Neglected and Underutilized Crops/Species (NUSs): Challenges and Opportunities

ICRISAT
INTERNATIONAL CROPS RESEARCH
INSTITUTE FOR THE SEMI-ARID TROPICS

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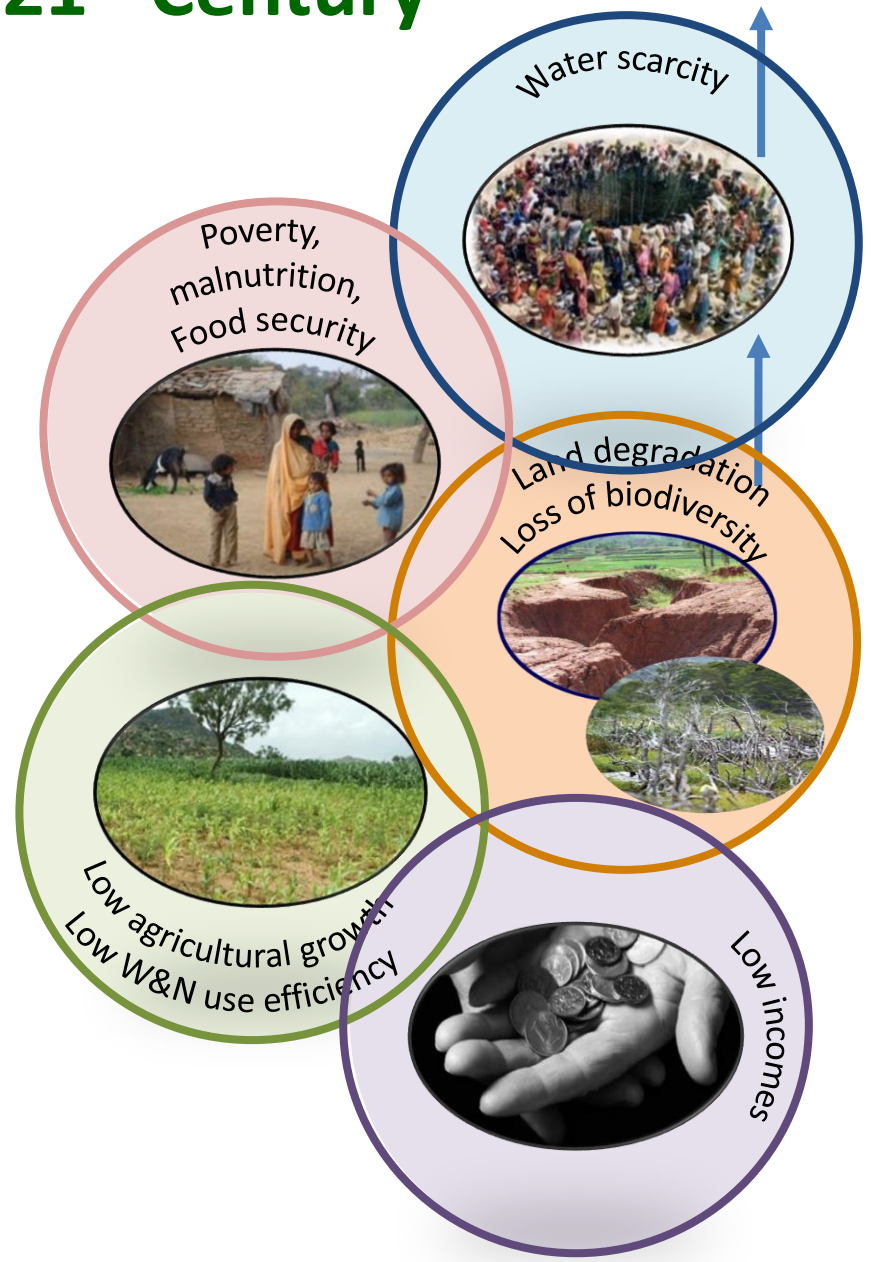
Research Program - Asia

Challenges of the 21st Century



5177 m^3

1545 m^3

120 m ha

Opportunities

- Out of 30,000 edible species only 7000 plant sp. Have been cultivated
- Out of 7000 plant sp. Only 30 spp. Feed the world and provide 95% calories needed
- NUSs of crops account for 97% spp. Of world crops and supply 50% of calories, other micronutrients and livelihood for poor farmers in developing countries
- Many NUSs are at a risk of being eroded or becoming extinct
- Insufficient information available on many crops

