22 Towards Improved Natural Resource Management in African Agriculture

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This final chapter draws together lessons learned from the preceding chapters as to how governments and donors might stimulate necessary investment in improved natural resource management (NRM). The mass of evidence clearly demonstrates that improved NRM practices can contribute significantly to increased agricultural productivity, environmental sustainability and reduced poverty and vulnerability. Since these are strategic objectives in all sub-Saharan African countries, NRM in agriculture plainly merits attention. Moreover, widespread uptake of improved NRM, on a scale sufficient to have a significant impact on aggregate productivity and income measures, is not occurring spontaneously and remains unlikely in the near term without external stimulus. Continued neglect of NRM in agriculture therefore comes at a significant cost.

The key issues revolve around the 'what' and 'how' questions of support to improve NRM: what principles and priorities need to be followed and how can governments and other influential stakeholders take practical steps to follow those principles and priorities? Although the dearth of past policy interventions to support improved NRM limit existing knowledge, some clear principles and priorities exist for fostering the accelerated uptake of improved NRM in African agriculture, as do a few practical findings concerning their implementation.

This chapter highlights these findings, which cumulatively recommend a 'five ins' strategy built on the fundamental point that NRM is an investment choice.[1] Investment is the first and biggest 'in', the strategic objective. Investment depends on four supporting 'ins' – incentives, information, inputs and institutions – just as a table rests upon its four legs. Individuals invest only when adequate information supports the conclusion that the investment will probably prove profitable within the relevant planning horizon and when they have the resources to put into it and confidence in the rules and organizations (the institutions) that ensure they will reap their just returns. As this concluding chapter goes on to describe, each of these four supports is individually necessary, but not sufficient, to stimulate investment in improved NRM and, with it, the dynamic of sustainable agricultural

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intensification and rural development in Africa.

The Policy Imperative: the 'Five Ins' Strategy

Global economic history teaches us that investment in agriculture lays the foundation for economic growth, industrialization and improved health and nutrition. Agriculture continues to account for the largest sectoral share of employment in sub-Saharan Africa (SSA), where poverty remains primarily a rural phenomenon. Africa is the lone continent where per capita agricultural productivity and the incidence of undernourishment have stagnated over the past 40 years. Plainly, agricultural development is a prerequisite for poverty reduction in Africa and yet no significant, widespread and sustained progress has been made since independence. Over the past decade or two, agricultural researchers and rural communities have jointly concluded that the poor state of the natural resource base on which agriculture depends is a primary factor limiting agricultural development and, derivatively, rural economic growth, poverty reduction and food security, both in the near term and for future generations. Unfortunately, however, policy-makers and donors have been slow to invest in improved NRM for agriculture.

The preceding chapters document that improved NRM is feasible and can be economically profitable throughout the continent. Improved fallows, inorganic and organic fertilizers and soil- and water-conservation structures indeed increase yields, returns to labour and cash income in systems as diverse as the semi-arid areas of Niger, Tanzania and Zimbabwe, highland Ethiopia and Rwanda and the subhumid zones of western Kenya and Nigeria. The challenge stems from the limited scale of uptake of improved NRM practices thus far. In order to stimulate aggregate agricultural productivity and rural incomes, adoption rates need to increase by several orders of magnitude, to millions and tens of millions of African farmers. So there is both a pressing need and a demonstrable potential for improved NRM.

The challenge is the dearth of generalized private investment in NRM – the 'in' at the apex of the strategy we advocate – due to problems of incentives, information, inputs and institutions – the remaining four 'ins' that support investment. The constituent problems of this challenge are surely familiar to most readers, but the studies assembled in this volume point towards a new, holistic view that satisfies the crucial test of providing both a useful descriptive lens on recent history and a prescriptive model for moving ahead. Perhaps more importantly, this collection of studies offers key insights on how to promote improved incentives, information, inputs and institutions. Before moving to these issues, we first consider a very brief historical narrative to underscore the under-recognized interrelation between the five 'ins'.

