

Navigating the Complexity of

Plant Nutrition in African Landscapes



apni 2030



Mission and Vision

Mission: Enhanced plant nutrition for a resilient and food-secure Africa.

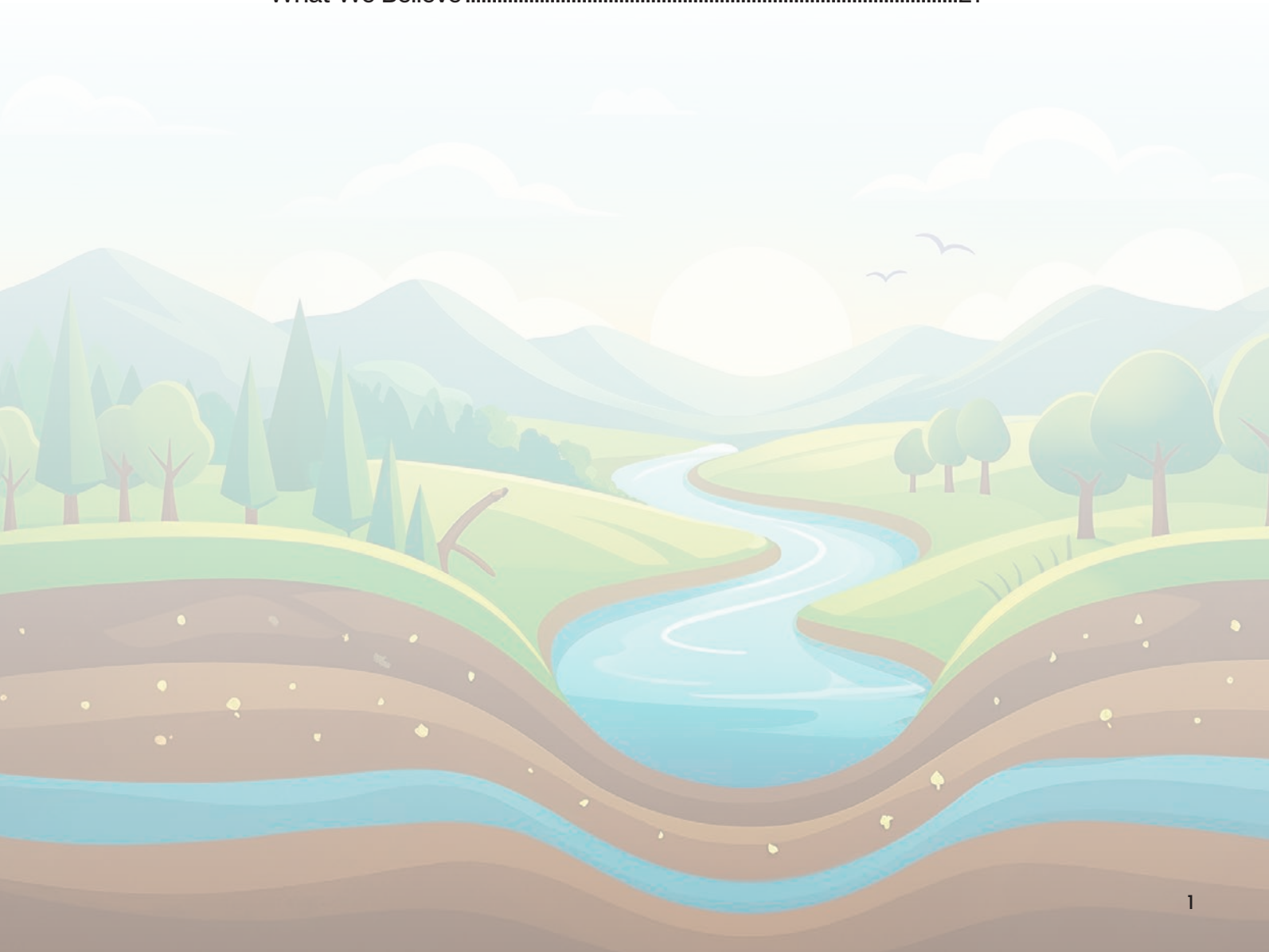
Vision: By 2030, APNI aims to contribute to an Africa where 4R Nutrient Stewardship functions as a core framework for agricultural transformation, delivering resilient landscapes, reliable productivity under climate stress, and dignified livelihoods through reduced risk and improved returns.

APNI Headquarters
UM6P Experimental Farm
Benguérir 41350, Morocco

www.apni.net

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Navigating the Complexity of **Plant Nutrition in African Landscapes**



President's Message



From Science to Systemic Impact

Africa's agricultural transformation stands at a critical juncture. Climate variability, soil degradation, and persistent productivity gaps are converging to threaten food security and rural livelihoods. Yet, these challenges also present a decisive opportunity: to reframe how we approach plant nutrition—not as an input, but as a system-level lever for resilience, sustainability, and inclusive growth.

At APNI, our strategy is grounded in a simple conviction: science must translate into value at scale. This requires moving beyond fragmented, yield-centric approaches toward integrated, context-specific solutions that simultaneously enhance productivity, restore soil health, and strengthen ecosystem resilience. Central to this vision is the operationalization of 4R Nutrient Stewardship as a unifying scientific framework—anchored in evidence, adapted to local realities, and designed for adoption.

Our way forward is structured around four strategic priorities. First, advancing frontier science that demonstrates the multiple benefits of improved nutrient management across landscapes. Second, delivering decision-grade, site-specific solutions for diverse cropping systems. Third, accelerating adoption through farmer-centric innovation and co-creation. And fourth, building enduring institutional capacity within national research and extension systems to ensure long-term ownership and scalability.

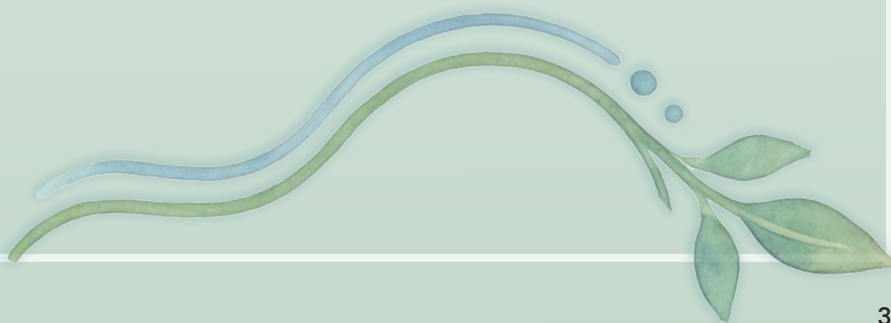
APNI's role is not to act alone, but to serve as a system enabler—bridging science, policy, and practice through strong partnerships. By aligning research with real-world demand and embedding innovation within existing systems, we aim to close the persistent gap between agronomic potential and farmer adoption.

The path ahead is ambitious but necessary. By anchoring agricultural transformation in science-driven, context-responsive solutions, we can contribute to resilient landscapes, reliable productivity, and dignified livelihoods across Africa.

A handwritten signature in blue ink, appearing to read 'K Baddou', with a horizontal line underneath.

Khalid Baddou

APNI President and Board Chair



Scientific Advisory Committee's Message



A Road Map towards Transformation

This APNI 2030 Strategy establishes a road map for advancing sustainable crop nutrition and soil health across the African continent through integrated approaches that enhance productivity, resilience, and environmental sustainability.

While the continent faces intensifying climate risks, accelerating soil degradation, and rising demand for data driven agronomic solutions, there is also strengthened commitment to fertilizer use and improving soil health.

With a vision of prosperous African farmers sustainably managing crop nutrition to ensure a secure supply of nutritious food at an affordable cost, APNI is uniquely positioned to provide scientific evidence, analytical tools and capacity building initiatives that lead to measurable outcomes at farm, landscape and national levels.

APNI's 4R Nutrient Stewardship framework—Right Source, Right Rate, Right Time, and Right Place—will continue to scale out, informing research, technology development and decision support tools, moving from science to impact.

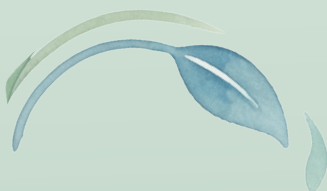
APNI 2030 establishes the ambition to expand our reach across Africa, leveraging partnerships and regional coordination to scale solutions that address the continent's diverse agro-ecological and institutional challenges. The Growing Africa Hub and flagships will ensure that APNI's scientific outputs continue to be transformed into actionable solutions, driving adoption, investment and policy influence.

