

Neglected and Underutilised Crops as Drivers of Climate-Resilient Food Systems: A Comparative Total Factor Productivity Analysis of Neglected vs Staple Crops in Uganda and South Africa

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1. INTRODUCTION AND OBJECTIVES

- Staple crop systems (maize, rice, beans) dominate African agriculture but are increasingly vulnerable to climate shocks and high input costs, driving ecological degradation [1,2,3]
- Neglected and underutilised crops (NUCs) as sorghum, finger millet, cowpea, groundnut, offer promising agroecological traits: drought tolerance, nutritional richness, and lower input requirements: yet remain marginal in research, policy, and markets [4,5,6]
- **Despite these ecological advantages, their economic productivity relative to staples has rarely been rigorously tested, leading to persistent assumptions of economic inferiority** [4,7,8]

Objectives:

- To explore NUCs contribution towards sustainable, climate-resilient food systems
- To assess whether underutilised crops can compete with staple crops in Total Factor Productivity (TFP)

Crops studied and study area



Figure 1 Crops Studied (Source: Wikimedia Commons)



Figure 2. Study Area Map of Africa: Uganda & South Africa, (Source: Wikipedia)

2. METHODOLOGY

Phase I

Literature synthesis (2010–2025) · PRISMA protocol · 38 peer-reviewed studies

Phase II

- DEA–Malmquist Productivity Index (Efficiency change + Technological change decomposed) [9,18]
- 13-year harmonised panel (2010–2022) from FAOSTAT, UBOS, Stats SA, 4 NUCs × 3 Staples
- Statistical validation: Welch t-tests, VRS sensitivity

3. KEY FINDINGS

NUC Advantages

- ☀️ **Climate Resilience:** NUCs maintain yield where staples decline 30–50% under drought ; Sorghum & cowpea retain >70% yield with 30–40% less water [10,11,12]
- 🌱 **Soil Health:** Cowpea & groundnut fix 30–235 kg N/ha, reducing fertilizer needs · NUC intercropping achieves LER > 1.0 [13,14,12]
- 🍲 **Nutrition & Food Security:** Finger millet has >10× calcium of maize · Bambara groundnut: 20–40% protein incl. lysine absent in cereals [15,16,17]
- ⚙️ **Resource Efficiency:** NUCs use 40–50% less fertiliser, pesticide & irrigation than staples and thrive on marginal/degraded lands
- 🏆 **TFP Parity Confirmed:** Underutilised crops demonstrate comparable Total Factor Productivity to staple crops across both low- and high-input systems ($p > 0.05$). The assumption of economic inferiority is empirically unfounded
- 📈 **Input Efficiency Advantage:** NUCs require 40–50% less fertiliser than staple crops yet match their TFP. NUCs convert each unit of fertiliser into more output thus sustainable intensification without increased cost