One can usefully oversimplify the history of agricultural development efforts in post-independence Africa as divisible into three distinct periods. The first, post-independence era, roughly from the early 1960s to the early 1980s, emphasized state provision of inputs, such as subsidized credit and fertilizer, and the establishment of institutions intended to support agriculture through parastatal marketing bodies and national agricultural research and extension services. Unfortunately, heavy-handed government intervention generally proved fiscally unsustainable, involved top-down designs that restricted information flow and badly distorted farmer incentives to invest in agriculture, particularly by depressing output prices so as to make farming unprofitable for those with alternative opportunities. This sowed the seeds of institutional collapse in African agriculture.

The failures of the first-generation strategy fed the macroeconomic crisis of the early 1980s and the ensuing era of liberalization and structural adjustment. The policy rhetoric turned almost entirely to incentives – 'getting prices right', as the famous injunction termed it – and macroeconomic reform programmes across the continent emphasized scaling back the state and letting

market allocation mechanisms take over. Unaccompanied by ancillary investments in the physical and institutional infrastructure necessary to support markets, these changes often merely exposed the underlying structural weaknesses that had previously spawned state intervention in rural Africa. The virtual institutional collapse that beset African agriculture reduced the availability of inputs, slowed the flow of information and ultimately undermined the profitability of all sorts of crops, thereby reducing incentives to invest in soil or water conservation or in integrated nutrient or pest management.

Most recently, the failure of market-oriented reforms to stimulate a robust supply response or to reduce rural poverty appreciably has prompted a new-found emphasis on democratization and civil society, moving the focus from incentives to institutions and information. The virtues of participatory approaches to development, of a free press and of social capital have become celebrated by governments, donors and scholars alike. Attention has rightly returned to the need to build capacity in community-based organizations for improved management of common property resources, to reduce information costs and increase information and financial flows through farmer field schools, farmer research committees and microfinancial institutions and to carry out authentically participatory research on poverty and technologies. None the less, the natural resource base continues to deteriorate, as African smallholders respond to weak NRM incentives and scarce essential inputs by divesting their natural capital through the harvesting of nutrients without adequate replenishment.

By its nature, improved NRM in agriculture requires widespread private investment. The absence of widespread, spontaneous adoption of improved methods indicates that conditions prevailing in rural Africa, at least outside intensively supported pilot projects, do not support farmers making essential investments in NRM. The only feasible path forward requires concerted public investment in providing the necessary incentives, information, inputs and institutions. In so far as these pieces of the puzzle have each been the subject of extensive reflection in the past, much appears familiar in the strategy we advocate. It is their necessary integration into a whole, as a foundation for broad-based investment in improved NRM, that is new, as well as urgent.

Core Principles, Priorities and Practical Next Steps

The 'five ins' strategy rests upon several core, interrelated principles that emerge clearly from the preceding chapters. Each principle implies certain priorities for policy-makers who are serious about stimulating improved NRM for accelerated agricultural development in Africa. Where both theory and empirical evidence provide support, we also offer practical suggestions as to the appropriate next steps in policy.

Knowledge-intensive integrated natural resource management

The first core principle around which policy must be designed is that improved NRM practices are knowledge-intensive. They are management practices, not discrete inputs like those that underpin agricultural or industrial production technologies commonly embodied in seed, chemicals or machinery. In part, the knowledge intensity of NRM arises because practices are inherently interrelated. Economists accustomed to thinking about inputs as substitutes would do well to heed the cautions of biological scientists that natural inputs are primarily complements to crop and livestock production. Plants need sufficient minerals and soil organic matter, water and sunlight to grow well. Substitution possibilities among these essential inputs are somewhat limited. So farmers must manage multiple resources well in order to attain and maintain high productivity. This basic observation is too commonly overlooked in the agricultural and development policy communities.

This principle carries several implications for policy priorities and practices. First, the agricultural community needs to move more vigorously towards integrated NRM that tackles the simultaneous problem of soil, water and biomass management, as distinct from promotion of individual practices or technologies (e.g. alley farming, irrigation, terracing, tied ridges). Appropriate packages of practices have been insufficiently identified and extended in most of Africa. Most individual elements of these packages exist already, but they are scattered. In business terms, the issue is less production than packaging and distribution. A high research priority needs to be placed on identifying and promoting best-bet packages of practices and technologies, much as the Soil Fertility Network is doing in southern Africa (Makuria and Waddington, Chapter 17). The economic pay-off appears to be high. The collaborative report *Can Africa Claim the 21st Century?* (World Bank, 2000b) finds a 37% internal rate of return on agricultural research, and recent International Food Policy Research Institute (IFPRI) research shows similar, spectacular expected returns to agricultural research (Alston *et al.*, 2000).