Why NUSs

- Nutrition
- Poor people’s food
- Unrecognized nutritional value
- Reputational problems
- Health
- Food security
- Income generation
- Environmental services
- Dietary and culinary diversification
- Poor consumer awareness
- Poor shelf life

Challenges to NUS

❖Social

- Replaced with new varieties and Improved crops
- Changing diet
- Loss of indigenous knowledge
- Inadequate awareness of the nutritional value
- Social Stigma
- Migration of farm labor
- Over-exploitation of wild resources

❖Economic

- Changes in land use
- Low commercial value
- Lack of market
- Lack of incentives

❖Environmental

- Genetic erosion
- Climate change
- Environmental pollution
- Ecosystem degradation

❖Agronomic

- Insufficient seeds
- Lack of seed supply systems
- Insufficiently trained human resources

❖Political

- Failure of governments to conservation and use
- Lack of funds
- Failure of governments to support research
- Absence of legal frameworks and policies

Important Characteristics of NUS

- Represented by wild species, ecotypes and landraces
- Highly adapted to agro-ecological niches and marginal areas
- Cultivated and utilized based on indigenous knowledge
- Important in local consumption and production systems
- Under-represented in *ex-situ* gene banks
- Characterized by fragile or non-existent seed supply systems
- Overlooked by policy-makers and research and development agendas, and scientific information and knowledge about NUS are scanty

NUSs in Vietnam and Lao PDR

- In Vietnam 800 plant spp.
  - 41 Starchy foods
  - 105 Fruits
  - 44 Oil crops
  - 12 Beverages
  - 50 Ornamental
  - 5 Shading trees
  - 95 Non-starchy foods
  - 55 Vegetables
  - 16 Fiber
  - 181 Medicinal
  - 49 Woody
- In Lao NUSs are close to NTFPs which provide HHs subsistence (44%)
- Nutritionally rich and adapted to low input agriculture
- 80% scientists felt NUS are valuable genetic resource – contribute to development of sustainable agriculture and poverty alleviation

NUSs in Bangladesh

Sl. No.	English/Local Name	Scientific Name	Accessions	Priority
Cereals				
1	Foxtail millet	Setaria italica	546	I
2	Proso millet	Panicum miliaceum	199	II
3	Barley	Hordium vulgare	62	III
Roots and Tubers				
1	Yam	Dioscorea spp.	60	I
2	Elephant foot yam (Ol kachu)	Ammorphophallus campanulatus	2	III
3	Sweet potato	Ipomoea batatas		II
Nuts and Pulses				
1	Pigeon pea	Cajanus cajan	83	II
2	Cowpea	Vigna unguiculata	37	III
3	Mung bean	Vigna radiata	114	I
Horticulture				
1	Snake gourd	Tricosynthes anguina	143	I
2	Sapota	Achras zapota	1	II
3	Jamun	Syzygium cumini	5	III
Others				
1	Black cumin	Nigella sativa	11	II
2	Coriander	Coriandrum sativum	31	I
3	Ajowan	Trchyspermum ammi	1	III

NUSs in Cambodia

Sl. No.	English/Local Name
Cereal	
1	Wild rice
2	Glutinous maize
Roots and Tubers	
1	Taro
2	Wild yam
3	Cassava
Nuts and Pulses	
1	Cashew nut
2	Local peanut
3	Black-eyed-pea
4	Mungbean
Horticulture	
1	Winter melon
2	Papaya
3	Rattan
Other	
1	Bael
2	Common custard
3	Burmese grape

