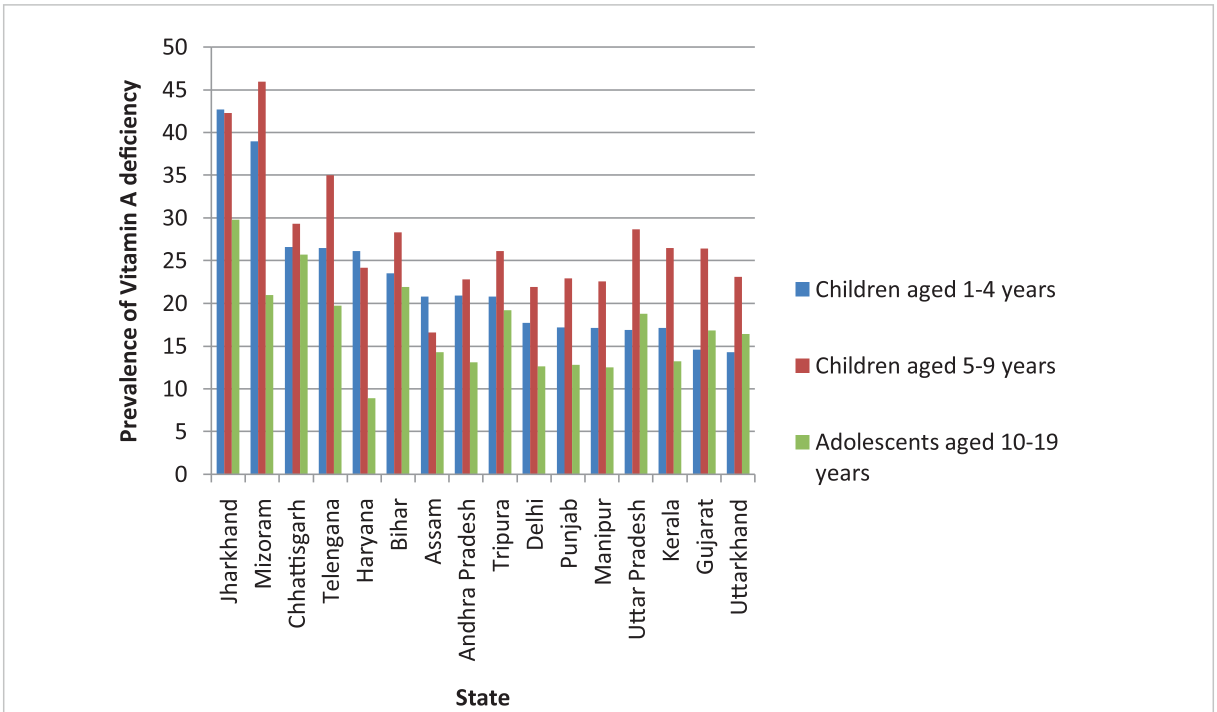

Fig. 4. Vitamin A deficiency in severe form (≥20% prevalence) across states (Source: Ministry of Health and Family Welfare, UNICEF and Population Council, 2019).

Among Indian states, Jharkhand has severe vitamin A deficiency across the age groups (≥20% prevalence), followed by Mizoram, Chhattisgarh, Telangana, Haryana and Bihar (Fig. 4). According to the WHO guideline of prevalence ≥ 20% (WHO, 2007), vitamin A deficiency was identified as a severe public health problem in 12 states among pre-school children and in four states among adolescents (Ministry of Health and Family Welfare, UNICEF and Population Council, 2019).

Among North-Eastern Hill states, 5-9 years age children from Tripura and Manipur have severe vitamin A deficiency (≥20%) with moderate level in other states (Fig. 5).

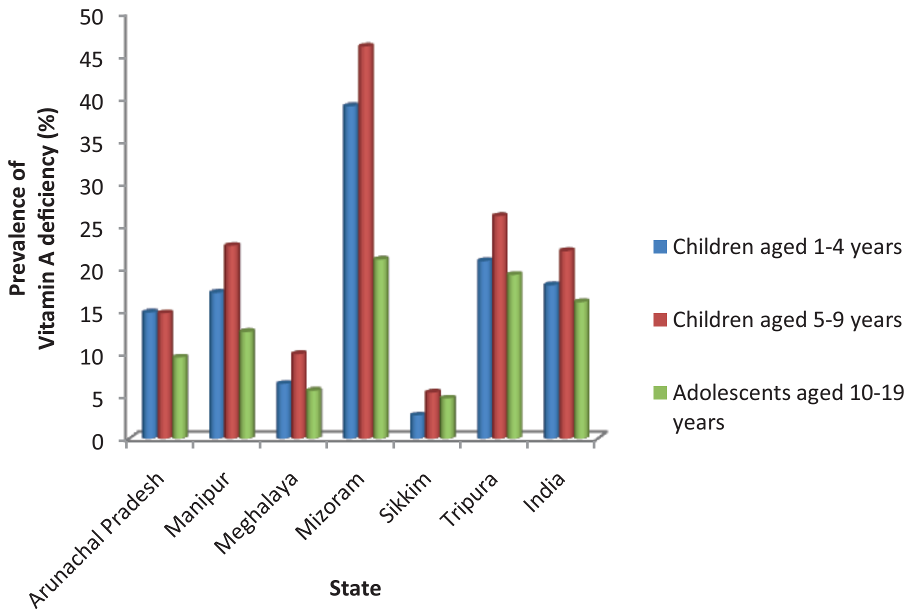

Fig. 5 Prevalence of vitamin A deficiency among children and adolescents by state, India (Ministry of Health and Family Welfare, UNICEF and Population Council. 2019)

The World Health Organisation indicates that poverty has a strong association with undernutrition, obesity and micronutrient deficiencies because poor households have less access to nutrient rich food which is often expensive. It is necessary to assess the reasons for high prevalence of high micronutrient deficiencies.