Mean TFP NUCs vs Staples by Country

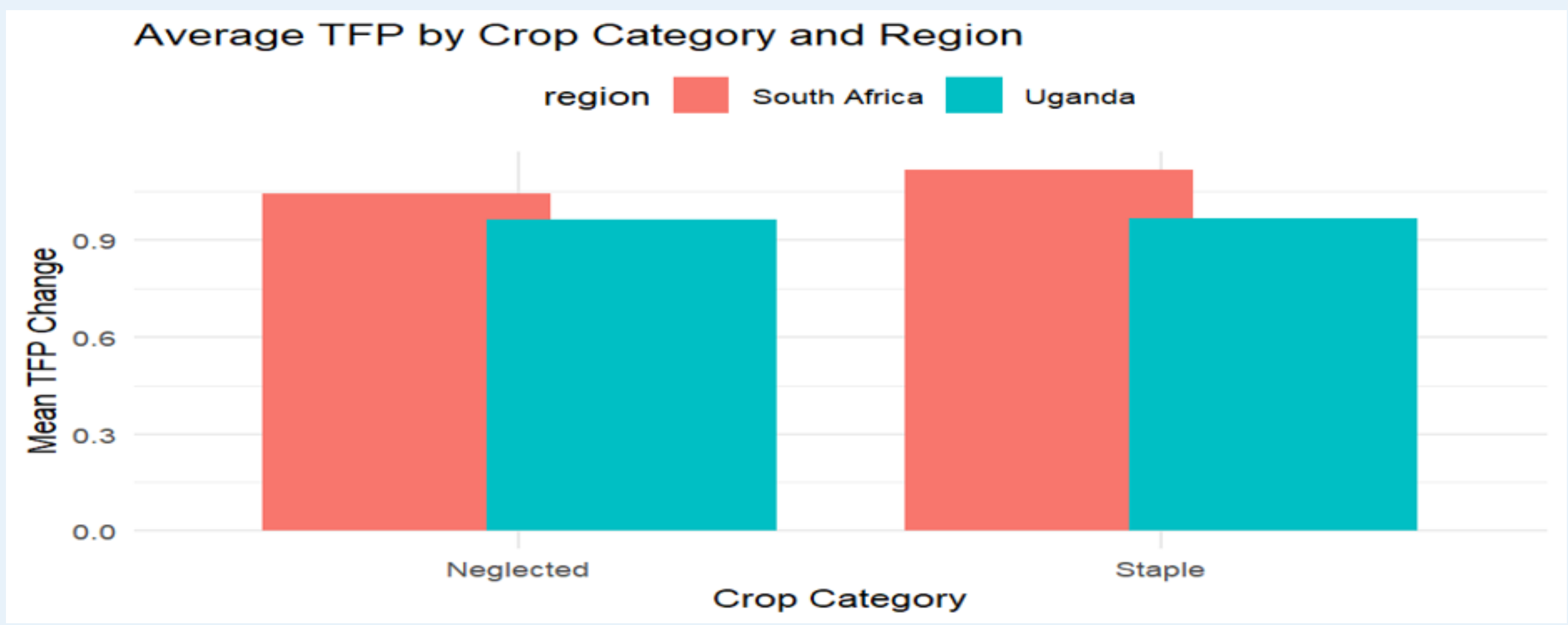


Figure 3. Mean Total Factor Productivity: NUCs vs Staple Crops by System Type (Source: Authors' own computation). Two-way ANOVA: regional variation significant ($p = 0.035$), crop-type variation not ($p = 0.497$)

5. REFERENCES

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Malmquist TFP Decomposition: Efficiency vs. Technological Change

Country	Category	MPI	Effch	Techch	Driver
Uganda	NUCs	0.963	1.016 ✓	0.956	Efficiency
Uganda	Staples	0.966	0.998	0.968	Neither
South Africa	NUCs	1.044	0.998	1.054 ✓	Technology
South Africa	Staples	1.119	1.034	1.075 ✓	Technology

Table 1 Malmquist TFP Decomposition: Effch) and Techch (Source: Authors' own computation)

Input Intensity: NUCs vs Staples

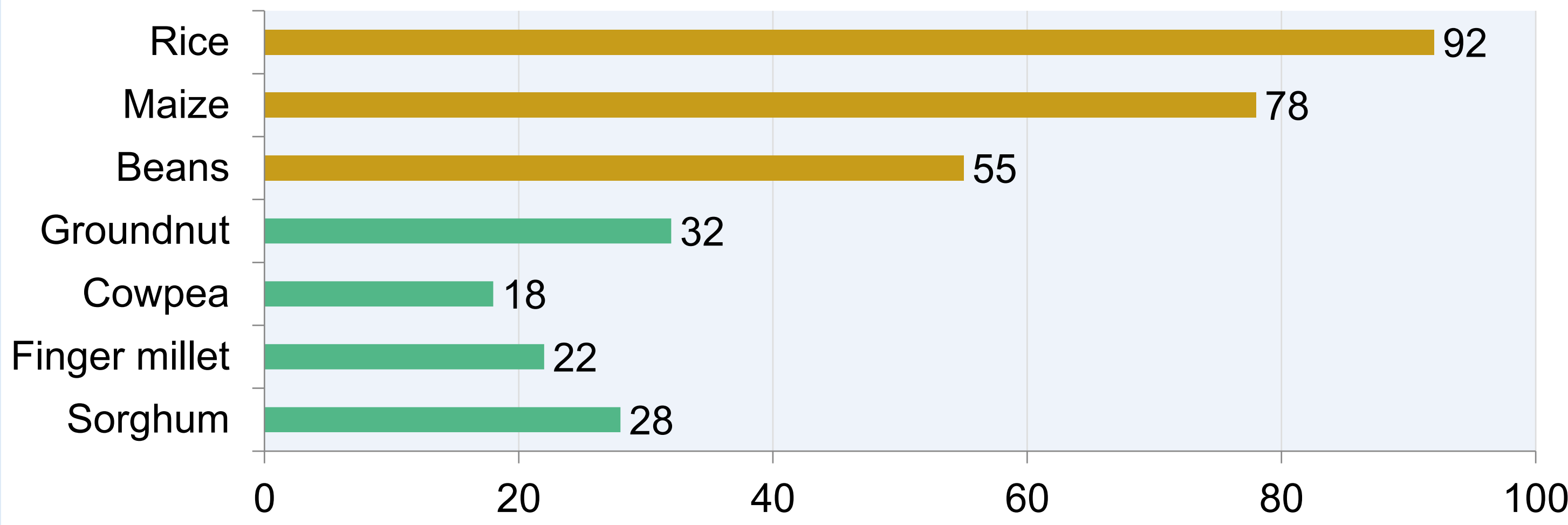


Figure 4. Fertiliser Use Intensity: NUCs vs Staple Crops (Source: Authors' own computation)

