

Agricultural Research and Innovation for food and nutrition security in Nepal



Devendra Gauchan*, Ram Krishna Shrestha, Krishna Timsina, Sushil Subedi,
Tek Gotame, Tulsi Paudel, Priyambada Joshi and Krishna Dev Joshi

Email*: d.gauchan@cgiar.org

Paper presented in the 7th SAS Convention held in Kathmandu on April 4, 2022

Outlines of the Presentation

- **Problems and Issues in Food System Transformation**
- **Current Status of Food & Nutrition Security and Agri Import Growth**
- **Role of Agri Research and Innovation in Food and Nutrition**
- **Drivers of Agri Research & Innovation Ecosystem**
- **Pillars of Food Security: Outcome and Research & Innovation Indicators**
- **Technology Types; Promising Technologies; Productivity Growths and Gaps**
- **Status and Gaps in Research and Innovation**
- **Way-Forward: Research and Investment Priorities**

Problems and Issues in Food System Transformation

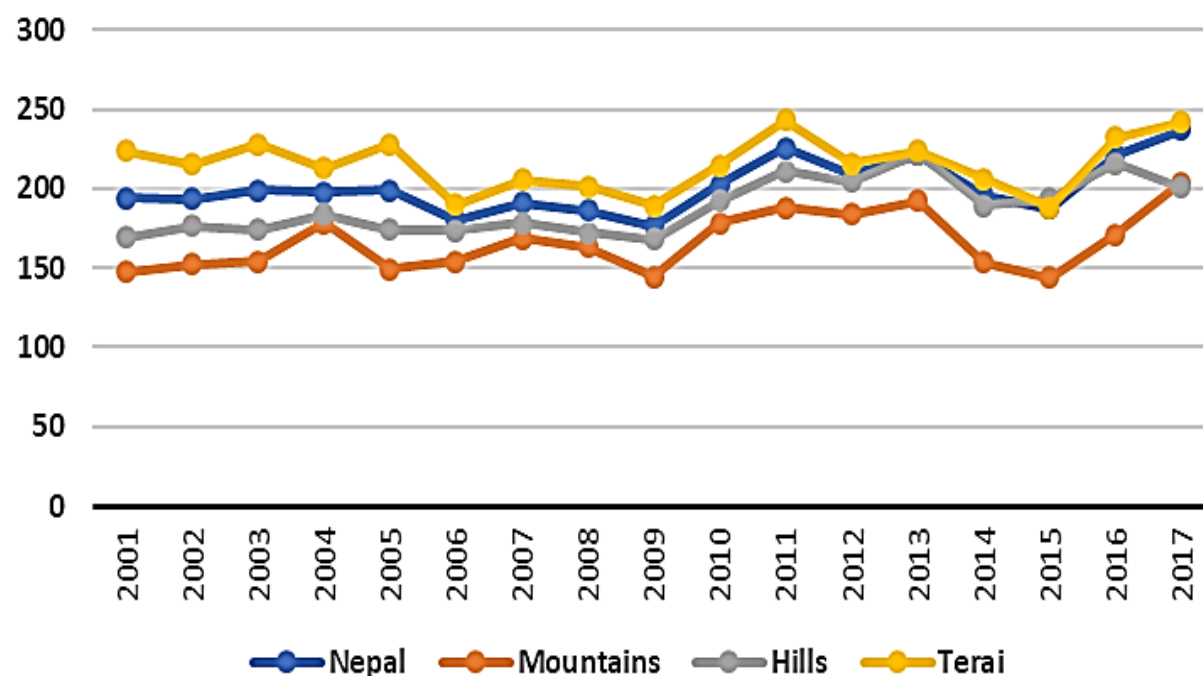
- **Growing Food Crisis** in the country from 3 'C' (**Climate, Covid-19 and Conflict**) including degradation of natural resources
- **Triple Burden of Malnutrition** (undernutrition, micronutrient deficiency and overnutrition/obesity)
- **High cost of healthy nutritious diets** (nearly **3 times expensive** than normal energy-based diets; WFP, 2021)
- **Low agricultural productivity, increasing cost of production, high food price volatility**
- **Escalating import of agricultural products** in recent years with Increased **Import Dependency** and **declining balance of payments**
- **Gaps in research and innovation** with **lack of clear priorities, policies and resource allocations** to increase **productivity** of major commodities to reduce escalating import vital for ensuring food and nutrition security

Status of Food and Nutrition Security in Nepal

National Food Security Status: **48.2%** HHs food secure; Per Capita Food Availability **237 kg**

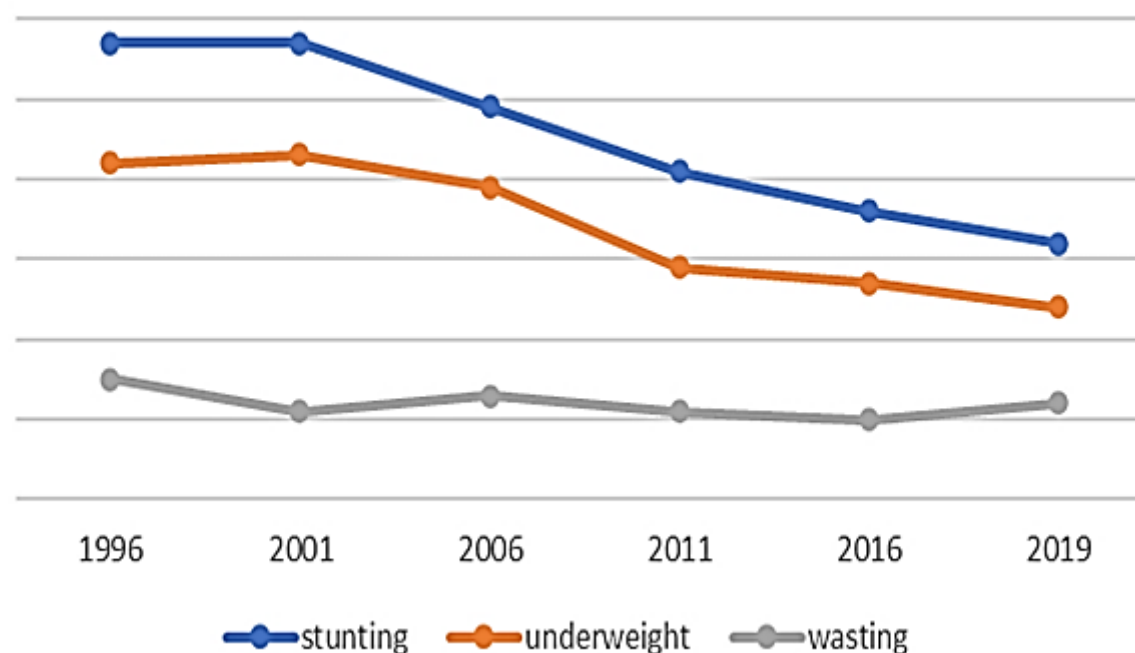
Children Nutrition Status: Stunting **32%**; Underweight **24%**; Wasting **12%**

