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Beyond COVID-19:

Promoting Local Health Traditions and Health Foods for Conservation and Sustainable Use of Biodiversity

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Summary

The severity of the impact of COVID-19 on human health security is huge and expected to continue for a few more years in many parts of the world. A major reason for emergence of new viruses and diseases is destruction of forests and loss of biodiversity. This paper examines the criticality of Local Health Traditions (LHTs) and environmental health to boost immunity and conservation of biodiversity. The need for revitalization of the age-old healthcare practices and homestead-level conservation of biodiversity for a post-COVID India is discussed. As case points, MSSRF interventions and their impact in promoting conservation, cultivation, consumption and community-centric commerce of biodiversity in three bio-cultural diversity hotspots of India are described. A set of ten recommendations is given to address some of the policy gaps in promoting the LHTs and conservation of biodiversity in homesteads. The recommendations can help in effective implementation of the objectives of National Nutrition Mission, POSHAN Abhiyaan, National Health Policy (2017), National Health Mission, and the National Biodiversity Act (2002). These recommendations, we hope, willbenefit translation of present policies and initiatives into effective practices to protectlocal health and biodiversity heritage of India and strengthen primary healthcare support services.

I. INTRODUCTION

Human beings are provided with five principal defensive barriers to protect their body against disease: physical barriers such as skin, body secretions and mucous membranes and specialized immune cells in the blood, granulocytes and lymphocytes (Terry L. Levin, 2018). The secret of health is in protecting and enhancing these five natural barriers coupled with maintenance of sound emotional, social and economic practices. Nature keeps diverse proteins and genes at the microscopic level in the form of flora, fauna, and ecosystems– and landscapes at the macroscopic level-biodiversity to boost nature-human health systems. Through evolution, biodiversity has been used in multitude ways in the form of perfume, clothing, cosmetics, housing, food, beverages, medicine and as a source of vital energy to body, mind and materials for spiritual / religious and social rituals. These practices and rituals among human groups in diverse locations resulted in the origin and existence of cultural diversity. The symphony in the nature-culture relationship is called bio-cultural diversity. The core regions of bio-cultural diversity in the world are the Amazon Basin, Central Africa, and Indo-Malaysia (Peter Howard and Thymio Papayannis 2007).

M S Swaminathan Research Foundation (MSSRF) has been working in three 'Bio-cultural diversity hotspots' of India - the Wayanad region in Kerala, Koraput region in Odisha and Kolli Hills in Tamil Nadu, with the objective of revitalizing non-codified Local Food and Health Traditions such as home remedies, use of medicinal and nutritionally rich rice, millets and wild foods. The need for rejuvenation of Local Health Traditions (LHT) and the approach required for drawing on the local environment and biodiversity to boost immunity are discussed in thispaper. A set of ten recommendations is also made to address policy gaps in promoting the LHTs, and conservation of biodiversity in homesteads.

II. Green-health Programme

MSSRF's Green-health programme started at different periods in Wayanad (Kerala), Koraput (Odisha) and Kolli hills (Tamil Nadu) during 1998 to 2005 and focused on implementation of efforts such as (i) Rejuvenation of Local Health Traditions, (ii) inventory, collection, multiplication and documentation of medicinal plants; (iii) promotion of medicinal rice Navara in Kerala; (iv) survey and documentation of wild food plants; and (v) promotion of millet-based health foods.

Project 01: Rejuvenation of Local Health Traditions

The core objective of the programme was to revitalize and promote time-tested primary healthcare and nutrition practices among local community men and women. The programme was aimed to promote sustainable use of medicinal and edible wild and little-known nutrient-rich plant diversity in the three hotspots. The activities were promoted through trained women Self Help Groups (SHG) and farmers' forums under the supervision of traditional healers, ayurvedic physicians, botanists and nutrition experts and have resulted in the revitalization of many primary healthcare traditions, household level herbal collections and consumption of medicinal and wild edible plants, and establishment of herbal gardens in these three hotspots. The programme started in late 2000 and continued for about 10 years in Wayanad district of Kerala and was then replicated in Koraput district of Odisha.

Home Remedy and Primary Health Care System: case study from Odisha

The traditional healers of undivided Koraput District are called *Disaris*. The wealth and knowledge of the medicinal plants among the *Disaris* are based on hundreds of years of belief and observations. Studies conducted from 2006 to 2009 found that these Disaris carry practical knowledge on the use of medicinal plants for the prevention of malaria. There are several groups/associations of traditional

healers belonging to *Paroja*, *Bhumia* and *Bonda* communities in Koraput, Rayagada and Malkanagiri districts of Odisha who claim to possess the knowledge to treat many primary health care issues. The information on malarial cure was documented from the *Disaris* and other local people who have traditional knowledge of medicinal plants (Poonalet al. 2011, Swain 2014).

Plants parts: The whole plant of *Andrographis paniculata* along with leaves of *Nyctanthes arbortristis* and stem of *Tinospora cordifolia* are crushed together to make the decoction.

Decoction preparation process: Take about 100g of *Andrographis paniculata*, 100g of *Nyctanthus arbor-tristris* leaves and 100g of *Tinospora cordifolia* stem. Put them together in a pot. Add 500ml water and boil it in mild fire for half an hour to one hour till the quantity of decoction is reduced to around 150ml. Keep it overnight; the decoction is ready to use in the next day morning. The practice is that a family prepares the decoction based on the need of all its members. In some villages, the preparation is done at once for all households.

Dosage: An adult person needs 10 to 15ml based on the health condition. Similarly, for a child, the dosage can vary from 5ml to 10ml based on the age group. This decoction should be taken once in a week along with a teaspoon of honey. Every person has to take four times a month and for three months continuously.

Evidence from a campaign on the preparation and usage of this decoction in and around 15 malaria-prone villages of Kundra block of Koraput district and also in the Bonda Hills of Khairput block, Malkangiri district showed that no fresh malaria cases were reported within a period of six to nine months in those villages. It was also observed that cases of skin disease were reduced to a great extent in those villages (Swain 2014). People still have the practice of usage of this decoction to prevent malarial infection.

Home Remedy and Primary Health Care System: case study from Kerala

Under the Kerala programme, a total of 28 SHGs were formed –22 in Wayanad and six in Calicut. Out of 180 members belonging to 18 SHGs, 126 were women belonging to the poorest class. The selected groups, each group comprising 10–12 women from resource-poor families, received intensive training for about eight days over a period of eight months for the preparation of a set of 34 herbal formulations. These formulations were in five categories: *Choornam* (powder), *Lehyam* (colloid form), *Thailam* (oil form), *Gulika* (tablet form) and powdered seed mixture (Annexure 1). One of the Lehyams was *Chyavanaprash* prepared by using 47 different ingredients (Table 1). The trainees prepared these formulations for catering to their healthcare needs and marketed them locally. Nine products were found to have high local demand. The quality of the new formulations was assessed before marketing with the help of reputed research organizations. One of the formulations 'Navadhanya mixture' was found to be nutritionally richer than many similar products in the market as per the results of analysis by the Central Food Technological Research Institute, Mysore.

Table 1: Ingredients in the Chyavanaprash Lehyam

Sl. No.	Local Name (Malayalam)	Binomial Name
1	Munja root	*Premna serratifolia* L.
2	Koovala root	*Aegle marmelos* (L.) Corrêa
3	Payyani root	*Oroxylum indicum* (L.) Benth. ExKurz
4	Kumizhu root	*Gmelina arborea* Roxb.
5	Paathiri root	*Stereospermum tetragonum* DC.
6	Kurunthotti root	*Sida alnifolia* L.
7	Orila root	*Desmodium gangeticum* (L.) DC.
8	Moovila root	*Pseudarthria viscida* (L.) Wight& Arn.
9	Kaattuzhunnu root	*Vigna radiata* (L.) R. Wilczek
10	Thippali root	*Piper longum* L.
11	Cheruthippali root	*Piper longum* L.
12	Vanthippali	*Piper chaba* Trel. & Yunck.
13	Naikkurana root	*Mucuna pruriens* (L.) DC.
14	Cheruvazhuthana root	*Solanum violaceum* Ortega
15	Cheruchunda	*Solanum indicum* L.
16	Karakkadakasringi	*Pistacia chinensis* subsp. *integerrima* (J. L. Stewart ex Brandis) Rech. f.
17	Keezharnelli	*Phyllanthus niruri* L.
18	Munthiringa	*Vitis vinifera* L.
19	Adapathiyankizhangu	*Holostemm aada-kodien* Schult.
20	Pushkaramoolam	*Inula racemosa* Hook.f.
21	Akil	*Dysoxy lummalabaricum* Bedd. ex C.DC.
22	Kadukkathodu	*Terminalia chebula* Retz.
23	Amruthu	*Tinospora cordifolia* (Thunb.) Miers
24	Kaattumuthira root	*Dolicho strilobus* L.
25	Jeevakamidavakam	*Malaxis rheedii* B. Heyne ex Wallace
26	Kacholam	*Kaempferia galangal* L.
27	Muthanga	*Cyperus rotundus* L.
28	Thazhuthama	*Boerhavia diffusa* L.
29	Kaatupayar root	*Vigna vexillata* (L.) A. Rich
30	Sathavarikkizhangu	*Asparagus racemosus* Willd.
31	Amukkuram	*Withania somnifera* (L.) Dunal
32	Chittelam	*Heracleum rigens* Wall. ex DC
33	Chengazhineerkizhangu	*Kaempferia rotunda* L.
34	Chandanam	*Santalum* album L.
35	Palmuthakku	*Ipomoea mauritiana* Jacq.
36	Adalodakam	*Justicia adhatoda* L.
37	Kakkathondi	*Capparis sepiaria* L.
38	Nellikka	*Phyllanthus emblica* L.
39	Neyyu	Ghee
40	Then	Honey

