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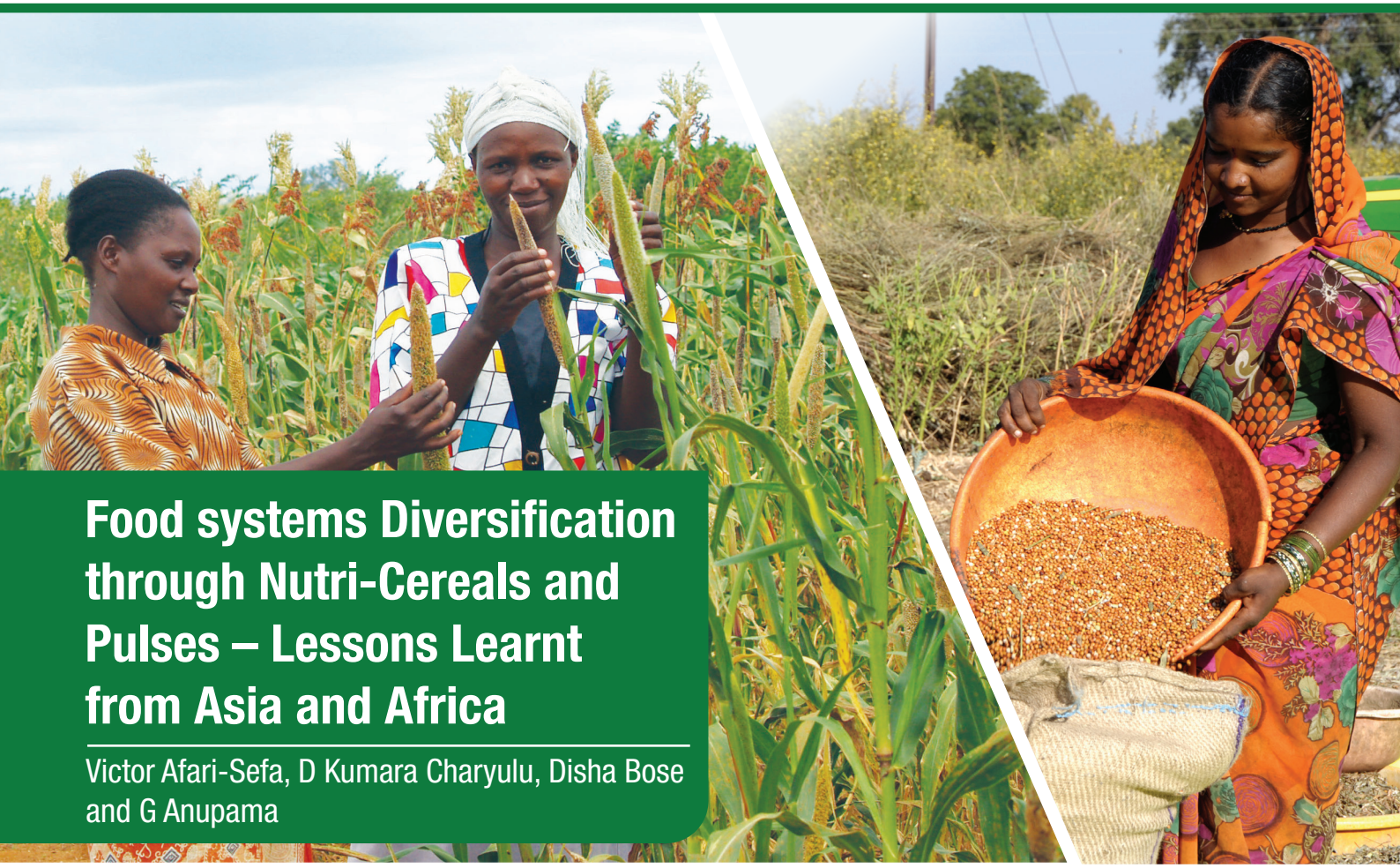


Food systems Diversification through Nutri-Cereals and Pulses – Lessons Learnt from Asia and Africa