Per capita Food Availability (2001-2017)



Source: Joshi, Ghale & Gauchan, (2021)

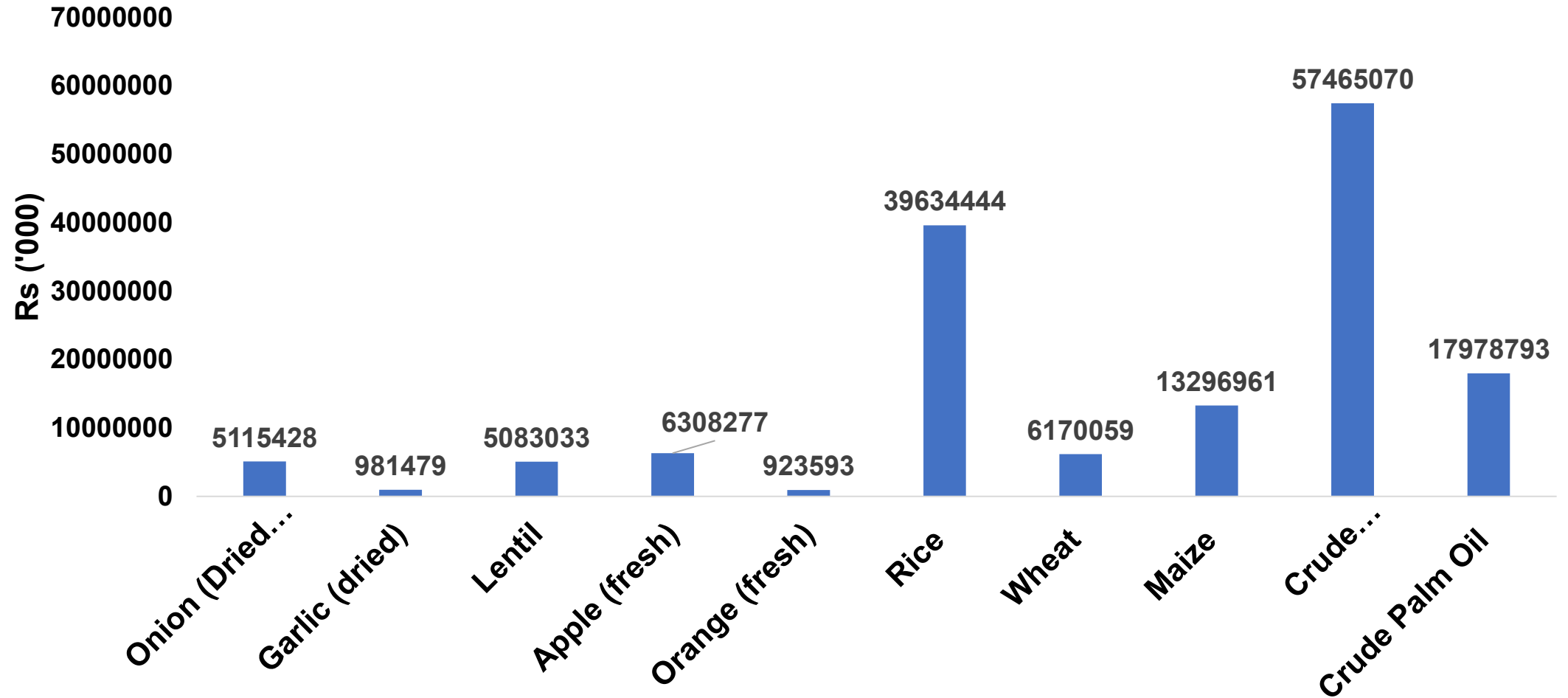
Trend in Children Nutrition Status (%)



Source: NMICS (2019)

Escalating Import of Major agri. Commodities in 2021

(Value in Rs'000)

