# 7 Smallholder maize-based systems

## A piece of the puzzle for sustaining food security in Nigeria

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### Status of maize-based systems

Maize is the backbone of food security across Sub-Saharan Africa (Shiferaw *et al.* 2011), accounting for up to half of the calorie intake (Nuss and Tanumihardjo 2011), and a core ingredient in animal feed. Almost all the continent's total maize output (96 per cent) comes from 20 countries, with Nigeria at the top with 15 per cent of African maize production or 10.4 million tonnes (FAOSTAT 2018). The importance of staple crops for food security can be viewed against Nigeria's population trends, which went from 45 to over 190 million between 1960 and 2017 (WB 2017), among the fastest growth in the world and projected to double by 2050 (IF 2019).

In Sub-Saharan Africa, about 70 per cent of maize cultivation is done by smallholder farmers (Macauley 2015; Smale *et al.* 2011) who depend on it for both their subsistence and livelihoods. Many smallholder farmers' maize yields are one-tenth those of average yields for the United States (Figure 7.1). The latter can leverage economies of scale that are unavailable to African smallholders, whose holdings range between 0.2 and three hectares and are often spread across small scattered parcels. Instead, maize-based multiple-cropping systems have evolved as livelihood strategies in response to remoteness, where poor transport and infrastructure hinder marketing opportunities and access to extension services. Here, local small-scale markets have developed, where maize and similar staple crops can be locally processed and stored.

### Maize in Nigeria and Africa at large

Maize was introduced to Nigeria in the fifteenth century (Blench 1997). It was cultivated as a subsistence crop and gradually evolved into a commercial crop providing raw materials for agro-industries, such as grains for animal feeds, processed cereal, and beer (Ammani 2015; Iken and Amusa 2004).

Maize production first started in the humid forest zones in the south. While cassava (Onoja Chapter 4) remains the main crop in the southern

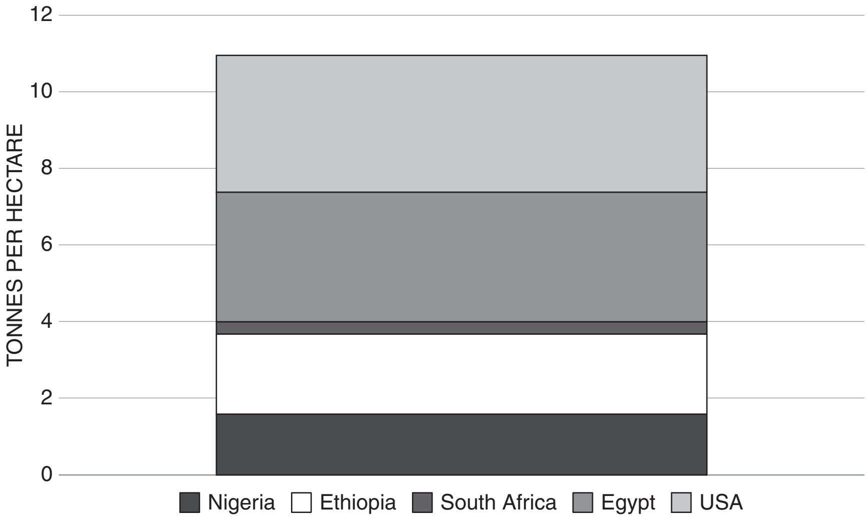


*Figure 7.1* Average maize yields in 2016 in selected countries.
Source: FAOSTAT 2018.