Together, we can strengthen African farmers, increase food security, and foster more resilient agricultural landscapes for generations to come. Thank you for joining us on this transformative journey.

A handwritten signature in blue ink that reads "Amy Sullivan". The signature is fluid and cursive.

Amy Sullivan

Chair, APNI Scientific Advisory Committee



Foreword

A New Era for Plant Nutrition in Africa



The focus on plant nutrition research and development in Africa has shifted significantly in recent years. Shocks from the global pandemic, geopolitical conflicts, and climate change have exposed vulnerabilities in food systems and brought resilience to the forefront. These disruptions have reinforced the critical role of fertilizers in food and livelihood security, while elevating soil health as a foundation for sustainable agricultural growth. The African Union's Fertilizer and Soil Health Action Plan provides a clear direction for how plant nutrition can contribute to agricultural transformation over the next decade.

APNI2030 builds on our previous strategy, which was anchored in three domains, Climate and Weather-Smart Plant Nutrition, Soil Health for Improved Livelihoods, and Precision Nutrient Management. It sharpens our value proposition in response to evolving continental and global priorities, positioning APNI as a catalytic organization delivering data-driven context-specific solutions for a resilient, food secure and prosperous Africa.

APNI2030 marks a strategic shift from a yield-centric approach to a system-based approach to plant nutrition that simultaneously delivers productivity, resilience, environmental sustainability and nutritional outcomes.

Our strategy addresses four persistent structural challenges. First, the absence of a multiple-benefit agronomy approach that captures the full value of plant nutrition for overall system performance. Second, the lack of locally relevant innovations suited to Africa's diverse biophysical, socio-economic and cropping systems. Third, the low adoption of Innovations that can reduce risks and enhance both productive and ecosystem services. And finally, limited institutional capacity to generate, adapt and independently scale these innovations sustainably. Together, these challenges define the need, and opportunity for APNI's contribution to agri-food system transformation in Africa.

At the core of APNI2030 is the **4R Nutrient Stewardship framework (4R)** of right source, right rate, right time and right place, applied as a unifying scientific approach to guide research, delivery and impact. By applying 4R as a unifying architecture, APNI2030 aims to **institutionalize multiple-benefit agronomy** to realize and value the overall benefits from plant nutrition, **improve the quality and relevance of crop nutrition innovation** for stable cropping system performance across diverse agro-ecologies, and **strengthen the adoption pathways and institutional capacity**, improving decision making that reduces risks and enhance economic security for communities.

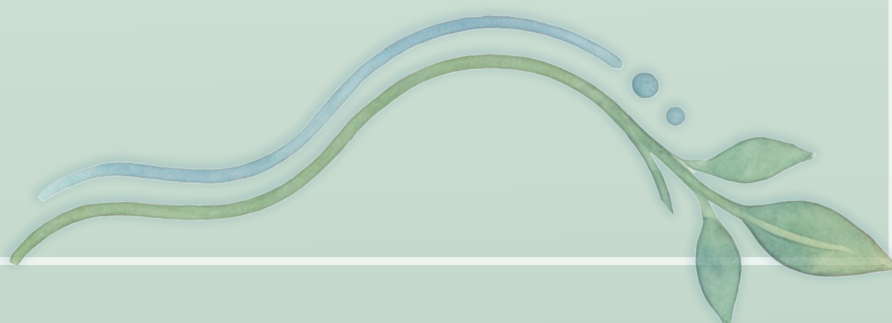
Under APNI2030, we extend the 4R concept beyond efficiency gains to deliver value across multiple dimensions—ecological, economic, operational, and social—and at multiple scales, from farm to landscape. This integrated approach strengthens system resilience, improves the relevance of agronomic innovations, and enhances livelihoods.

As a catalytic scientific partner in Africa's agri-food system transformation, APNI is uniquely positioned to bridge science, practice, and policy. We are committed to generating and openly sharing data, knowledge, and insights, while working with a diverse set of partners to ensure that innovations are effectively delivered, adopted, and scaled. Through this approach, we aim to make plant nutrition a central lever for driving productivity, resilience, resource-use efficiency, and environmental sustainability across the continent.

APNI2030 has been shaped through the contributions and critical insights of our Board members, Scientific Advisory Committee, staff, and a wide network of partners and collaborators across Africa and beyond. We are deeply grateful for their guidance.

We invite partners, institutions and donors to join us in advancing this vision—redefining the role of plant nutrition in building resilient, sustainable, and prosperous agri-food systems in Africa.

Kaushik Majumdar
APNI Director General





The Case for **Science-Driven Action**

Africa's agri-food systems face a convergence of interlinked and escalating pressures that threaten food security, livelihoods, and long-term development prospects. Climate change is intensifying risks to agricultural production through rising temperatures, increased rainfall variability, and more frequent extreme weather events while exacerbating pest and disease pressures and undermining rural livelihoods. Projections suggest that these impacts could place an additional 38 million people at risk of hunger. At the same time, land and soil degradation affect more than 65% of agricultural landscapes across the continent, generating economic losses estimated at over USD 60 billion annually and eroding the natural resource base on which sustained agricultural productivity depends.

Raising crop productivity therefore remains foundational for Africa's broader economic transformation. Sustained productivity growth reduces persistent hunger, lowers food expenditures for a rapidly growing population, and releases labor and capital for non-farm economic activities. These are dynamics that have historically underpinned successful structural transformation; however, the interacting stresses facing African food systems increasingly expose the limitations of only yield-focused approaches. Climate variability, soil nutrient depletion, and ecosystem degradation require agronomic responses that not only increase production but also strengthen resilience, restore soil health, and sustain ecosystem services. Despite the availability of productivity-

enhancing technologies, adoption remains persistently low, particularly among smallholder farmers who manage the majority of Africa's farmland, highlighting the need for solutions that are both technically effective and feasible under real-world constraints.

In response to these challenges, African leaders have articulated a coherent continental policy agenda for agri-food systems transformation. The Africa Common Position on Food Systems, adopted at the United Nations Food Systems Summit in 2022, provides a unifying framework grounded in Africa's realities, priorities, and ambitions. This position is also aligned with the African Union's Comprehensive Africa Agriculture Development Programme (CAADP), which has progressively evolved toward a stronger food systems lens. More recently, renewed political commitment to fertilizer and soil health has been articulated through the 2024 Africa Fertilizer and Soil Health Action Plan. Together, these frameworks signal a clear recognition that future agricultural growth must be science-based, context-specific, and capable of simultaneously advancing productivity, resilience, inclusivity, and environmental sustainability.

However, a critical gap remains between this policy ambition and implementation on the ground. Existing agronomic approaches and delivery models often address productivity, climate resilience, soil health, and nutrition as separate objectives, limiting their effectiveness in complex and risk-prone farming systems. There remains a need for coherent scientific frameworks that can translate

continental priorities into farmer-relevant, adoptable, and scalable solutions while being embedded within national research, extension, and policy systems.

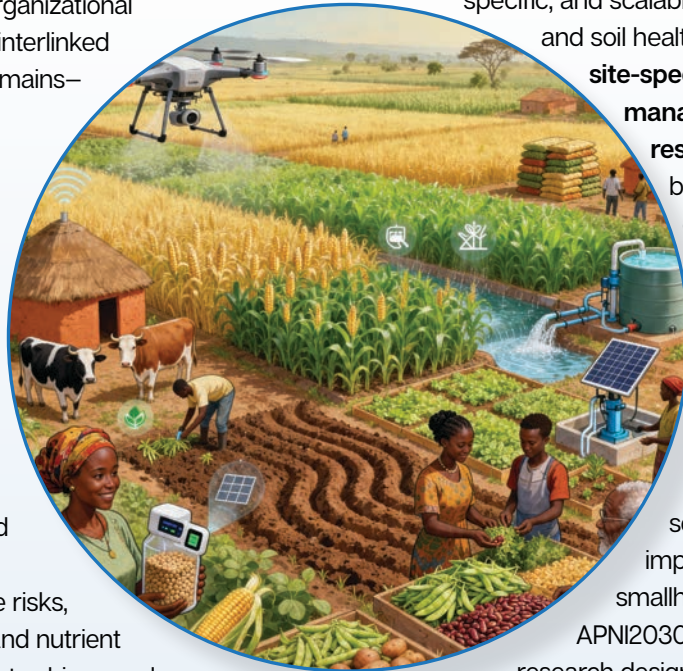
The African Plant Nutrition Institute (APNI) was established in 2019 to help address this gap by advancing science-based crop nutrition solutions tailored to African contexts. APNI operationalized its first organizational strategy in 2021 around three interlinked research and development domains—**Climate and Weather-Smart Plant Nutrition, Soil Health for Improved Livelihoods, and Precision Nutrient Management**—which continue to form the scientific backbone of its work. APNI2030, APNI's second strategic plan spanning 2026–2030, builds on this foundation while responding to an evolved continental and global context shaped by: intensifying climate risks, accelerating soil degradation and nutrient depletion, rising demand for data-driven and context-specific agronomic solutions, and strengthened continental commitment to fertilizer and soil health.