Secondly, and relatedly, it is time to end the artificial conflict between so-called 'modern' methods, based on chemical fertilizers, irrigation and improved cultivars, and 'traditional' or 'agroecological' methods, based on intercropping, rotations, cover crops and organic nutrient supplements. Most of the chapters emphasize the existence of crucial complementarities between inorganics and organics. Although farmers will try to substitute one sort for the other, as occurred in much of Africa over the past decade as fertilizer prices rose sharply in the wake of structural adjustment policies (see Barrett *et al.*, Chapter 1, Gladwin *et al.*, Chapter 9, and Shapiro and Sanders, Chapter 20), such substitution mainly limits the rate of productivity decline. Productivity improvements depend on recognizing and reinforcing complementarities. Governments and donors might do well to enact explicit interlinkage and cross-compliance policies, such as providing farmers who undertake and maintain soil- or water-conservation investments with coupons to subsidize fertilizer purchases through commercial distributors – that is, subsidies that foster NRM investment and simultaneously provide demand stimulus for the development of private fertilizer markets. This same basic design has proved remarkably successful in other settings, such as in respect of investments in early childhood nutrition through the USA's Women, Infants and Children (WIC) programme (Barrett, 2002).

Thirdly, information flow must improve between and within national agricultural research and extension systems (including universities), rural communities, non-governmental organizations (NGOs), private traders and individual farmers. The issue extends well beyond familiar prescriptions to encourage participation. More effort needs to go into conceptualizing and implementing institutional and organizational frameworks within which participation occurs, so as to harness the comparative advantages of inherently complementary groups in a resource-starved environment. There is, as yet, no accepted analytical model for how to effectively integrate universities and agricultural research institutes, which are better positioned to undertake *de novo* applied research and to conduct both *ex ante* impact assessment and *ex post* evaluation of interventions, with NGOs, extension services and community-based organizations, which are relatively more able to engage farmers in an ongoing dialogue about research and policy priorities, and with cooperatives and commercial traders, which are effective at distributing new materials (e.g. germ-plasm, fertilizer, lime) to those who can best use them. Entities' capabilities vary across functions and user groups, so there need to be multiple, complementary channels for the production and dissemination of information for farmers.

Information is central to the ongoing research problem surrounding NRM (Place *et al.*, Chapter 21). Although some technology gaps remain – especially in water management, less so with respect to soil conservation and fertility management – the immediate scaling-up problem reflects

mainly insufficient farmer demand for investment in improved NRM under prevailing conditions. Although essential technological components exist amid the wealth of modern and traditional practices observable on the African continent, the agricultural research and extension community still lacks a clear understanding of how best to combine techniques to suit different agro-ecological and market conditions. As several chapters establish, where truly practised, farmer participation is realizing much of its potential by accelerating the identification of which among the many potentially problematic factors limits farm productivity and the uptake of existing techniques in a given location, thereby accelerating the development of more suitable practices. The experiences Tarawali *et al.* (Chapter 5) report from West Africa are especially encouraging.

Fourthly, knowledge intensity places a premium on education, not just for literacy or numeracy, but for analytical, observational and communication skills. Rural schools have suffered across Africa over the past decade, as central government budgets have been cut and local government revenues have proved insufficient to sustain public schools. The introduction of user fees has caused many poorer families to pull children out of school, at least in times of financial stress, although households commonly go to great lengths to try to get and keep at least some of their children in school. In high-potential areas, education often provides not only the capacity to respond better to changing technologies and environmental conditions (Schultz, 1975; Barrett *et al.*, 2001e), but also access to non-farm income-earning opportunities, which are essential to on-farm investment in improved NRM (Tiffen *et al.*, 1994; Barrett *et al.*, 2001d; Barrett *et al.*, Chapter 1, Clay *et al.*, Chapter 8, and Wyatt, Chapter 10, this volume). In lower-potential areas, the relationship between education and NRM appears more complex, as the educated commonly disinvest from agriculture (Wyatt, Chapter 10). Donors and NGOs can contribute materially here since investment in education remains low. For example, less than 8% of World Bank lending since 1994 has gone to education projects. Doubling this would help improve the quality of instruction for existing students, as well as making education accessible to children from poorer families and more remote regions. One appealing possibility is to couple this with the global school feeding programmes being advocated in high-level policy discussions currently, paying for education partly through food-aid deliveries, so as to pursue integrated human-capital formation linking education, health and nutrition.