Victor Afari-Sefa, D Kumara Charyulu, Disha Bose and G Anupama

1. Why food systems diversification?

Agri-food systems are defined as "encompassing the entire range of actors and their interlinked value-adding activities involved in the production, aggregation, processing, distribution, consumption, utilization and disposal of food products that originate from agriculture, forestry or fisheries, and parts of the broader economic, societal and natural environments in which they are embedded" (FAO 2018). For over ten decades, these food systems have been able to feed increasing populations and reduce chronic malnutrition and poverty. However, the current agri-food systems are under constant pressure of hunger, undernutrition, obesity epidemic, loss of biodiversity, environmental damage and climate change, threatening its sustainability. The transformation of the food systems through a sustainable trajectory is likely to achieve the following outcomes and provide economic benefits equivalent to USD 5 trillion annually (Ruggeri et al., 2024).

- Elimination of undernutrition and reduction in the prevalence of diet-related chronic diseases
- Sustainable consumption patterns and indirect changes in land use
- Growth in agricultural productivity and sufficient income for farmers
- Environmentally sustainable production in agriculture is reversing biodiversity loss, reducing synthetic and other agro-chemical applications and reducing demand for irrigation water
- Conversion of the food system into a net carbon sink
- Lower labor intensity in agriculture

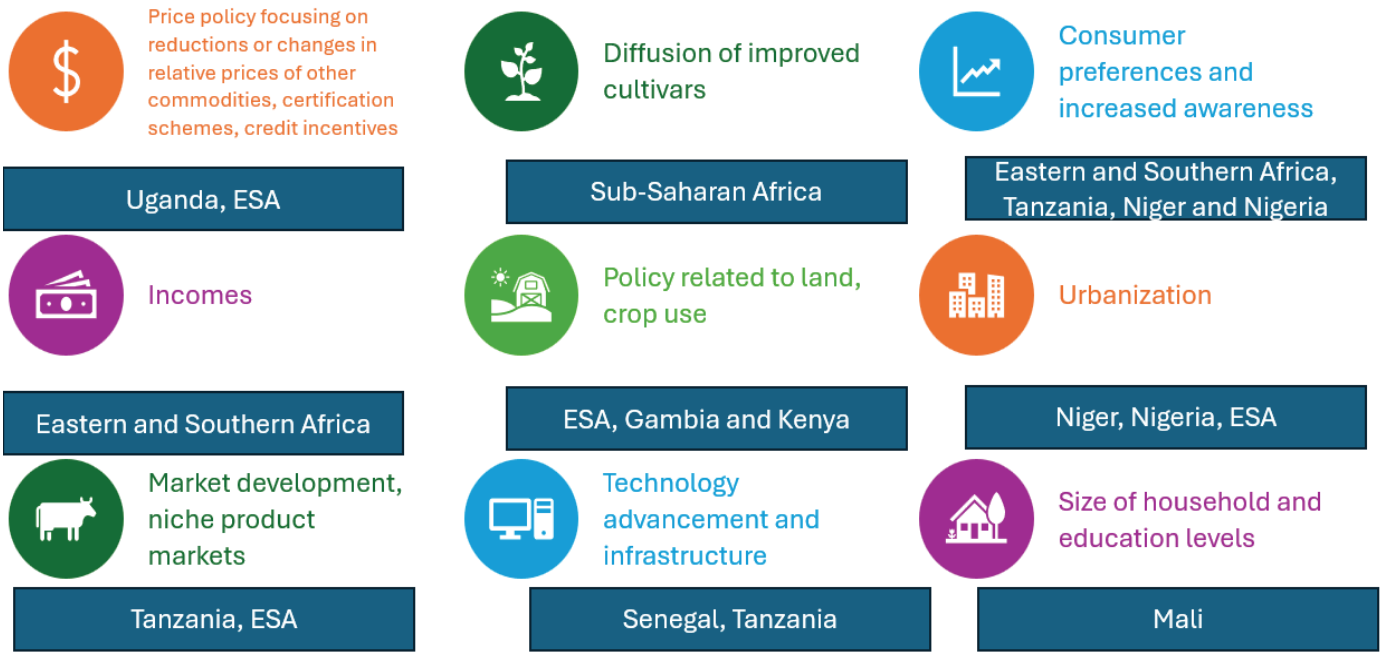
Diversification of the food system can occur across the entire supply chain, from production to consumption and at different levels of organization from field to global (Hertel et al., 2023). Diversification of the food systems into adaptable dryland crops such as millets, sorghum and pulses indicate that it can enhance climate resilience, risk reduction, nutrition, soil health, optimal