Within this context, APNI is positioned to contribute scientific evidence, analytical tools, and capacity strengthening that support the translation of policy commitments into measurable and durable outcomes at farm, landscape, and national scales. Guided by its vision of prosperous African farmers sustainably managing crop nutrition to provide consumers with a secure supply of nutritious food at an affordable cost, and its mission of enhanced plant nutrition for a resilient and

food-secure Africa, APNI advances integrated approaches to crop nutrition that link productivity improvement with resilience, soil health, and One Health outcomes under climate-constrained conditions.

To deliver on this mandate, APNI draws on a set of **core scientific competencies** that enable integrated, context-specific, and scalable responses to plant nutrition and soil health challenges. These include **site-specific fertilizer and agronomic management, farmer-centered research approaches** that integrate biophysical and socio-economic data, and **rigorous assessment of environmental services** generated by agricultural systems. Central to this approach is the application of **4R Nutrient Stewardship**—Right Source, Right Rate, Right Time, and Right Place—as a science-based framework for improving nutrient management in smallholder farming systems. Through APNI2030, this framework informs research design, technology development, decision-support tools, and capacity development, and positions improved plant nutrition as a key lever for advancing productivity, resilience, resource-use efficiency, and environmental sustainability across African agri-food systems.

This convergence of escalating food system challenges, strengthened continental policy ambition, and advancing scientific capability creates a strategic opportunity for APNI to expand its continental reach and serve as a catalytic scientific partner in advancing Africa's agri-food systems transformation toward **system resilience, reliable productivity, and dignified livelihoods**.



APNI2030 responds to an evolved continental and global context shaped by: intensifying climate risks, accelerating soil degradation and nutrient depletion, rising demand for data-driven and context-specific agronomic solutions, and strengthened continental commitment to fertilizer and soil health.



APNI Theory of Change

Structural Challenges to Transformation

The role of plant nutrition, and specifically 4R-based nutrient stewardship, in Africa's agricultural transformation remains insufficiently contextualized, articulated, and operationalized within food systems strategies. While opportunities to improve productivity, resilience, and livelihoods are substantial, they remain fragmented and weakly connected to farmer decision-making and institutional delivery systems. As a result, the potential of crop nutrition to contribute to sustainable intensification, climate resilience, and improved livelihoods has not been fully realized.

APNI identifies four interrelated structural challenge areas that define the demand for its work and require differentiated, science-based responses:

1 *Absence of a Multiple-Benefit Agronomy Strategy*

There is a lack of a coherent nutrient management framework capable of simultaneously delivering productivity gains, restoring soil health, strengthening ecosystem resilience, and supporting One Health outcomes. Nutrient management is often treated narrowly, limiting its contribution to broader food system goals.

2 *Limited Crop Nutrition Innovation for Diverse Cropping Systems*

Africa's heterogeneous and climate-variable cropping systems lack sufficient access to site-specific crop nutrition solutions and the economic intelligence needed to optimize nutrient use, manage risk, and de-risk investment across agro-ecological contexts.

3 *Low Adoption of Innovations*

Prevailing linear technology-transfer approaches fail to account for critical socio-technical pull factors, such as labor availability, risk exposure, gender dynamics, and economic constraints, that shape farmer decision-making, resulting in weak and uneven adoption of agronomic innovations.

4 *Under-Resourced Institutional Capacity*

National Agricultural Research and Extension Systems (NARES) often lack the institutional, human capacity and knowledge required to generate, adapt, and independently scale locally relevant plant nutrition innovations, limiting the durability and reach of scientific advances.

Opportunities to improve **productivity, resilience, and livelihoods** are substantial, but they remain fragmented and weakly connected to farmer decision-making and institutional delivery systems.





APNI's Value Proposition

APNI addresses these structural challenges by deploying 4R Nutrient Stewardship as a science-based, problem-solving framework that aligns nutrient supply with crop demand and farmer contexts and decision-making, while delivering multiple agronomic, environmental, and economic benefits. In the 4R context, scientific relevance is defined by evidence that:

- improves crop productivity and profitability;
- increases nutrient-use efficiency and reduces losses and environmental externalities;
- restores and sustains soil health, contributing to climate adaptation and mitigation; and
- provides robust analytical foundations for evidence-based fertilizer policies, soil health strategies, and public and private investment decisions.

To deliver on this mandate, APNI draws on a set of internal core scientific competencies that enable our integrated, context-specific, and scalable responses to plant nutrition and soil health challenges. These include **site-specific fertilizer and agronomic management** that aligns nutrient supply with crop demand across

diverse agro-ecologies, **farmer-centered research approaches** that integrate biophysical and socio-economic data to ensure feasibility, relevance, and adoption, and **rigorous assessment of environmental services** generated by agricultural systems, providing credible evidence on soil health, nutrient cycling, climate mitigation, and ecosystem outcomes. Together, these competencies ensure that 4R Nutrient Stewardship functions not only as a technical framework but also as a robust system for value creation and decision-making.

APNI's distinctive contribution lies in generating this science while anchoring it explicitly in farmer and institutional pull factors. By ensuring that research responds to user demand rather than researcher supply, APNI bridges the persistent gap between agronomic potential and real-world adoption. Few actors combine applied crop nutrition science, farmer-centric co-creation, and institutional embedding at the continental scale. This integrated approach defines APNI's added value. APNI operationalizes this value proposition through a challenge–solution model comprising four mutually reinforcing R&D pathways.

Solution Pathways



PATHWAY 1:

Expanding Crop Nutrition Frontiers. This pathway advances multiple-benefit landscape agronomy, investigating and demonstrating how 4R-based nutrient management can move beyond yield enhancement to simultaneously regenerate soil health, stabilize carbon stocks, and improve human nutrition through nutrient-dense crops.



PATHWAY 2:

Innovating Crop Nutrition for Diverse Cropping Systems. This pathway establishes the 4R framework as a systemic approach to optimizing performance across agro-ecologies and cropping systems. By generating intervention intelligence, it calibrates nutrient use to water availability and return on investment (ROI), producing validated business cases and data-driven tools that de-risk fertilizer use for smallholders and enable responsible private-sector engagement.



PATHWAY 3:

Accelerating Adoption through Farmer-Centric Innovation. Through farmer-led research and social co-creation, this pathway integrates labor, risk, gender, and economic constraints directly into 4R solution design. Innovations are thus shaped by lived realities, building trust, relevance, and adoption at scale.



PATHWAY 4:

Building Capacity in Research and Extension Systems. This pathway strengthens NARES by embedding 4R science within national research programs, curricula, and extension systems, creating durable institutional competency to generate, adapt, and scale locally relevant crop nutrition knowledge independently.