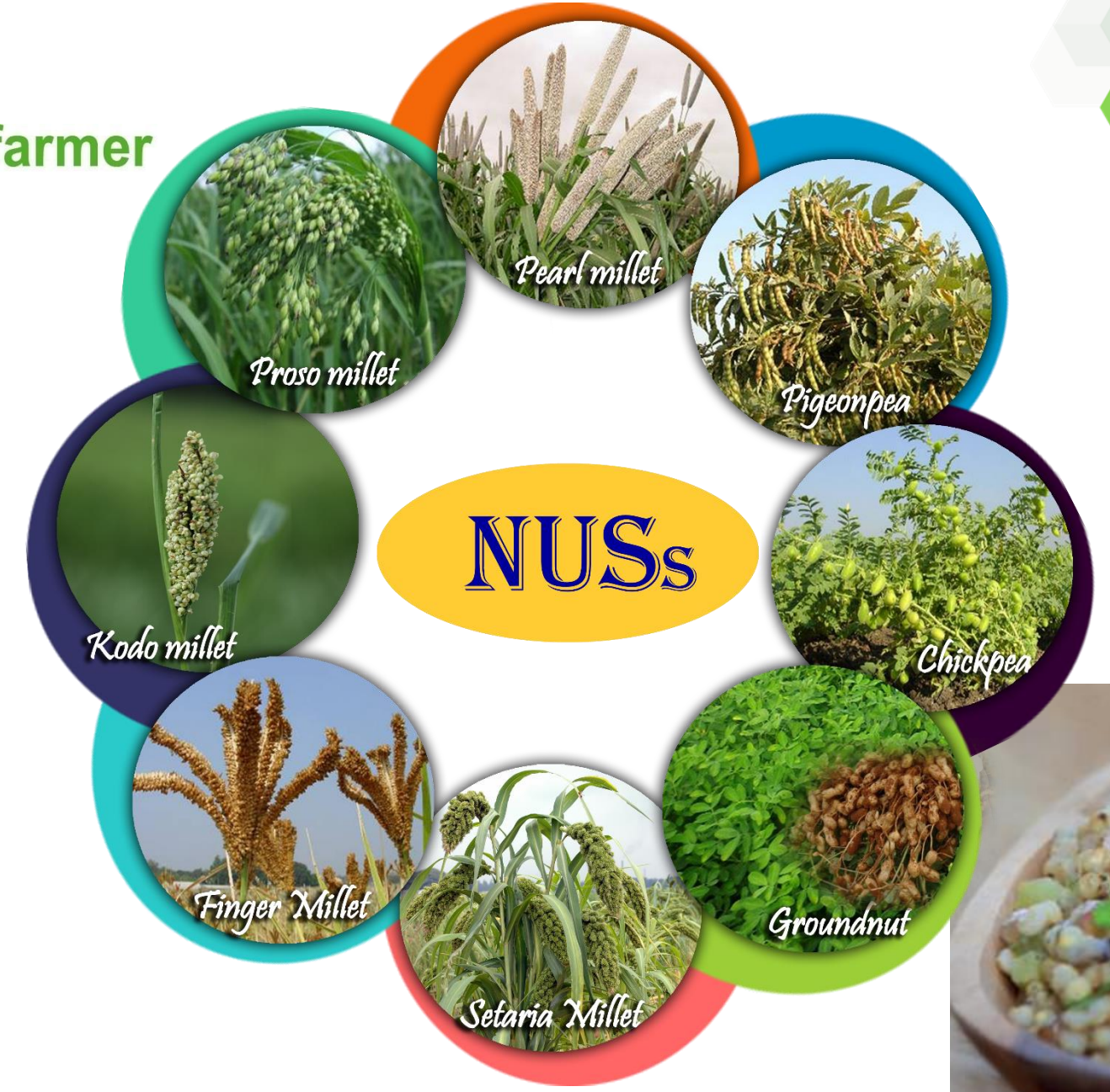
Constraints for Enhancing Production

- Inadequate research and development focus
- Processing and marketing
- Germplasm accessibility
- Low yields and social stigma
- Potential collaborative and development areas

NUSs are Smart Foods

Good for you - the planet - the farmer

- ✓ **Highly nutritious**
- ✓ **Environmentally friendly**
- ✓ **Climate smart** – resilient under extreme weather conditions
- ✓ Significant **yield gap**
- ✓ Good opportunities to **diversify** both diets and on-farm
- ✓ **Untapped demand** and uses



NUSs and SDGs

Focus to realize global food security and nutrition and empower smallholder farmers

- The Sustainable Development Goals launched and agreed to by 193 nations on September 25, 2015 at the 71st UN General Assembly
- The 17 Goals are lead off with no poverty (Goal 1) and zero hunger (Goal 2) – In all seven SDGs are related to NUSs
- These goals underpinned by 169 targets

Crop Yield, Consumptive Water Use and Water Productivity of some NUS Crops

Category	Crops	Yield (kg ha^{-1})	Rainfall (mm)	ET (mm)	Water productivity (kg m^{-3})
Cereal	Finger Millet	1561	493	317	0.49
Cereal	Pearl Millet	1637	493	323	0.51
Cereal	Sorghum	1303	541	349	0.37
Pulse	Chickpea	967	551	351	0.28
Pulse	Green gram	650	625	402	0.16
Pulse	Pigeon pea	987	558	352	0.28
Oil Seed	Groundnut	1187	457	296	0.40

(Data source: Bhoochatana from Karnataka between 2009 and 2012)