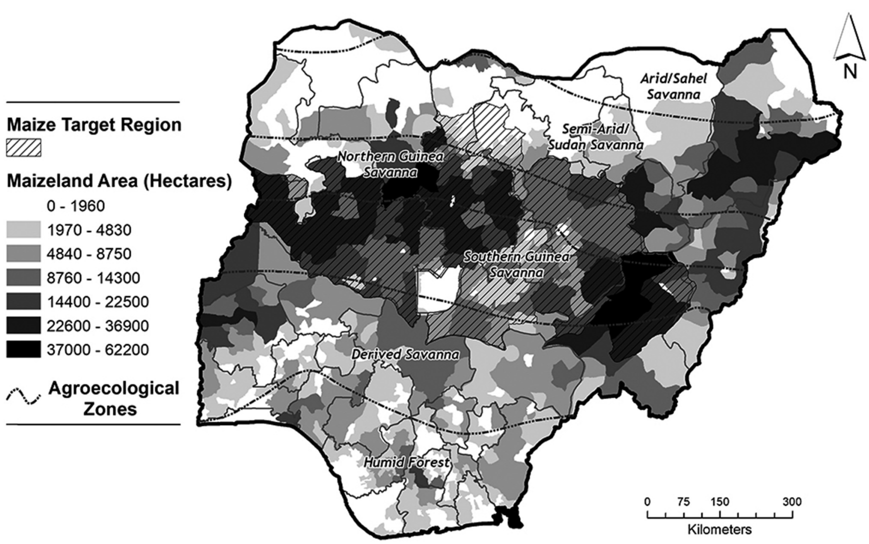


*Figure 7.2* Major maize-producing regions in Nigeria.
Sources: Author's adaptation from HarvestChoice 2015*a*, *b*.

to central forest zones, maize has shifted northwards into the Guinea and Sudan savanna agroecological zones across the middle of the country since the 1970s (Blench 1997; Figure 7.2). Maize is suitable across diverse altitudes and latitudes, however, compared to the humid zones, the savanna has more favourable growing conditions, particularly less cloud cover (more solar radiation), suitable rainfall ranging from 700 to 1050 millimetres annually, and a terrain that enables livestock production to be combined with field operations (Kim *et al.* 1993; Obi 1991).

Although among the top producers in Africa (FAOSTAT 2018), Nigeria has marginally been a net maize importer. According to the 2016–2020 policy and strategy document for agricultural promotion, maize is the only one of the 13 listed food crops and products where supply closely matches national demand (93 per cent; FMARD 2016). Historically, Nigeria's food production deficit and inability to meet the increasing domestic grain demand were linked to inadequate input supply and poor extension support (Liverpool-Tasie *et al.* 2017). Food security is not only challenged by market failures, lack of support and a growing population but also by insurgents and conflicts. In the spring of 2019, the food insecurity situation was deemed 'stressed' in at least ten states, and at 'crisis' and 'emergency' phases in the north-eastern states bordering Cameroon, Chad and Niger, using the Integrated Food Security Phase Classification (FEWSNET 2019).

First, Nigeria's maize production is summarized in a historical policy development context over five periods, to frame the context of maize-based multiple-cropping systems.

### *1970s – Multiple-cropping systems*

Figure 7.3 shows stagnating trends for maize production and area in the 1960s and declining trends in the 1970s. In 1972, the National Accelerated Food Production Programme was launched and in 1976 Operation Feed the Nation. These two policies can be described as revolutionary, but the impacts remain debatable. They served as precursors of subsequent policies that resulted in an expansion of the area used for maize. Broadly, these policies favoured maize in multiple-cropping systems by providing input subsidies on major grain and legume crops (mainly maize, cowpea, and soybeans) and by encouraging the establishment of farms and gardens on any available nearby land. Furthermore, the River Basin and Rural Development Authorities were established in 1976 with the mission to accelerate rural development through support for year-round production under irrigated and rainfed systems. This provided an advantage to farmers in the savanna region, where most of these basins were established, by allowing for year-round maize production intercropped with other seasonal crops, including vegetables, spices and legumes.

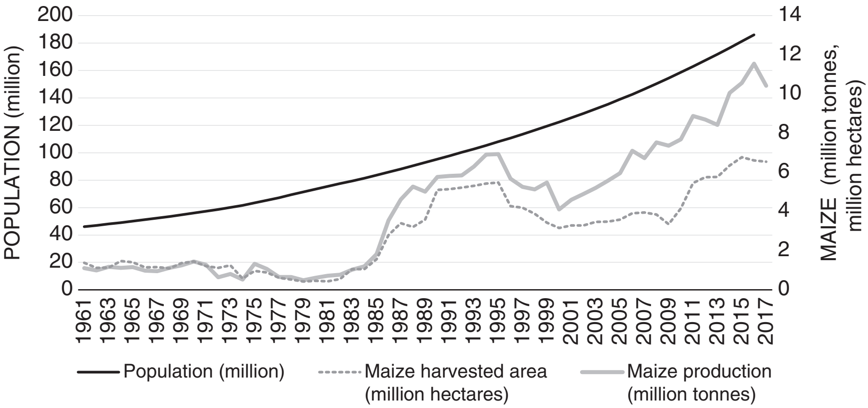


*Figure 7.3* Population, maize area and maize production in Nigeria 1961–2017.
Source: FAOSTAT 2018.