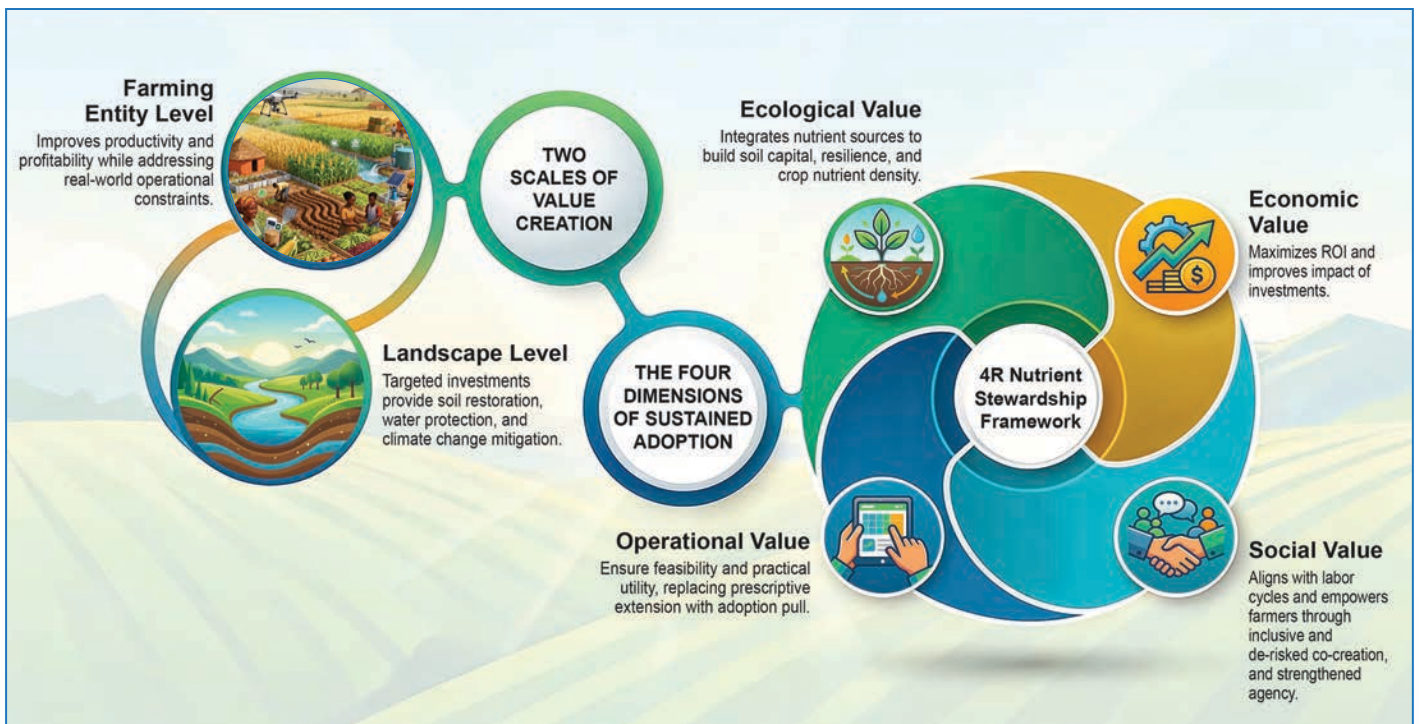
Institutional Outcomes and Systemic Contribution

Through the integrated delivery of these four pathways, APNI contributes to a set of institutional outcomes that define its direct contribution to agri-food systems transformation. These outcomes reflect durable changes in how crop nutrition science is generated, applied, and scaled, including shifts in professional practice, decision-making norms, and institutional incentives. Specifically:

- The **institutionalization of multiple-benefit agronomy** strengthens the scientific and policy foundations for resilient landscapes.

- **Improved quality and relevance of crop nutrition innovation** support stable cropping system performance across diverse agro-ecologies, contributing to reliable productivity under climate variability.
- **Strengthened adoption pathways and institutional capacity** ensure that innovations translate into improved decision-making, sustained practice, income stability, and reduced risk, supporting dignified livelihoods.

These outcomes represent APNI's contribution to system-wide transformation rather than sole attribution, linking scientific evidence to policy ambition and investment at scale.



Change Logic and Value Creation

APNI's Theory of Change is grounded in the premise that adoption is driven by value creation rather than a technology push. Within this logic, 4R Nutrient Stewardship functions as a framework capable of generating value at two interlinked scales:

- **A farming entity level**, where improved nutrient management enhances productivity, profitability, and feasibility under real-world constraints.
- **A landscape level**, where spatially targeted 4R-based investments deliver broader environmental and societal benefits, including soil restoration, water protection, and greenhouse gas mitigation.

This value is realized through four reinforcing dimensions that precede and enable sustained adoption.

Ecological Value: 4R-based nutrient management integrates inorganic, organic, and biological nutrient sources to build soil capital, resilience, and crop nutrient density.

Economic Value: Precision nutrient management maximizes ROI and improves the efficiency and impact of public and private investments.

Operational Value: By aligning with labor availability, cash flow cycles, and logistics, 4R-based approaches ensure feasibility and practical utility, replacing prescriptive extension with adoption pull.

Social Value: Farmer-centric co-creation and institutional learning strengthen agency, reduce risk, and support inclusive livelihoods under climate and market uncertainty.

Beneficiaries, Strategic Partners, and Scaling

APNI operates as a system enabler, distinguishing between actors directly engaged in co-creation and the broader beneficiaries of systemic change. Primary beneficiaries include farmers, researchers, extension agents, private-sector partners, and policy stakeholders who directly receive tools, data, analytical frameworks, and capacity support. Through their engagement, these actors generate, test, and validate agronomic innovations that are technically sound, economically viable, operationally feasible, and socially relevant. Subsequent beneficiaries, including an expanding circle of smallholder farmers, women, and youth who advance as validated solutions are scaled through strengthened institutions, improved policies, and more inclusive markets.

APNI achieves scale through strategic partnerships with NARES, universities and training institutions, private-sector actors, farmer organizations, development partners, and policy bodies. Rigorous field pilots serve as proof of concept, while institutional and market mechanisms embed innovation within existing systems to ensure relevance, credibility, and adaptability.

Vision, Alignment, and Assumptions

By 2030, APNI aims to contribute to an Africa where 4R Nutrient Stewardship functions as a core framework for agricultural transformation, delivering resilient landscapes, reliable productivity under climate stress, and dignified livelihoods through reduced risk and improved returns.

This Theory of Change aligns with SDGs 2, 3, 5, 13, 15, and 17, as well as AU/CAADP goals and the Africa Fertilizer and Soil Health Action Plan. APNI adopts a contribution-based approach to impact, remaining accountable for the quality, relevance, and uptake of its scientific outputs.

The Theory of Change assumes sustained political commitment, functional input markets, institutional stability within research and extension systems, the effectiveness of pull-driven co-creation, and the absence of prolonged systemic shocks beyond APNI's scientific mandate.

Supporting Change through Integrated 4R Solutions

4R Research Solutions for Continental Challenges

APNI2030 advances APNI's institutional outcome goals by positioning 4R Nutrient Stewardship as the core driver of research design, execution, and impact. Through a challenge–solution research model, each major constraint to agricultural transformation is addressed through a purpose-built Integrated 4R Research Solution that applies the Right Source, Right Rate, Right Time, and Right Place as a unifying scientific architecture rather than a set of stand-alone practices.

These solutions operationalize APNI's Theory of Change by generating decision-grade evidence for value creation, the essential precursor for adoption, scaling, and durable system change. APNI deliberately translates this evidence into Minimum Viable Products (MVPs), which are fit-for-purpose research outputs that convert 4R science into usable proof-of-concepts for farmer decision-making, institutional practice, policy formulation, and public and private investment.

Implemented across APNI's four solution pathways, these 4R-driven research solutions directly support the institutionalization of multiple-benefit agronomy, improve the relevance and quality of crop nutrition innovation, strengthen adoption pathways, and build national capacity.

PATHWAY 1:



Expanding Crop Nutrition Frontiers:

The Demand: Scientists, policymakers, and development partners lack a coherent agronomy framework capable of delivering multiple system benefits simultaneously.

While nutrient management is widely recognized as central to productivity, there is limited integrated evidence demonstrating how it can jointly enhance crop yields, ecosystem resilience, and human nutrition outcomes. This limits the ability of stakeholders to justify policy shifts, institutional change, and large-scale investment, reinforcing continued reliance on narrowly yield-focused approaches.

Integrated 4R Research Solution: APNI addresses this gap by systematically applying 4R Nutrient Stewardship as a unifying research framework to reposition nutrient management as a driver of ecosystem services and regenerative outcomes. By explicitly linking the Right Source, Right Rate, Right Time, and Right Place to soil, plant, and human health processes, this solution reframes agronomy from yield maximization to landscape-scale value creation, where productivity, environmental integrity, and crop nutritional quality are optimized together rather than traded off.