41	Nallenna	Gingelly oil
42	Sarkkara	Locally made Sugar
43	Koovanooru	*Maranta arundinacea* L.
44	Thippali	*Piper longum* L.
45	Nagappoovu	*Mesuathwaitesii* Planch. & Triana
46	Elam	*Elettaria cardamomum* (L.) Maton
47	Ilavangam	*Cinnamomum malabatrum* (Burm.f.) J.Presl

Project 02: Inventory, Collection, Multiplication and Documentation of Medicinal Plants

Inventory and documentation were carried out in both Wayanad district, Kerala and Koraput district, Odisha. MSSRF's botanical garden in Wayanad has an active collection of 300 species and Koraput, an active collection of 350 species. A nursery has been set up in these gardens to raise all important plants used in primary healthcare, to supply identified medicinal plants to households, promote community level medicinal plant gardens and commercial cultivation (tables 2-4). Over the last ten years, MSSRF, Jeypore centre, Odisha, has provided approximately 6,000 seedlings of medicinal plants to 65 schools, five colleges and three other institutes, 15,000 plants to disaries, 2,500 plants to Primary Health Centres (PHC) and the district government hospital, conducted 14 plant campaigns in 12 villages at household level and distributed around 9,000 plants, undertaken plantation of around 5,000 plants on the roadside and barren land in Kundra Gram Panchayat (GP) and supplied around 17,000 plants to the Forest Department. In Wayanad, during the period 2000 to 2012, MSSRF provided seedlings of 50 species of medicinal plants of high potential to households of 158 SHG members to set up home herbal garden as part of promotion of herbal healthcare practices. Most of the households are still utilizing the plants for addressing various minor ailments at household level.

Table 2. List of Medicinal Plants recommended for Home Herbal Gardens (Kerala)

Dashapushpa			
Malayalam name	**Binomial Name**	**Family**	**Uses**
Cheroola	*Aerva lanata*	Amaranthaceae	Ten flowers/plants used during festivals and in folk medicine preparations
Karuka	*Cynodon dactylon*	Poaceae	
Kayyonni	*Eclipta prostrata*	Asteraceae	
Mukkutti	*Biophytum reinwardtii*	Oxalidaceae	
Muyalcheviyan	*Emilia sonchifolia*	Asteraceae	
Nilappana	*Curculigo orchioides*	Hypoxidaceae	
Poovamkurunthal	*Vernonia cinerea*	Asteraceae	
Thiruthali	*Ipomea obscura*	Convolvulaceae	
Valli Uzhinja	*Cardiospermum halicaca-bum*	Sapindaceae	
Vishnukranthi	*Evolvulus alsinoides*	Convolvulaceae	
Thrikadu			

Inchi	*Zingiber officinale*	Zingiberaceae	• Help to clear excess kapha or mucous from the body. Support respiratory functions. Improves digestion. Helps in weight management.
Kurumulaku	*Piper nigrum*	Piperaceae	
Thippali	*Piper longum*	Piperaceae	
Hruswa Panchamoolam			
Njerinjil	*Tribulus terrestris*	Zygophyllaceae	Five non-tree ingredients of Dashamoolarishtam, recommended for abdominal and gastrointestinal discomforts
Cheruvazhuthina	*Solanum violaceum*	Solanaceae	
Kandakaarichunda	*Solanum xanthocarpum*	Solanaceae	
Orila	*Desmodium gangeticum*	Fabaceae	
Moovila	*Psuedarthria viscida*	Fabaceae	
Vallipanchamoolam			
Paalmuthukku	*Ipomea mauritiana*	Convolvulaceae	Five important vines used in ayurveda in various medicinal preparations
Naruneendi	*Hemidesmus indicus*	Asclepiadaceae	
Chittamruthu	*Tinospora cordifolia*	Menispermaceae	
Maramanjal	*Coscinium fenestratum*	Menispermaceae	
Aaduthodappaala	*Tylophora asthmatica*	Apocynaceae	
Panchakolam			
Thippali	*Piper longum*	Piperaceae	Five important heat generating ingredients used in herbal product formulations
Kaattuthippali	*Piper mullesua*	Piperaceae	
Kaattumulaku	*Piper trioicum*	Piperaceae	
Chethikkoduveli	*Plumbago indica*	Plumbaginaceae	
Chukku	*Zingiber officinale*	Zingiberaceae	
Panchathikthakam			
Chittamruthu	*Tinospora cordifolia*	Menispermaceae	Five bitter plants used in ayurveda
Veppu	*Azadirachta indica*	Meliaceae	
Aadalodakam	*Justicia adhatoda*	Acanthaceae	
Putharichunda	*Solanum anguivi*	Solanaceae	
Padavalam	*Trichosanthes cucumerina*	Cucurbitaceae	
Thrikantakam			
Cheruvazhuthina	*Solanum violaceum*	Solanaceae	A group of three thorny plants used in ayurveda
Chethikkoduveli	*Plumbago indica*	Plumbaginaceae	
Vizhal	*Embelia ribes*	Myrisinaceae	

Table 3. List of Medicinal Plants for Community Herbal Garden (Across India)

Malayalam name	Scientific name	Family	Use
Nalpamara			
Arayal	*Ficus religiosa*	Moraceae	Group of four fig trees, whose powdered bark is used for skin care
Athi	*Ficus racemosa*	Moraceae	
Ithi	*Ficus microcarpa*	Moraceae	
Peral	*Ficus benghalensis*	Moraceae	
Thriphala			
Kadukka	*Terminalia chebula*	Combretaceae	A group of three fruits, helpful in weight loss, acts as a detoxifier, cures digestive Issues, helps in fighting infections and enhances immunity; beneficial in maintaining oral hygiene, eye health; helpful in treating gastric ulcers and urinary tract infections
Nelli	*Phyllanthus emblica*	Euphorbiaceae	
Thanni	*Terminalia bellirica*	Combretaceae	
Thrigandha			
Akil	*Dysoxylum malabaricum*	Meliaceae	Group of three fragrant trees frequently used in ayurveda
Chandanam	*Santalum album*	Santalaceae	
Rakthachandanam	*Pterocarpus santalinus*	Fabaceae	
Brihatpanchamoolam			
Koovalam	*Aegle marmelos*	Rutaceae	Five tree roots used for the preparation of Dasamoolarishtam in ayurveda
Munja	*Premna serratifolia*	Lamiaceae	
Palakappayyani	*Oroxylum indicum*	Bignoniaceae	
Paathiri	*Stereospermum tetragonum*	Bignoniaceae	
Kumizhu	*Gmelina arborea*	Verbenaceae	
Panchapallavam			
Mavu	*Mangifera indica*	Anacardiaceae	Five plants whose tender leaves are used in ayurveda
Njaval	*Syzygium cumini*	Myrtaceae	
Mathalanarakam	*Punica granatum*	Lythraceae	
Vilaarmaram	*Limonia acidissima*	Rutaceae	
Koovalam	*Aegle marmelos*	Rutaceae	

Table 4: List of Commercially Important Medicinal Plants recommended for cultivation

Names and family	Uses
1. Amalpori *Rauwolfia serpentina* Apocynaceae	Plants used in Allopathy and ayurveda. Reserpine is used to treat high blood pressure. It also is used to treat severe agitation in patients with mental disorders.
2. Asokam *Saraca asoka* Caesalpiniaceae	Skin diseases, uterine disorders, germicide, stomach ache
3. Chandanam *Santalum album* Santalaceae	One of the most valuable timber used to extract the sandal oil
4. Chittamruthu *Tinospora cordifolia* Menispermaceae	Vomiting, antidiabetic, cardiac, indigestion, foot crack
5. Ekanayakam *Salacia fruticosa* Celastraceae	Very well known anti diabetic plant
6. Jyothishmathi *Celastrus paniculatus* Celastraceae	Seeds promote intestinal health. The seed oil used for massage. The oil is used to alleviate skin inflammation
7. Karimkurinji *Strobilanthes ciliates* Acanthaceae	Antiinflammatory, analgesic, anticancer, antimicrobial, antidiabetic and hepatoprotective
8. Karimuthukku *Adenia hondala* Passifloraceae	The young shoots and leaf stalks can be cooked and eaten. The tubers, which are poisonous, have antibacterial and antimicrobial properties and are used in Ayurvedic medicine for the treatment of skin disorders and to treat hernias
9. Koovalam *Aegle marmelos* Rutaceae	Antidiarrhoeal, antimicrobial, antiviral, radioprotective, anticancer, ulcer healing, antigenotoxic, diuretic, antifertility and anti-inflammatory properties
10. Maramanjal *Coscimium fenestratum* Menispermaceae	Used for eye and skin diseases, inflammation, wounds, ulcers, abdominal disorders, jaundice, diabetes, fever, general debility, skeletal fractures.