2.4. Poor dietary intake – A key cause of hidden hunger

A healthy diet is a combination of foods that are rich in vitamins and minerals, which are consumed in adequate quantity. It involves a variety of fruits and vegetables, whole grains, beans and legumes, low-fat protein, and dairy products. Among them, the phytonutients obtained from fruits and vegetables play a key role in meeting the micronutrients requirement of the human body.

India is one of the largest producers and a net importer of many fruits and vegetables and has one of the largest consumer markets in the World. About a third of its total private final consumption expenditure in India goes on food and beverage combined, which is higher than United States (9%), China (25%) and Brazil (17%). Despite having strong food production and consumption market, the fruit and vegetables intake of Indian consumers is only 9% of the total calorie intake (Arpita *et al.,* 2016).

The World Health Organisation (WHO) has recommended a daily intake of at least 400 grams (or five daily servings with an average serving size of 80 gm) of fruits and vegetables, excluding potatoes, cassava and other starchy tubers, to prevent diet-related chronic diseases and micronutrient deficiencies (Nishida *et al*., 2004). A recent survey by Indian Council for Research on International Economic Relations (ICRIER) (Arpita *et al.,* 2016) indicates that Indian consumers across all income groups consume less than the 'recommended' quantity of at least 400 grams (or five daily servings with an average serving size of 80 gm) of fruits and vegetables. While the women (both working and housewives) consume relatively higher fruits and vegetables (> 3.5 servings/ day), the intake among the students and youth is very low (<3 servings/day) (Fig. 6).

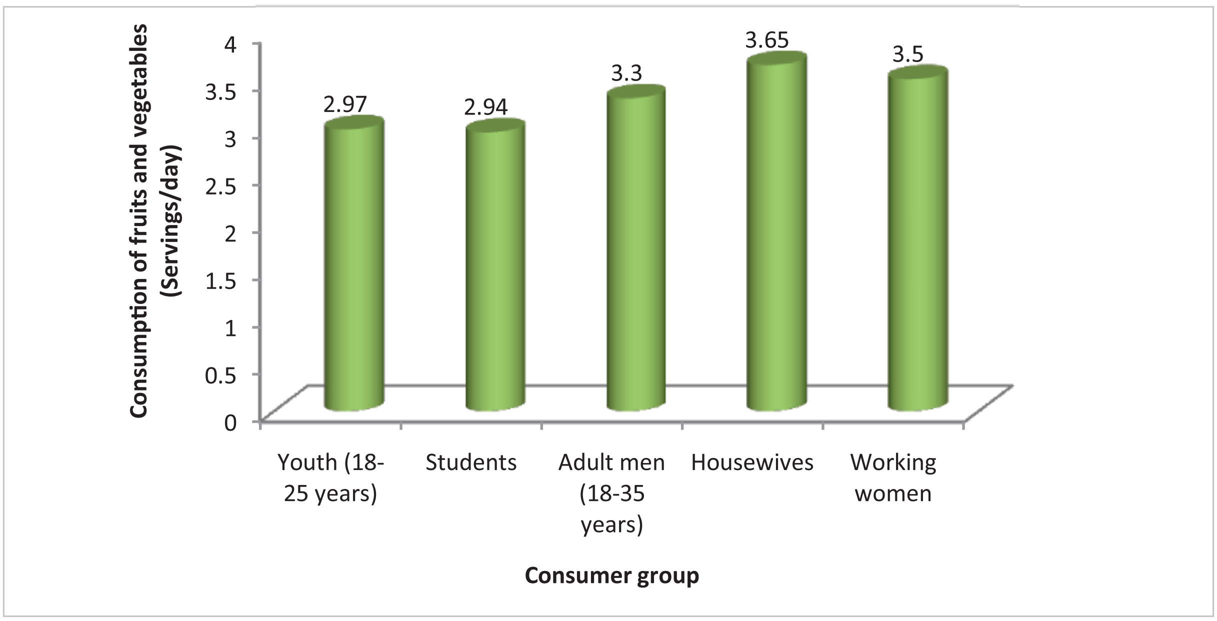

Fig. 6. Fruits and vegetable intake in India

This trend in inadequate consumption of natural sources of micronutrients in the form of phytonutrients, leads to micronutrient deficiencies.

2.5. Reasons for inadequate intake of fruits and vegetables

The ICRIER survey (Arpita *et al*., 2016) indicates that the consumers failed to meet WHO recommendations in fruit and vegetable consumption, due to lifestyle issues (51.1 %) followed by seasonal availability (25.7%) and high cost (20.6%) (Fig. 7).