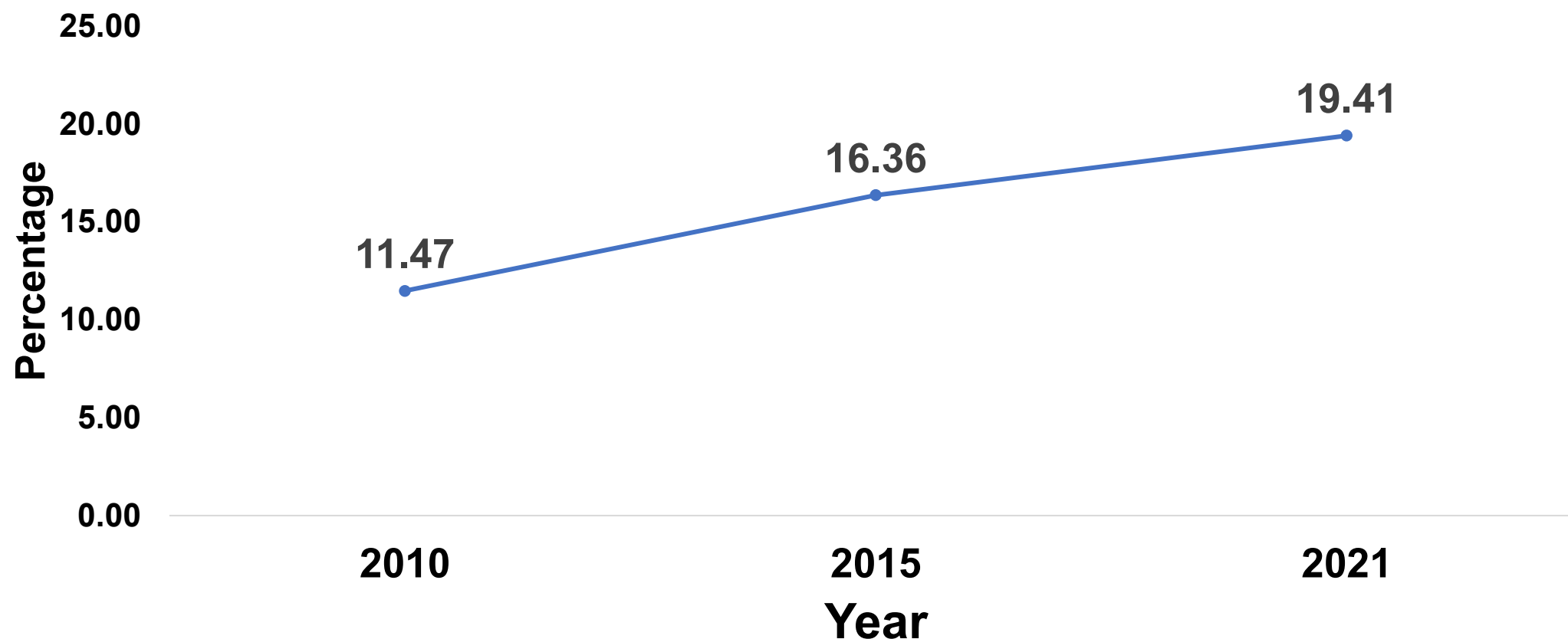


Proportion of Agri. Import on Total Import over decade

Total Agri. import in 2010 (NRs Arab): 42.94

Total Agri. Import in 2021 (NRs Arab): 275.50

- High Import dependency ratio
- Foreign currency reserve declining



Source: Authors estimation, 2022 from TEPC

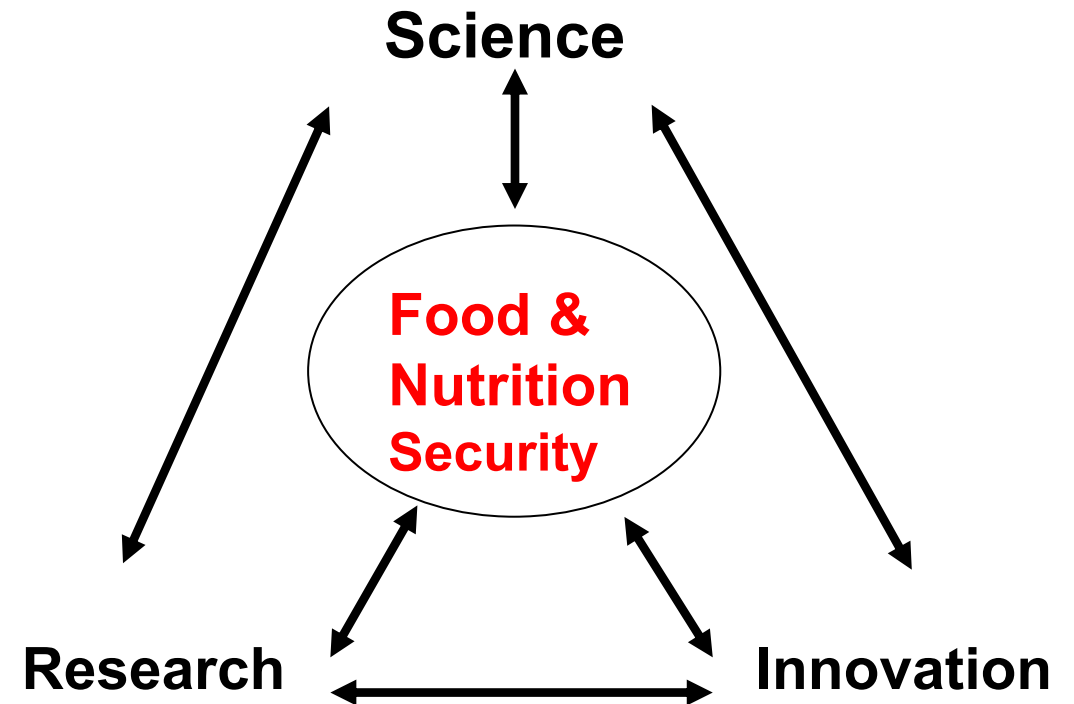
Drivers of Import Demand of Agri-Products

(mainly after 1985)

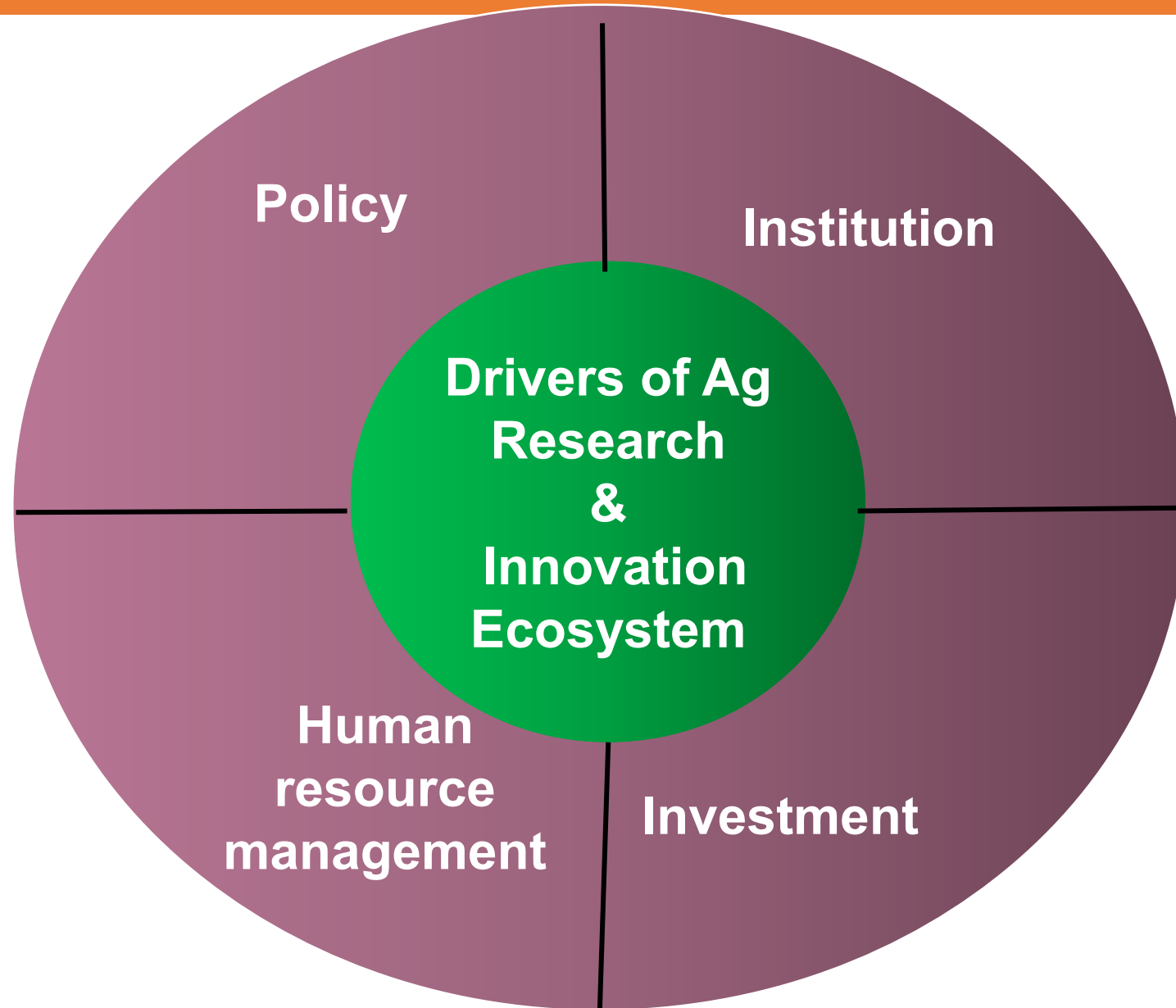
- **Population Growth:** Population has **doubled** from 1985 (15 million) to 2020 (30 million)
- **Income Growth:** **GDP Percapita** has increased by **fivefold** from US \$200 to US \$1155 from 1985 to 2020
- **Shift in Consumption Pattern:** **Urbanization** and **Increased road connectivity** has changed the **food habits** towards **processed** & high value products (fruits, vegetables, Jam, Jelly, Juice, Butter, flour etc.) and **rice** from **coarse grains**