### *1980–1992 – First expansion*

The first major expansion of maize production in Nigeria coincided with the Green Revolution in the early 1980s. Policies targeted improved access to inputs through subsidies and credits and aimed to reverse the declining trend of national agricultural productivity in cereals and pulses (Adeyemo 1984; Hassan *et al.* 2014). Between 1987 and 1992, the annual total maize production increased from 0.4 to 5.7 million tonnes and resulted in a simultaneous drop in maize imports from 347 to 0.3 million tonnes (FAOSTAT 2018). However, this production increase was largely due to an unprecedented increase in the total maize area, by converting 4.5 million hectares of previously uncultivated land (Figure 7.3).

### *1992–2002 – Stagnation*

In 1992 the Nigerian Agricultural Land Development Authority was established with the mission to provide support for agricultural expansion through provision of funds to agricultural programmes, facilitation of input sourcing and procurement, acquisition of machinery and training of agricultural programme staff. Through the Authority, farmers were organized into cooperative societies and farmer groups for ease of access to credit and training, with the expectation that this would translate into improved support for rural farmers, especially those in proximity to previously established infrastructure such as the River Basins. Similarly, the National Fadama Development Project and the World Bank-funded Agricultural Development Project were initiated in the early 1990s. Bureaucracy and poor technical oversight have meant that these interventions are rife with shortcomings (Akinsola and

Oladele 2004; Uche 2011), with minimal gains in maize productivity or cultivated maize area during the period.

### *2002–2007 – Maize boom*

In 2002 the National Special Programme on Food Security was launched and focussed more on providing general support to encourage farming than on promoting maize production. Nevertheless, this seems to have benefitted maize, and production increased from 4.0 to 7.6 million tonnes within five years (Figure 7.3). Maize gained popularity because it was compatible with many environmental conditions as well as other crops and because it offered a fast return-on-investment, which met the needs of households. This policy effect continued after the policy ended in 2008, reaching 2.1 tonnes per hectare in 2009 (Cadoni and Angelucci 2013).

### *2009 – ongoing – Second expansion*

The Agricultural Transformation Agenda programme launched in 2009, introducing new fertilizer support with a focus on improving farmers' access to quality fertilizer at lower cost, especially during the main cropping season (see also Onoja Chapter 4). Between 2009 and 2014, the harvested maize area increased from 3.4 to 5.9 million hectares, which increased production from 3.3 to 6.8 million tonnes (Figure 7.3; FAOSTAT 2018). Furthermore, although farms larger than ten hectares do exist, up to 80 per cent of the Nigerian maize remains predominantly cultivated in multiple-cropping systems on small fragmented plots (Onuk *et al.* 2015). In 2016, the Agricultural Transformation Agenda was modified to become the Agriculture Promotion Policy (FMARD 2016). This policy attempts to redirect government efforts to address some major deficiencies of previous programmes, including engagement of stakeholders, leveraging digital technologies and prioritizing poverty reduction among farmers.

## Comparisons of maize development in Africa

Productivity remains a challenge for Nigeria, as it is for the neighbouring countries. Nationally, maize yields are around two tonnes per hectare, while the potential yield is more than four times that, about 8.6 tonnes per hectare (Olaniyan and Lucas 2004). Nigeria's average maize yield is half of the yields in South Africa and Ethiopia, and one-fifth of that in Egypt (Figure 7.1). There are several explanations for the yield gaps. First, like in many Sub-Saharan African countries, most Nigerian maize is rainfed. Second, comparatively less land was required to achieve the production increase in Egypt and Ethiopia, which suggests that as land was available, the need to develop land-efficient technologies was less of a driver in Nigeria (Figures 7.1, 7.4a, b). Ethiopian maize remains rainfed; however