Research Focus: APNI prioritizes research that:

- Quantifies environmental co-benefits of agricultural production, such as carbon stabilization, nutrient retention, and water quality protection, to strengthen the evidence base for multiple-benefit agronomy.
- Optimizes 4R nutrient management across topographic, soil, and hydrological gradients to account for spatial and temporal heterogeneity in agricultural landscapes.
- Demonstrates how specific 4R source, rate, time, and place combinations stabilize soil carbon, increase soil organic matter, and reduce nutrient losses.
- Links soil biological and chemical processes under 4R management to nutrient density and dietary quality, strengthening the evidence base for nutrition-sensitive agronomy.

Minimum Viable Products (MVPs): Scalable proof-of-concepts that demonstrate measurable, integrated gains in productivity, soil health, ecosystem services, and nutritional quality and density. These MVPs generate decision-grade evidence and transferable methodologies to inform policy formulation, guide development programming, orient applied research by national and international partners, and catalyze large-scale public and private investment in multiple-benefit agronomy.

PATHWAY 2:



Innovating Crop Nutrition for Diverse Cropping Systems

The Demand: Farmers and their organizations, the fertilizer industry, financial institutions, and policymakers lack decision-grade, site-specific crop nutrition solutions needed to manage risk and optimize performance in Africa's diverse and increasingly climate-variable landscapes and cropping systems. In absence of credible evidence linking nutrient use to predictable returns on investment (ROI), including gains in fertilizer use efficiency and water productivity, fertilizer use remains difficult to de-risk for smallholders. This constrains the design of profitable input-service delivery models and limits access to credit and insurance, hindering investment and adoption.

Integrated 4R Research Solution: APNI addresses this constraint by positioning 4R Nutrient Stewardship as the core scientific engine for agronomic intelligence and economic value creation. By applying the 4Rs as a credible, systemic framework to managing functional and diversified cropping systems—from annuals to agroforestry and irrigated drylands—APNI calibrates nutrient management to soil, water, and crop interactions. This ensures that economic value emerges predictably from biological performance, enabling each unit of nutrient applied to deliver measurable and profitable returns. By grounding economic projections in biological and hydrological responses, APNI provides the decision-grade clarity required to unlock large-scale public and private investment.

Research Focus: APNI prioritizes research that, in selected cropping systems:

- Calibrates nutrient application to water availability, including rainfall, irrigation, and soil moisture dynamics, to optimize nutrient use efficiency, water productivity, and yield stability.
- Optimizes nutrient management by explicitly accounting for spatial and temporal variability within cropping systems, including interactions in intercropping and crop rotation arrangements.
- Generates location-specific ROI, yield-gap, and risk analyses that provide a clear economic rationale for sustainable nutrient management and investment decisions.
- Quantifies and optimizes root-water-nutrient interactions so that economic projections reflect crop performance under stress and climate variability.

MVPs: Validated 4R packages of practice that combine value-creation principles, practices, high-quality data, and decision-grade evidence to de-risk fertilizer use for smallholders and value-chain actors. These MVPs provide the technical and economic foundations for smart subsidy design, profitable input-service delivery models, expanded credit and insurance products, and increased private-sector investment across Africa's diverse cropping systems.

PATHWAY 3:



Accelerating Adoption through Farmer-Centric Innovation

The Demand: Research, extension, farmer-based organizations, and their business partners lack effective models for translating crop nutrition science into practices that farmers are willing and able to adopt at scale. Conventional approaches continue to prioritize pushing standardized technology packages mainly based on yield potential. In practice, smallholder farmers adopt innovations only when they align with labor constraints, gender roles, risk exposure, cash-flow dynamics, and farming objectives. There is therefore an urgent demand for innovation models that embed these adoption-pull factors directly into the research process, ensuring that agronomic solutions translate into changed decision-making and sustained practice.

Integrated 4R Research Solution: APNI addresses this gap by positioning 4R Nutrient Stewardship as a farmer-centered, co-created system rather than a prescriptive recommendation. Through 4R Social Co-Creation, APNI establishes farmer-led research as the primary model for developing agronomic solutions. This approach integrates social science with 4R systems agronomy to ensure that nutrient management strategies are co-designed with farmers and value-chain actors, reflecting real-world constraints and incentives. By aligning technical performance with operational feasibility and perceived value, 4R practices shift from a researcher's recommendation into a farmer's rational choice, creating the behavioral foundation for adoption at scale.

Research Focus: APNI prioritizes research on 4R systems agronomy that:

- Integrates critical pull factors, including labor availability, gendered responsibilities, risk exposure, and cash-flow cycles, directly into the design of nutrient management strategies.
- Utilizes on-farm experimentation (OFE) to align the scientific potential of the 4Rs with the lived realities, constraints, and decision-making processes of farming households.

- Develops analytics and digital decision-support tools that enable co-interpretation of data with farmers, translating complex on-farm data into actionable, site-specific recommendations.
- Generates insights into behavioral and economic drivers of adoption, ensuring that technically sound innovations are also optimized for long-term ownership by women, youth, and marginalized groups.
- Embeds research within agricultural value chains and engages strategic research, extension, development, and private-sector partners to accelerate learning, validation, and scaling.

MVPs: Validated learning systems, digital decision-support tools, and socially adapted 4R packages of practice that enable farmer-owned experimentation, data capture, and co-interpretation. These MVPs replace the push of traditional extension with the pull of practical utility, significantly increasing the likelihood of adoption by aligning innovation design with farmer decision-making and ensuring scalability across diverse social and economic contexts.

PATHWAY 4:



Building Capacity in Research and Extension Systems

The Demand: National Agricultural Research and Extension Systems (NARES), universities, and national programs often lack the sustained

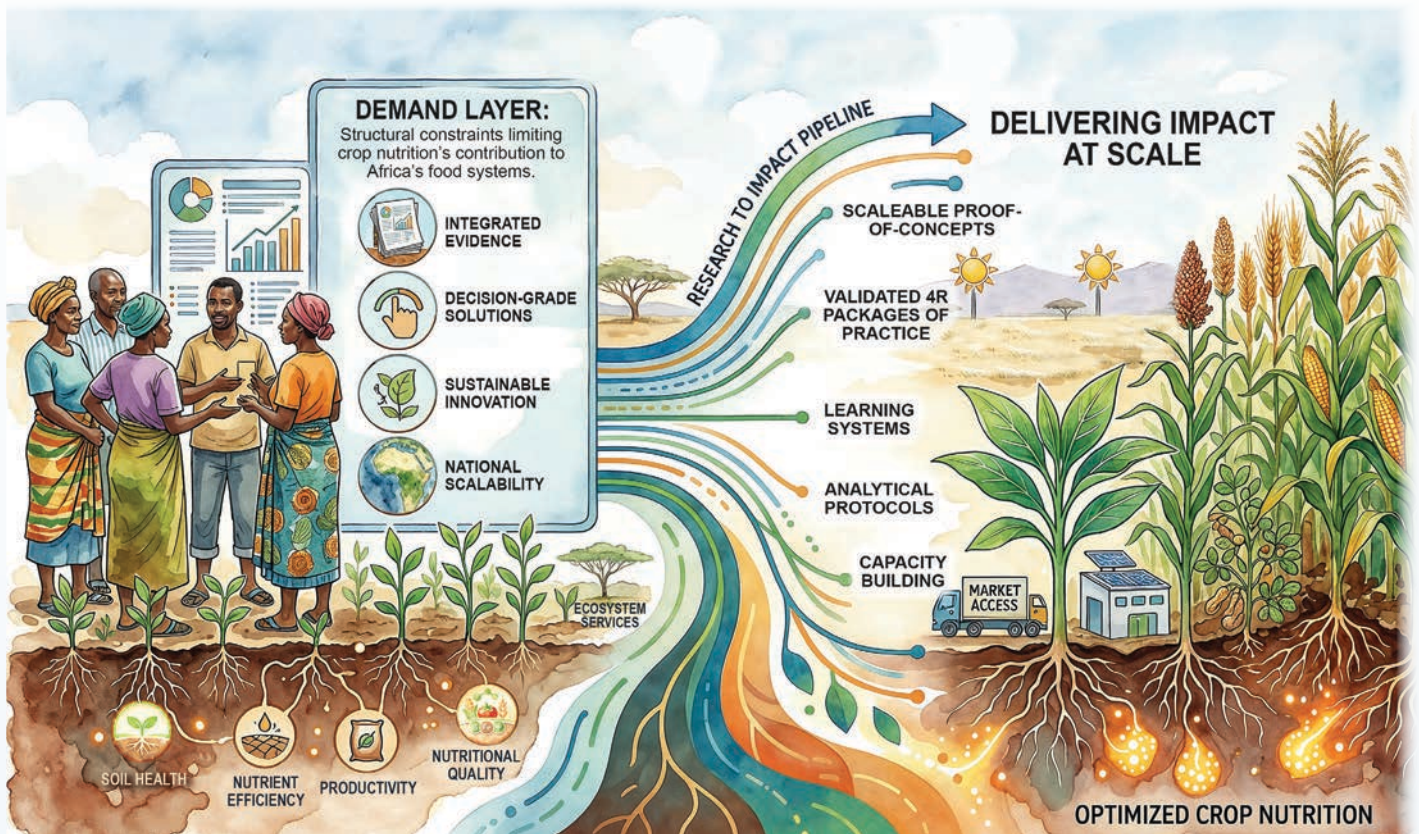
human, institutional, and analytical capacity to generate, update, and deploy locally relevant nutrient advice as a core public function, rather than through time-bound projects. This constrains country ownership of crop nutrition innovations and creates long-term dependence on external research support. There is a critical demand for a methodological backbone that enables national institutions to independently generate, adapt, and scale 4R-based nutrient stewardship knowledge.