Farmer-centred policy and research design

The second core principle evident in the preceding chapters – and closely related to the first – is that the development, extension and evaluation of NRM innovations and policies must be farmer-centred. The extraordinary biophysical, cultural and economic variability of rural Africa makes it difficult to identify effective local solutions without early, active involvement of local farmers and communities. The undistinguished history of top-down technology development, input distribution and extension services in Africa stands in stark contrast to encouraging cases of rapid adoption and resourceful adaptation of researcher-developed techniques in places where farmers have been fully involved as co-developers and co-evaluators of NRM practices from the early, problem-identification stage onwards (Pretty and Buck, Chapter 2, Adesina and Chianu, Chapter 4, Tarawali *et al.*, Chapter 5, Kelly *et al.*, Chapter 15, Shapiro and Sanders, Chapter 20, and Place *et al.*, Chapter 21). An insufficiently nuanced understanding of the local context by outsiders and the (often prudent) distrust of outsiders' 'science' account for much of the low adoption rates of many 'improved' practices and technologies among African smallholders. Quite apart from ethical and political-economy questions of empowerment, participatory methods are necessary in order to identify and promote locally appropriate practices. Relatedly, there is an inherent

complementarity between 'indigenous' and 'scientific' knowledge (Peters, Chapter 3).

The disconnection has been not only between bench scientists developing supposedly 'improved' NRM techniques and farmers who reject these innovations, but also between policy-makers, who set national-level policy, and their constituents, who pursue strikingly different priorities. Hatibu *et al.* (Chapter 16) offer an especially vivid description of the policy failure of top-down approaches in semi-arid Tanzania.

Three policy priorities emerge from this second core principle. First, although both the agricultural and development communities have largely embraced participatory approaches, there remains little institutional structure for expanding participation to scales beyond specific research or intervention sites. The establishment of effective local governance complemented by competent, specialized central government agencies must be made a priority. In recent years, much emphasis has rightly been placed on decentralization of authority from the centre to localities in response to past malfeasance or misfeasance. Too often, however, decentralization and the broader roll-back of the public sector have emasculated the central government's capacity to perform essential functions. As Krueger (1990) emphasized, past government nonfeasance is as much the problem as malfeasance or misfeasance.

There are important, unresolved issues surrounding the appropriate division of responsibility between different levels of government authorities and between state and extrastate institutions (Pretty and Buck, Chapter 2, Gebremedhin and Swinton, Chapter 6, Freudenberger and Freudenberger, Chapter 14, Kelly *et al.*, Chapter 15, and Hatibu *et al.*, Chapter 16). These issues revolve largely around reconciling the need to: (i) internalize environmental externalities associated with NRM – a classic common-property management problem; (ii) achieve a minimum efficient scale in activities characterized by significant fixed costs – a coordination problem familiar to students of cooperatives; and (iii) respect different institutions' comparative advantage in performing distinct, but complementary tasks. For example, communities commonly prove more effective at enforcing access and use rules (Ostrom, 1990; Baland and Platteau, 1996; Gebremedhin and Swinton, Chapter 6, this volume), but are ineffective at providing essential infrastructural services, in which case regional or national governments must be involved (Freudenberger and Freudenberger, Chapter 14). The appropriate level for control depends fundamentally on the scope of the ecological externalities, as well as on the capacity of institutions at different levels to gather information, to make and enforce sound judgements and to raise the necessary financing for essential operations (Barrett *et al.*, 2001c; Gjertsen and Barrett, 2001).