water usage and economic and environmental sustainability (Goud et al., 2023). The shift to more sustainable cropping systems by including millets in the cropping pattern and subsequently encouraging the incorporation of millets into diets across various food systems, to match supply can alleviate climate change-related risks to agricultural production and food security.

With this background, the current policy brief highlights diversification experiences in Asia and Africa, diversification towards nutri-cereals and pulses in the last two decades, and the relationship between the income levels of major countries and their food systems diversification across regions. Further, the brief also synthesizes the major drivers and challenges for agricultural transformation across regions. Finally, the policy brief concludes with key lessons learnt under food systems diversification in Asia and Africa regions.

2. Drivers of food systems diversification in Africa and Asia

Major drivers of food systems diversification among select African countries were identified from a systematic literature review and depicted below:



Similarly, the major drivers of food systems diversification among Asian countries were documented and summarized below:

From our systemic review of literature, the study found that urbanization, rising incomes, price policy, enhanced access to markets, technological advancement and infrastructure development amongst others played a significant role in food systems diversification, positively both in Asia and Africa. Though there are similarities, it is interesting to observe that the drivers of diversification may vary depending on the socio-economic and agro-ecological conditions.

3. Status of diversification towards nutri-cereals and pulses

The present study tried to understand the patterns of food systems diversification towards nutri-cereals and pulses using FAOSTAT[1] time series data during the last two decades period (2001-2022). We deploy a simple indicator – 'share of cropped area' (i.e., share of respective crop area from total arable land during that year) was calculated and used to track the extent of diversification over time. This value indicates the relative importance of identified crop in the targeted geography. Due to inconsistency issues among different crop groups in FAOSTAT, the present study did not attempt to build any diversification index.