Integrated 4R Research Solution: APNI addresses this challenge by positioning 4R Nutrient Stewardship as the institutional backbone for research, training, and extension. Through the systematic transfer of 4R science, digital diagnostics, and research protocols, APNI builds institutional competency that enables national partners to become primary drivers of locally relevant nutrient management. By embedding these capabilities within universities, NARES, and national programs, rather than delivering them through stand-alone projects, APNI secures long-term local ownership, continuity, and sustainability of the innovation process.

Capacity Development Focus: APNI prioritizes efforts that:

- Embed 4R science and systems agronomy into university curricula, graduate and early-career research programs, and national extension training frameworks, building a sustained pipeline of next-generation African scientists and practitioners.
- Integrate graduate students and early-career researchers directly into APNI's core research pathways (Pathways 1–3), linking capacity development to the generation of decision-grade evidence.
- Transfer digital toolkits, diagnostics, data management systems, and decision-support capabilities that strengthen national institutional autonomy and performance in nutrient stewardship.

MVPs: A standardized 4R certification curriculum, digital toolkits, and analytical protocols adopted by universities and national extension services. Graduate students embedded within APNI's core research pathways to complete their degree programs while contributing to the generation of locally relevant nutrient stewardship knowledge. Together, these MVPs transform 4R Nutrient Stewardship from a project-based intervention into a permanent institutional asset, enabling sustained national capacity to generate, adapt, and scale crop nutrition innovation.



From Research to Impact

APNI2030 is structured around a clear progression from why research is needed to how it delivers impact at scale. The logic begins with a defined demand layer, which articulates the structural constraints limiting the contribution of crop nutrition to Africa's food systems.

These demands are addressed through APNI's core scientific competence areas, which define what APNI is uniquely positioned to contribute. These competencies enable integrated, context-specific, and scalable responses to complex crop nutrition and soil health challenges.

APNI mobilizes these competencies through four interdependent solution pathways, which together define how science is translated into impact. The pathways function as a coherent system rather than as standalone workstreams and provide the strategic structure within which research is generated, synthesized, and applied.

The outputs generated across these pathways are consolidated into a set of MVPs, which represent APNI's high-level research outputs. MVPs integrate evidence, analytics, and coordination mechanisms into structured platforms that are explicitly designed to be taken up, adapted, and scaled by strategic partners rather than delivered directly by APNI at scale. For

strategic visualization purposes, MVPs are aggregated in the **Theory of Change Diagram** below, while operational implementation may retain greater granularity.

Through strategic partnerships, MVPs are embedded within national systems, regional platforms, policy processes, market mechanisms, and investment frameworks. Scaling partners play a central role in translating validated MVPs into sustained adoption, policy uptake, and investment at scale.

A Co-Creation Delivery Model

A defining feature of this model is that APNI does not seek to build parallel delivery infrastructure. Instead, we deliver impact by empowering partners to co-create the scientific contributions and resulting MVPs alongside us. This collaborative process ensures that the science is anchored within existing national and private-sector systems from the outset.

Our role is to facilitate this co-creation, resulting in decision-grade tools that our partners are then uniquely positioned to deliver at scale. In this architecture, APNI's success is measured not by our direct reach, but by the extent to which our partners own, internalize, and deploy 4R science within their own institutional mandates and market operations.

The Role of Minimum Viable Products (MVPs)

In the context of this strategy, an MVP is defined as the most concise, fit-for-purpose version of a research output, such as a validated return on investment to a specific 4R practice, a digital decision-support tool, or a training curriculum, designed to provide immediate value to early adopters and generate the decision-grade evidence required to trigger broader investment and scaling. While the APNI2030 strategy defines the value creation logic and core thematic focus of these MVPs across the four solution pathways, they are not intended to be static deliverables. Instead, they are operationalized through APNI's Annual Action Plans. This modular approach allows the organization to remain agile, tailoring the specific platform, complexity, and delivery mechanism of an MVP to the unique requirements of different cropping systems, regional geographies, and partner capacities. Illustrative examples of operationalized MVPs include:

PATHWAY 1:

Expanding Crop Nutrition Frontiers. A “Landscape 4R Dashboard” that visualizes nutrient-water trade-offs for a specific watershed to guide policy-level resource allocation.

PATHWAY 2:

Innovating Crop Nutrition for Diverse Cropping Systems. A mobile-based “4R ROI Calculator” designed to de-risk fertilizer credit for smallholders within a specific value chain.

PATHWAY 3:

Accelerating Adoption through Farmer-Centric Innovation. A digital “Social Feedback Loop” that allows real-time adjustment of 4R practices based on farmer-reported labor or gender-specific constraints.

PATHWAY 4:

Building Capacity in Research and Extension Systems. A “4R Micro-Credential” and diagnostic toolkit adopted by a national agricultural university to certify the next generation of extension practitioners.

By defining these products in annual cycles, APNI ensures that its science remains responsive to the value pull of its partners, moving beyond academic boundaries to become a catalytic engine for Africa's agri-food systems transformation.

APNI2030 defines outcomes as emergent system-level changes that arise through the interaction of multiple capabilities, solution pathways, and MVPs rather than as linear or pathway-specific results. Outcomes are therefore not attributed to individual pathways or interventions but reflect the cumulative and reinforcing effects of APNI's integrated research-to-impact architecture.