Staples vs. NUCs: Comparative feature summary

Features	Staples	NUCs
Yield	High	Moderate
Input demand	High	Low ✓
Drought resistance	Low	High ✓
Water efficiency	Moderate	High ✓
Nutrition	Moderate	High ✓
Total factor productivity	Comparable	Comparable ✓

Table 2. Summary comparison of key agronomic and economic attributes of staple crops and NUCs across study countries (Source: Authors' own synthesis)

TFP Variability by Crop type and Country

🌱 Stable TFP positions NUCs as resource-efficient crops for climate-resilient food system

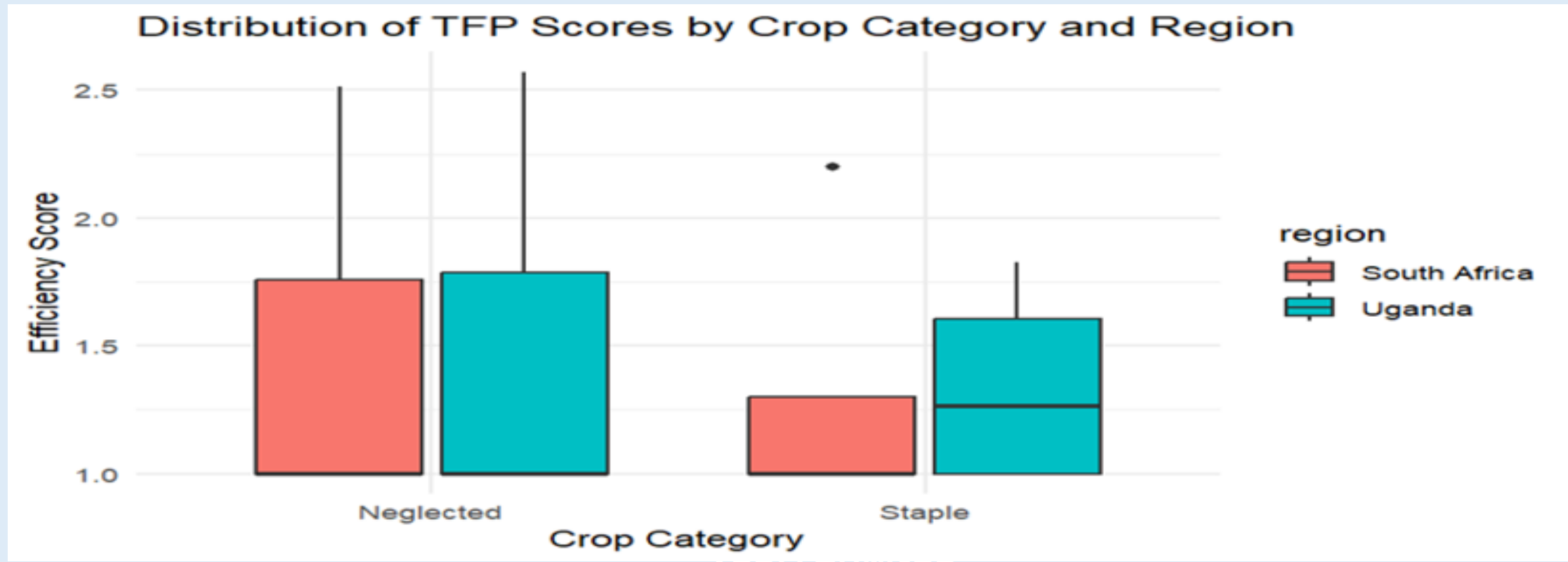


Figure 4. TFP Distribution: NUCs vs Staples by Region (Source: Authors' own computation) NUCs: high, stable efficiency; staples more variable, especially in South Africa

The Adoption Paradox: From NUCs Potential to Plate

NUCs' nutritional and environmental benefits are not in question, and the TFP results show they are productive-competitive too. Yet their integration into mainstream diets remains limited. The challenge



Figure 5. The NUC Innovation Pathway: From Indigenous Heritage to Sustainable Food Systems (Source: Adapted from University of Zululand, Dept. of Consumer Sciences, Unathi Kolanisi)

4. CONCLUSIONS

- NUCs achieve total factor productivity statistically comparable to staple crops (Welch's t-test, $p = 0.497$), while using 40–50% less fertiliser, pesticide and irrigation
- NUCs also show relatively stable productivity across Uganda and South Africa, strengthening their potential under low-input and resource-constrained production conditions
- This does not mean NUCs are simply 'as good as' staples: absolute yields remain lower, and weak marketing and value chains limit uptake; a gap this study has not itself analysed

Acknowledgements



Interested to get more details?
Check out the working paper!