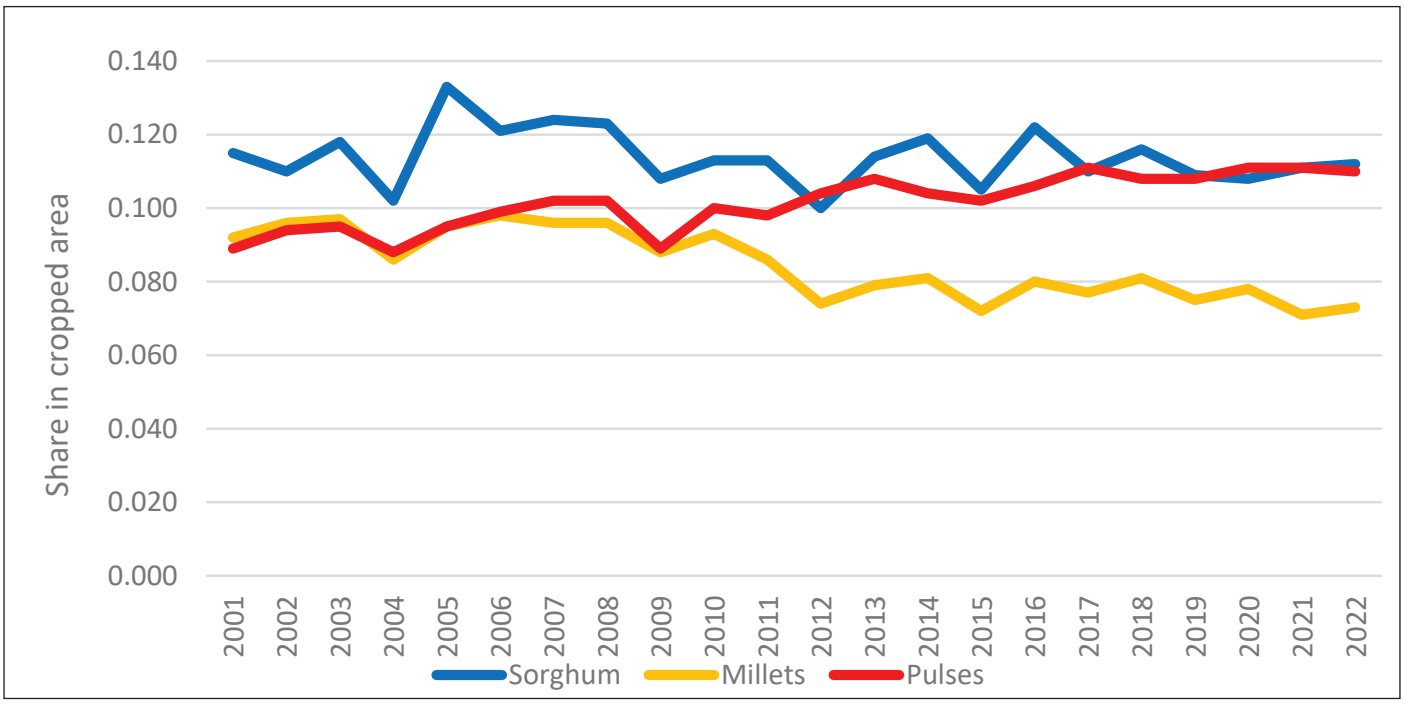


Figure 1: Food system diversification towards nutri-cereals and pulses in Africa, 2001-2022.

In the case of Africa, between 2001 and 2022, the cropped area under sorghum marginally increased from 23.4 to 29.0 million ha. Notably, the cropped area under millets hovered around 18 million ha during the same period. A remarkable jump in total pulse cropped area was noticed from 18.2 to 28.6 million ha during the last two decades. The corresponding pulse production went up significantly from 10.1 to 23.1 metric tons.

Similarly, in the Asia region, both sorghum and millet cropped areas declined significantly during the last two decades because of changes in food preferences and increased household incomes. The sorghum cropped area declined significantly from 11.8 to 5.1 million ha while millet lost about 4.5 million ha (from 14.8 to 10.3 m ha) during the study period. In contrast, a remarkable increase (16 million ha) in total pulse cropped area was observed from 32.3 to 48.3 million ha. The pulse production increased significantly from 25.0 to 41.7 metric tons during the same period. There is a conspicuous shift of food systems towards pulse crops when compared to nutri-cereal crops.