How Agriculture Research and Innovation contribute to Food and Nutrition Security?

- **Development** of new and **advanced science, technologies** and **innovation** that increase productivity, profitability and price stability
- **Sustained generation & flow** of **scientific knowledge, technology & information** with appropriate **institutional** and **technical innovation** from continuous research
- **Investment in research and innovation** to build **scientific HR capacity, infrastructure** and **facilities**
- **Innovative knowledge dissemination** and **communication links** with the **farmers, agro entrepreneurs** and **consumers** (women)



Drivers of Agriculture Research & Innovation Ecosystem



Drivers and Status of Ag Research & Innovation Ecosystem, Nepal

Drivers	Status	Gaps /Issues
Policy	<ul style="list-style-type: none"> -Separate Law & By-laws for NARC -National Ag Extension policy (2007) 	<ul style="list-style-type: none"> -Lack National Agri Research Policy -National Ag Extension Policy is not applicable in the changed federal context
Institutions /Governance	<ul style="list-style-type: none"> -NARC has <u>structure</u> to act as NARS -Ag Extension decentralized to local & provincial levels 	<ul style="list-style-type: none"> -Limited coordination of R-E-E -Ineffective role of NARC as facilitator and coordinator of NARS
Investment & Infrastructure	<ul style="list-style-type: none"> <0.30 % of AGDP in Research <1% of total Ag budget in Extension - Research Infrastructure exist across the country 	<ul style="list-style-type: none"> -Public sector investment is limited -Lack of private sector investment in R-E -Limited modern research, outreach & Extension facilities and infrastructure
Human resources	<ul style="list-style-type: none"> -NARC has approved 1800 staff position - Some Agri Extension staff in Provincial Government 	<ul style="list-style-type: none"> -About 49% of scientific positions vacant -Very limited frontline Ag Extension staff at Provincial & Local Govts - Major time of experienced senior Research & Extension staff time is devoted in admin and management work

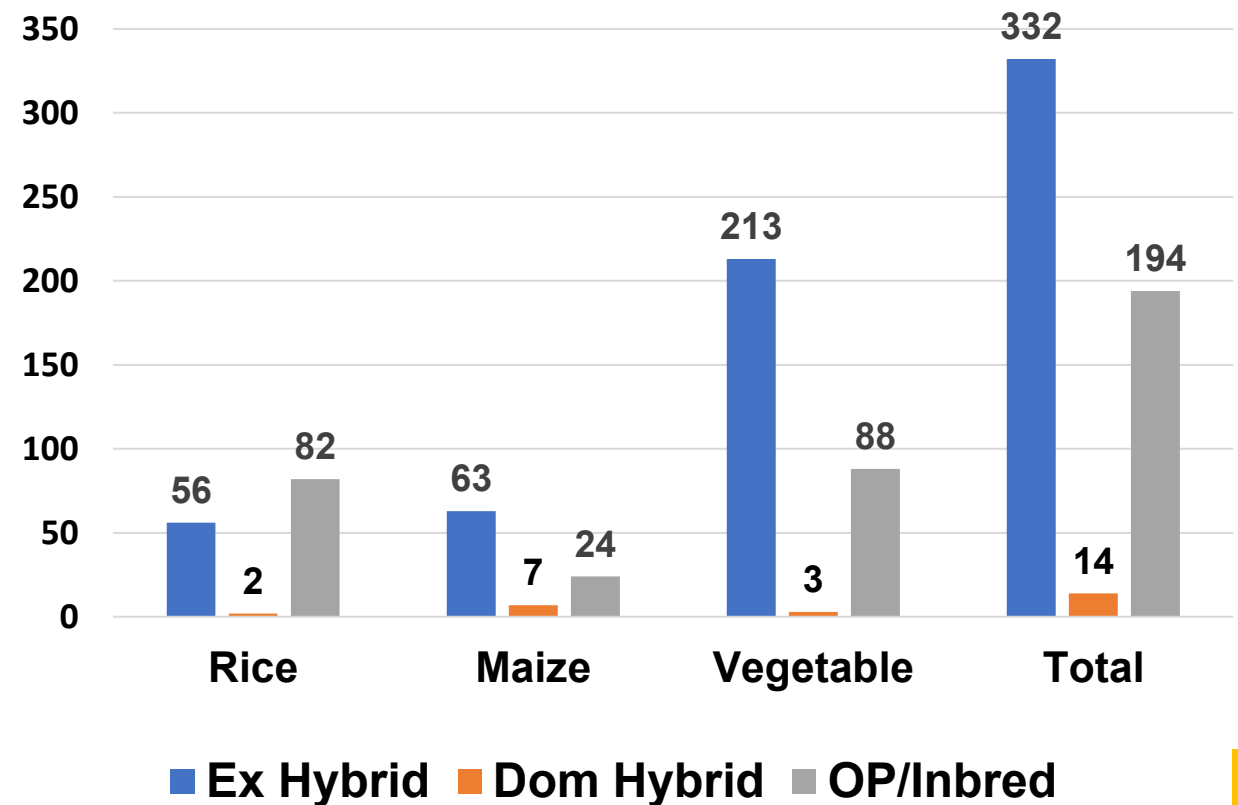
Technology and Innovation for Food Security Pillars