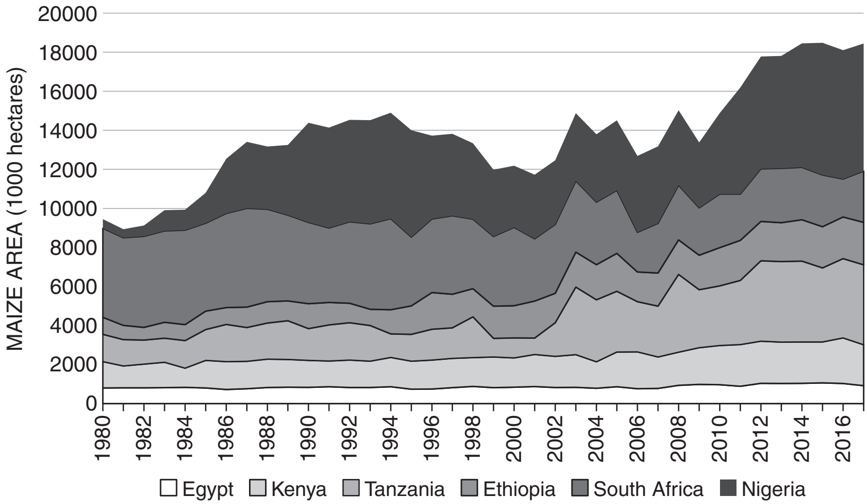


*Figure 7.4a* Maize area harvested for Africa's top maize producers 1980 to 2017. Unit: 1000 hectares.

Source: FAOSTAT 2018.

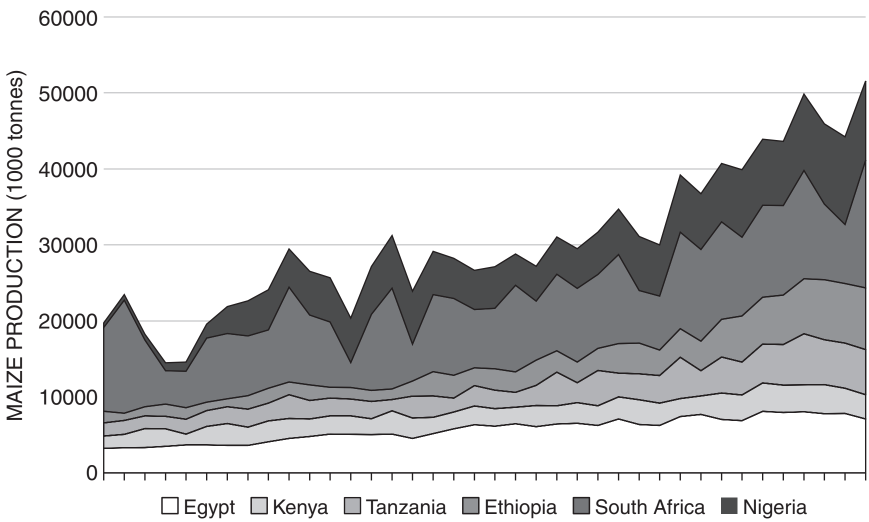


*Figure 7.4b* Maize production for Africa's top maize producers 1980 to 2017. Unit: 1,000 tonnes. See also Nigeria in Figure 7.3.

Source: FAOSTAT 2018.

after the famine in the mid-1980s, the government has invested in research, development and extension to find suitable higher-yielding varieties, nitrogen and phosphorous fertilizers, and in converting some teff and sorghum areas to maize (Abate *et al.* 2015). South Africa has similar average yields to Ethiopia but produces rainfed high-yielding varieties of white maize with large interannual variability due to droughts (FAO 2018). Moreover, in Ethiopia domestic demand is fuelled by the population increase, while as South Africa also supplies large parts of Southern Africa, the unstable production has a large impact on regional food prices and food security. In contrast, the maize area in Egypt has been relatively stable at about one million hectares (Figure 7.4a) for the past 50 years, while yield increases are predominantly attributed to intensified use of surface irrigation, high-yielding varieties, and fertilizer (Zohry *et al.* 2017). For example, according to FAOSTAT 2018, in Egypt the average fertilizer use for the period 2002–2015 was 594 kilogrammes per hectare, compared to eight kilogrammes per hectare in Nigeria. While the accuracy of these numbers may be debatable, the magnitude of the difference is instructive.