[1] @ https://www.fao.org/faostat/en/#data

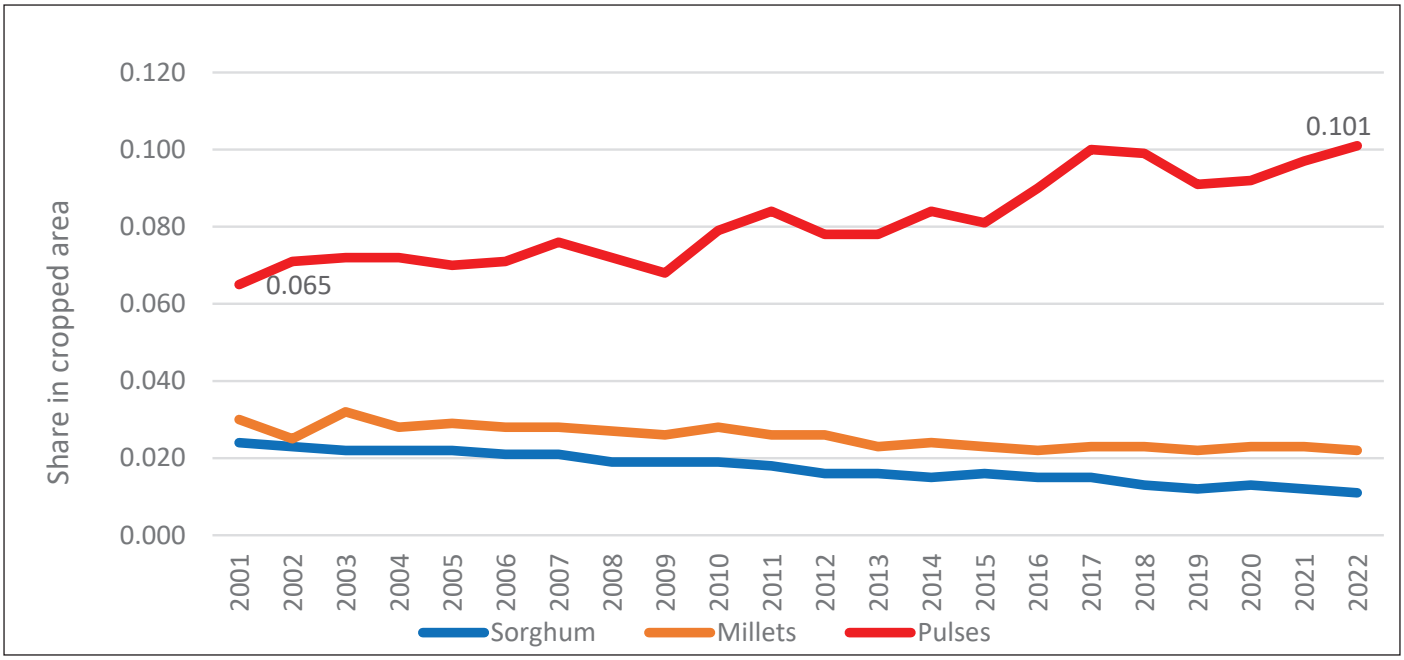


Figure 2: Food systems diversification towards nutri-cereals and pulses in Asia, 2001-2022.

Relationship with income level and food systems diversification

Our systematic literature review revealed that rising incomes are driving food systems transformation across regions. This policy brief also made an attempt to understand the relationship between income status of major countries and the extent of food systems diversification over time. By using the World Bank classification[2] for determining the income status of major countries, we summarized country-wise details for Asia and Africa regions in Tables 1 and 2 respectively.

Table 1: Relationship with income level and food systems diversification in Africa region.

Countries	Income status	Share of sorghum cropped area			Share of millet cropped area			Share of pulses cropped area		
		2001-03	2011-13	2020-22	2001-03	2011-13	2020-22	2001-03	2011-13	2020-22
Burkina Faso	Low income	0.287	0.265	0.236	0.255	0.188	0.132	0.164	0.181	0.186
Chad	Low income	0.195	0.235	0.216	0.203	0.238	0.218	0.050	0.047	0.052
Ethiopia	Low income	0.125	0.115	0.104	0.030	0.029	0.028	0.122	0.129	0.100
Malawi	Low income	0.019	0.404	0.029	0.012	0.581	0.015	0.190	0.087	0.201
Mali	Low income	0.159	0.026	0.202	0.299	0.002	0.256	0.064	0.017	0.070
Mozambique	Low income	0.076	0.004	0.049	0.010	0.040	0.009	0.136	0.003	0.258
Niger	Low income	0.164	0.315	0.207	0.395	0.117	0.370	0.278	0.217	0.337
Rwanda	Low income	0.161	0.026	0.217	0.005	0.031	0.789	0.347	0.098	0.233
Somalia	Low income	0.337	0.815	0.039	0.000	0.036	0.012	0.060	0.033	0.072
Sudan	Low income	0.350	0.365	0.313	0.149	0.123	0.139	0.010	0.017	0.021
Uganda	Low income	0.051	0.054	0.031	0.070	0.025	0.009	0.167	0.110	0.113
Ghana	Lower middle	0.088	0.009	0.065	0.052	0.044	0.028	0.081	0.014	0.126
Kenya	Lower middle	0.028	0.003	0.033	0.022	0.000	0.016	0.251	0.003	0.266
Morocco	Lower middle	0.002	0.055	0.000	0.001	0.010	0.000	0.047	0.178	0.045
Nigeria	Lower middle	0.189	0.003	0.158	0.124	0.000	0.050	0.106	0.013	0.138
Senegal	Lower middle	0.064	0.074	0.018	0.273	0.000	0.009	0.041	0.026	0.034
Zambia	Lower middle	0.009	0.005	0.008	0.020	0.009	0.013	0.027	0.042	0.048
Zimbabwe	Lower middle	0.029	0.056	0.061	0.042	0.052	0.038	0.006	0.027	0.039
South Africa	Upper middle	0.006	0.466	0.059	0.001	0.170	0.004	0.006	0.028	0.003

[2] See at https://ourworldindata.org/grapher/world-bank-income-groups?tab=table

Absolutely, there is no consistent trend established to explain the relationship between income level of the country and the extent of food system diversification.