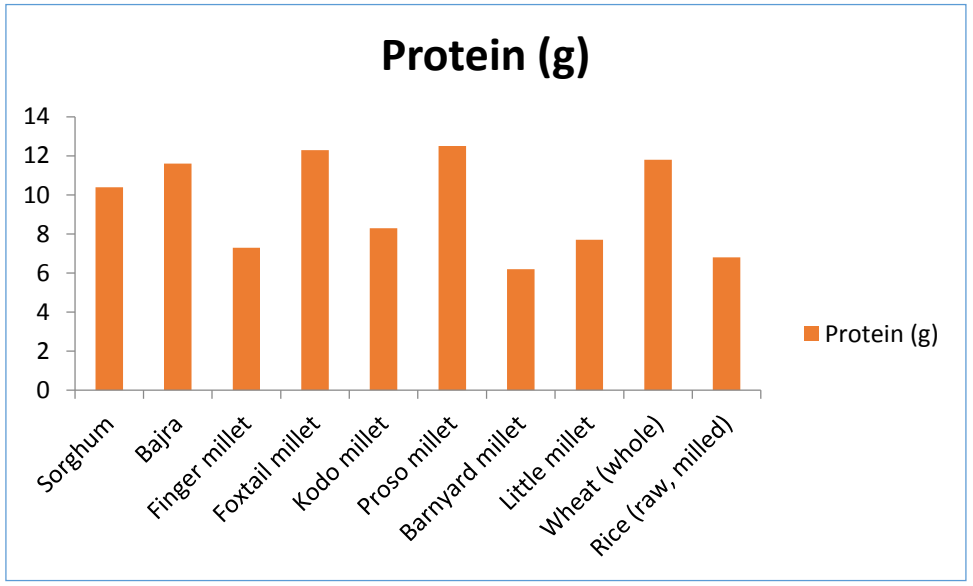
Nutritional Value and Energy Content of Some NUS Cereals, Pulses and Oil Seeds in 100 gm (Dry Weight) Quantity

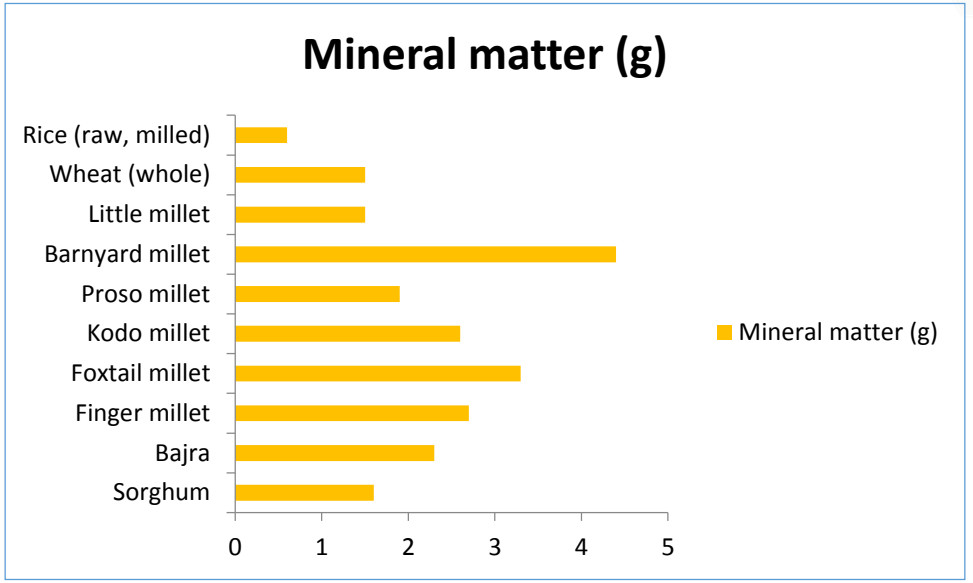
Crop	Protein	Carbs	Fat	Zn	Fe	Ca	Mg	K	P	Vita B1	vit b2	Vit b3	Energy
Unit	gram	gram	gram	mg	mg	mg	mg	mg	mg	mg	mg	mg	(K cal)
Finger Millet	7.7	72.6	1.5	2.3	3.9	350	137	408	283	0.4	0.2	1.1	336
Pearl Millet	11.8	67.0	4.8	3.1	11.0	42	137	307	296	0.4	0.2	2.8	363
Sorghum	10.4	70.7	3.1	1.6	4.1	25	171	309	222	0.4	0.2	4.3	329
Chickpea	17.1	60.9	5.3	6.1	4.0	220	119	875	366	0.3	0.2	1.7	360
Greengram	24.0	56.7	1.3	2.7	8.5	124	189	1246	405	0.6	0.2	2.3	348
Pigeonpea	22.3	57.6	1.7	3.0	2.9	16	79	1392	367	0.6	0.2	2.9	335
Groundnut	23.7	21.5	49.6	440	400	1180	180	470	680	0.6	0.3	12.9	585