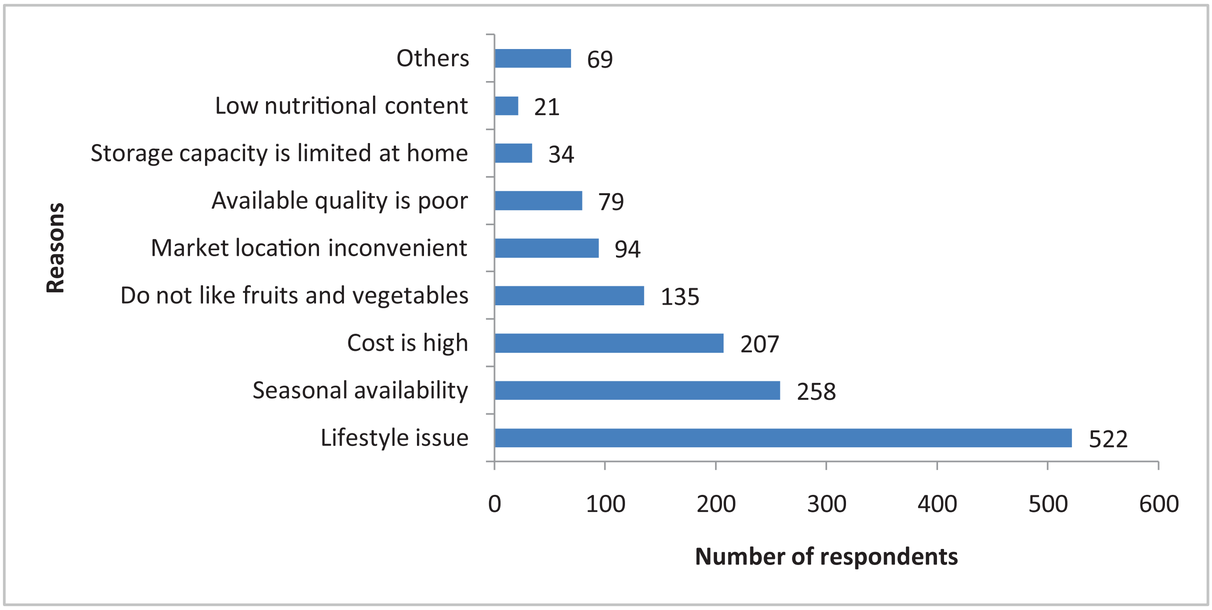

Fig. 7. Reasons for not being able to meet WHO recommendation on consumption of fruits and vegetables (Source: Arpita *et al.,* 2016).

The prices of fruit and vegetable rose steadily over the last decade, with most prices doubling, even trebling in the case of sweet potato and ginger. Cost was the third most frequently cited reason for the low consumption of fruit and vegetables, in the Phytonutrient Report (Arpita *et al.,* 2016). The percent of decadal price rise of various fruits and vegetables are illustrated in Fig. 8.

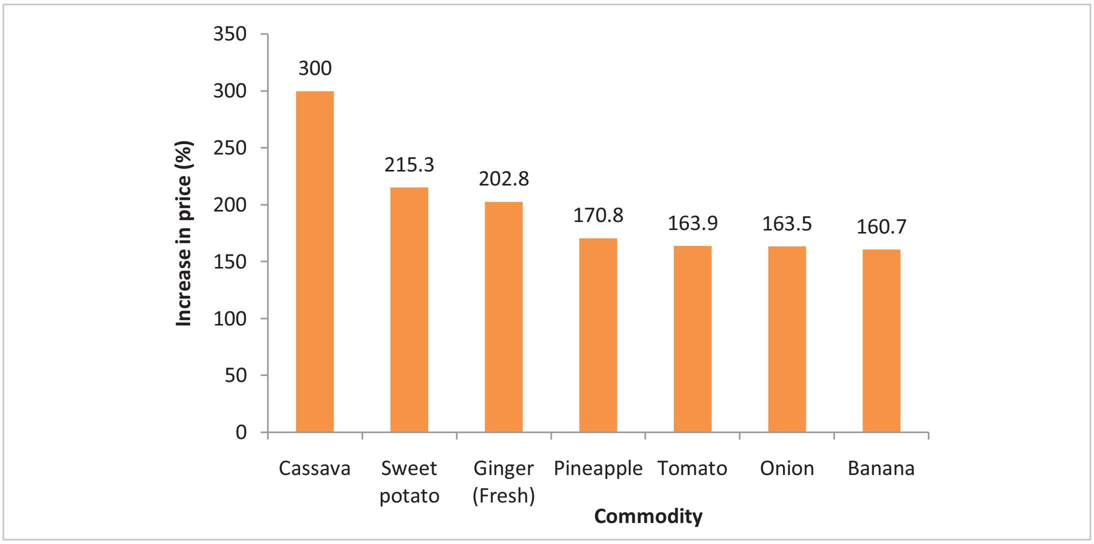

Fig.8. Increase in fruit/vegetable prices over a decade (2007-2016) (Source: Office of the Economic Adviser, 2019).

The highest price rise was noticed in Roots and tubers especially cassava and sweet potato. These crops are regarded once as “Poor mans crop” which are now consumed mostly by affluent communities.

As a result, the fruits and vegetable consumption has significantly reduced or not reached the desired level. The high cost of fruits and vegetables lead to widespread disparities in the amount spent on foods across the economic classes in the country. The NSS 68th Round Household Consumption of various Goods and Services in India 2011-2012 indicated that rich consumers spend 61.23 times than poor, 5.23 times than urban middle class and 11.30 times than rural middle class on fruits, leaving wide disparity in fruit consumption (National Sample Survey Office, 2014) (Fig. 9). However, the rich spent twice amount than other classes on vegetables. Therefore, the expenditure on fruits and vegetables varied widely among economic class while rural middle class and poor spent too less on these nutritious foods.