- Many low-income countries were shifted towards nutri-cereal crops while both low- and low-middle income countries showed diversification towards the pulse crops. Countries such as Chad, Mali, Niger, Rwanda and Sudan exhibited a shift of food systems towards sorghum and millet crops during the last two decades.
- The remaining African countries are observed to be losing their cropped area under nutri-cereals. Many African countries such as Burkina Faso, Malawi, Mozambique, Niger Ghana, Kenya, Nigeria, Zambia and Zimbabwe showed expanding cropped areas under pulses cultivation during the study period.

Table 2: Relationship with income level and food systems diversification in Asia region.

Country	Income status	Share of sorghum cropped area			Share of millet cropped area			Share of pulses cropped area		
		2001-03	2011-13	2020-22	2001-03	2011-13	2020-22	2001-03	2011-13	2020-22
Japan	High income	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.010	0.008
Saudi Arabia	High income	0.045	0.013	0.016	0.002	0.001	0.002	0.001	0.001	0.001
Afghanistan	Low income	0.000	0.000	0.000	0.003	0.001	0.000	0.006	0.010	0.010
Bangladesh	Lower middle	0.000	0.000	0.000	0.004	0.004	0.001	0.056	0.035	0.046
Cambodia	Lower middle	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.017	0.016
India	Lower middle	0.059	0.042	0.028	0.076	0.065	0.058	0.129	0.171	0.219
Laos PDR	Lower middle	0.000	0.000	0.000	0.000	0.000	0.000	0.017	0.009	0.004
Myanmar	Lower middle	0.023	0.021	0.014	0.023	0.021	0.015	0.288	0.374	0.347
Nepal	Lower middle	0.000	0.000	0.000	0.111	0.129	0.144	0.129	0.139	0.185
Pakistan	Lower middle	0.012	0.007	0.003	0.014	0.015	0.009	0.049	0.048	0.040
Philippines	Lower middle	0.000	0.000	0.000	0.000	0.000	0.000	0.015	0.015	0.014
Sri Lanka	Lower middle	0.000	0.000	0.000	0.007	0.004	0.000	0.025	0.013	0.013
Vietnam	Lower middle	0.000	0.000	0.000	0.000	0.000	0.000	0.051	0.052	0.044
China	Upper middle	0.007	0.005	0.006	0.009	0.006	0.008	0.031	0.022	0.024
Indonesia	Upper middle	0.000	0.000	0.000	0.000	0.000	0.000	0.018	0.014	0.010
Iran	Upper middle	0.000	0.000	0.000	0.000	0.000	0.000	0.068	0.048	0.044
Iraq	Upper middle	0.001	0.006	0.000	0.001	0.001	0.000	0.042	0.002	0.001
Kazakhstan	Upper middle	0.000	0.000	0.000	0.002	0.001	0.001	0.002	0.004	0.014
Thailand	Upper middle	0.004	0.002	0.002	0.000	0.000	0.000	0.019	0.013	0.013

None of the Asian countries expanded their cropped area towards sorghum and millet cultivation during the last two decades except Nepal. Both these crops are losing their ground in the existing food systems due to various constraints and lack of market and value addition opportunities. Countries such as Afghanistan, Cambodia, India, Myanmar, Nepal and Kazakhstan were observed to be expanding their cropped area towards pulses cultivation when compared to other study countries.

4. Drivers and challenges of food systems diversification

Understanding the drivers of food systems diversification is critical for designing appropriate interventions for optimal food systems transformation in both regions. Many researchers have attempted to document observed experiences across regions and countries.