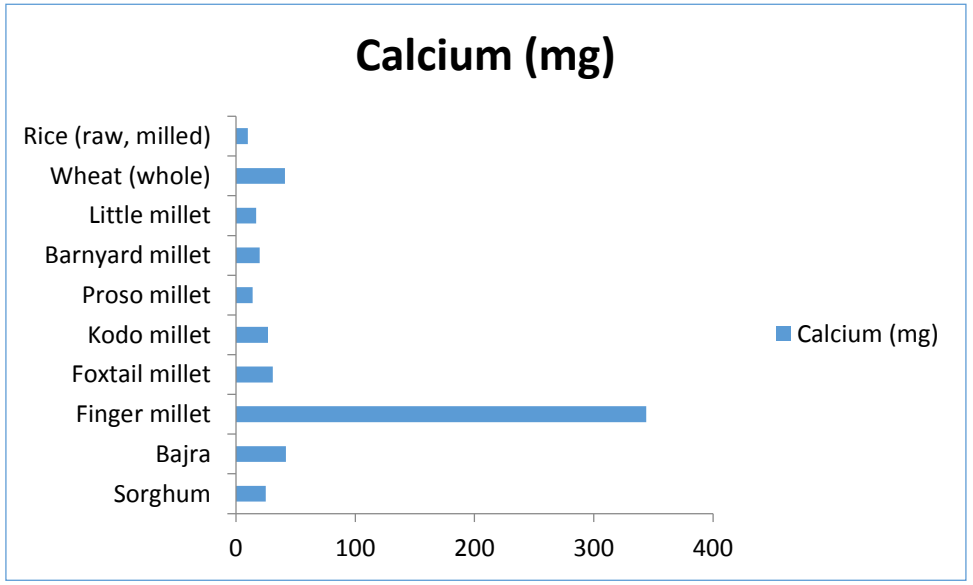
Data Source

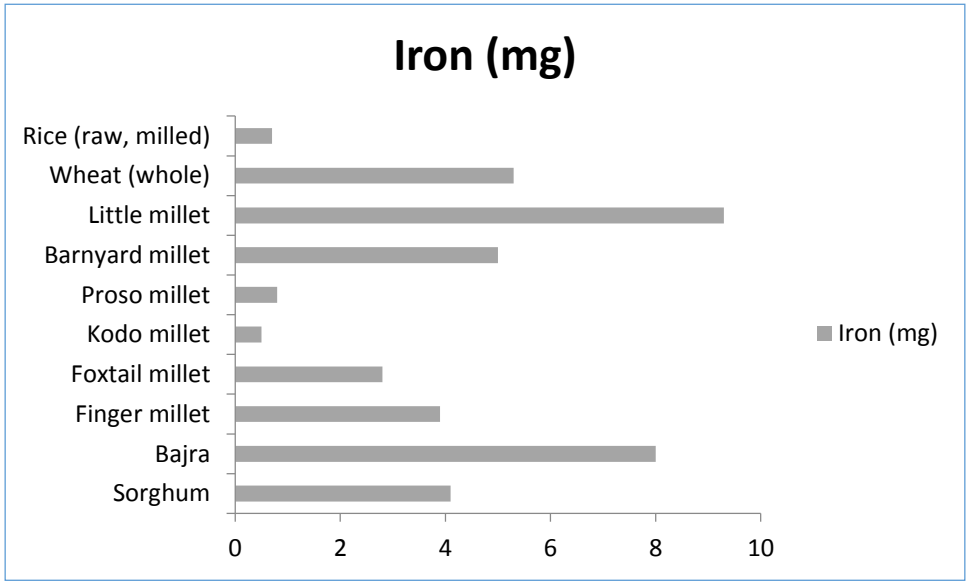
i) Sorghum and Millets in human nutrition - FAO Report;
ii) Maize in human nutrietio - FAO Report;
iii) AK Jukanti1, PM Gaur1*, CLL Gowda1 and RN Chibbar2 http://dx.doi.org/10.1017/S0007114512000797
iv) Kul Bhushan Saxena, Ravikoti Vijaya Kumar*, Rafat Sultana, Quality nutrition through pigeonpea—a review
v) Ayoola, P.B1., Adeyeye,A1 and Onawumi,O.O2, AMERICAN JOURNAL OF FOOD AND NUTRITION
vi) V. S. Settaluri1,2, C. V. K. Kandala3, N. Puppala1, J. Sundaram4 ,Food and Nutrition Sciences, 2012, 3, 1644-1650