11.	Menthonni *Gloriosa superb* *Colchicaceae*	Used in the treatment of gout, infertility, open wounds, snakebite, ulcers, arthritis, cholera, kidney problems, itching, leprosy, bruises, sprains, hemorrhoids, cancer, impotence, smallpox, sexually transmitted diseases, and many types of internal parasites.
12.	Moovila *Pseudarthria viscid* Fabaceae	It is used in the treatment for asthma and nervous dysfunction.
13.	Naagadandhi *Baliospermum montanum* *Euphorbiaceae*	It is a blood purifier, paste of danti roots and seeds are used to reduce edema and pain. Both act as analgesics to relieve pain. This herb has antipyretic properties and used to treat fever. This herb is also anti-inflammatory and used to reduce inflammation.
14.	Neermaruth *Terminalia cuneata* Combretaceae	Widely used for treatment of cardiovascular diseases, including heart diseases and related chest pain, high blood pressure and high cholesterol. It is also used for earaches and diseases of the urinary tract
15.	Paachotti *Symplocos cochinchinensis* Symplocaceae	Antidiabetic
16.	Palakapayyani *Oroxylum indicum* Bignoniaceae	The root bark of plant is astringent to the bowels, cooling, aphrodisiac, tonic, increases appetite, useful in fevers, bronchitis, intestinal worms, vomiting, dysentery, leucoderma, asthma, inflammation
17.	Panthappain *Canarium strictum* Burseraceae	The species is rich source of Sambrani which is used to cure various bronchial ailments. The resin powder is given orally to cure rheumatism, fever, cough, asthma, epilepsy, chronic skin disorders, syphilis, and hernia and also helps to improve complexion
18.	Rakthachandanam *Pterocarpus santalinus* Leguminoceae	Used in traditional herbal medicine as an antipyretic, anti-inflammatory, antihelminthic, tonic, hemorrhage, dysentery, aphrodisiac, anti-hyperglycaemic
19.	Thippali *Piper longum* Piperaceae	Used to treat chronic bronchitis, asthma, constipation, paralysis of the tongue, diarrhea, cholera, chronic malaria, viral hepatitis, respiratory infections, stomachache, bronchitis, diseases of the spleen, cough, and tumors.
20.	Vayambu *Acorus calamus* Araceae	Rhizome is used for treating ulcers, inflammation of the stomach lining (gastritis), diarrhea, intestinal gas (flatulence), upset stomach
21.	Vizhal *Embelia ribes* Myrsinaceae	Used as antibacterial, antifertility activities, antiprotozoal, abdominal disorders, lung diseases, constipation, indigestion, fungus infections, mouth ulcer, sore throat, pneumonia, heart disease and obesity, analgesic, anti-inflammatory, antioxidant

Project 03: Evoking Renewed Interest in Navara - A '2500 years old' Medicinal Rice

Navara rice is in cultivation in Kerala for about 2,500 years since the time of Susruta, the Indian pioneer in medicine and surgery. Navara is reported to have multiple uses- much nutritious, balanced and safe food for people of all ages. Rice paste of this variety is recommended for external application to rejuvenate muscles. According to Ayurveda, body massage with boluses made out of Navara (Navara kizhi) rice along with the roots of a much popular medicinal plant Bala (*Sida alnifolia* var. alnifolia) in boiled milk offers vitality and immunity. In local health care system Navara is also used internally in ailment like diarrhoea, diseases of urinary organs, also externally as an application to muscle wasting, burns and scalds.

MSSRF had undertaken a detailed survey of this variety in Kerala during 2003-2010 and reported for the first time, occurrence of four distinct subtypes within Navara, which include awned and awnless black- glumed and yellow-glumed grains. Later, a collaborative mode of varietal selection was held in this varietal complex with farmer participation- wherein scientists worked together with farm men and women to strengthen farmers' informal research and development system. All four types of Navara were evaluated for their performance in different fields. In the participatory varietal selection, farmers were not just providers of land or labour to do experiments, but also were partners in the research process and played an active role in activities where the emphasis was on learning from farmers.

A project during 2005-2008, mobilized more farmers at cluster level for Navara cultivation and tried to develop and promote seven value-added products. Chemical prospecting revealed that the crude hexane extracts of Navara awned and awnless (both yellow and black types) had shown the presence of a component fraction and this was high in both unpolished and polished samples. It was studied that the compound is a type of aliphatic ester. Another compound fraction was also unique in a lesser percentage in Navara. Thermal retention test comparing Navara and other rice varieties suggested only marginal differences in the heat retention between the varieties. The pilot effort to clinically evaluate the efficacy of Navara rice (yellow awnless) in collaboration with the Institute of Applied Dermatology, Kasaragod was also successful. When evaluated, the muscle tone, muscle strength, tendon reflexes, range of movement and balance of functional abilities of the hemiplegic patients at baseline, 7th day, and on the 14th day after having kizhi, the intra quartile range values showed better range in patients who received Navara kizhi. These preliminary results called for profiling these varieties for the presence of specific components responsible for the unique characteristics and to define its benefits in hemiplegia and other neuromuscular disorders (Anil Kumar et al. 2003, 2004, Yasmin 2006, Aggithayaet al. 2014).

Project 04: Survey and Documentation of Wild Food Plants for Improving Nutrition Security

A study during the years 2002-2005 revealed that tribal groups of Wayanad have extensive knowledge regarding wild food and using a wide array of plants and animals with variations amongst different tribal groups. There were 372 wild edibles accessed by tribe communities, which include 102 leafy greens, 19 species of Dioscorea, 40 species of wild mushrooms, 5 species of crabs, 39 species of fishes and five types of honey (Ratheesh Narayanan et al. 2004, Anil Kumar et al. 2011).

Two genera – Taro and Dioscorea – contribute much of the diversity of wild tuber crops and serve as a 'life saving' plant group to marginal farming and forest-dwelling communities, during periods of food scarcity. Balakrishnan et al. (2003) reported collections of 10 species of Dioscorea and seven less well-known varieties of it from the southern part of Western Ghats. They reported several morphologically distinguishable forms in species such as *D. pentaphylla*, *D. wallichii*, *D. hamiltonii* and *D. belophylla*. Among the different species of Dioscorea, Nallanoora (*D. pentaphylla* var. *pentaphylla*) is the most commonly consumed

tuber. Among the various tubers, *D. hamiltonii*, *D. oppositifolia* and *D. pentaphyllavar pentaphylla* are the varieties most frequently consumed. They consume nine kinds of dioscorea tubers, in which the most preferred ones are Kavalakizhangu (*D. oppositifolia*) and Noorakizhangu (*D. pentaphylla* var. *pentaphylla*). They consider the Noorakizhangu and Kavalkizhangu to be rich in 'Podi' (starch) and 'Kozhuppu' (fat) and the Narakizhangu (*D.wallichii*) to be rich in 'Naru' (fibre).

Noora and Kavala do not need any detoxification before cooking. Wild dioscorea species are still a major source of food for forest-based communities like Kattunaikka. The communities who are dependent on wild dioscorea for their food classify each member of this genus, based on characteristics like edibility, taste, colour, size, the direction of growth, fibre content, cooking properties and occasionally the proliferation underground. Kattunaikka calls these tubers as 'Kalasu' and the present study revealed that they know about 21 different Kalasu. Among the varieties known to them, Vennikalasu (*D. hamiltoni*), Hehkkukalasu (*D. belophylla*), Kavalakalasu (*D. oppositifolia*) are seen in interior evergreen and moist deciduous forests, and Erakalasu (*D. wightii*) in rocky grasslands. Noorakalasu (*D. pentaphylla*), Narakalasu (*D. wallichii*), Hendiridaekalasu (*D. bulbifera*) are found in wayside bushes and Boojikavalakalasu (*D. pubera*) in marshy areas.