Food Security Pillar	Outcome Indicators	Research & Innovation Indicators	Research & Innovation Methods/Tools
<u>Availability</u> (Quality and Diversity)	<ul style="list-style-type: none"> • Increase productivity • Quality enhancement • Disease & pest resistance • Natural Resource management 	<ul style="list-style-type: none"> • Stress tolerant HYVs & breeds • Nutrient dense varieties • IPM/IDM technologies • Resource conservation technology 	<ul style="list-style-type: none"> • Conventional breeding, • Biotechnology & Nano technology • Precision technologies • Farm Mechanization
<u>Access</u> (Quality and Diversity)	<ul style="list-style-type: none"> • Reduced post-harvest losses • Value addition & product diversification • Fair price of agri-products 	<ul style="list-style-type: none"> • Drying, preservation, processing & product dev technology • Low cost refrigerated technology • Marketing technologies 	<ul style="list-style-type: none"> • Modern drying, cold storage, processing tech • Nano technologies • Block chain technology
<u>Utilization</u>	<ul style="list-style-type: none"> • Use of nutritious diets • Use of safe quality foods • Information on healthy diets 	<ul style="list-style-type: none"> • Biofortification and food fortification technologies • Technologies for food safety 	<ul style="list-style-type: none"> • Biotechnology • Value addition, GAPs • Block chain technology
<u>Stability</u>	<ul style="list-style-type: none"> • Predictability, Risk minimization & mitigation • Assured financial mechanism 	<ul style="list-style-type: none"> • Weather forecasting technologies • Infra-red sensors- stress detection • Index-based insurance 	<ul style="list-style-type: none"> • Remote sensing & GIS • Insurance index methods • Artificial Intelligence tech

Status of Research and Innovations

- **Limited domestically developed technologies and innovations** to increase productivity, profitability & commercialization
- Limited **research and innovation on quality enhancing technologies** (nutrient rich, food safety, healthy)
- **Limited research and technologies on post-harvest handling, storage, processing, marketing & business innovations**
- Limited use of **local biodiversity for development of improved technologies and utilization of fallow lands (30%)**

- Total 723 varieties of 80 crops notified until 2021
- >70% are directly introduced; 45% Exotic hybrids
- **In rice maize & vegetables <3% are domestic hybrids & 63% notified are only exotic hybrids**

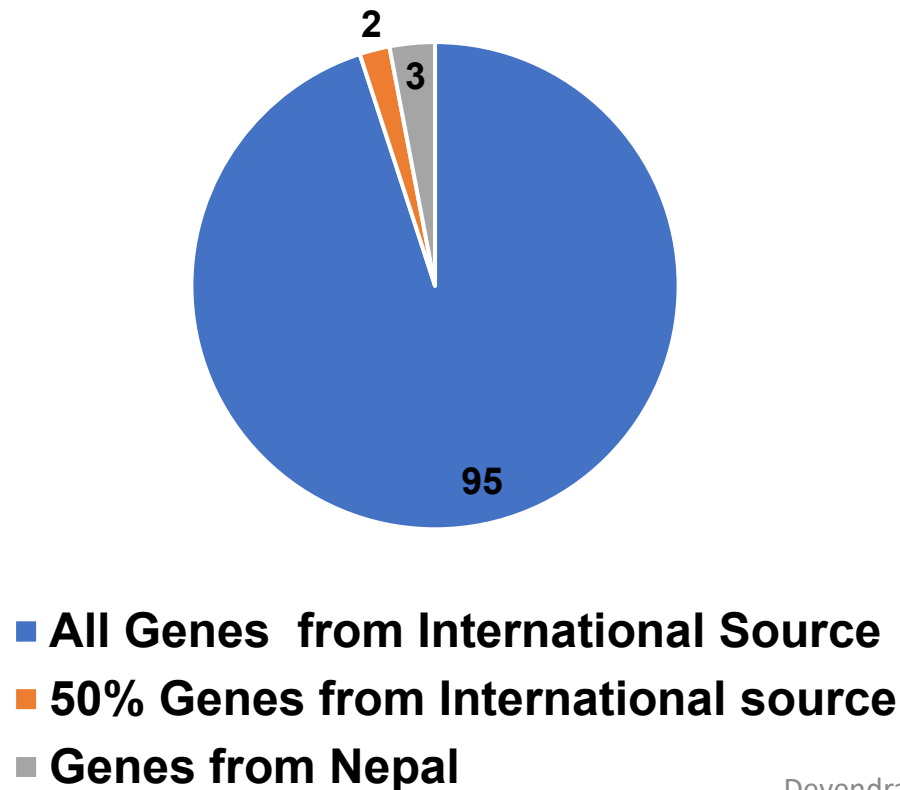


Source: Data source SQCC (2021)

Nepal's High Dependence on Imported Technologies (Crop Varieties)

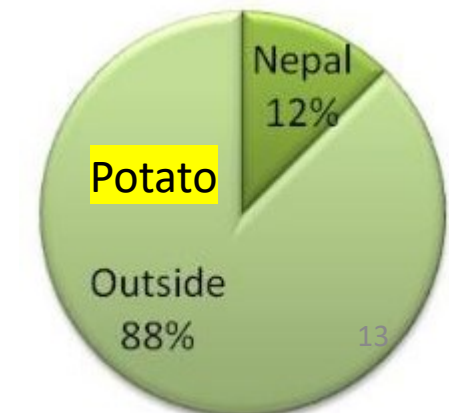
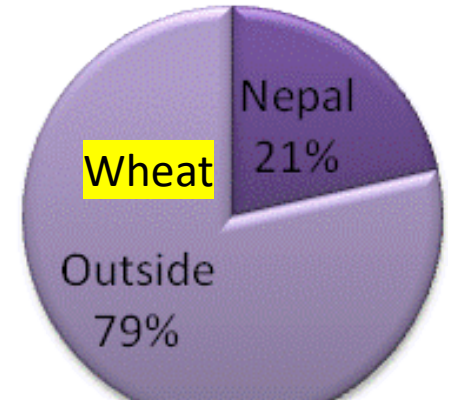
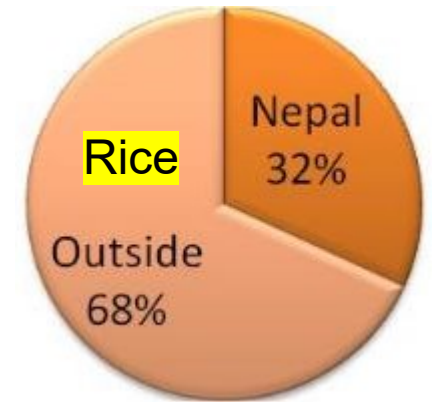
The genes of **95% of rice varieties** adopted on-farm in Nepal comes fully from **foreign sources** (Gauchan 2017)