Secondly, and relatedly, civil strife impedes the effective functioning of government and extragovernmental institutions responsible for coordinating resource use and policy. Divisive politics and recurrent violence pose hazards beyond and more serious than poor NRM. Much as macroeconomic factors tend to have a greater effect on agriculture than do sectoral interventions (Krueger *et al.*, 1988), so too do broader societal conditions trump narrower NRM policies in conditioning the use of soils and water. There is, at best, limited potential for progress in stimulating improved NRM, agricultural intensification and rural economic growth and poverty alleviation if governments and donors fail to effectively address the widespread problems of uncivil society and violations of the rule of law. Indeed, these fundamental problems undermine the functioning of rural institutions to support agriculture and NRM. Although agricultural specialists have little expertise – and sometimes interest – in inherently political questions about social stability, its importance must be acknowledged and supporting efforts to establish a civil social and political discourse must be made a priority, even by those of us with expertise elsewhere.

Thirdly, and perhaps paradoxically, a farmer-centred approach to NRM in agriculture must transcend traditional sectoral specificity in order to take seriously the broader livelihood objectives of rural

Africans. Priority must be placed on developing the rural non-farm economy along with agriculture. Most rural Africans farm because, given the assets they hold, the opportunities and constraints they face and their location, farming is an attractive piece of a broader strategy to take care of themselves and their families. Most African farmers none the less undertake non-farm activities, and non-farm earnings are positively related to subsequent upward income mobility in rural Africa (Reardon, 1997a; Barrett *et al.*, 2001b,d).

Beyond introducing the non-farm rural economy into the debate about agricultural development policy, a broader livelihoods perspective also implies a caution against mistaking adoption of NRM methods as an end in itself. Indeed, as Tarawali *et al.* (Chapter 5) show, disadoption of NRM – in their case, of green-manure cover crops – may indicate attainment of the livelihood objective that motivated the initial adoption. Furthermore, as Wyatt (Chapter 10) emphasizes, for some rural Africans the most economically and agroecologically appropriate investment opportunities lie in non-farm sectors, not in agriculture.

In the medium to long term, economic growth will inevitably spawn a disproportionately rapid expansion of the rural non-agricultural sector, as has been the case in all agricultural transformations in history (Timmer, 1986). Growth in the rural non-farm economy can fuel a virtuous circle of improved NRM management by resolving liquidity constraints (Holden and Shiferaw, Chapter 7, Clay *et al.*, Chapter 8, and Hatibu *et al.*, Chapter 16) or it can induce disadoption of improved NRM practices, or even accelerated resource degradation, as the returns to labour and capital outside agriculture outcompete investments in improved NRM (Barrett *et al.*, 2001a; Wyatt, Chapter 10, this volume). At present, we have insufficient understanding of the factors behind the empirically ambiguous relationship between NRM and the rural non-farm economy in SSA. Much seems to depend on whether input and output market conditions make investment in agriculture and supporting natural capital attractive.

Improved natural resource management must pay

Farmers incur real costs to undertake NRM investments. They must dedicate time that could be devoted instead to other farm or non-farm activities, and they must often also use land or cash having considerable opportunity costs. Investment in immovable natural resources also exposes them to considerable risk – of poor harvests, low prices, asset appropriation – which weighs heavily on vulnerable people. No reasonable person would incur such costs unless the broader economic environment makes it pay, and within a reasonable time span. The third core principle of these studies is consequently that the widespread uptake of improved NRM practices depends on commercially viable agriculture or significant subsidies. While long fallow rotations worked in the distant past, in the face of low population densities, semi-subsistence agriculture cannot support widespread improved NRM in contemporary Africa.

Improved NRM consistently appears among high-value cash crops. Farmers apply chemical fertilizer and invest in conservation structures, organic-matter application, cover crops and improved fallows at much higher rates on areas planted in commercial crops than they do on areas devoted to subsistence production. Farmers see the return to the quite tangible costs of investing in improving productivity (and sustaining improved productivity) when they get an obvious pay-out from the market. If the returns to agriculture cannot compete with those from other activities, the empirical evidence clearly indicates that farmers do not invest scarce investment resources in natural capital.