Nutrient Profile for NUSs









Nutrient profile (g/mg per 100 g grains of NUSs)

Nutritional Water Productivity (gm/m^3 or mg/m^3) of Some NUS Crops

Crop	Protein	Carbs	Fat	Zn	Fe	Ca	Mg	K	P	Vita B1	Vita B2	Vita B3	Energy
Units	gm/m^3	gm/m^3	gm/m^3	mg/m^3	mg/m^3	mg/m^3	mg/m^3	mg/m^3	mg/m^3	mg/m^3	mg/m^3	mg/m^3	*Mega cal/m^3
Finger Millet	38	358	7	11	19	1725	675	2011	1395	2.1	0.9	5.4	166
Pearl Millet	60	340	24	16	56	213	695	1556	1501	1.9	1.1	14.2	184
Sorghum	39	264	12	6	15	93	639	1154	829	1.4	0.6	16.1	123
Chickpea	47	168	15	17	11	607	328	2415	1010	0.8	0.6	4.7	99
Green gram	39	92	2	4	14	201	306	2015	655	1.0	0.4	3.6	56
Pigeon pea	63	162	5	8	8	46	221	3907	1030	1.8	0.5	8.1	94
Groundnut	95	86	199	1764	1603	4730	721	1884	2726	2.4	1.2	51.7	234

*Mega cal = 1000 K cal

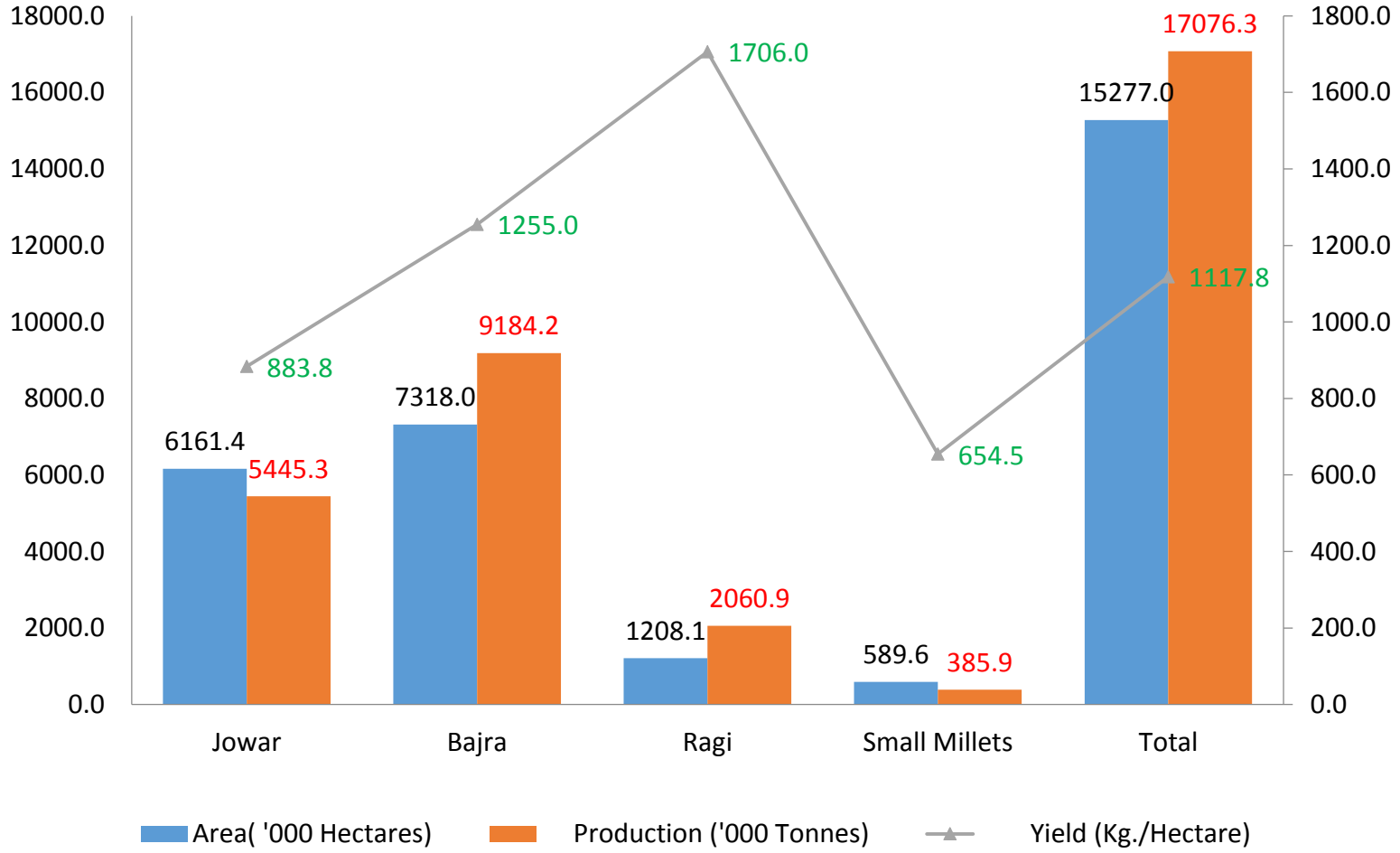
Germplasm Collection at ICRISAT – A Valuable Resource