% Share of Genes for Rice MV area, Nepal



Over **70% of released varieties are from foreign Sources**

(Joshi et al. 2016)



Domestically Developed Promising Varieties & Breeds

*Only **few improved varieties and breeds** are developed and widely **promoted** in Nepal using domestic research and utilization of **native genetic resources in research***

- **Khumal-4*** variety of **rice** recommended and cultivated in the Mid hills popularly marketed as **local Mansuli /Jira Masino**
- **Shrijana Tomato** hybrid widely grown in Nepal with its high yield, unique **local taste** and **preference**
- **Pakharibas black pig** breed which is popular in eastern Hills and Mountains and some urban market (e.g.Lalitpur) as **Dharane black local Pig**



Specific Innovation & Technology types in Agriculture



**Innovation &
Technology
Types**



**Yield
enhancing**

**Cost and
resource
saving**

**Quality
improving**

Yield Enhancing Technologies



Domestic Hybrids

- **Rice:** Hardinath Hybrid-1 and Hardinath Hybrid-3
- **Maize:** Khumal-4; Rampur-2, 4, 8, 10
- **Tomato:** Srijana Hybrid

Promising Varieties

- **Drought tolerant:** rice varieties (Sukha:1-6)
- **Flood tolerant** rice varieties (Swarna Sub-1, Shamba Sub-1)
- **Good eating quality** rice varieties (Khumal-4; Ramdhan etc.)
- **Disease resistant** wheat varieties (Vijaya Ug99 etc.)

Cost and Resource Saving Technologies



- Zero /minimum Tillage
- Bed Planting
- Permanent Bed Planting
- Strip Tillage
- Surface Seeding
- Crop Residue Management
- Nutrient Management



Source:
NARC
(2016)

Quality Enhancing Technologies

- **Low-cost solar dryer** for drying **high value** vegetables, fruits, meat and fish products 12 kg per batch (24-48 hrs)

(Source: NARC AED, 2016)



- **Millet thresher** for reducing **drudgery of women**, **attracting youth** and promoting **traditional nutrient dense crops** (finger millet, prosomillet, buckwheat)



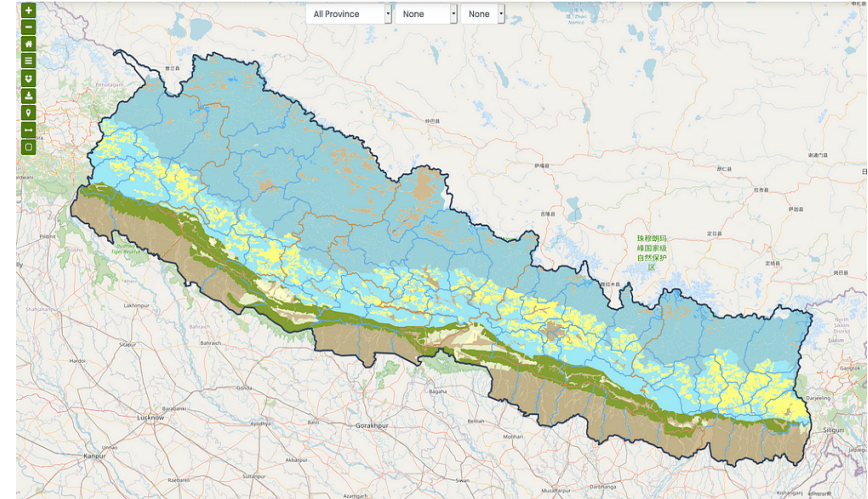
- **Nutrient rich varieties** eg. Posilo maize, Zinc enriched wheat (Zinc Shakti).

- **Nutrient dense indigenous crops and their varieties** (e.g., Rato Kodo, Rato Latte, Dudhe chino, Bariyo Kaguno)



Other Promising Crop and NRM Technologies

- **Digital Soil Mapping (DSM)** for **efficient nutrient application** based on soil attributes
- **Disease and Pest management technologies** in crops, horticulture, livestock & fishery
- **Intercropping**, multi-cropping and crop rotation & agroforestry technologies
- **Tissue culture technologies** for disease free seeds/seedlings (eg. PBS in potato and disease-free seedlings in Cardamom)

