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Harnessing Solar-Powered Irrigation in Nigeria

Fix the "missing middle" to scale solar-powered small-scale irrigation for food security, jobs, and climate resilience

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Key Messages

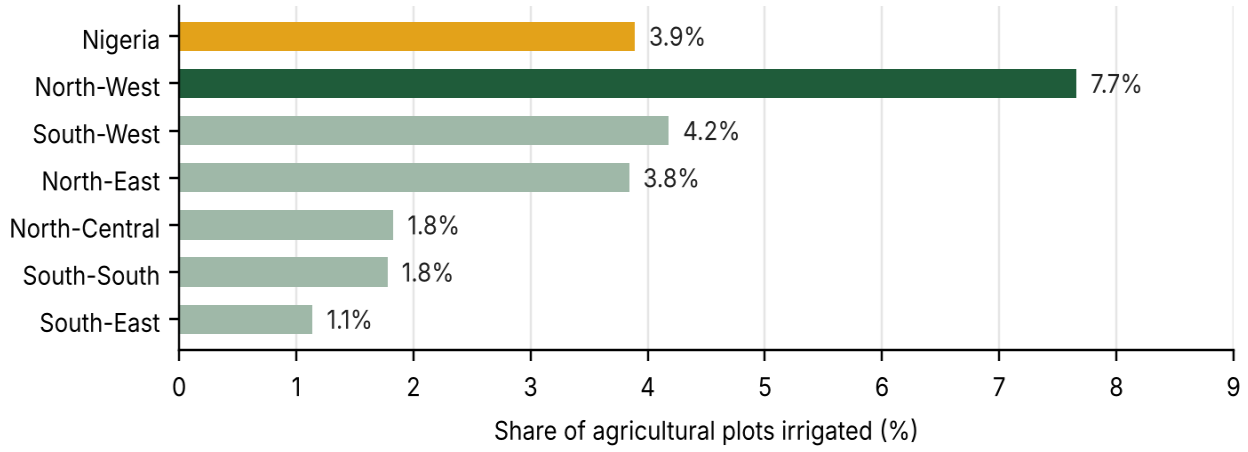
- **Nigeria irrigates only a sliver of its farmland.** Just 3.9 percent of the country's 76 million agricultural plots are irrigated, while more than 90 percent of agricultural output depends on increasingly erratic rainfall.
- **The country's potential gains from irrigation are among the largest in Africa.** About 1 million hectares could profitably be brought under small-scale irrigation in the dry season, backed by abundant sunshine and shallow groundwater across the north.
- **Solar is now the smart energy choice.** Since the removal of the petrol subsidy in 2023, fuel-based pumping has become far more expensive; solar pumps can cut operating costs by an estimated 60–80 percent and emissions by more than 95 percent.
- **The binding constraint is not the farmer but the "missing middle."** This includes fragmented public mandates, risk-averse lenders, thin and unregulated supply chains, gender exclusion, and missing data.
- **Government should build the middle, not just buy pumps.** These efforts must include setting up a standing coordination platform, de-risking finance with harvest-synced repayment, enforcing equipment quality, investing in data as a public good, and designing for women, youth, and groundwater safety from the start.

The case for action: A rainfed economy in a hot, dry climate

Nigeria's agrifood system anchors the country's non-oil economy, contributing roughly 40 percent of gross domestic product and about two-thirds of employment. Despite this, around 41 million agricultural households still farm almost entirely under rainfed conditions (Edeh et al., 2026). More than 90 percent of agricultural output comes from rainfed farming, leaving production exposed to dry spells, late onset of rains, and drought (Balana et al., 2025). Only 3.9 percent of agricultural plots are irrigated, according to nationally representative data from the 2022/23 National Agricultural Sample Survey (NASS), which covers 152,485 households and 76.5 million plots (NBS, 2024; Iraoya and Balana, 2026). Even in the northwest, the country's irrigation heartland, less than 8 percent of plots are irrigated (Figure 1).

The lack of irrigation is a missed opportunity on a national scale. Among all countries in sub-Saharan Africa, Nigeria has long had the greatest potential to expand small-scale irrigation (SSI) (You et al., 2011). Accounting for both biophysical and economic limits, about 1 million hectares are suitable for profitable SSI investment in the dry season and 0.65 million hectares in the rainy season (Xie, You and Takeshima, 2017). Farmer-led irrigation is one of the most cost-effective levers for increasing yields, enabling a second or third cropping season, stabilizing incomes, and improving nutrition (Burney and Naylor, 2012; Woodhouse et al., 2017).