4.1 Drivers of food systems diversification in Asia

Indicators such as market density and road length, net profits from crop production, literacy, urbanization and per capita income levels showed a positive impact for food systems diversification in many Asian countries. The impact of the size of land holding was ambiguous and thus no exact effect of its influence could be determined. In contrast, variables such as access to improved technology (i.e., seeds, inputs such as fertilizers), agricultural mechanization and irrigation (including precipitation amounts recorded) showed negative impact on food systems diversification.

Table 3: Drivers of food systems diversification in Asia.	
Positive drivers	Infrastructure, profits, literacy, urbanization, per capita incomes
Negative drivers	Climate and technology
Ambiguous drivers	Resources and information

Source: Joshi et al., 2004

4.2 Drivers of food systems diversification in Africa

The drivers of food systems diversification or specialization in Africa have been summarized into three broad categories based on World Bank study (Kray et al., 2019). Table 4 summarizes the effects of drivers for diversification decisions in Africa region.

Table 4: Drivers of food systems diversification in Asia.

Effect	Environmental drivers	Policy drivers	Socio-economic and Institutional drivers
Positive	• Long growing seasons • Poor environmental conditions • Climate shocks and risks	• Price volatility • Market infra • Technology access	• Knowledge and nutritional awareness • Community support and power structures • Labor availability
Negative		Subsidies and incentives	• Small size or tenure insecurity • Lack of education and gender equity
Ambiguous			• Vertical coordination

Source: Kray et al., 2019

It is worth noting that all environmental drivers have a positive effect on diversification. Subsidies and incentives are the only negative drivers from the policy perspective that impact diversification decisions negatively. While labor availability affects diversification positively, lack of education and gender disparities hurt the prospects of food systems diversification.

4.3 Key challenges in food systems transformation in Asia and Africa

Africa	Asia
Africa's food systems are prone to various shocks and stressors largely due to factors such as climate variability, economic volatility, political instability, and public health crises	The food systems of Asia are under increasing pressure due to multiple drivers including population growth, urbanization, biodiversity loss, and the uncertainties stemming from climate change
This vulnerability is exacerbated by the fact that many African countries rely heavily on rain-fed agriculture	Yield stagnation and limited land and farming expansion become a key challenge for the region in the context of increasing global and regional demand in the future
Fluctuations in global commodity prices, sudden changes in exchange rates, or economic recessions can significantly impact the affordability and availability of food	The challenge for major cereals in the region is to meet the increased demand brought by urbanization and dietary pattern change. However, these are also the drivers of greenhouse gas (GHG) emissions and natural resource degradation
Failures can lead to reduced food variety and quality negatively impacting the nutritional status of populations	Climate impacts are expected to hit most of the cereal crops in SA with a negative effect on income and total calorie availability and an increase in the population at risk of hunger

5. Policy recommendations for food systems diversification

Numerous researchers and studies from Asia and Africa have summarized the lessons learnt under different project interventions. Apart from that, globally, many countries have recently tried to diversify their food systems through nutri-cereals under the "International Year of Millets (IYM)" as declared by FAO in 2023. Similarly, policies can be designed, learning from the lessons under the south-south collaboration and knowledge exchange among researchers and policymakers, as summarized below:

- Value chains that supply domestic markets have dominated the transformation process (transformation to local or community needs)
- Off-farm growth is successfully driving agricultural transformation
- Access to finance is a key driver to invest in inputs and technologies for agricultural diversification
- Production and market infrastructure development aided diversification in many parts of the world
- Agricultural exports are highly concentrated within a narrow set of value chains, limiting their ability to drive broad-based growth
- Promoting import substituting value chains could drive even faster transformation – but not sustainable in long run
- Enabling policy environment is critical for agricultural transformation which protects the interests of stakeholders in the value chain
- Developing sustainable production systems by incentivizing farmers is critical for promoting diversification
- Enable businesses by facilitating fund support for entrepreneurs, including small and medium-sized enterprises (SMEs), involved in mechanization and food processing including efficiency of processing machinery
- Promote sustainable consumption and healthy diets by creating awareness as well as behavioural change process

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About the authors

Victor Afari-Sefa, Global Program Director and ICRISAT NPS Focal Point, Enabling Systems Transformation, ICRISAT, Patancheru, Hyderabad.