## Maize in multiple-cropping systems

The land area of Nigeria is 91 million hectares, of which 39 per cent is classified as arable land, while permanent crops and forest resources make up 7 and 9 per cent, respectively. In 2016, maize was cultivated on 6.5 million hectares (FAOSTAT 2018), which may be a conservative estimate since it is unclear how maize intercropped with other crops, such as cowpea and groundnut, is accounted for in the national statistics. In the 1970s and 1980s, researchers estimated that 99 per cent of cowpea, 95 per cent of groundnut, 90 per cent of sorghum and millet, and 75 per cent of maize grown in Nigeria was intercropped (Ofori and Stern 1987). Recent statistics on intercropping practices are unavailable. With the emergence of large-scale producers, who primarily practice monoculture, multiple-cropping systems' share of the total maize production has likely decreased. Some estimates from the Nigerian savanna region state that one out of every five farmers now practices maize as monoculture, while the rest combine maize with other crops (Mustapha and Salihu 2015). Furthermore, an unpublished agronomic pilot survey of 780 farmers in Kano, Kaduna, and Katsina states in the Guinea and Sudan savanna (IITA 2016) indicated that three out of every five farmers intercropped maize as a general practice, and about four out of five mixed maize with other crops during the last three years of the maize rotation (Figure 7.5).

*Figure 7.5* A typical mixed maize-based system with okra, soybeans and cowpea on *c.*1 to 2 hectares of farmland in Doguwa, Kano State, in the Sudan Savanna agroecological zone, Nigeria.

Photo credit: Adewopo 2017.

## Factors for success in studied cases

Table 7.1 highlights some of the reviewed research conducted on various maize-based systems in Nigeria since the 1970s as examples of success. These examples demonstrate a focus on productivity and inputs towards a more efficient use of resources with interaction effects.

### *Diversification of products*

An important explanation for the popularity and fast expansion of maize-based systems is that maize can easily be planted within existing farming systems and that it offers higher yields than traditional grain crops (Macauley 2015). Although the savanna region supplies 65 per cent of Nigeria's maize production, it remains a low-input system with widespread intercropping practices. For instance, in the northern region maize is mixed with legumes such as soybean, cowpea or groundnut, or cereals, such as sorghum and rice, while in the southern region, maize is intercropped with cassava (Onoja Chapter 4) and yam (Thayamini and Brintha 2010). As maize matures in succession, it is suitable for intercropping with tuber crops such as sweet potato, and vegetables such as tomato, onion and pepper.

*Table 7.1* Indicators studied in maize-based multiple-cropping systems in Nigeria

| *Main farming systems studied* | *Main benefits studied* | *Reference* |
|---|---|---|
| Maize intercropped with groundnuts, sorghum, and millet, Northern Nigeria | Profitability (increased), as indicated by cash return | Baker 1978 |
| Maize in alternated intercropping with millet and sorghum, Northern Nigeria | Yield (increase) of maize in alternate intercropping compared to monoculture | Baker 1979 |
| Maize intercropped with cowpea sequential cropping on intensively cultivated tropical Ultisol, Abeokuta, Nigeria | Yield and net profitability, improved nitrogen uptake of maize on poor soils | Adetunji 1996 |
| Maize after soybean, Guinea savanna, Nigeria | Micro-nutrient uptake of maize after legume: maize yield | Carsky *et al.* 1997 |
| New intensive system with maize in rotation with soybeans and livestock, dry savanna, northern Nigeria | Resource management of new germplasm; income, production, and land area | Sanginga *et al.* 2003*b* |
| Maize cultivated with cowpea, groundnut, or soybean; soybean with cowpea or groundnut, Zaria, Nigeria | Land-use efficiency based on farm size and production | Herbert 2005 |
| Maize intercropped with cowpea, south-western Nigeria | Input optimisation, biological nutrient fertiliser effects of cowpea | Amujoyegbe *et al.* 2008 |
| Maize intercropped with cowpea, north-central region, Nigeria | Technical efficiency of maize intercropped with cowpea, based on gross margin | Onuk *et al.* 2015 |

### *Soil nutrient management*

According to one study, maize production under the current situation is optimal on 28 per cent of African agricultural land, suitable on 59 per cent, and unsuitable on 13 per cent (Peter *et al.* 2017). The same study concluded that intercropping to utilize biological nitrogen fixation can benefit areas that are suboptimal for maize. Biological nitrogen fixation is a process in which organisms in symbiosis with certain plants, such as legumes, convert atmospheric nitrogen to ammonia, which crops can assimilate (Wagner 2011). This can improve soil fertility and reduce nitrogen fertilizer requirements for subsequent non-legume crops (Table 7.1, see for example Sanginga *et al.* 2001, 2003*a*). For example, one field trial showed increases in maize yields by 16 to 32 per cent, when planted directly after soybeans (Carsky *et al.* 1997).