The Kattunaikkas collect dioscorea from almost all these places, but more frequently from the forests and other such unmanaged habitats (Balakrishnan and Anil Kumar 2017).

Project 05: Promotion of Millets as Health Food

Compared to rice the main staple food in India, millets have higher protein and micronutrient content (Table 5). The common feature of minor millets is that lysine is the most limiting amino acid and therefore millet-based diets should be complemented with legumes to fulfil protein needs (Iqbal et al. 2006). On the other end, the sulfur-containing amino acid content in finger millet is equal to milk protein (Antony, Sripriya, and Chandra 1996). Interestingly, fermentation of finger millet increases the percentage of free amino acids, as protein binding phytates are degraded during the fermentation process, thereby improving the bioavailability (Antony et al. 1996).

When it comes to the fat content, the fat from finger millets contains linoleic acid, an essential fatty acid (Hegdeet al. 2005). The fat content of finger millet (1.5-2.0 per cent), although low, is high in polyunsaturated fatty acids (PUFA) (Antony et al. 1996). PUFAs are preferred over saturated fatty acid because they reduce the risk of cardiovascular disease.

For the third macronutrient, carbohydrates, finger millet contains starch as the main constituent. Kamath and Belavady (1980) found that small millets are superior to rice and wheat as a source of dietary fibre. The total dietary fibre in finger millet (18.6 per cent) was higher than that in sorghum (14.2 per cent), wheat (17.2 per cent) and rice (8.3 per cent) (Kamath and Belavady 1980). Worth noting that adequate fibre intakes have potential health benefits such as normalization of bowel movements and helps maintain bowel health, lowering of cholesterol levels, helping control blood sugar levels and aiding in achieving healthy weight (Schneeman 1999). For these reasons, minor millets could be excellent ingredients for the preparation of fibre-rich healthier bread products (Malleshi 1993).

Diabetes constitutes a severe health problem in India. WHO reported that in 2000, 31.7 million people suffered from this ailment and by 2030 incidence is predicted to rise to 79.4 million (WHO 2020). Diets containing Kodo millet (*Paspalum scrobiculatum*) and finger millet (*Eleusine coracana*) flour have been found to have potential benefits to mitigate or delay the onset of diabetes-related complications since they can reduce blood glucose, lower blood cholesterol and protect against alloxan-induced oxidative stress in diabetic rats and these positive effects are attributable to the fibre and antioxidant phenolics found in these crops (Hegdeet al. 2005).

Starchy foods, which are digested gradually and are followed by a lower blood glucose response, are more beneficial to health and for the management of diabetes and hyperlipidemia (Wolever 1990). They have a so-called low glycemic index (a measure of the effect of carbohydrates on blood sugar levels). Some of the products produced by using minor millets have a low glycemic index, meaning 55 or lower (University of Sidney 2011).

For example, *laddu*, an Indian sweet which is an integral part of most Hindu festivals and celebrations, prepared with foxtail millet, has a glycemic index of only 24, whereas other products prepared with minor millets have a higher glycemic index. These are, for example, ragi laddu made of finger millet, which has a glycemic index of 68, classifying the product in the category of the medium glycemic index (56-59) (Foster-Powell, Holt, and Brand-Miller 2002). As a reference, products such as white bread, cornflakes and doughnuts have a high glycemic index (>70). Consumption of finger millet based diets has been reported to result in significantly lower plasma glucose levels than consumption of diets based on rice or wheat due to the higher fibre content of finger millet (Lakshmi Kumari and Sumathi 2002).

The great advantage of millets becomes even more apparent when iron (Fe) and calcium (Ca) content are considered. Compared to rice and wheat, finger millet is extremely high in calcium, the highest content among all cereals (334 mg per edible portion) (Gopalan et al. 1989). Of this 334 mg, only 162 mg/100 g is bioavailable in the raw grain, however, processing by fermentation and germination improves its bioavailability to 227mg/100 g (Sripriya et al. 1997).

Finger millet could be used to overcome the calcium deficiency in a rice based diet. Investigations under a project on neglected and underutilized species (NUS) supported by the International Fund for Agricultural Development (IFAD) – IFAD-NUS project,to assess nutrition/health outcomes have also shown that in Karnataka state, women's adequate dietary level of calcium was directly linked to their consumption of finger millet (Bergamini et al. 2013). Iron deficiency occurs when diets are based mostly on staple foods and include little meat (WHO 2002). This can be seen in India where meat consumption is very low and depends heavily on income class (Hopper 1999). Given the high prevailing levels of iron deficiency anaemia in the country, attention should be paid to the iron content of crops used as a staple food. Mainstreaming minor millets as a nutritious food can bring substantial benefits in addressing iron deficiency anaemia in India.

Table 5 shows that compared to rice and wheat, barnyard and little millet especially contain much more iron. Iron from plant source is less easily absorbed than iron from a meat source, but processing the finger millet will improve its iron availability (Sripriya et al. 1997). Including ascorbic acid-rich fruits with a meal can enhance uptake of minor millets' non-heme iron (UNICEF, WHO, and World Bank 2012).

The nutritional status of 60 school children of age group 11–14 years children, fed for three months with ragi (finger millet) or foxtail millet was also assessed under the IFAD-NUS project. Children fed with millet showed an improvement in weight and haemoglobin level compared to the control group fed with rice. Haemoglobin level was significantly increased in the groups fed with millets to the extent of 32-37.6 per cent (Bergamini et al. 2013).

When it comes to vitamins, Table 5 shows that foxtail millet, in particular, is rich in vitamin B1 (thiamine) (0.59 mg per 100 g). The riboflavin (vitamin B2) content of millets is generally higher than rice, whereas rice and wheat are generally higher in niacin (vitamin B3).

Table 5 : Nutrient composition of minor millets and other cereals (per 100g edible portion)

Food	Protein (g)	Fat (g)	Carbo-Hydrate (g)	Ca (mg)	Fe (mg)	Vitamin B1 (mg)	Vitamin B2 (mg)	Vitamin B1 (mg)
rice (brown)	7.9	2.7	76	33	1.8	0.41	0.04	4.3
wheat	11.6	2	71	30	3.5	0.41	0.1	5.1
maize	9.2	4.6	73	26	2.7	0.38	0.2	3.6
sorghum	10.4	3.1	70.7	25	5.4	0.38	0.15	4.3
pearl millet	11.8	4.8	67	42	11	0.38	0.21	2.8
finger millet	7.7	1.5	72.6	350	3.9	0.42	0.19	1.1
foxtail millet	11.2	4	63.2	31	2.8	0.59	0.11	3.2
proso millet	12.5	3.5	63.8	8	2.9	0.41	0.28	4.5
little millet	9.7	5.2	60.9	17	9.3	0.3	0.09	3.2
barnyard millet	11	3.9	55	22	18.6	0.33	0.1	4.2
kodo millet	9.8	3.6	66.6	35	1.7	0.15	0.09	2

Source: Hulse, Laing, and Pearson (1980)

III. DISCUSSION: REVITALIZING LOCAL HEALTH HERITAGE AND STRENGTHENING TRADITIONAL MEDICINE SYSTEM

1. Biodiversity and Human Health

Biodiversity is a major link between environment, medicine and human health. Although areas of rich biodiversity may have a high number of pathogens, biodiversity and the services they provide can have the capacity to serve as a protective factor to prevent transmission of infectious diseases that threaten both wild species as well as the people who depend on them (WHO & CBD 2015). In the human-dominated anthropocene epoch where disruptions in the natural environment have become rampant, the emergence of many more pathogens like COVID-19 in the future cannot be ruled out. Unfortunately, biodiversity heritage and health linkages are not widely recognized or valued in developing low cost plans and programmes for the Sustainable Development Goal of good health and well being for all (SDG 3).

The research and communication needs are enormous for modern society to understand the interlinkage of human and animal health. However, the local health traditions across the globe have recognized clearly this determinant and treated environment and human health synergistically as one health to fight many of the human health problems. One of the six building blocks WHO described for a Health System Framework is a well-functioning Health Information System that ensures production, analysis, dissemination and use of reliable and timely information on health determinants, health systems performance and health status (WHO 2007). A national information system with reliable information data sources on the services of biodiversity and LHT for health thus becomes an urgent need for countries where the large majority of people depend on traditional medical systems.