Crop	Number of accessions in genebank	Number of origin countries
Sorghum	39,923	93
Pearl millet	23,092	52
Chickpea	20,602	59
Pigeonpea	13,778	74
Finger millet	7,186	25

NUS Accessions at Genebank, NARC

SN	English Name	Local/ Nepali Name	Scientific Name	Accessions
Millets				
1	Tatary Buckwheat	Tite Phaper	Fagopyrum tartaricum Gaertn.	400
2	Sorghum	Junelo	Sorghum bicolor Moench	100
3	Prince's Feather	Latte dana	Amaranthus hypochondriacus L.	70
4	Foxtail Millet	Kaguno	Setaria italica (L.) Beauv.	50
Root and Tubers				
1	Taro	Pindalu	Colocasia esculenta Schott	30
2	Greater Yam, White Yam	Tarul, Ghar Tarul	Dioscorea alata L.	5
Pulses				
1	Ricebean	Mashyang/ Jhilinge / Siltung	Vigna umbellata [Thunb.] Ohwi & Ohashi	80
2	Horsegram	Gahat	Macrotyloma uniflorum (Lam.) Verdc.	30
3	Grasspea	Khesari	Lathyrus sativus L.	50
Fruits vegetables				
1	Chayote	Iskush	Sechium edule Swartz	15
2	Balsam Apple	Barella	Momordica balsamina L.	20
3	Drumstick	Sahinjan/Sital Chini	Moringa oleifera L.	0
Leafy vegetables				
1	Fenugreek	Methi	Trigonella foenum-graecum L.	10
2	Dill	Soup	Anethum graveolens L.	4
3	Lamb's Quarter	Bethe	Chenopodiun album L.	2

All India Production, Area and Yield of Millets TE 2014-15



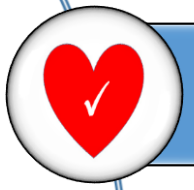
Source: FAO Stat 2016; DES 2015

Good Health begins with Good Food and

Good Food begins with Millets

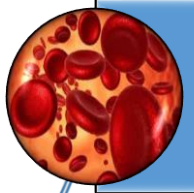
Health Benefits of Millets

Obesity: Intake of high dietary fibre (present in millets),hunger satisfaction and increases satiety decreases incidence of obesity.



Coronary Heart Disease (CHD): Regular consumption of whole millet grains (40 g/day) reduces the risk of CVD and thus reduces the risk of CHD by 20%.

Beneficial in treating stomach ulcers and gall stones: Millet consumption turns the stomach alkaline and prevents the formation of stomach ulcers or reduces the effect of ulcers.



For Anemia control: Finger millet is a very good source of natural Iron. Its consumption helps in conditions of anemia. It helps in keeping malnutrition, degenerative diseases, liver disorders and asthma at bay.

Beneficial in preventing allergic reactions: Pearl millet especially has a very low probability of causing allergic reactions, due to the hypo-allergic property;

Good Health begins with Good Food and

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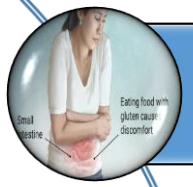
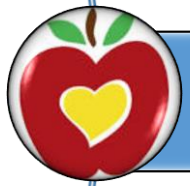
Health Benefits of Millets *(Contd..)*



Celiac disease: Millets are gluten free grains hence, used for celiac disease patients.