### *Diversified incomes*

As high-yielding maize varieties require a higher supply of nitrogen than local varieties (Onwueme and Sinha 1991), the degraded and nutrient-poor soil conditions prevalent in most Nigerian croplands limit the potential to optimize yields (Adetunji 1996; Giller *et al.* 2011). Despite the past efforts to develop drought-tolerant higher-yielding varieties and fertilizers for nutrient-poor soils (Binswanger-Mkhize and Savastano 2017; Liverpool-Tasie *et al.* 2017) for monoculture systems, smallholder farmers seem to prefer to cultivate maize in traditional ways with other crops (see example in Figure 7.5). By managing rotation and intercropping on multiple plots within one farm holding, farmers can often optimize the allocation of resources (labour and capital) within the season and improve farm-level technical efficiency (Adetunji 1996; Amujoyegbe *et al.* 2008; Awotide and Agboola 2014; Sanginga *et al.* 2003*b*). Smallholder farmers with less than five hectares are relatively flexible and can make intra-seasonal changes. Some studies suggest that farmers were able to optimize return-on-investment on smaller farmlands by adopting maize-based multiple-cropping (Sanginga *et al.* 2003*a*,*b*) and intercropping practices to maximize returns and economic flexibility, under prevalent circumstances of poor access to infrastructure and financial resources, and uncertain land tenure and user rights (Makinde *et al.* 2011; Quainoo *et al.* 2000). Making available shorter-term varieties can help farmers take more flexible and adapted decisions as seasonal climatic situations vary. Also, the yield and net profitability can be strategically improved on nutrient-impoverished soils through compensatory nutrient dynamics of the constituent crops (Adetunji 1996; Onuk *et al.* 2015).

### *Social, economic and environmental co-benefits*

Each year, crop residues from millions of hectares provide additional benefits such as soil quality amelioration, construction materials for low-cost thatch roofs, fodder for livestock and fuel for cooking, especially in savanna areas where trees are sparsely distributed (Olaniyan 2015). These benefits often incentivize farmers to continue to cultivate maize lands for household consumption and contribute to national maize grain production. Scientists in Egypt have studied environmental functions, such as different root depths and root biomass, and experimented with maize in rotations and intercropping systems with legumes, forage and fruit trees to identify new systems that benefit yields of all crops, reduce land, water and fertilizer use, and control weed and pests (Zohry and Ouda 2017; Zohry *et al.* 2017).

In summary, the major advantages of maize-based multiple-cropping systems accrue to farm-level resource use-efficiency, such as improved nutrient management, reduced labour input per unit area, and reduced transportation cost per unit produced (Tables 7.1 and 7.2).

## Limitations

### *Scale*

Land fragmentation can be discussed both as a cause and an effect of small-scale multiple-cropping systems. The potential negative impacts of smallholder maize-based systems are primarily linked to economies of scale (Table 7.2). Certain multiple-cropping systems may limit the use of modern technologies on small-scale farms. For example, intercropping or dense and multi-level canopy structures can be incompatible with machinery for

*Table 7.2* Benefits and potential drawbacks of smallholder maize-based multiple-cropping systems in Nigeria

| | *Benefit* | *Potential drawbacks* |
|---|---|---|
| Soil | Nutrient management efficiency through legume-induced biological nitrogen fixation and improved nutrient cycling though farm residue incorporation<br>Improved soil quality (microclimate, tilth, organic matter, structure) | Inefficient nutrient management may encourage maintained status quo in production or overlooked yield decline<br>Indirectly incentivises land fragmentation |
| Economics | Increased return on investment by harnessing multiple crop yields<br>Low investment cost to establish and generate food and livelihoods<br>Diversification as risk reduction strategy of harvest time | Difficult to apply farm technology and economies of scale<br>Labour intensive, with potential implications for women and children labourers in some cultures |
| Food security | Diversified household nutritional intake and diets (legumes, vegetables, spices)<br>Provision of other materials, e.g. feed, fuel, and shelter materials | May not be compatible with yield optimisation or yield-gap minimisation for main crops, including maize |
| Crop and technical knowhow | Crop diversity reduces the risk for pest- and disease-related losses<br>Improved weed control after crop establishment | System-level knowledge of crop interactions and optimal thresholds of management practices are critical to balance risks and rewards<br>Requires well-developed extension support |