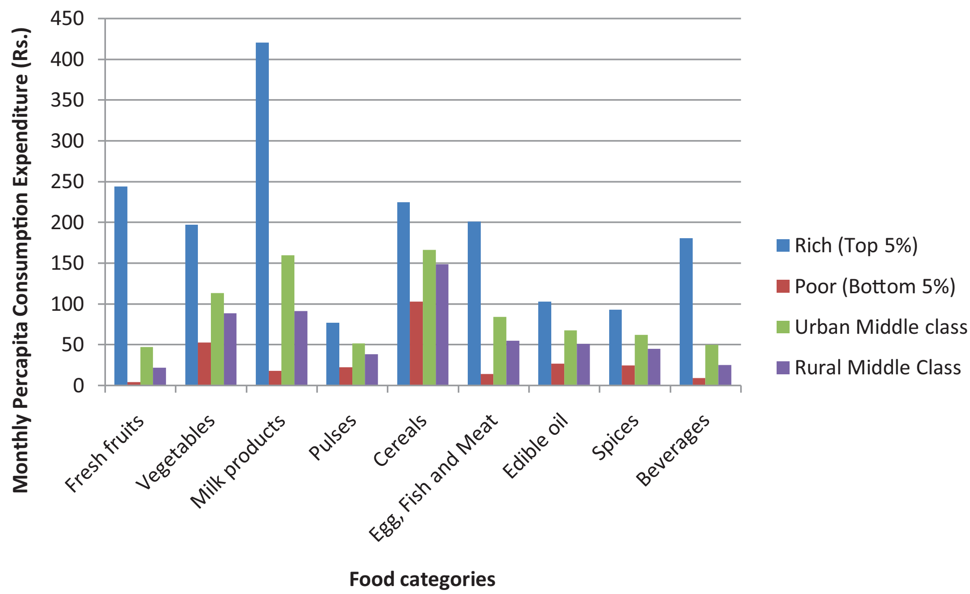

Fig. 9. Monthly percapita consumption expenditure on foods by economic class (Source: National Sample Survey Office, 2014).

2.6. The problem

From the above discussion, it is evident that the fruits and vegetable intake in many Indian states, across the age groups and economic classes is lesser than the WHO prescribed level of 400g/ day. This inadequate intake by youth and students (< 3 servings a day) is a serious issue, which has already lead to various micronutrient deficiencies including vitamin A deficiency.

Besides, the life style issues, seasonal availability and high cost were found to be primary reasons for inadequate consumption of fruits and vegetables. The high cost of fruits and vegetables, especially fruits, has affected the accessibility of middle class and poor to vital micronutrients available in fruits.

In this context, there is a need to develop a strategy to make the micronutrient access affordable to all economic classes including children and youth, to enable them to consume balanced diet which provide adequate micronutrients. The current work at ICAR-CTCRI is focusing on combating micronutrient malnutrition especially vitamin A in the North-Eastern States, through biofortified tuber crops varieties.

Chapter 3

Approaches for Combating Micronutrient Malnutrition in India

3.1. Strategy for combating micronutrient deficiencies

Various approaches followed for combating micronutrient deficiencies include food-based strategies, supplementation programmes and biofortification (Burchi *et al*., 2011; Lockyer *et al.,* 2018).

A. Food-based strategies

The food based strategies like dietary diversification and food fortification, are considered effective approaches to prevent and combat hidden hunger (Bouis *et al*., 2011). Few examples of fortified foods include iodised salt and fortification of Iron, Folic acid and vitamin B12 with wheat flour as well as healthy variants of noodles including atta noodles, and vegetable noodles. However, the effectiveness of food fortification largely depends on behaviour change among consumers which is a difficult process (Burchi *et al*., 2011). Beside fortification of foods or ingredients at a national level often takes longer to implement within a country as changes in policy and food production are required.

B. Supplementation programs

Supplementation programmes provide specific micronutrients that are not available as part of the regular diet. Supplementation is especially important at times when the body has particularly high micronutrient needs – for example during pregnancy, early ages of infants – that are difficult to meet with diet alone. The problem in supplementation programmes is that reaching 100% coverage is difficult (Wirth *et al.,* 2017).

C. Biofortification

Biofortification is the breeding process that develops and deploys micronutrient-rich staple crops aiming to improve the nutritional statuses of resource-poor populations (Bouis *et al.,* 2011). In general, biofortification is achieved in three ways (Lockyer *et al.,* 2018).

1. Conventional biofortification – Choosing the parental lines which naturally contain higher amounts of a micronutrient, and cross-breeding those lines using conventional

methods to produce staple crops with desirable nutrients and agronomic traits. The biofortified varieties developed at ICAR-CTCRI followed the conventional approach to address the vitamin A deficiency.

2. Agronomic biofortification – In this approach, the micronutrient-rich fertilisers or sprays are applied which are temporarily absorbed into the edible portion of the crop.

3. Transgenic biofortification – In transgenic approach, the genes responsible for synthesis or accumulation of a micronutrient are inserted into popular varieties or lines to increase the bioavailability of specific micronutrients.

Though food based strategy is effective, the difficulties faced by the consumers in changing their consumption pattern hampered the effectiveness of this approach (Wirth *et al.,* 2017). Besides, supplementation programmes had limitations in achieving 100% coverage of target population. Biofortification of staple food crops will provide nutritional benefits on a regular basis, thereby eradicating micronutrient deficiencies. Besides, biofortified varieties are easily accessible and affordable to people living in remote areas and with limited resources.

3.2. Scaling up of Biofortified varieties

Scaling up of biofortified varieties refers to the approaches followed in making these varieties available to the target population in adequate quantity and affordable cost to maximise their reach to address the nutritional issues. Since biofortified varieties are developed to address the public health problem such as micronutrient deficiencies, which affects a large proportion of the population and reduce their productivity, there is a need to maximise their uptake by target population.