The tough challenge then revolves around how to make NRM investment pay among the broad mass of smallholders producing cereals, tubers and roots under rain-fed conditions for home consumption or purely local markets. Simply put, this requires subsidies – information production and dissemination, institutions to organize input procurement and output marketing, or complementary inputs (not just fertilizer or

only terraces). Improved NRM takes place in the production of semi-subsistence staples almost only where one finds localized, *de facto* subsidization through temporary projects offering institutional and informational support and inputs (Gebremedhin and Swinton, Chapter 6, Place *et al.*, Chapter 12, Kristjanson *et al.*, Chapter 13, Freudenberger and Freudenberger, Chapter 14, Kelly *et al.*, Chapter 15, Hatibu *et al.*, Chapter 16, Mekuria and Waddington, Chapter 17, and Shapiro and Sanders, Chapter 20). Across the continent, such mini-packages have replaced and replicated policies terminated 15–20 years ago in the context of structural adjustment programmes. Scant NRM investment takes place outside these implicitly subsidized intervention zones and commercially viable operations. Improved NRM practices can render staples production profitable without ongoing subsidies to farmers, but adoption does not seem to occur without an initial stimulus through subsidized, public investment in information and institutions. Poor smallholders dependent on low-value crops cannot afford to invest much in experimentation, so the upfront costs of establishing the efficacy of a technique must be borne more broadly, as are the later benefits of improved NRM. Thereafter, improved NRM adoption may boost agricultural profitability, rather than the other way around, by either or both of two pathways. Cereals, roots and tubers can become profitable, as demonstrated by the studies of improved fallows in western Kenya (Place *et al.*, Chapter 12) and soil- and water-conservation structures in the Sahel and Ethiopia (Shapiro and Sanders, Chapter 20). Or improved NRM can encourage the adoption of higher-value crops, as in the case of biomass transfer that was demonstrated on maize to western Kenyan farmers, who then began to use the technique on vegetables grown for market (Place *et al.*, Chapter 12).

Generalized subsidization of investment is fiscally infeasible in sub-Saharan Africa. Even for rich-country governments in North America and Europe, conservation programmes involving direct payments or subsidies to farmers pose significant budgetary burdens. The practical question of how to make NRM investment pay must therefore be approached more obliquely: what feasible public investments can increase the returns to agriculture enough to make investment in improved NRM pay? Put differently, what public goods and institutions 'crowd in' private investment in improved NRM practices and soil- and water-conservation structures? This is in marked contrast to pre-structural-adjustment policies, which crowded out private investment.

Physical infrastructure and associated technologies are an important ingredient. Freudenberger and Freudenberger (Chapter 14) emphasize the importance of transport infrastructure if smallholders are to play to their agroecological comparative advantage (e.g. cultivating a commercial and sustainable banana crop rather than an extensive rice crop in the forests of Madagascar's eastern escarpment). One might also emphasize communications infrastructure, since informational deficiencies appear to be an important part of rural market imperfections in Africa (Omamo, 2001). The African continent has only as many phone lines as does the Borough of Manhattan within New York City. Cellular and wireless communication technologies make it possible to establish and maintain service to areas too costly to serve with wire-based technologies. Such innovations are taking place in rural Bangladesh already, under the leadership of Mohammed Yunus, the founder of the celebrated Grameen Bank, a pioneer in the area of microfinance. Credible government or donor guarantees of infrastructural investments in the event that the local community undertakes the minimum necessary levels of private investment in improved NRM, whether through collective or individual efforts, can be used effectively as inducements, as has been the experience in India (Chopra, 1997).

The second priority area associated with establishing an enabling market environment relates to the institutional setting, or the rules of conduct necessary for individuals to contract with confidence and to feel secure in their claims to durable assets, such as land, livestock and water. Most of the preceding chapters emphasize the importance

of clear, durable property rights. This includes security against seizure by invaders, by the state or by powerful individuals, which can include husbands and brothers who prey upon women's relative powerlessness in resource control in some cultures (Gladwin *et al.*, Chapter 9). Building up land markets can help to capitalize soil quality in land values, thereby making investment in NRM more attractive. But, in the presence of binding financial constraints, increased investment may be concentrated mainly among the wealthy, exacerbating rural wealth and productivity inequality (Carter and Olinto, forthcoming).

The institutional issues extend well beyond the security of productive assets – especially land and livestock – to ensuring that farmers indeed receive what a package's label or a trader or another farmer promises, or else they can reasonably expect compensation for breach of contract. Trust is an essential ingredient of market exchange, but is itself a scarce commodity. Individuals' repeated interaction provides a modest level of contract enforcement capacity, but economic history clearly shows that public and private order institutions are central to the minimization of transactions costs and the development of commerce (Platteau, 1997a,b). Establishing or restoring the rule of contract law in agricultural markets can substantially extend the reach of commercially viable agriculture in rural Africa.