basic operations such as weeding, thinning and harvesting. Such systems are therefore often perceived to disfavour practices aiming at economic efficiency, such as mechanization and land mergers. Small-scale farms also rely on household members for permanent and temporary farm work, which often has implications for children's opportunities to attend school and women's participation in meetings and networks, which can have more impacts on farm productivity and household incomes in the long run.

The prevalent practice of dividing farmlands and allotting plots to entitled family members as inheritance reinforces fragmentation and subsistence (McPherson 1983; Simmon 1987). A major downside of smaller plots is farmers' reluctance to test new agriculture solutions that require standard spacing between crops or trees. As smallholder farmers are often poorly equipped to manage soil nutrient balance in their farmlands (Giller *et al.* 2011), they may seek more fertile lands in forests and protected land. Fragmentation may therefore also result in encroachment into forestlands and protected areas. Although multiple-cropping systems have supported subsistence and household food security in the past, achieving ecologically sustainable systems will require new solutions to halt fragmentation and either aggregate farming practices across plots, or aggregate farmlands (Iheke and Amaechi 2015; Okezie *et al.* 2012).

Furthermore, technology adoption is constrained by gender imbalances in terms of land tenure (for example Pretty 2008) and limited access to cash and credit (AfDB 2015). As in many rural areas in Africa, low literacy levels and inefficient extension systems limit outreach on agricultural information. Moreover, many farmers are women who have less direct access to land, resources, and information updates than men, which often leads to misinformed management decisions. Some studies found that women-headed households had lower yields than those headed by men (a pattern also found in Onoja Chapter 4), likely associated with poorer households needing to work extra for wealthier farmers for cash, usually right when they need to work the most on their own farms (Peter *et al.* 2017).

### *Inconsistent input support*

Although past government policies aimed at improving access to seeds and fertilizers, inconsistent fertilizer policies have often favoured either monopoly or liberalization at different times (Nagy and Edun 2002; Oko 2011). For instance, the discontinuation of the national fertilizer subsidy and distribution programme between 1997 and 2002 led to a 50 per cent increase in fertilizer prices, with a consequent sharp decline in fertilizer use (Oko 2011); the area cultivated with maize declined from 5.2 to 4.2 million hectares (Cadoni and Angelucci 2013). Despite this, maize production remained relatively unchanged and consequently national maize yields increased slightly from 1.2 to 1.5 tonnes per hectare between 1997 and

2002 (FAOSTAT 2018; Figure 7.3). Little research-based documentation exists to fully elucidate coping strategies that have been adopted by smallholder farmers during periods when optimal fertilizer usage is cost-prohibitive due to shifting government policies. Some scientists argue that the deregulation of input markets and provision of fertilizer credits to farmers, starting in the 1980s, unintentionally resulted in increased cultivation of natural lands rather than in the expected intensified production on existing croplands (Binswanger-Mkhize and Savastano 2017; IITA 1991; Nagy and Edun 2002). This can partly be explained by the abundant availability of cheap labour and that fertilizer credits led landless people who did not have their own farm holdings to venture into previously uncultivated lands for farming, including fringes of forest reserves, buffer zones, national parks and important ecological corridors with major environmental implications.

Without incentives that nudge farmers to adopt sustainable practices, and structured policies to guide local planners and decision-makers, the fragmentation and expansion of farmlands onto previously uncultivated lands and clearing of important ecological corridors will likely continue. This raises concern about the agroecological sustainability within the savannas in general.

## Policy aspects

Nationally, the most widely practised maize-based systems are those with legumes or cereals. Cropping systems with legumes were promoted in the 1970s. However, since the 1980s, no national agricultural policy or programme has directly promoted multiple-cropping systems with maize in Nigeria. Similarly, intercrops of roots and tubers have evolved in southern Nigeria, largely without policy support (Onoja Chapter 4). The co-benefits of intercropping, such as additional crops in maize-based systems, are rarely recognized in national agricultural planning or performance assessments, hence no data are reported on the presence of multiple-cropping systems in the statistics.