The basic premise of scaling up is to introduce biofortified varieties to several states or countries and convince the stakeholders i.e., farmers, consumers, traders, local extension agencies etc., on the benefits of taking up biofortified food.

To achieve this objective of scaling up of biofortified varieties, an integrated approach involving Govt policy support to promote them, large scale seed production, consumer education on the need to use these varieties, sensitisation of farmers to grow biofortified varieties, developing entrepreneurship for seed production and value addition, is followed.

Several programmes like HarvestPlus, Sweet potato Action for Security and Health in Africa; SASHA I and II (2010–2019), Reaching Agents of Change (RAC; 2011–2014) and Building Nutritious Food Baskets (BNFB; 2015–2018) were implemented to scale-up biofortified varieties of various crops including cassava and sweet potato.

Though biofortified varieties can combat micronutrient malnutrition in a natural way, there have been efforts in many countries around the world to increase fruit and vegetable intake, including many national campaigns. In the United States, the national US '5-a-day' scheme was introduced to promote the practice of eating five to nine servings of fruits and vegetables each day. Later the 'My Plate' model was introduced which shows separate categories for grains, protein, vegetables and fruits, with more emphasis placed on vegetables (Buttriss, 2012). Few schemes from other countries to promote fruit and vegetable consumption are illustred in Box. 2.

Box 2. National schemes of various countries to increase fruit and vegetable consumption

1. **5 A Day** – The national campaigns of developed countries such as the United States, the United Kingdom, France, and Germany, to encourage the consumption of at least five portions of fruit and vegetables each day.

2. **Go for 2 & 5** - A National Campaign of Australia, in which adults are encouraged to eat at least two servings of fruit and five servings of vegetables each day. A "standard serving of fruit" is 150 grams of fresh fruit, whereas a "standard serve of vegetables" is 75 grams.

3. **Fruits and Veggies — Mix it up! Campaign** – A Canadian campaign focusing on easier ways that Canadian families can eat more healthy foods.

4. **PNNS (https://www.mangerbouger.fr/PNNS)** – The French National Nutrition and health Programme which recommends consumption of at least 5 portions of fruit and/or vegetables per day.

5. **5 + A Day Fresh fruits and vegetables (https://www.5aday.co.nz/)**- A Charitable Trust in New Zealand that encourages all Kiwis to eat five or more servings of colourful, fresh fruit and vegetables every day for health and vitality.

6.**5aldia** (http://www.5aldia.org/) - A Spanish programme to promote consumption of fruits and vegetables.

Chapter 4

Rainbow Diet Campaign

4.1. Rainbow Diet

The Rainbow Diet approach was proposed by nutritionist Dr. Deanna Minich, an internationally-recognized teacher, author, scientist and speaker, as a way to get balanced nutrition through visual cues of the natural foods. The Rainbow diet is a specialised eating plan designed in a form of "rainbow" by carefully selecting fresh and natural foods with specific colours.

Fruit and vegetables fall into five different colour categories - red, purple or blue, orange, green and white or brown, and a combination of these forms a "Rainbow". Each color in fruits and vegetables is caused by specific phytonutrients.

Various colours and associated phytochemicals present in fruits and vegetables along with their health benefits are displayed in Fig. 10.