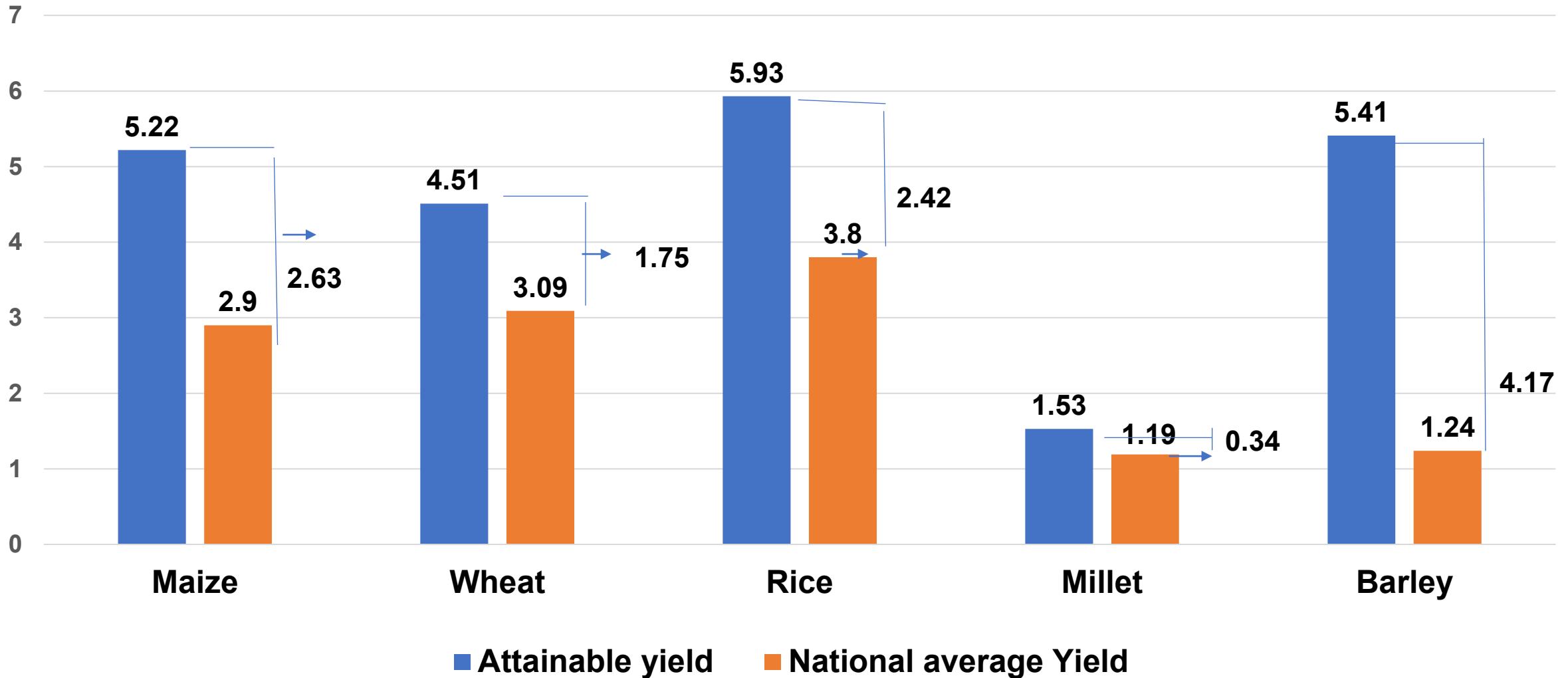


Current Productivity & Compound Growth Rate of Agro-products Nepal

Commodities	Production (mt) in 2020	Productivity (mt/ha) in 2020	Compound Growth/Yr (1999-2018)
Rice	5,550,878	3.80	1.73**
Maize	2,835,674	2.96	2.10**
Wheat	2,185,289	3.09	2.61**
Potato	3,131,830	16.65	2.17**
Vegetables	3,962,383	14.09	1.89**
Fruits	1,249,764	10.50	-0.17 ns
Milk	2,301,000	0.82 (mt/animal)	3.54**
Goat Meat	75,023	-	3.80**
Chicken	255,001	-	10.19**
Mutton	2,735	-	3.58**
Total Meat	552,156	-	3.55**
Egg (No/bird)	1,620,000,000	120	6.08**
Fish (pond culture)	66,906	4.96	8.08**

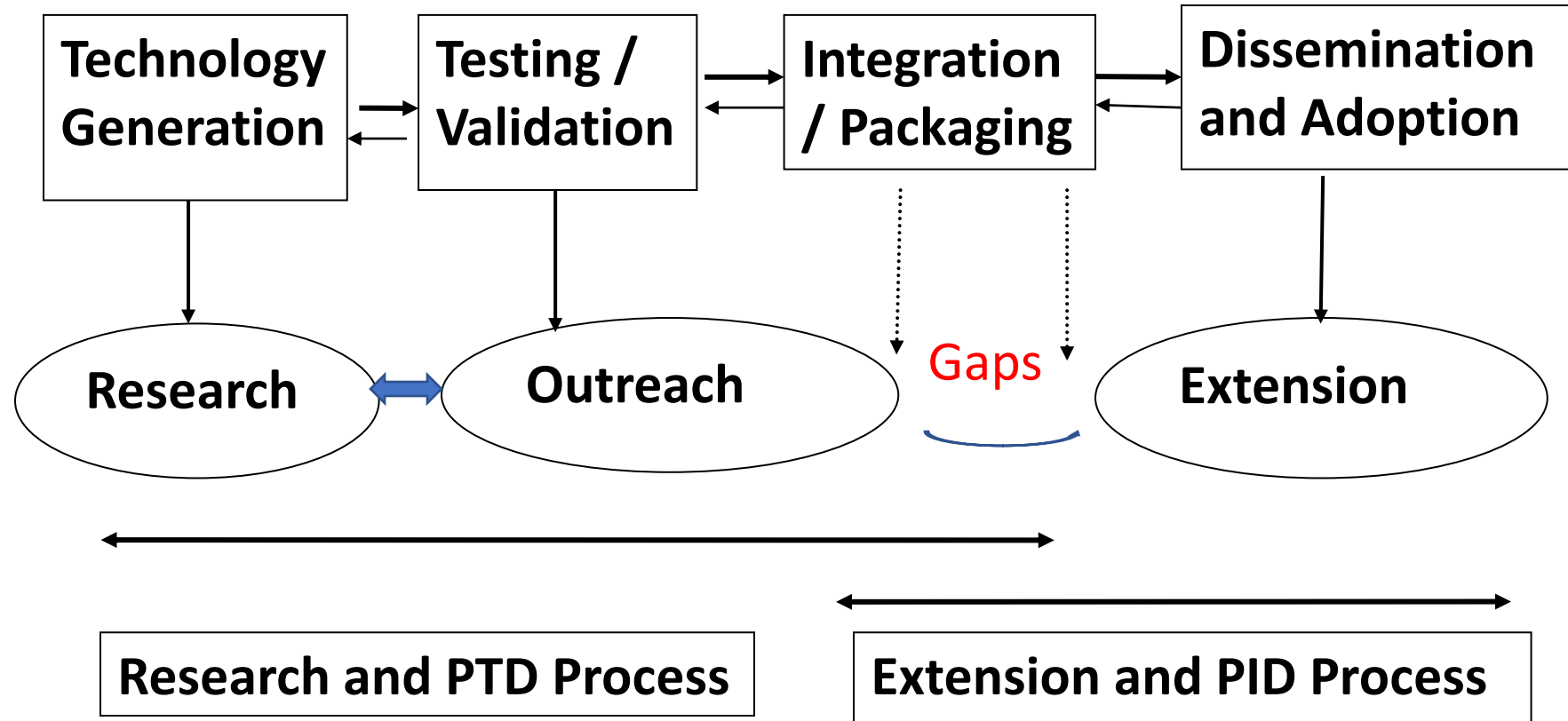
Source: (Data source MoALD, 2021); (Estimated by Joshi et al, 2021; Gauchan et al. 2021)