Figure 1. Share of agricultural plots under irrigation, by geopolitical zone, 2022/23



Source: Iraoya and Balana (2026), computed from NASS 2022/23 microdata (NBS, 2024).

Why solar, and why now?

Northern Nigeria, home to more than 60 percent of the country's farming households, combines three assets that make it unusually well suited to solar-powered irrigation systems:

- **Abundant sunshine.** Much of the north receives some of the highest solar irradiation in Africa, with year-round output strongest in the dry season, when irrigation is needed (World Bank/ESMAP Global Solar Atlas n.d.).
- **Accessible groundwater.** On-farm groundwater from shallow wells and boreholes already supplies 53.5 percent of irrigated plots nationally and 81.4 percent in the northeast (Iraoya and Balana,

2026). The *fadama* floodplains of Kebbi, Niger, Jigawa, Kano, and Kaduna hold shallow aquifers that remain largely untapped for dry-season farming (Ojeleye et al., 2026; MacDonald et al., 2012).

- **Strong unmet demand.** Across workshops in Kano, Oyo, and Abuja, intermediaries consistently reported high farmer demand for affordable, off-grid pumping. As summed up by one participant, "Farmers are ready; it is the system that is not ready for them" (Iraoya and Balana, 2026).

The economy has also shifted significantly. When diesel was subsidized at about US$0.57 per liter in 2018/19, solar pumping in Nigeria was only competitive at very low system costs (Xie, Ringler and Mondal, 2021). The removal of the petrol subsidy in May 2023 sharply raised fuel costs and reduced dry-season irrigation intensity; solar pumping can cut operating costs by an estimated 60–80 percent relative to diesel (Ojeleye et al., 2026). Solar pumps carry higher upfront costs but, in many locations, their lifetime costs are cheaper than petrol or diesel pumps, and they can cut greenhouse gas emissions per unit of energy by more than 95 percent (FAO, 2018). India's expansion from about 10,000 solar irrigation pumps in 2013/14 to roughly 2 million today shows how fast the technology can scale when policy, finance, and supply chains are aligned (Ojeleye et al., 2026).

What is holding Nigeria back? The "missing middle"

Conventional opinions blame low adoption on farmers being unaware, risk-averse, or too poor to invest. New peer-reviewed evidence reframes the problem: By combining an agricultural innovation systems lens with human-centered design (HCD) workshops involving 85 stakeholders from 37 governmental, financial, and private-sector organizations, Iraoya and Balana (2026) show that Nigeria's SSI bottlenecks stem primarily from systemic failures among the "missing middle," which includes all the intermediaries that must work together to make markets function. Table 1 presents the major interlocking failures.

Table 1: Systemic failures, as reported by stakeholders

Failure	What stakeholders reported
Fragmented governance	Overlapping mandates at the federal, state, and River Basin Development Authority level lack shared data and joint planning: "Every agency has its own irrigation project, but no one has the complete picture." Most public irrigation budgets are dedicated to large dams and canals rather than farm-level systems.
Finance and risk	Lenders perceive high risk; require collateral that many smallholders, especially women, cannot provide; and offer short monthly repayment tenors that conflict with seasonal farm incomes. "We have capital to lend, but we lack confidence in the repayment environment."
Thin, unregulated supply chains	Challenges include few dealers, high import costs, and currency volatility; uncertified equipment that fails quickly and erodes trust; and a scarcity of rural technicians and spare parts. "We sell the pump, but there are no service and maintenance centers to keep it running."
Data, extension, and inclusion gaps	No irrigation-suitability or groundwater maps exist to guide lenders and planners; some states have as few as 1 extension agent per 10,000 farmers; and women "ask for pumps every season, but suppliers rarely approach them."

Source: Iraoya and Balana (2026); Balana et al. (2025); Ojeleye et al. (2026).

The implication of these findings is powerful: the technology works and demand exists, but functioning links are missing between farmers, suppliers, financiers, and government. Similar institutional bottlenecks slowed farmer-led irrigation in Ghana, Ethiopia, and Kenya, but markets there expanded quickly

once finance, supply, and governance were aligned (Lefore et al., 2019). If the binding constraint is the missing middle, then the solution is to build the middle.

Proof of concept: Convening the solar irrigation market in Jigawa State

In July 2026, IFPRI and the Jigawa Agricultural Transformation Agency (J-ATA), under CGIAR's Scaling for Impact Program, convened actors from across the full solar irrigation supply chain for an innovative encounter (Edeh et al., 2026). Field demonstrations at three sites, each with more than 100 farmers, gave farmers the opportunity to directly ask dealers about prices, servicing, and spare parts, a genuine demand–supply encounter rather than a conventional extension demonstration without the presence of sellers. A workshop with about 100 participants followed to link farmers, five equipment dealers, banks (Jaiz, Sterling, TAJ, and the Bank of Agriculture), NIRSAL, women's organizations, and government representatives.