Since 2016, the Agriculture Promotion Policy (FMARD 2016) has been guided to deliver on three themes: productivity enhancements, private sector investment and institutional realignment. Soil fertility is considered a key element that must be addressed to achieve enhanced productivity. Therefore, the policy includes mandates for soil fertility management to improve environmental values as well as food security, for example, formal fallow periods, erosion control measures, tree planting, improved conservation, reforestation and, green belt policies. Moreover, the policy targets fertilizer quality control, the use of organic fertilizer, and an aligned strategy on fertilizer supply and demand in regions that require the most support. The strategies could include crop rotations and intercrops with suitable annual or perennial legumes where biological nitrogen fixation has positive benefits on subsequent crops, which would benefit poor farmers in particular (Peter *et al.* 2017). Interventions towards sustainable production can provide a new entry point for raising the visibility of the multiple benefits that smallholder farmers with multifunctional land uses bring to the national agenda and rural livelihoods through improved productivity.

One policy intervention that remains critical for more effective land-use pertains to land tenure and ownership. The current tenure system acknowledges communal ownership, inheritance, individual ownership, leasehold, rent, gift, free hold and tenant at the government's will, where communal ownership and inheritance are the most common. Although individual or community access to land for cultivation is allowed, the policies are often not aligned with the national land use act (Nwocha 2016), which gives government the sovereign ownership or control of land. This contributes to land fragmentation, as increasing numbers of community or family members lay claim on communally or family-held land (compare with Shomkegh Chapter 2 and Onoja Chapter 4).

There is public investment in farmers' access to training and materials that could improve farm management practices, such as seed varietal selection, fertilizer application, spacing, and timing of tending operations (Adama *et al.* 2016; Degrande *et al.* 2015). Moreover, government policies on input access typically focus on improving yields, but the net increase in production (from maize or companion crops) does not always translate into market access and higher net returns for farmers (Binswanger-Mkhize and Savastano 2017; Liverpool-Tasie *et al.* 2017). Therefore, policies should also consider strengthening farmers' access to markets and provide incentives for value-added processing of farm outputs, for instance by credit and extension support.

## Lessons learned from the case

In contrast to monocultures, the contribution of Nigeria's smallholder maize-based multiple-cropping systems to national food security is insufficiently assessed and likely underestimated. For example, these farming systems are overlooked in policy initiatives, such as the 'Zero Hunger Initiative' which was implemented in 2017 and is envisioned to empower youth and rural population to produce adequate food and improved nutrition.

Agricultural policies and actions of the federal government should be guided by a clear understanding of the comparative advantage of multiple-cropping systems with maize. For instance, the strategic Anchor Borrowers Programme (CBN 2016) and Growth Enhancement Scheme (Ejiogu 2017) initiatives are implemented to encourage agricultural production and can offer incentives such as extension support and higher credit lines to farmers who adopt production practices with environmental, social, and economic benefits. So far, the Central Bank of Nigeria's Quarterly Report (CBN 2017) showed that over US$4.1 million had been disbursed to 10,260 farmers under the Agricultural Credit Guarantee Schemes, with at least 30 per cent of the credit recipients being maize (monoculture) producers. Higher production impacts could be achieved if farmers were supported in adopting practices that generate multifunctional benefits from their maize farmlands.

Past policy interventions to improve maize production in Nigeria have prioritized optimizing maize grain yields and improving tolerance or resistance to biotic and abiotic stress (Olaniyan 2015). Successful policies must be intentionally geared towards providing a blend of critical inputs, mainly fertilizer and seed, and investing in extension services for appropriate farm-level solutions (Liverpool-Tasie *et al.* 2017). National food security policies should be guided by scientific evidence on the unique characteristics of, and potentials for, crop rotations and multiple-cropping farming systems that support and strengthen small-scale farmers' contributions to multiple Sustainable Development Goals. Such evidence needs to be based on real indicators of multifunctional land uses (see examples in Tables 7.1 and 7.2), such as net profitably, land-use equivalent ratio, biological nitrogen fixation, and co-benefits.

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