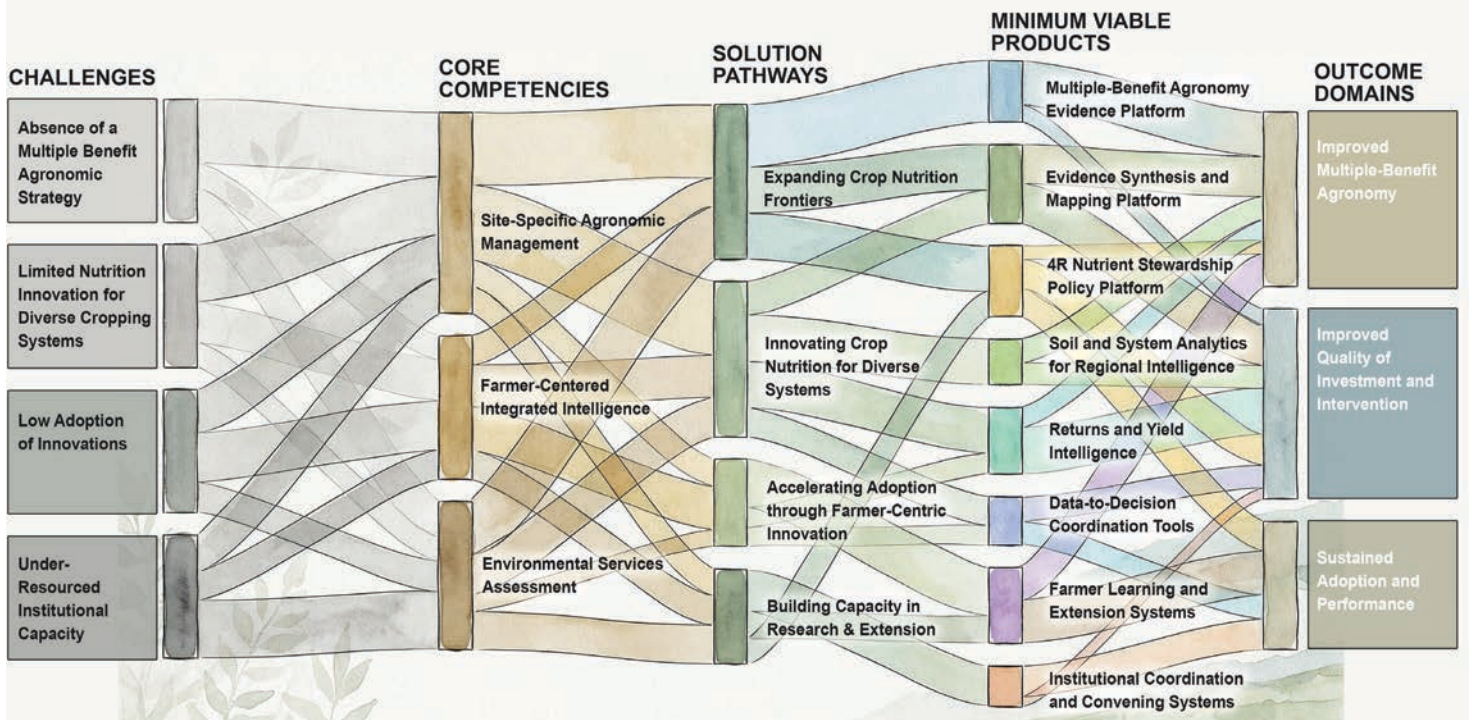
APNI's Theory of Change articulates three outcome domains: **Improved Multiple-Benefit Agronomy;** **Improved Quality of Investment and Intervention;** and **Sustained Adoption and Performance.** These outcome domains are mutually reinforcing and collectively reflect APNI's contribution to durable transformation. Through these outcome domains, APNI2030 envisions three system-level impact qualities that define the desired direction of change in Africa's agri-food systems:

- **Systems Resilience:** The capacity of agricultural systems to absorb shocks, adapt to climate variability,

and sustain function over time, supported by improved soil health, nutrient cycling, and institutional learning.

- **Reliable Productivity:** The ability of farming systems to deliver stable and predictable productivity and resource-use efficiency across seasons and contexts, reducing volatility and risk for farmers and value-chain actors.
- **Dignified Livelihoods:** Improved economic security, agency, and well-being for farmers and rural communities, underpinned by reduced risk exposure, improved returns on investment, and inclusive participation in innovation processes.

These impact qualities are not direct deliverables but emergent properties of systems in which agronomic practices, investments, institutions, and adoption dynamics are aligned.



APNI Theory of Change: From Structural Challenges to Outcomes through Core Competencies, Solution Pathways, and Minimum Viable Products (MVPs).

Vision (2030): What APNI2030 is Working Toward

APNI2030 is guided by a shared long-term vision of how crop nutrition contributes to Africa’s agricultural transformation. This vision articulates the desired future state that APNI’s integrated Theory of Change is designed to be enabled by 2030.

Multiple-Benefit Agronomy for Ecological Stewardship: Nutrient management sustains landscape resilience while enhancing productivity, ecosystem services, and crop nutritional quality and density.

4R Nutrient Stewardship for Agronomic Intelligence: 4R Nutrient Stewardship is established as the credible,

decision-grade framework for managing nutrient performance across Africa’s diverse and functional cropping systems.

Farmer-Centric Social Co-Creation as the Norm: Farmer-centric, digitally enabled co-creation becomes the dominant model for developing crop nutrition solutions, ensuring relevance, trust, and adoption at scale.

Institutional Competency in National Research and Extension Systems: National systems sustain the continuous development and application of crop nutrition solutions through strong research, education, and extension pipelines anchored in 4R science.

Mechanisms for **Delivery and Scale**

Geographies and Anchoring Strategy

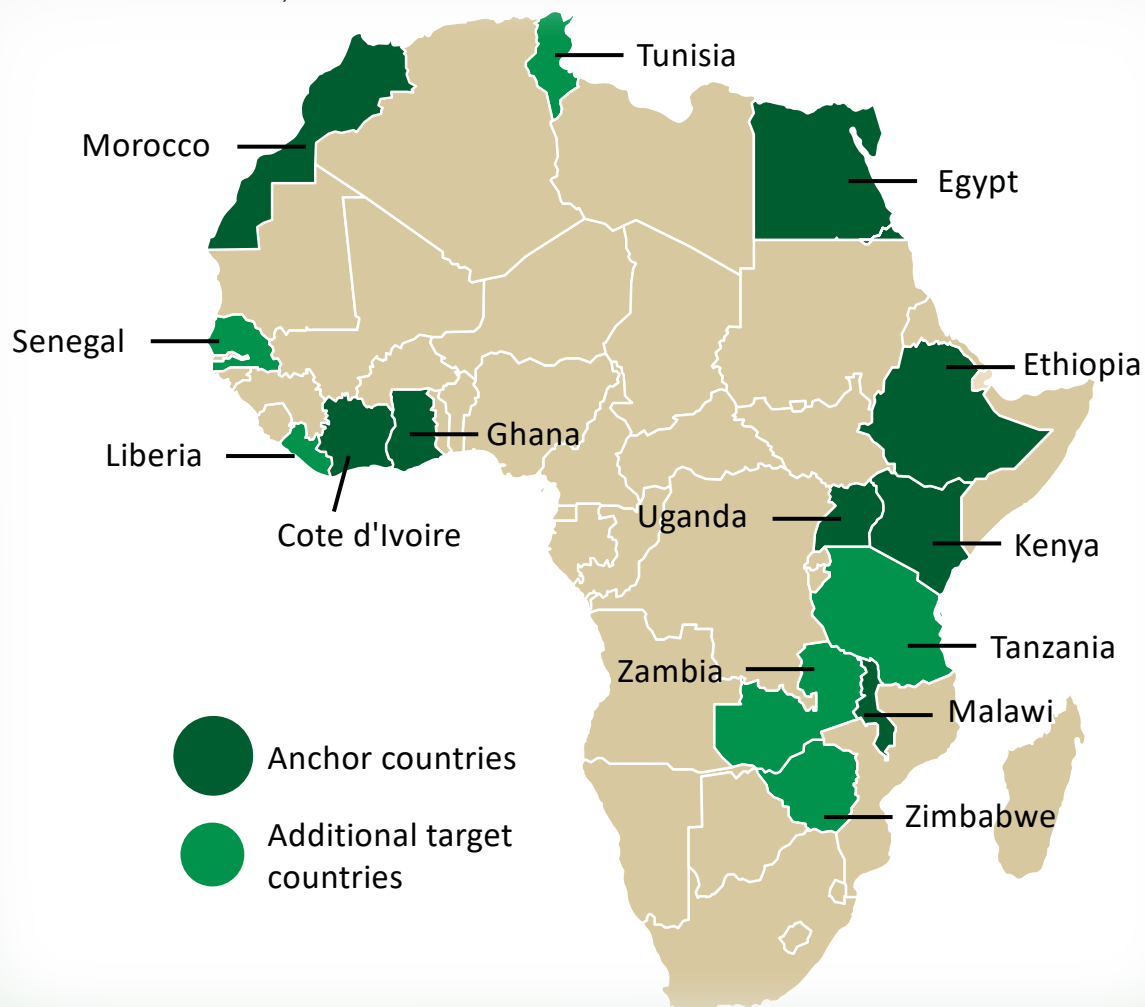
APNI's delivery and scaling strategy is anchored in a select group of core countries that represent critical cropping systems, diverse agro-ecologies, and varying levels of institutional capacity. These anchor countries function as primary learning and investment zones for generating, testing, and refining APNI's integrated crop nutrition research outputs and MVPs. Anchor countries are where APNI operationalizes its research agenda, embeds graduate and early-career researchers within core research activities, and develops MVPs that are robust, context-tested, and suitable for scaling by partners.