Kumara Charyulu Deevi, Senior Scientist (Agricultural Economics), Enabling Systems Transformation, ICRISAT, Patancheru, Hyderabad

Disha Bose, Associate Scientist, Enabling Systems Transformation, ICRISAT, Patancheru, Hyderabad.

Anupama Guvvalavenkata, Senior Scientific Officer, Enabling Systems Transformation, ICRISAT, Patancheru, Hyderabad.

Partners

ICRISAT
INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

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About

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a pioneering non-profit organization focused on scientific research for development, committed to transforming dryland farming and agri-food systems. Working with global partners, ICRISAT develops innovative solutions to address hunger, poverty, and environmental degradation, benefiting 2.1 billion people across the drylands of Asia, Africa, and beyond.

ICRISAT was established under a Memorandum of Agreement between the Government of India and CGIAR, dated 28 March 1972. In accordance with the Headquarters Agreement, the Government of India has extended the status of a specified "International Organization" to ICRISAT under section 3 of the United Nations (Privileges and Immunities) Act, 1947 of the Republic of India through Extraordinary Gazette Notification No. UI/222(66)/71, dated 28 October 1972, issued by the Ministry of External Affairs, Government of India.

Asia

ICRISAT - India (Headquarters)
Patancheru 502 324, Hyderabad
Telangana, India
Phone: +91 8455683071
Fax: +91 8455683074
Email: icrisat-ind@icrisat.org

ICRISAT - India (Liaison Office)
CG Centers Block
NASC ComplexDev Prakash Shastri Marg, New Delhi 110012, India
Phone: +91-11-25840294
Fax: +91 1125841294
Email: icrisat-ind@icrisat.org

West and Central Africa

ICRISAT - Mali
(Regional hub WCA)
BP 320 Bamako, Mali
Phone: +223 20 709200
Fax: 223 20 709201
Email: icrisat-mli@icrisat.org

ICRISAT - Niger
BP 12404
Niamey, Niger (via Paris)
Phone: +(227) 20722725, 20722626
Fax: +227 20734329
Email: icrisat-ner@icrisat.org

ICRISAT - Nigeria
PMB 3491
Sabo Bakin Zuwo Road
Tarauni, Kano, Nigeria
Phone: +234 7034889836
Email: icrisat-nga@icrisat.org

ICRISAT - Senegal
c/o Africa Rice
Mamelles Aviation, Villa 18
BP 24365 Dakar, Senegal
Phone: +221 338600706
Email: icrisat-sen@icrisat.org

Eastern and Southern Africa

ICRISAT - Kenya
(Regional hub ESA)
PO Box: 39063, Nairobi, Kenya
Phone: +254 20 7224550
Fax: +254 20 7224001
Email: icrisat-ken@icrisat.org

ICRISAT - Ethiopia
C/o ILRI Campus
PO Box 5689, Addis Ababa, Ethiopia
Phone: +251-11 617 2541
Fax: +251-11 646 1252, +251 11 646 4645
Email: icrisat-eth@icrisat.org

ICRISAT - Malawi
Chitedze Agricultural Research Station
PO Box 1096, Lilongwe, Malawi
Phone: +265 1 707 297/071/067/057
Fax: +265 1 707 298
Email: icrisat-mwi@icrisat.org

ICRISAT - Zimbabwe
Matopos Research Station
PO Box 776, Bulawayo, Zimbabwe
Phone: +263 292 809314/315
Fax: +263 383 307
Email: icrisat-zwe@icrisat.org

ICRISAT - Mozambique
(c/o IIAM) nr 2698 1st Floor, AV. FPLM
Maputo, Mozambique
Phone: +258 1 461657
Fax: +258 1 461581
Email: icrisat-moz@icrisat.org

ICRISAT - Tanzania
Plot 25, Mikocheni Light Industrial Area
Mwenge Coca-Cola Road, Mikocheni B,
PO Box 34441, Dar es Salaam, Tanzania
Email: icrisat-tza@icrisat.org