2. Revitalization of India's Local Health & Food Traditions

The Indo-Malaysian region, in particular, the Indian subcontinent is popular for the well documented examples of world cultural and health heritage. India with diverse geographies and climates as well as a high human population has higher biological and cultural diversities. India has one of the largest

healthcare systems in the world for addressing the primary, secondary and tertiary healthcare needs. The country also has age-old non-institutional healthcare with the active participation of around 1 million traditional healers and around 200 million informed households and use of over 7,500 plant species (Arima 2018). Ayurveda, Sidha, Unani, Yoga, Naturopathy and Swa-Rigpa systems of medicine originated in this region. Diverse methods of improving immunity measures in both codified and non-codified systems ranging from herbal water/ tea and Choorna, Lehya and Kashaya - the health supplements to complex rejuvenation therapies are known in India.

There are about 60,000 plant species reported globally with their medicinal, nutritional and aromatic properties. Plants and microbial diversity together serve as the single greatest source of natural product drugs to date. Origin from natural products can be traced in 75 per cent or more in the antibacterials, antivirals and antiparasitics approved by the USFDA between 1981 and 2010 (WHO & CBD 2015). The number of plant species used in the Indian Systems of Medicine areAyurveda: 1,200-1,800 species, Siddha: 500-900, Unani: 400-700, Swa-Rigpa: 300 and the Folk system: 7,500;the annual required quantity of raw drugs is about 2,000 tons from 178 species with consumption of over 100 metric tons. These therapeutic areas together produce about 25,000 effective plant-based formulations and are commonly used by a large majority of rural and indigenous people of India (Sen & Chakraborty 2017). Although India has an estimated 7,500 plant species recorded with diverse folk medicinal usages, only a fraction of these have been studied scientifically for the pharmacological potential or the health benefits. Sen & Chakraborty (2017) reported local trade of more than 1,500 herbals as dietary supplements or ethnic traditional medicines in India. However, the efforts are still not enough to provide good health to all with a low cost or revitalizelocal health traditions of the country. India's score on the Healthcare Access and Quality (HAQ) in 2019 was 41.2, which is lower than neighboring Bangladesh and well below the global average of 54.4. However, within India, states like Goa and Kerala scored more than 60 points. A major success factor of Kerala state is considered as the integration of the pluralistic healthcare systems with the promotion of health awareness and rights (Madore et al.2018).

WHO Traditional Medicine Strategy 2002–2005 has provided detailed strategic direction to achieve four integrated objectives (pertaining to policy; safety, efficacy and quality; access and rational use) with well-defined outcome indicators for the key performance of this sector. The top priority is 'to build the knowledge base for active management of Traditional and Complementary Medicine through appropriate national policies'. An expected outcome of this objective is 'Strengthened knowledge generation, collaboration and sustainable use of TM resources'. Arima and Harilal (2018) discussed in greater detail the marginalization of LHTs in India and the policy gaps and inconsistency in integrating LHT within national and local community-centred pluralistic healthcare systems.

3. Sustainable production and consumption of Health Foods

The prevalence of zinc deficiency, that can result in growth retardation, diarrhoea, immune deficiency, skin and eye lesions, delayed sexual maturation and behavioural changes (WHO 2000), is very high in South Asia where it varies between 34 per cent and 73 per cent (Caulfield and Black 2004). National risk of zinc deficiency in children under 5 years in India is very high (Black et al. 2008). One-quarter of the total Indian population is at risk of inadequate zinc intake, and therefore it is recognized as a public health problem (Black et al. 2008).

Including minor millets in diets might contribute to fulfilling zinc needs. Finger millet contains more zinc than rice but its bioavailability is lower (Hemalatha, Patel, and Srinivasan 2007). Finger millets are rich sources of phytates, which form complexes with zinc, iron and calcium and reduce their bioavailability. However, processing finger millet can reduce the presence of those complexes considerably and enhance the zinc bioavailability (Sripriya, Antony, and Chandra 1997). It is known that food-processing procedures such as heat

treatment (cooking), fermentation, germination, malting and soaking, as well as treatment with phytase, can improve zinc bioavailability in foods by decreasing the amount of dietary phytate or its lesser-phosphorylated derivatives (Agarwal 2001).

Millets are also important due to their hardiness, resilience to varied agro-climatic dangers and importance in marginal agriculture MSSRF has promoted millets as a strategic crop to address the food and particularly nutritional security of the communities. Over the last two decades, MSSRF has successfully demonstrated integrated management of millets covering conservation, cultivation, consumption and marketing dimensions through community-based demonstrations, outreach and influencing public policy (King 2018, Stefano et al. 2015, Veronica et al. 2017, Jessica et al 2019). When assessing the role of NUS in food and nutrition security, it should be stressed that other characteristics than just the caloric content of the plant should be taken into consideration. Minor millets in fact play an important role in the food and nutrition security of the poor, due to their excellent content of micronutrients, minerals, vitamins and fibres. Based on that, they should be rather called 'Nutri Millets'. Minor millets also contain all essential amino acids needed for an adequate diet (FAO 1995).

Worldwide, at least 30,000 plant species are known to various human societies as edible from long past, but most of these species remain neglected or under-utilized by the modern world (FAO, 1982, 1984, 1989; Falconer, 1990). In India, over 4,500 inhabitant ethnic communities, developed a multitude of foods, drinks and medicines out of every possible genetic resource. For example, the Malabar region (the south Western Ghats and coasts of the states of Kerala, Karnataka and Goa) is a historical global maritime destination known for its rich diversity of spices like black pepper, ginger, turmeric, and cardamom, and medicinal plants. Malabar region is recognized as the Centre of Origin of black pepper (*Piper nigrum*), which used to be referred as the "Black Gold", and its trade brought in the Romans, Arabs and much later the colonial powers to this region, and the rest is history. The hilly region of Malabar lies in the global biodiversity hotspot of the Western Ghats, which is one of the rich centres of endemic, endangered biodiversity and cultural diversity of the country.

One of the famous examples of herbal health food in India and marketed vigorously is "Chyavanaprash" whose main ingredient is gooseberry. Its sale reportedly registered a record high of INR 800 crores (double the amount of previous years) during the first month of the Corona pandemic. The potential of such herbal food or "nutraceuticals" has not been fully capitalized for achieving global health security. Similarly, many wild food plants are in use for their excellent functional health value. Fresh or processed collected foods have health-promoting and/or disease-preventing property beyond the basic nutritional function.

Despite challenges at various levels of the supply chain, increasing awareness on the healthy diets, favorable policy environment related to food and nutrition provides ample opportunities for sustainable production and consumption of health foods.

4. Home Remedies and Bio-diverse Homesteads

Homesteads and home remedy system are also popular in India. For instance, traditionally in almost all homes, spices and condiments are an integral part of food recipes. Spices are now proved to be ananti-cancer treasure house. The popular examples are turmeric and ginger for the anti-cancerous compound curcumin, and as a breast cancer super food respectively. Likewise, piperine in pepper is known for its action in inhibiting invasion of tumours, and the fruit extract of garcinia, a common ingredient in fish curries in central Kerala is rich in hydroxy citric acid that is now being promoted for weight loss and as an anti-cancer extract. This traditional wisdom of Indians to consume food and beverages with medicinal ingredient(s) has proven to provide many health benefits.

The cultural knowledge including the LHT associated with biodiversity utilization is getting eroded at a faster pace across most of the developing regions. This is mainly because of the change in societal values, as well as a change in the way health care practices being promoted. This has resulted in the loss of traditional knowledge and practices related to wild PGR management and local level extinction of many of the medicinal plants and wild edibles.

The loss of habit of consumption of diverse foods from both cultivated and wild sources has had serious repercussions on the nutrition status of tribal communities, especially of women and children. The advent of the modern system of medicine, neglect of traditional health care practices and commodification of herbal health products are the other major reasons. This demands focused attention on the preservation of the bio-cultural diversity and revitalization of the herbal health care heritage with back-up of scientific studies, behavioural changes, and capacity development programmes for conservation and promotion of local biodiversity and LHT.

5. Promoting a C4 Continuum for creating an economic stake in conservation

When intensification practices happen in a socially and environmentally benign manner with an inclusive approach in food, health and nutrition production and supply chain system, it can be called sustainable biodiversity business. Sustainability in the supply chain occurs when management practices and governance impact positively on the social, economic and environmental outcomes throughout the lifecycles of goods and services. Sustainable commerce can be better illustrated through a 4C continuum promoted by MSSRF.

In this approach, commerce is done with the primary aim of creating an economic stake in conservation through options in livelihood security of small and marginal farmers, and promoted through a consumption pattern that enhances biodiverse diets, ensures food and nutrition security, and drives cultivation practices which avoid hazardous chemicals and based on principles of organic farming. All the three sector activities lead to conservation of biodiversity in situ, on-farm and ex-situ off-farm levels. With this approach, sustainability can be achieved, and it will help companies protect long-term viability of businesses by reducing supply risk and securing a social license to operate in the market.