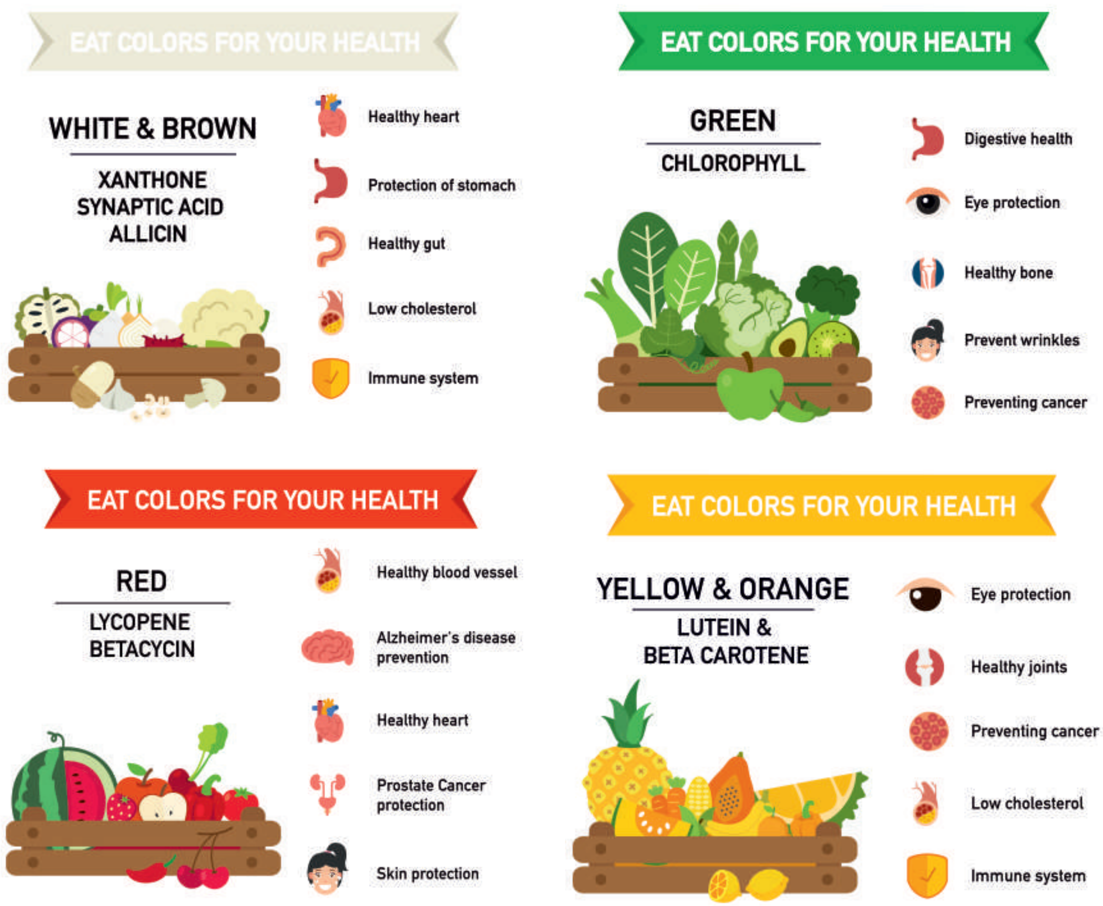

Fig. 10. Phytochemicals and their health benefits

4.2. Tuber Crops Rainbow Diet

Tuber Crops Rainbow diet is a specific meal plan focusing on anti-oxidant rich sweet potato and yam varieties such as Orange-fleshed sweet potato (Beta-carotene), purple fleshed sweet potato (Anthocyanin-rich) and purple yam (Anthocyanin rich) (Fig. 11) which are served along with edible taro/ sweet potato leaves (Green) and white fleshed sweet potato.

Fig 11. Tuber Crops Rainbow Diet

The sweet potato varieties *Bhu Sona* – Orange – fleshed and contain β carotene – a precursor of vitamin A. The purple fleshed sweet potato variety*, Bhu Krishna* contains anthocyanin (90mg/100g) while yam variety *Sree Neelima* also has 7.5mg/100g of anthocyanin (Fig 10). The sweet potato leaves contain high levels of phytonutrients Lutein (10.01-28.85 mg/100g), β-carotene (35-21-52.01 mg/100g) and total chlorophyll (440.9–712.2 mg/100 g) (Li *et al.,* 2017).

4.3. The Rainbow Diet Campaign

The Rainbow Diet Campaign is the initiative of ICAR – Central Tuber Crops Research Institute (ICAR-CTCRI) to scale up the biofortified tuber crops varieties to combat micronutrient deficiencies especially vitamin A deficiency. This campaign follows the "Rainbow Diet approach" which promotes a meal plan determined by colours of fruits and vegetables.

The Rainbow Diet Campaign was selected as scaling up strategy due to following reasons

- The biofortified varieties are developed for the staple foods to maximise their access and utilisation. Though tuber crops are staple foods in Africa and few countries in Latin America, they are not staples in India, except for few tribal areas in North East Hills where tubers are used as secondary staples. Therefore this campaign was designed to provide a holistic nutrition following Rainbow Diet approach by integrating various health benefits in a single food basket. The tuber crops rainbow diet focuses on both fresh and processed forms of tuber crops with a view to integrate the health benefits into a single package.
- "Traditionally tuber crops are food crops" which are either cereal substitutes (e.g. Kerala and tribal areas), vegetables (e.g. yams, elephant foot yam, taro) or used for preparing snacks like boiled tubers, chips, namkeen, and other home made products. With the development of biofortified varieties, the focus shifts from conventional foods to "designer foods" which cater to Health and Wellness market. The shift from "rural foods" to "urban functional foods" catering to a niche market expands their consumer base. Considering the fact that tubers are not staples in urban India, a holistic approach like Rainbow Diet is appropriate to promote these crops.

Objectives of Rainbow Diet Campaign

1. To promote tuber crops based rainbow diet as strategy for combating micronutrient malnutrition in a holistic way

2. To create an ecosystem for maximising farmers access to biofortified tuber crops varieties

3. To build capacities of stakeholders in growing and using biofortified varieties in both sustainable and commercial forms

4. To facilitate creation of small-scale industries on functional foods from biofortified tuber crops

Strategy for Rainbow Diet Campaign

The Rainbow Diet Campaign follows a multi-stakeholder approach towards promoting the biofortified tuber crops in the North Eastern Hill Region. This campaign model is based on the adapted version of *Transtheoretical Model or Stages of Change model* (TTM) developed by Prochaska and DiClemente in the late 1970s (Prochaska, and DiClemente, 1984). The TTM model focuses on the process of intentional behaviour change, including:

1. Initiating desired behaviors (i.e., beginning to eat biofortified varieties)
2. Modifying habitual behaviors (i.e. developing a balanced diet plan)
3. Terminating problematic behaviors (i.e., quitting harmful foods)

The TTM proposes that that in any social change process, the individuals progress through six stages of change - precontemplation, contemplation, preparation, action, maintenance, and termination. For each stage of change, different intervention strategies are most effective at moving the person to the next stage of change and subsequently through the model to maintenance, the ideal stage of behaviour. The process through which the consumer changes his/ her behaviour is given in Table 1.

Table 1. Stages of adopting Rainbow Diet

S.No.	Stage	A consumer at this stage
1	Precontemplation	Gives no thought to follow Rainbow Diet, and has no intention to follow in the near future i.e., within next 6 months.
2	Contemplation	Has begun to examine the Rainbow Diet and weighing the pros and cons of using the diet.
3	Preparation	Has made a commitment to follow Rainbow Diet (usually within next 30 days), and has begun developing a plan for adopting it.
4	Action	Starts following Rainbow Diet
5	Maintenance	Has successfully followed it for over six months

Various activities inclining publicity campaigns, product demonstrations, capacity building of farmers in growing biofortified varieties, conducting food festivals to create interest, entrepreneurship meet to orient aspiring youth in business opportunities associated with biofortified varieties, exhibition of technologies and varieties, signing agreement with partners for sustainable scaling up at grassroot level, and laying out Frontline demonstration are core activities of the campaign.