The third priority area relates to rural financial systems, which are notoriously underdeveloped throughout Africa. Insufficient credit, insurance and savings impede investment in improved NRM, just as in other forms of productive capital, and thereby trap rural Africans in long-standing cycles of poverty and vulnerability. As the old adage has it, 'it takes money to make money', and African smallholders too often lack the funds necessary to invest in remunerative (and sometimes risk-reducing) livelihood strategies based on improved NRM (Barrett *et al.*, 2001d; Holden and Shiferaw, Chapter 7, Clay *et al.*, Chapter 8, Wyatt, Chapter 10, and Hatibu *et al.*, Chapter 16, this volume). The preceding chapters none the less underscore that low-cost investments are increasingly available and adopted by small farmers. This includes the use of fertilizers now distributed in small sachets (Freeman and Coe, Chapter 11) and the adoption of inexpensive improved-fallow seedlings (Gladwin *et al.*, Chapter 9, and Place *et al.*, Chapter 12).

The fourth and final priority area concerns organization for collective action, echoing a point made in the previous subsection in respect of farmer-centred approaches to agricultural development. Significant fixed costs can make market participation unremunerative at the individual level. When farmers can cooperate in purchasing fertilizer, lime and other inputs, in building community nurseries to cultivate seedlings not readily purchased on the market and in selling marketable produce, they can thereby achieve the minimum efficient scale of production or distribution necessary to make investment in agriculture, and derivatively in improved NRM, pay. Cooperatives have unfortunately had a largely undistinguished history in independent Africa, but often that relates to top-down organizational designs and rules established outside the group itself, as in Tanzania's experience under *ujamaa*. Collective action can be highly complementary to market development, as amply demonstrated by the plethora of small self-help groups that have formed group marketing arrangements across the continent.

Conclusion

The agricultural development community has gradually come to recognize improved NRM as fundamental to sustainable agricultural intensification, which is itself a necessary, albeit not sufficient, condition of economic growth, poverty alleviation and environmental conservation (Lee and Barrett, 2000). However, the relatively slow rate of uptake of improved NRM practices by small farmers operating under harsh agroecological conditions and considerable socio-economic stress underscores the magnitude of the challenge of stimulating private investment on a capital-starved

continent. Meeting this challenge requires the proper incentives, information, inputs and institutions to support widespread investment in improved NRM, or what we term the 'five ins' strategy. For too long, policy-makers and donors have focused on just a subset of these, to the effective exclusion of the others, ultimately undermining African farmers' ability or willingness to invest in natural resources to support agriculture. All four pieces of the puzzle are necessary to promote investment in improved NRM. Donors and governments have searched for short cuts for too long.

The varied experiences reported in this volume reveal three core principles that must underpin an effective strategy of improved NRM for African agriculture: (i) improved NRM practices are knowledge-intensive; (ii) the development, extension and evaluation of NRM innovations and policies must be farmer-centred; and (iii) the widespread uptake of improved NRM practices depends on a commercially viable agriculture or significant subsidies. Each of these principles implies a few policy priorities, which this chapter has briefly outlined and the preceding chapters have elaborated on in some detail. Cumulatively, the resources required to advance this agenda will doubtless prove substantial. But these pale beside the cost of failing to pursue a strategy up to the task of stimulating NRM investment by African farmers. If the agricultural and development communities follow these principles and priorities, the encouraging improvements in NRM already evident on thousands of farms in communities ranging across Africa can be multiplied rapidly, thereby improving livelihoods for the current generation of rural Africans and sustaining the resource base on which their children and grandchildren will depend.

Note

[1] Just before this volume went to press, Tom Tomich helpfully pointed out the similarity between our 'five ins' strategy for NRM and the 'four Is' strategy for agricultural development in the 1986 Food and Agricultural Organization (FAO) report, *African Agriculture: the Next Twenty-five Years*, its expansion to a 'five Is' approach by the Kenyan agricultural economist Bill Omamo, and the later 'six Is' strategy in Tomich *et al.* (1995: 166–177). This volume reinforces those earlier analyses.