Anti-diabetic properties: Millets consumption lowers blood glucose response and glycosilated hemoglobin thus, rendering low glycaemic index; helps in reducing the risk of *diabetes mellitus.*



Reduction of oxidative stress: Free radicals, are removed by the phenolic compounds present in millet grains which reduces oxidative stress.

Anti-cancer properties: Millet extracts have anti-prolific effects on cancer cell line, inhibit DNA damage and induce the production of phase-2 detoxifying enzymes.

Anti-hypertensive: Millets prevent the oxidation of low density lipoproteins reducing lipase activity which reduces the occurrence of hypertension.

Holistic Approach: Watershed as an Entry Point

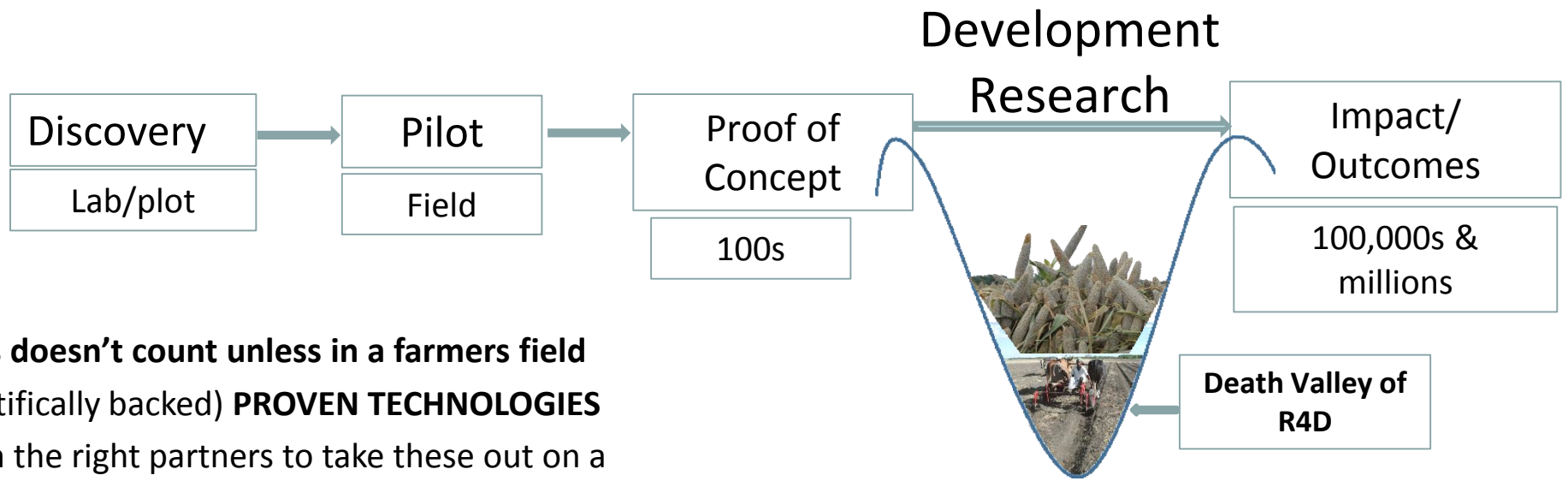
Scaling-up Strategy for Smart Foods

- Set up a Private-Public Partnership (PPP) advisory committee
- Collate scientifically backed information (Case studies)
- Develop a marketing plan and create base marketing material
- Set up a Smart Food accreditation
- Promotion and branding
- Curtain raisers
- Conduct a launch
- Undertake a public campaign

Strengthen R4D for NUSs

Science of Delivery

Large scale uptake of Science backed technologies



- **Technologies doesn't count unless in a farmers field**
- Taking (scientifically backed) **PROVEN TECHNOLOGIES**
- Working with the right partners to take these out on a very large scale **TO REACH THE PEOPLE (Collaborative capacity > Investment capacity)**
- Capturing lessons on how to do **LARGE SCALE ADOPTION**
- **On-farm and on-station STRATEGIC RESEARCH**

Way Forward

Considering challenges of water scarcity land degradation, food & nutritional security under climate change scenarios

- NUSs potential need to be harnessed through international collaborative R4D initiative
- Documentation of traditional knowledge about NUS (cultivation, preparation, distribution) is urgently needed
- Collection of germplasm of NUS is needed
- Available NUS material to be tested thru international trials
- Yield improvement along with stress tolerance to be strengthened thru research
- Scaling-up initiatives to enhance productivity, production and profitability are must

Thank You

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