Various stages and associated activities of the Rainbow Diet Campaign are displayed in Fig. 12.

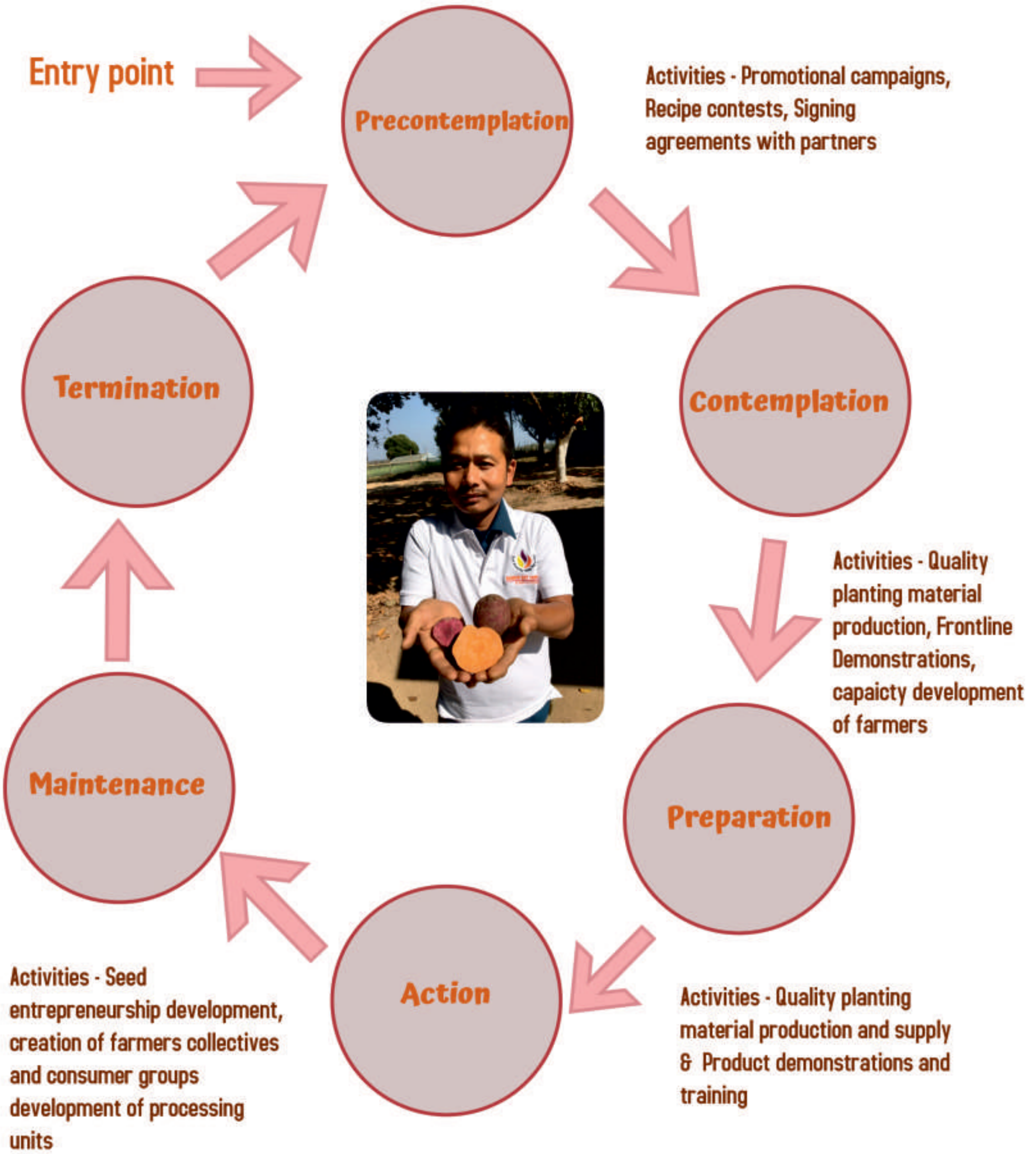

Fig. 12. The Stages in Rainbow Diet Campaign

The campaign is currently implemented in Five North Eastern Hill states - Arunachal Pradesh, Manipur, Meghalaya, Mizoram and Tripura Fig.13.

Fig.13. Map of North Eastern Hill states

Chapter 5

Conclusion and Way Forward

The Rainbow Diet Campaign is a scaling up activity for promoting Tuber Crops Rainbow Diet among target groups in North Eastern Hills Region. This region has moderate to severe micronutrient deficiencies and Mizoram and Tripura have largest population with Vitamin A deficiency. The tuber crops are traditionally considered as “poor man’s crop” have now attained the status of “affluent crops” which are priced high, which prohibits their access to middle class and poor consumers. In this context, the Rainbow diet strategy will expand the area under biofortified tuber crops while helping the consumers to access to these varieties at an affordable price. Besides helping consumers, this Campaign will provide stable and assured income to the farmers, traders and processers through diverse means.

The Rainbow Diet Campaign follows the Transtheoretical Model of Behaviour Change targeted at consumers especially children through a colourful Rainbow Diet to enable them to get access to a balanced diet. This Campaign is now at the Precontemplation stage implemented in five NEH states and strategies are formulated to influence the consumers’ behaviour towards the decision to consume Rainbow diet. Since it is a multi-stage campaign, it’s success depends on sustaining collaborations with grassroot organisations in the North Eastern Hill region, effective followup activities like supplying adequate quantity of planting materials, capacity building of farmers and other stakeholders and creating sustainable entrepreneurships.