IV. RECOMMENDATIONS:

Some of the policy gaps and the potential projects that could help translate the National Health Policy (2017) and Biodiversity Act 2002 recommendations for revitalizing LHTs and improving Human and Ecosystem health are outlined here.

1. **Need a national commitment to revitalize location-specific, culturally significant and time-tested health care and sustainable food production traditions.** Integrating local health traditions and traditional medicine in the sustainable development and health agenda of the world can benefit both biodiversity and human health. The report by WHO & CBD (2015) discussed in detail the criticality of developing and providing cost-effective, safe and efficacy and quality proved traditional medicine and involvement of traditional healers in building up the health care system with new knowledge. Adequate investment and effective integration between different departments that deal with food and nutrition and primary healthcare promotion are required to improve Human & Ecosystem health.

2. **Re-orient primary health care service priorities from an exogenous approach to an endogenous approach where the focus is the promotion of healthy foods and traditional medicine.** WHO recognizes traditional medicine as an integral part of Local Health Traditions, and as the "total of the knowledge, skill, and practices based on the theories, beliefs, and experiences indigenous to different cultures,whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness". The approach should be treating synergistically the human-animal-environmental health as 'one health' to fight against any human health problems. The twin goal of improving the human immune system and the environmental health system must be the foremost priority to safeguard the most vulnerable people against the killer pathogens in the future.

3. **Constitute Primary Health Services Coordination Committees at the district level** with Collector as Chairman and health, nutrition and herbal experts from different systems as members. This body can lead in developing comprehensive primary healthcare & wellness packages with special attention to tribal and rural areas. The Committee also needs to coordinate streamlining and integrating policies and programmes of AYUSH, National Rural Health Mission, Integrated Tribal Development Programme, National Nutrition Mission, National Livelihood Mission and National Biodiversity Mission which are currently aimed at promoting integrated healthcare and nutrition.

4. **Support projects that are aimed at documentation of LHTs and Village-level Herbal Knowledge Registration** on aspects such as immunity increase, seasonal food recipes, disease-specific recipes, Health boosting foods, and collection of the employed herbals. Building district-level databases by protecting the intellectual property rights of the knowledge providers will help Access and Benefit Sharing. Phytochemical validation of the local registered knowledge on such herbs and recipes needs to be undertaken in collaboration with the indigenous knowledge providers and scientists.

5. **Organize Trainers' training and Certificate programmes through scientifically designed curricula** to build a cadre of barefoot LHT practitioners and custodian farmers who can engage in primary health services covering health, nutrition, sanitation, hygiene, safe drinking water, and waste management-oriented activities. This can be done as part of the Skill India program by involving agencies like the National Council for Skill Development, National Medicinal Plant Board, and domain-specific NGOs. The skilled trainers can assist the health professionals for all primary health care services at household and community level.

6. **Promote "Green Health" practices at every home** with knowledgeable elderly people, trained primary health practitioners, custodian farmers, tribal and rural youth and women SHG members to focus on micro-nutrient rich (naturally or chemically bio-fortified plants) and immunity-boosting herbals in the Home Gardens. Few state governments have unleashed plans for strengthening community-based production systems of millets, household production of fruits and vegetables. This can be part of the promotion of the concept of Local Health Heritage villages or Biodiversity Heritage Sites proposed in the National Biodiversity Act (2002) wherein biodiversity is mainstreamed in production of food and nutrition, healthcare, and livelihood needs.

7. **Establish Herbal & Wild Food Gardens in every district**, with emphasis on location-specific medicinal and nutrition-rich plant species that are managed in partnership with knowledgeable local community members including traditional healers. Such botanic gardens can promote as many satellite gardens at the community level. The master garden and its network gardens can ensure the availability of nutrient-rich food species, a refuge of the genetic variability in wild or semi-wild foods, orphan crops, and forest foods and can engage in educating all the critical stakeholders about the sustainable management of such bio-resources. To our knowledge, there are no organized gardens or efforts in India that directed towards saving the wild and Neglected and underutilized species of food value in an integrated manner. Eventually, state-level networks of herbal healers and herbalgardens with the purpose of exchange of herbal knowledge and medicinal plants can be established.

8. **Value chain development for certified primary health-boosting foods, products, nutraceuticals** by organizing a cadre of trained Women Self Help Groups in the form of herbal producer organizations. They can engage in promoting conservation, cultivation, consumption, and local level commercialization of herbals and PGRs of food, nutrition and therapeutic value. They need to be trained in the identification of genetic diversity in nutridense crops, medicinal plants, wild food plants, and documentation of traditional knowledge and practices associated with such resources, along with preparation, storage and marketing aspects of the herbal health products - Nutraceuticals.

9. **Promote integrated scientific research in nutrition, health and well-being** to achieve health innovations and nutrition-products from the traditional and ethnomedicine system through a trans disciplinary approach (by involving traditional health care practitioners and physicians of multiple medical sciences) to understand the bidirectional linkage between undernutrition and immunity issues and the role of Nutrition and Herbal remedies for a healthy life. Research in the labs needs to focus on effects of multi-micronutrients on immunity and in medical health conditions, which make nutrients and herbal molecules of therapeutic value to both macro and micronutrients, multiple vitamins and minerals. Private sector and domain-specific NGOs with support of bodies like Department of Science and Technology and Department of Biotechnology (Government of India) may take up such projects.

10. **Identify and designate Bio-cultural Diversity Heritage Sites** where dynamic integration of cultural diversity and TK happens in the healthcare and food production systems. This can be done based on the location-specific traditions in herbal healing and availability of practising herbal healers, and richness in curative and culinary diversity. The sites should also qualify for rich on-farm availability of genetic diversity in nutri-dense crop varieties and livestock breeds that are conserved in a dynamic way for better nutrition and resistance to disease vulnerabilities.

V. CONCLUSION

The bold ideas outlined in the National Health Policy (2017) need to be urgently translated into on the ground action for strengthening the various legally recognized healthcare systems and finding possibilities of establishing an integrated healthcare system in the country.

Achieving the goal of ending preventable infectious diseases, and eradicating malnutrition by 2030 (SDG3 & SDG 2) will be a formidable task in the post-COVID-19 world. The 'Health for All' goal was perceived to achieve by adopting preventive measures, immunization, and acquiring the capacity to access treatment and good nutrition at an individual level.

Equally significant is the importance of protecting the wild landscapes, ecosystems and species diversity to succeed in this goal. This is possible if there is a transformation in the healthcare system by making the traditional healthcare sector as the fourth tier of the national healthcare system. As Darshan Shankar, Chairman of the Foundation for Revitalization of Local Health Traditions noted, this would help to cover the primary healthcare needs of 40-50 percent of India's population with only a fraction of the allocated budget that goes to the institutional health system (Darshan Shankar 2020).

It is to be appreciated that the Bharatiya Poshan Krish Kosh launched by the government of India in late 2019 proposes to strengthen cultivation of region-specific diverse crops across 127 agro-climatic zones of the country[1]. The proposed development of a Food Atlas as well as documentation of promising practices for POSHAN Abhiyaan shouldinclude documentation of nutria-dense local biodiversity and LHT.

The COVID-19 pandemic crisis is an opportune time to seriously reflect on our indigenous traditional knowledge systems based on local biodiversity and focus on improving the immunity and nutrition status of our people to face future challenges.The objectives of the National Health Policy, Health Mission, Nutrition Mission, Poshan Abhiyan, and Biodiversity Act (2002) all need to be seen holistically and an integrated approach evolved. The primary healthcare system stands to gain by integrating the vast knowledge base across the country that draws on our rich biodiversity, to develop decentralized and sustainable healthcare management systems that can effectively cater to the needs of our large population.

[1] PRESS INFORMATION BUREAU Bharatiya Poshan Krishi Kosh(BPKK),(2019), Ministry of Women and Child Development, Government of India 6 Dec https://pib.gov.in/Pressreleaseshare.aspx?PRID=1595250

References:

Agarwal, B. 2001. Women, Poverty, and Agricultural Growth in India. *Gender and Development: Theoretical, Empirical, and Practical Approaches* 130:3-58.

Aggithaya Madhur Guruprasad, Saravu R. Narahari, Shanthakumari Vijaya, Kandathu Valappil Sushma, Nadesa Panicker Anil Kumar and Parameswaran Prajeesh, 2014. Navarakizhi and Pinda Sweda as Muscle-Nourishing Ayurveda Procedures in Hemiplegia: Double-Blind Randomized Comparative Pilot Clinical Trial. *The Journal of Alternative and Complementary Medicine*. 20(1) :.57–64.