Farm field demonstration of solar-powered irrigation in Jigawa

Results came fast: A local community leader offered a warehouse to any dealer willing to open a local outlet, vendors began forming partnerships to bundle complementary products, and banks stressed that sharia-compliant leasing (*ijara*) and cost-plus (*murabaha*) products with harvest-synced repayment would be preconditions for uptake in the region. As one banker put it, "The challenge is no longer only access to solar technology. The challenge is access to the financing required to acquire it." Participants endorsed an 18-month state roadmap overseen by a multistakeholder steering committee, with success measured by the number of farmers owning working systems, hectares irrigated, jobs created, and incomes raised.

Policy options: What works and what does not?

Option 1: **Continue with business as usual** by focusing public investment on large dams and canal schemes. This approach works the least well: it has left most smallholders outside the irrigated economy and does not reach decentralized, groundwater-based farmers, where demand is greatest.

Option 2: **Distribute free or heavily subsidized pumps.** Giveaways can create quick visibility, but they risk crowding out private dealers, reach relatively few farmers, neglect servicing, and stall when grants end. At best, grant-funded distribution is a short-term measure (Ojeleye et al., 2026).

Option 3 (recommended): **Build a market system for solar irrigation.** The government can use its convening power, regulation, and targeted public finance to connect and de-risk farmers, dealers, and lenders. Stakeholders co-designed this approach in the HCD workshops, and Jigawa is now piloting this option. This approach works best because it mobilizes private capital, sustains post-sale service, and can be scaled beyond the reach of any single public budget.

Recommendations

Federal and state governments, working with financiers, suppliers, and development partners, should act on six priorities:

1. **Establish a National SSI Coordination Platform** anchored in the Federal Ministry of Agriculture and Food Security, with mirrored state platforms modeled on the Jigawa steering committee. It should align federal, state, and River Basin mandates; shift a share of irrigation budgets from large schemes to farmer-led systems; and establish ongoing engagement between dealers, lenders, and farmer groups that extend beyond one-off events.
2. **De-risk and redesign irrigation finance.** Scale partial credit guarantees, similar to Nigeria Incentive-Based Risk Sharing System for Agricultural Lending (NIRSAL) guarantees, and blended finance; mainstream harvest-synced repayment, equipment-as-collateral, and pay-as-you-go models; standardize the use of sharia-compliant *ijara* and *murabaha* products; and lend through cooperatives and micro-clusters to share liability. Smart subsidies should be targeted to growers of staple crops and women, while commercial loans should serve high-value horticulture.
3. **Enforce quality and grow the supplier network.** Task the Standards Organisation of Nigeria with certifying solar pumps and panels and removing substandard imports; give certified importers predictable foreign-exchange and customs treatment; reduce import duties and taxes on certified solar irrigation equipment; and support regional supplier and service hubs with trained local technicians and spare parts.
4. **Treat irrigation data as a public good.** Build a national irrigation data platform that integrates groundwater, irrigation-suitability, profitability, and market information, building on tools such as the IFPRI–ADUST Irrigation Technology Suitability Mapping Tool, so that lenders can see where irrigation pays and planners can target investment.
5. **Design for women and youth from the outset.** Use group and flexible collateral, women-led supplier franchises, and gender-responsive loan products, and pilot youth-led digital extension through the National Electronic Extension Platform to close the advisory gap (World Bank, 2022).

6. **Scale responsibly by safeguarding groundwater.** Pair every solar expansion program with aquifer monitoring, water-use plans, and efficient application (drip and well-designed furrows), so that cheap solar energy does not drive over-abstraction (FAO, 2018; Kihoro et al., 2025).

Conclusion: From commitments to installed systems

Nigeria has sun, water, and farmers. What it lacks is a functioning middle that converts farmer demand into financed, serviced, and sustainable solar irrigation systems on the ground. Building that middle is a design problem, and demand-supply linkages in Kano and Jigawa show that this challenge can be tackled inexpensively. By coordinating institutions, de-risking finance, enforcing quality, and investing in data and inclusion, governments can unlock year-round, climate-resilient production, create rural jobs, and lower fuel costs for millions of farm households. Above all, progress should be judged by one measure: how many farmers own working solar irrigation systems and how many hectares they irrigate.

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A generative AI tool (Claude AI) was utilized exclusively to optimize sentence structure and the flow of the narrative text. All core findings, strategic framing, recommendations, and conclusions were independently authored by the team.

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