Anchor countries are selected where crop nutrition challenges align strongly with APNI's strategic focus, such as the need for multiple-benefit agronomy, high adoption barriers, or weak institutional capacity, and where sufficient political commitment, research infrastructure, and partnership depth exist to enable scaling beyond individual projects.

Learning, tools, and MVPs generated in anchor countries are subsequently extended to additional target countries (e.g., Tanzania, Zimbabwe, Zambia, Tunisia, Senegal, Liberia) through partner demand, regional coordination, opportunity development, and external resource mobilization.

Anchor Countries

- **North Africa:** Morocco, Egypt
- **East Africa:** Kenya, Ethiopia, Uganda
- **Southern Africa:** Malawi
- **West Africa:** Côte d'Ivoire, Ghana



Integrated Research and Delivery Mechanisms

APNI deploys a set of integrated, mutually reinforcing research and delivery mechanisms that support evidence generation, learning, validation, and MVP development. These mechanisms are not parallel delivery channels, but function collectively to bridge research, practice, and policy and to enable partner-led scaling.

Pilot Landscapes: Pilot landscapes serve as regional platforms for demonstrating the system-level value of multiple-benefit agronomy. They integrate productivity, environmental services, and nutritional outcomes in real agricultural contexts, linking field-level innovation to policy visibility and investment traction.

On-Farm Experimentation (OFE) Networks: Farmer-hosted and farmer-owned OFE networks enable participatory experimentation, peer learning, and co-creation of solutions. They ensure that research outputs reflect farmer realities and adoption drivers and provide the empirical foundation for socially adapted 4R Packages of Practice.

On-Station and Long-Term Trials: Long-term trials generate the decision-grade biophysical evidence required to quantify nutrient–soil–water–climate interactions, environmental co-benefits, and system resilience. They de-risk innovation by testing and refining agronomic concepts before they advance to on-farm experimentation and underpin MVP development and national soil and nutrient strategies.

Digital Knowledge and Decision-Support Platform: All mechanisms are enabled by APNI's digital platform, which provides the analytical backbone for data integration, agronomic and economic modeling, ROI and risk analysis, and joint interpretation with partners and farmers. The platform supports MVP development and strengthens institutional learning, performance, and transparency.

Graduate and Early-Career Researcher Embedding: Graduate students and early-career researchers are embedded directly within APNI's research activities, contributing to priority questions while completing degree programs. This simultaneously strengthens scientific outputs, accelerates MVP development, and builds a pipeline of next-generation crop nutrition scientists.

APNI as an African Research Catalyst: APNI operates as a scientific convener and knowledge broker, mobilizing and aligning internal and external resources in support of African-led crop nutrition

research. Resources are channeled through trusted NARES and university partners to ensure that investments advance both cutting-edge science and long-term institutional capacity, in line with continental priorities.

Partnerships, Stakeholders, Policy Support

Partnering is central to APNI's ability to translate research outputs into sustained system-level impact. Through partnerships, MVPs and institutional competencies developed in anchor countries are adapted, transferred, and scaled across regions, value chains, and policy systems. APNI works through five complementary partner types, each with a distinct and coordinated role:

Strategic Partners: Co-create long-term value through shared vision, scientific leadership, and the co-development of MVPs that drive system-level change.

Scaling Partners: Possess the mandate, networks, and market position to take validated MVPs and institutional solutions beyond their original development domain, translating them into policy uptake, investment instruments, market integration, and multi-country or regional programs.

Resource & Investment Partners: Industry, governments, development agencies, foundations and financiers who provide the core funding and collaborate to convert research evidence and MVPs into actionable policy instruments, investment cases, and blended-finance models.

Functional Development Partners: Deliver project-level execution and early-stage innovation, supporting on-the-ground research activities and learning processes.

Operational Partners: Provide the essential services, inputs, technologies, and infrastructure required for day-to-day office and research operations and efficient execution.

Partnerships are selected and managed based on alignment with APNI's mission, scientific credibility, institutional capacity, ability to support scale, and financial robustness.

APNI actively engages private-sector actors, value-chain stakeholders, and policymakers to ensure that research outputs and MVPs inform real-world decisions. By embedding 4R Nutrient Stewardship within commercial systems, service-bundling models, and procurement frameworks, APNI creates continuous feedback loops that generate decision intelligence and ensure responsiveness to emerging market and policy priorities.

APNI works with governments, development partners, and financiers to translate research evidence and MVPs into actionable policy instruments, investment cases, and blended-finance models. This approach moves crop nutrition innovations beyond pilots toward sustained national and regional scaling, closing the loop from research to institutionalized impact.

Communicating Outcomes and Impact

Under APNI2030, communication is positioned as a strategic driver of impact through its transformation of scientific results into influence, investment, and system-wide change. Its purpose is not only to share evidence, but to motivate action, shape decisions, and mobilize partnerships.

Communication serves three core functions:

- Translating evidence into decision-relevant narratives that contextualize findings and drive adoption of preferred actions and practices.
- Mobilizing partners and resources to accelerate uptake, scaling, and impact across African agri-food systems.
- Positioning APNI as Africa's leading scientific voice on sustainable crop nutrition and 4R Nutrient Stewardship.

To deliver this strategy, APNI structures its communication around a set of thematic flagships created to describe the outputs and outcomes achieved along our solution pathways.



4R Knowledge in African Cropping Systems (4R4Africa): Driving the research and development required to build science-based 4R strategies, while supporting the widespread adoption of 4R practices at scale.



Empowering Farmer-Centric Agricultural Transformation (Empower OFE): Advancing data driven co development and discovery of actionable agronomy, with a strong emphasis on scalable solutions that build on farm value and farmer led innovation.



Agronomy to Recapitalize Multiple-Benefit Landscapes (Land CAPITAL): Developing and promoting innovative nutrient use and crop diversification combinations that optimize landscape performance and ecosystem benefits.



Resilient Agriculture for African Drylands (RAFAD): Fostering adaptive, on farm, climate smart research solutions that enhance soil health, productivity, and resilience in dryland systems.



Excellence in African Crop Nutrition Research and Outreach (EXCEL Africa): Recognizing outstanding contributions to crop nutrition research across Africa, while strengthening mentorship, supervision, and research capacity for early and mid-career researchers through training and embedded research partnerships.



The **Growing Africa (GA) Hub** serves as APNI's central platform for communication and visibility. It integrates evidence, success stories, and policy-investment narratives generated across APNI's research portfolio—demonstrating how our science-to-impact model links research outputs and MVPs to measurable improvements in food security, productivity, resilience, and livelihoods.

This modular digital hub currently houses the Growing Africa hybrid journal designed to expand access to practitioner-centric science. Throughout APNI2030, the GA platform will be scaled to broaden institutional capacity for digital outreach through a suite of communications products and interactive forums.

Together, our Growing Africa Platform and thematic communication flagships ensure that our outputs are communicated as credible, actionable, and investable solutions. Expanded digital outreach is supported by our regional communication capacity and monitored through a systematic integration of communication performance indicators (e.g., reach, engagement, influence) into APNI's Results Framework. This approach moves APNI's work beyond academic or project boundaries, translating evidence into real-world adoption, investment, and policy influence, and reinforces APNI's role as a catalytic leader in Africa's agri-food systems transformation.

What **We Believe**



Science creates **lasting impact** only when it is **contextualized**, **actionable** and **value-driven**.



Our philosophy centers on **empowering farmers** through informed decision-making rather than prescriptions, while maintaining high **ethical standards** and **FAIR data policies**.



APNI seeks to foster a **healthy environment** and ensure that African agriculture remains globally competitive, sustainable, and locally fulfilling.



By valuing the **shared wisdom** of **strong and diverse partnerships**, we aim to contribute to a **food-secure** Africa where no community is overlooked.

Learn more about partnering opportunities at apni.net/partnering.

APNI Offices:

Headquarters - Benguéir, Morocco

North Africa - Settat, Morocco

West Africa - Yamoussoukro, Côte d'Ivoire

East & Southern Africa - Nairobi, Kenya



www.apni.net