Amy Madore, Julie Rosenberg, Tristan Dreisbach, and Rebecca Weintraub 2018: Positive Outlier: Health Outcomes in Kerala, India over Time- Cases in Global Health Delivery are produced by the Global Health Delivery Project at Harvard. https://www.globalhealthdelivery.org

Anil Kumar, N., G. Girigan and V. Balakrishnan. 2002. Conserving Navara- a traditional rice variety with medicinal qualities, *Amruthu,* FRLHT.

Anil Kumar, N. 2002. Navaranellu: Keralathinte Varadhanam (in Malayalam), *Karshakan*, 11: 50-51.

Anil Kumar, N., G. Girigan, and V. Balakrishnan. 2003. Medicinal Rice of Kerala: Navara, a rice variety cultivated only in Kerala, is widely use in local health care systems as well as in Ayurveda for many ailments. *Amruthu,* FRLHT. 2 :.14-16.

Anil Kumar, N. and M. K. Ratheesh Narayanan. 2011. Diversity, use pattern and management of wildfood plants of Western Ghats: A study from Wayanad district. *http://www.westernghatsindia.org/commissioned papers*

Antony, U., G. Sripriya, and T. S. Chandra. 1996. Effect of fermentation on the primary nutrients in finger millet (Eleusine coracana). *Journal of Agricultural and Food Chemistry* 44 (9): 2616-2618.

Arima Mishra and Harilal Madhavan 2018. The Making of Local Health Traditions in India: Revitalization or Marginalization? *Economic and Political Weekly.* 53(30) : 41-50.

Balakrishnan, V., M., K. Ratheesh Narayanan and N. Anil Kumar. 2003. Ethnotaxonomy of Dioscorea among the Kattunaikka People of Wayanad District, Kerala, India. *Plant Genetic Resources Newsletter*. 135: 24-32.

Balakrishnan V., and N. Anil Kumar. 2017. Sustainable Use of Wild Yams (Dioscorea) by Tribal Communities in Kerala, India. Biodiversity for Sustainable Development, In Robert J. Cabin, Brevard College, Brevard, N C K. .P. Laladhas, Preetha Nilayangode, Oommen V. Oommen. (eds). *Environmental Challenges and Solutions Series,* Vol. 3. London: Springer. 273- 294 pp.

Bergamini, N., S. Padulosi, S. Bala Ravi, and N. Yegani. 2013. Minor millets in India: neglected crops go mainstream. In *Diversifying Food and Diets Using Agricultural Biodiversity to Improve Nutrition and Health* London: Earthscan.

Black, R. E., L. H. Allen, Z. A. Bhutta, L. E. Caulfield, M. de Onis, M. Ezzati, C. Mathers, and J. Rivera. 2008. Maternal and child undernutrition: global and regional exposures and health consequences. *The Lancet.* 371 (9608): 243-260.

Caulfield, L .E., and R.E. Black. 2004. Zinc Deficiency. In A. D. L. Majid Ezzati, Anthony Rodgers and Christopher J. L. Murray (eds). *Comparative Quantification of Health Risks*,

Darshan Shankar 2020. Future of Healthcare. *Civil society.* 17(5): 20-23

Falconer, J. 1990. Hungry season food from forests. *Unasylva*, 40 (160).

Food and Agriculture Organisation. 1982. Fruit bearing forest trees- technical notes. FAO forestry paper 34, Rome.

Food and Agriculture Organisation. 1984. Food and fruit bearing forest species 2: examples from south-eastern Asia. Forestry paper 44/2. FAO, United Nations, Rome.

Food and Agriculture Orgnisation. 1989. Forestry and nutrition – a reference manual. FAO regional office, Bangkok.

Food and Agriculture Organization. 1995. Sorghum and millets in human nutrition. Rome: Sorghum and millets in

human nutrition.

Foster-Powell, K., S. H. A. Holt, and J. C. Brand-Miller. 2002. International table of glycemic index and glycemic load values: 2002. The American Journal of Clinical Nutrition 76 (1):5-56.

Gopalan, C., B. V. R. Sastri, and S. C. Balasubramanian. 1989. Nutritive value of Indian foods: National Institute of Nutrition, Indian Council of Medical Research.

Harinarayan, C. V., T. Ramalakshmi, U. V. Prasad, D. Sudhakar, P. V. L. N. Srinivasarao, K. V. S. Sarma, and E. G. T. Kumar. 2007. High prevalence of low dietary calcium, high phytate consumption, and vitamin D deficiency in healthy south Indians. *The American Journal of Clinical Nutrition.* 85 (4):1062-1067.

Hegde, P. S., N. S. Rajasekaran, and T. S. Chandra. 2005. Effects of the antioxidant properties of millet species on oxidative stress and glycemic status in alloxan-induced rats. *Nutrition Research*. 25 (12):1109-1120.

Hemalatha, S. , K. Platel, and K. Srinivasan. 2007. Zinc and iron contents and their bioaccessibility in cereals and pulses consumed in India. *Food Chemistry*.102 (4):1328-1336.

Hopper, G.R. 1999. Changing Food Production and Quality of Diet in India, 1947–98. *Population and Development Review*. 25 (3):443-477.

Iqbal, Amjad, Iqtidar A. Khalil, Nadia Ateeq, and Muhammad Sayyar Khan. 2006. Nutritional quality of important food legumes. *Food Chemistry*. 97 (2):331-335.

Jessica Raneri, Stefano Padulosi, Gennifer meldrum, Oliver King, 2019 Promoting neglected and underutilized species to boost Nutrition in LMICs. In: Food Environments: Where people meet the food systems (eds.) Christine Campeau, Denise Costa Coitinho Delmuel̀, Stineke Oenema. *UNSCN- Nutrition-* 44:10-25,

Kamath, M. V., and B. Belavady. 1980. Unavailable Carbohydrates Of Commonly Consumed Indian Foods. *Journal Of The Science Of Food And Agriculture* 31 (2):194-202.

King I Oliver, Meldrum G, Kumar. N, N.L, Manjula C., Padulosi S., Sivakumar. M.N., Baskar. R, Madeshwaran. K., 2018 Research Brief: Value chain and market potential of minor millets to strengthen climate resilience, nutrition security and income in India. *ASA India*, 4.

Lakshmi Kumari, P., and S. Sumathi. 2002. Effect of consumption of finger millet on hyperglycemia in non-insulin dependent diabetes mellitus (NIDDM) subjects. *Plant Foods for Human Nutrition*. 57 (3-4); 205-213.

Malleshi, N. G., Hadimani, N. A. 1993. Nutritional and technological characteristics of small millets and preparation of value added products from them. In Advances in small millets, (eds) K. W. Riley, Gupta, S. C., Seetharam, A., Mushong, J. N. New Delhi: Oxford and IBH Publishing.

Peter Howard and Thymio Papayannis. 2007, Natural heritage : at the interface of nature and culture London ; New York : Routledge. 123 p.

Poonam G. Daswani, Appasaheb A. Ghadge, Brijesh S., and Tannaz J. Birdi. Preparation of Decoction of Medicinal Plants: A Self-Help Measure? *The Journal of Alternative and Complementary Medicine*. 17(12): 99–110.

Ratheesh Narayanan, M. K., M.P. Swapna and N. Anil Kumar. 2004. Gender Dimensions of Wild Food Management in Wayanad, Kerala. M. S. Swaminathan Research Foundation, MSSRF/RR/04/12.

Schneeman, B.O. 1999. Building scientific consensus: the importance of dietary fiber. Am. *J. Clin. Nutr*. 69:1.

Saikat Senand Raja Chakraborty 2017: Revival, modernization and integration of Indian traditional herbal medicine in clinical practice: Importance, challenges and future. *J Tradit Complement Med*. 7(2): 234–244.

Sripriya, G., U. Antony, and T. S. Chandra. 1997. Changes in carbohydrate, free amino acids, organic acids, phytate and HCl extractab ility of minerals during germination and fermentation of finger millet (Eleusine coracana). *Food chemistry* 58 (4):345-350.

Stefano Padulosi, Bhag Mal, Oliver I. King and Elisabetta Gotor. 2015. Minor Millets as a Central Element for Sustainably Enhanced Incomes, Empowerment, and Nutrition in Rural India. *Sustainability.* 12: 8904-8933.

Swain S. 2014. Survey of Phytodiversity of Eastern Ghats in Odisha State with special reference to Ethno Medicinal Plats - PhD thesis, University of Madras,Chennai

Terry L. Levin, 2018, https://healthfully.com/5-natural-body-barriers-to-prevent-disease-4741613.html.

UNICEF, WHO, and World Bank. 2012. Joint Child Malnutrition Estimates. UNICEF, New York; WHO, Geneva; The World Bank, Washington, DC.