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Annexure 1

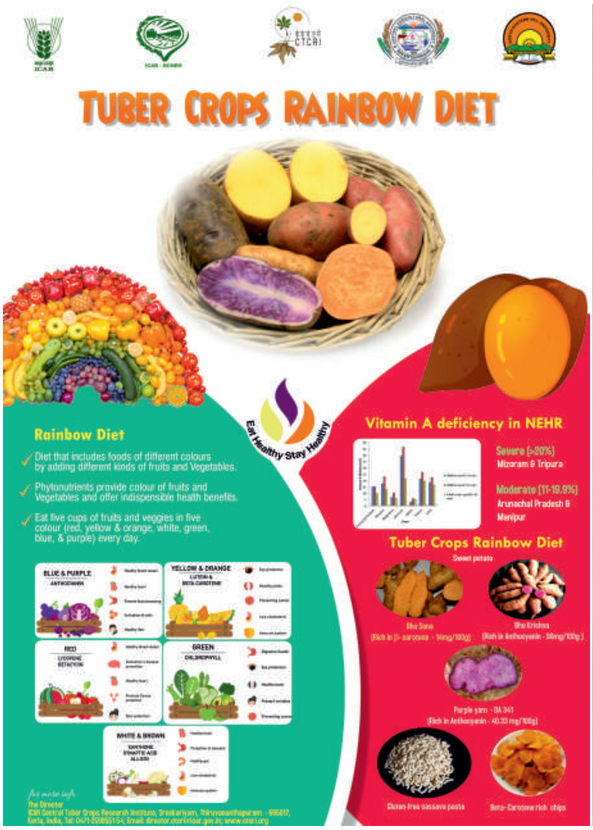
ICAR-CTCRI Team for NEH programme - Rainbow Diet

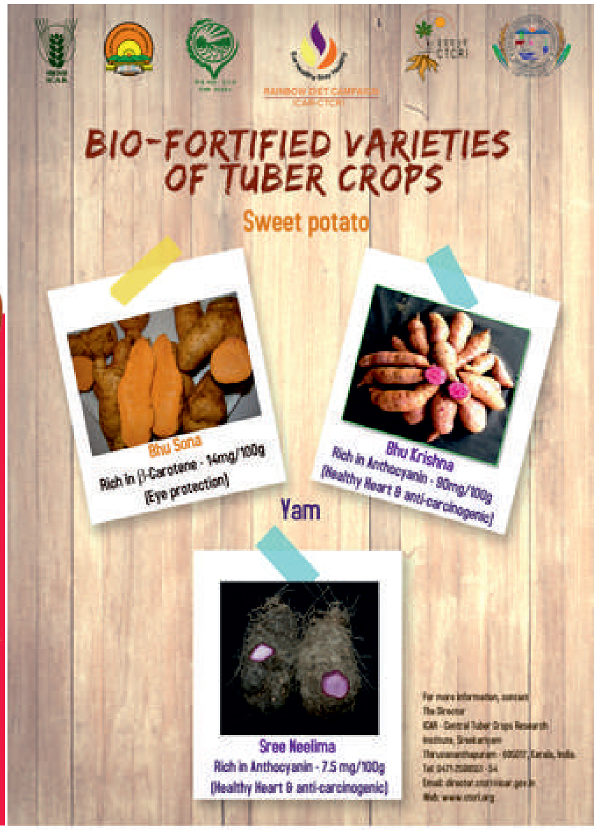
State and place	Team Leader	Team members	Tentative dates	Partnering organisation
Manipur	Dr. M.N. Sheela	Dr. M.S. Sajeev Dr. S. Sunitha Dr. M. Nedunchezhiyan	March third week, 2020	Manipur - Central Agricultural University, Imphal, Manipur
Meghalaya (West Garo Hills dist) and Arunachal Pradesh (Anjaw/ Namsai districts)	Dr. C.A. Jayaprakas	Dr. P. Sethuraman Sivakumar Dr. H. Kesava Kumar Dr. V. Bansode Dr. A.V. V. Koundinya Mr. A. Madhu	Arunachal Pradesh Anjaw – 28-2-2020 Lohit – 2-3-2020 Meghalaya Tura – March 5-6, 2020.	Arunachal Pradesh – Anjaw & Namsai - KVK/Agriculture department West Garo Hills, Meghalaya – North Eastern Hill University, Tura.
Tripura (Lembucherra)	Dr. P. Murugesan	Dr. K. Laxminarayana Dr. Namrata A. Giri Dr. Sanket More Dr. J. Suresh Kumar Dr. Visalakshi Chandra Mr. V.R. Sasankan	Feb 24-25, 2020	ICAR Research Complex for NEHR – Tripura Centre, Lembucherra, Tripura & College of Fisheries, Central Agricultural University , Lembucherra, Tripura
Mizoram (Kolasib)	Dr. C. Mohan	Dr. K.M. Senthil Kumar Dr. Vivek Hegde Dr. T. Krishnakumar Dr. V.B.S. Chauhan Mr. V. Ganesh	Feb. 19-25, 2020.	ICARRCNEHR – Mizoram Centre, Kolasib, Mizoram.

Campaign Coordinators: Dr. P. Sethuraman Sivakumar & Dr. H. Kesava Kumar

Annexure 2

Campaign posters and Campaign Dress





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