Yield GAPS: GAPS in Innovation



(Data source: <https://ourworldindata.org/crop-yields>)

Research & Innovation Policy: Gaps in Technology Integration



Source: Gauchan (2008)

Research Investment and Impact

- Nepal's Investment on **Research never exceed 0.3% of AGDP**. Investment in **extension is less than 1%** of the national agriculture budget.
- India invested about **0.4%** of agricultural GDP during 2012-14
- Brazil has invested about **1.8%** and some high-income countries around 3.0% of AGDP
- **Despite limited Investment in Agri-Research**, the **Return to Research is very high**

- **Returns to investment in research for major cereals in Nepal (Economic Surplus Analysis)**

- **Return from wheat research** in Nepal from **1960-1990** was very high with **IRR of 75%-84%** (Morris et al. 1994)

Description of variables	Major Cereals (based on trials data)		
	Rice	Maize	Wheat
Benefit-cost ratio	65	45	154
Internal Rate of Return (IRR) (%)	92	91	106
Total surplus (Million NRs)	4030	3999	6445

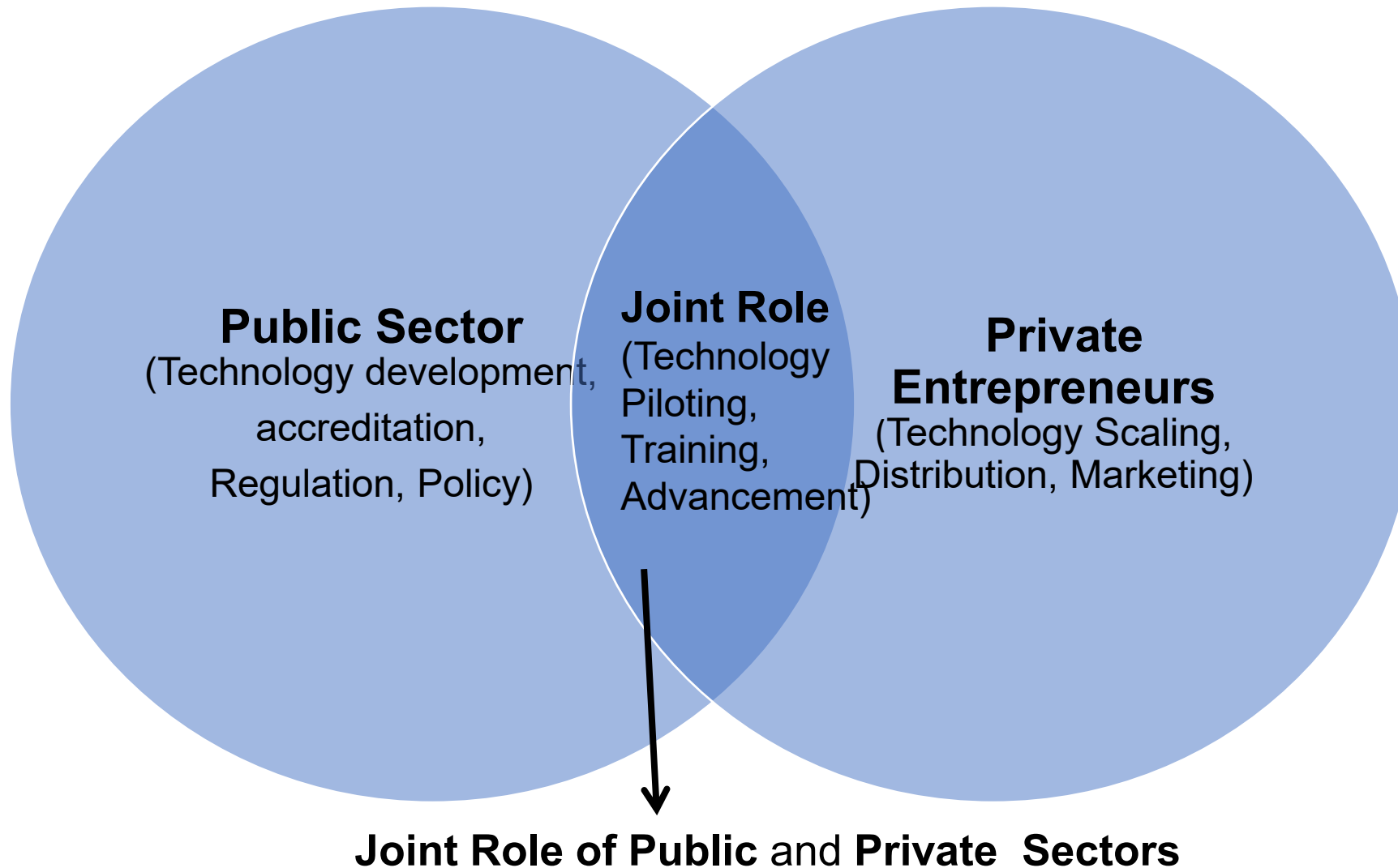
Source: Timsina, 2021: National Agri. Policy Research Centre

Ways Forward: Research & Investment Priorities

- **Increased Investment in modern science, research, innovation and infrastructure** (at least 1% of AGDP)
- **Research priority setting and resource allocation** on specific commodities and thematic areas (youth, DAGs, gender, geography and ecosystems)
- **Building national scientific capacity and Governance of NAREES** to address current coordination and linkage at multiple hierarchies (3-tiers) among R-E-E system
- **Research and Innovation** to address **Yield and Innovation Gaps** with focus on agroecological diversity and integrated use of land, water, energy and biodiversity
- Focus on **productivity enhancement, profitable and sustainable production, post-harvest, marketing, distribution and food safety** technologies to **reduce import**
- **Research and innovations** to address **value chains of nutrient rich biodiverse crops**, commodities, varieties/breeds to address malnutrition, food insecurity & equity
- **Urban agriculture** (protected and precision agriculture, vertical agriculture etc.) to address **urban malnutrition**, health and environment concerns

Public-Private-Partnership (PPP) in Research & Innovation

Supporting National System of Innovation



**Thank you for
your Kind
Attention !!**