University of Sidney. 2011. Available from http://www.glycemicindex.com/.

Veronica Notaro, Stefano Padulosi, Gea Galluzzi & Israel Oliver King 2017 A policy analysis to promote conservation and use of small millet underutilized species in India, International Journal of Agricultural Sustainability, DOI: 10.1080/14735903.2017.1334181

WHO 2000 Nutrition for health and development: A global agenda for combating malnutrition. Geneva: World Health Organization.

WHO 2002 The world health report 2002 - Reducing Risks, Promoting Healthy Life Geneva: World Health Organization.

WHO 2007 Everybody's business: Strengthening health systems to improve health outcomes: WHO's Framework for Action. ISBN 9789241596077

WHO and CBD, 2015. Connecting global priorities: biodiversity and human health: a state of knowledge review. 1.Biodiversity. 2.Global Health. 3.Public Health. 4.Socioeconomic Factors. 5.Communicable Disease Control. 6.Climate Change. 7.Humans. I .World Health Organization. II. Convention on Biological Diversity. ISBN 978 92 4 150853 7 (NLM classification: WD 600)

WHO 2020. https://www.who.int/diabetes/facts/world_figures/en/index5.html

Wolever, T. M. 1990. The glycemic index. World review of nutrition and dietetics 62:120.

Yasmin S.H, Gipson Makil, Nandakumar P.M & N. Anil Kumar. 2006. Scope of Navara Cultivation. Proceedings of the Gene Seminar July.

Annexure 1: List of 34 Herbal Formulations produced for consumption and marketing by women SHGs

SI. NO.	Product Type & Name of The Formulation	Plants Used	Uses
	CHOORNAM (Powder form)		
1	*Thriphalachoornam*	Nellikka-*Emblica officinalis* Thannikka-*Terminalia bellirica* Kadukka-*Terminalia chebula*	Cough, eye disease, Piles, Constipation
2	*VasapushtadiChoornam*	Adalodakam(flower)-*Adhatoda beddomei* Chukku-*Zingiber officinale* Kurumulaku-*Piper nigrum* Thippali-*Piper longum* Irattimadhuram-*Glycyrrhizia glabra*	Cough suppressant
3	*Danthachoornam*	Mavila-*Mangifera indica* Thulasiyila-*Ocimum tenuiflorum* Marakkari-Charcol Uppu-Salt	Tooth powder
4	*Ashtachoornam*	Chukku-*Zingiber officinale* Kurumulaku-*Piper nigrum* Thippali-*Piper longum* Ayamodakam-*Carum copticum* Indhuppu-Pottassium chloride Jeerakam-*Cuminum cyminum* Karinjeerakam- *Nigella sativa* Kayam-*Ferula asafoetida* Chukku-*Zingiber officinale*	Vomiting, Diarrhea, indigestion and other stomach problems
5	*Thaleespathradichoornam*	Thaleespathram Kurumulaku-*Piper nigrum* Thippali-*Piper longum* Karuvappatta-*Cinnamomum zeylanicum* Elakka-*Elettaria cardamomum* Kalkandam	Vomiting, Cough, Asthma

6	*Thrikaduchoornam*	Chukku-*Zingiber officinale* Kurumulaku-*Piper nigrum* Thippali-*Piper longum*	Cough, Asthma, Throat pain etc.
		LEHYAM (colloid form)	
7	Muthiralehyam	Fried muthira-*Dolicos biflorus* Karippetti- Jaggery Fried jeerakam-*Cuminum cyminum* Elakka-*Elettaria cardamomum*	Rheumatism, Back pain, Urinary stone
8	Uluvalehyam	Fried uluva-*Trigonella foenum-graecum* Jaggery; Fried Jeerakam-*Cuminum cyminum* Elakka-*Elettaria cardamomum*	Pregnancy care
9	Thumbalehyam	Thumba flower-*Leucas aspera* Jaggery; Elakka-*Elettaria cardamomum* Grambu-*Syzygium aromaticum*	Post-delivery care and improving breast milk
10	Aswagandhalehyam	Amukkuram (*Withania somnifera)* Jaggery; Ghee & Honey	General health tonic
11	Kumarylehyam	Aloe vera; Jaggery; Alium sativum Honey; Ghee	Uterus disease
12	Muringalehyam	*Moringa oleifera* Jaggery; Ghee; Honey	General health tonic for children
13	Nellikkalehyam	*Emblica officinale;* Jaggery; Ghee; Honey; Piper nigrum; *Elettaria cardamomum; Cinnamomum zeylanicum*	General health tonic for all
14	Inchilehyam	*Zingiber officinale* Ghee &*Elettaria cardamomum*	Cough and digestion
15	Kariveppilalehyam	*Murraya koenigii; Zingiber officinale* *Citrus acida;* Jaggery Ghee & Honey	Diarrhea, indigestion and other abdominal issues.

16	Brahmi lehyam	*Bacopa monnieri; Centella asiatica* *Clitoria ternatea; Tinospora cordifolia* *Withania somnifera; Asparagus racemosus* *Cyathula prostrata; Maranta arundinacea* *Acorus calamus*; Ghee; Honey Jaggery; *Piper longum*	Brain tonic for school going children and insane babies.
PAIN BALM			
17	Balm	Coconut oil; Lac; Eucalyptus *Cymbopogon citratus; Commiphora mukul*	Head ache, Body pain
THAILAM (Herbal Oil)			
18	Bhrungarajathailam	*Eclipta prostrata; Tinospora cordifolia* *Emblica officinalis* *Glycyrrhiza glabra* (Irattimadhuram) Coconut oil; Cow milk	Hair tonic
19	Bhoomi amalakithailam	*Phyllanthus niruri; Vitex negundo* *Azadiracta indica;* Coconut oil *Curcuma longa*	Skin disease
20	Thinthranithailam	*Tamarindus indicus; Alpinia calcarata* Coconut oil	Anti Rheumatic and Anti inflammatory
21	Sahadevithailam	*Vernonia cinerea; Allium sativum* Coconut oil; Camphor	Head-ache, joint pain and balk pain
22	Thulasithailam	*Ocimum tenuiflorum; Commiphora mukul* Coconut oil	Ear pain and puss
23	Neergundithailam	Vitex negundo; *Calotropis gigantea* *Cocos nucifera* root; Coconut oil *Ricinus communis;* Camphor	Joint pain, Rheumatic pain
24	Dandhathailam	*Eugenia caryophyllata; Acorus calamus; Alium sativum;* Coconut oil	Toothache and ear pain

25	Murivenna	*Pongamia pinnata; Piper betle* *Erythrina indica; Moringa oleifera* *Oldenlandia auricularia; Aloe vera* *Alium sativum; Asparagus racemosus* Coconut oil; Starch water	Burn, fracture, skin diseases, pain etc
26	Prasavaraksha kuzhambu	Coconut oil; *Sida alnifolia var. alnifolia; Centella asiatica* *Curcuma longa*	Post-delivery care and skin care

GULIKA (Tablets & Capsules form)				
27	Sahadevigulika	*Piper nigrum; Pavetta indica; Vernoni acinerea; Leucas aspera; Ocimum tenuiflorum*	Vomiting, diarrhea and fever in children.	
28	Thilanagarathigulika	*Sesamum indicum; Zingiber officinale* *Piper nigrum; Cuminum cyminum*	Digestion	
29	Villwapathradigulika	*Eagle marmelos; Azadiracta indica* *Piper nigrum; Catharanthus roseus* *Ocimum tenuiflorum; Gymnema sylvestre*	Diabetes	
30	Udaravrinanashini	*Curcuma longa;* Honey	Ulcer	
31	Arshovinashini	*Cassia fistula; Vitis vinifera* *Terminalia chebula; Curcuma longa*	Piles	
32	Marmanigulika	*Terminalia chebula; Tinosporacordifolia*	Skin disease	

33	Uragulika	*Centella asiatica; Bacopa monnieri* *Eclipta prostrata; Coleus aromaticus* *Vernonia cinerea; Carum copticum (Ayamodakam)* *Alium sativum; Ferula asa-foetida* *Myristica fragrans;* Acorus calamus *Piper nigrum; Picrorrizha kurroa* (Kadukurohini*); Galls on Qeurcus infectoria (*Mayak) *Curcuma longa; Zingiber officinale* *Piper nigrum &* Indhuppu	Ulcer, piles, stomach pain, digestive and gastric problems, fever; also for treatment of ailments in animals.	
HEALTH SEED MIXTURE (9 Seeds powder)				
34	Navadhanya Mixture	Njavara rice; Barley; Wheat; Maize Ragi; Jowar; Ground nut; Horse gram Green gram	General nutrient rich food for all, and especially babies and diabetics	

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