INTEGRATED FERTILIZER POLICY GUIDE

for Maize-Legume Cropping Systems in Malawi

Developed by the Best Fertilizer Management Practice (BFMP) Group, Africa Rising -Malawi

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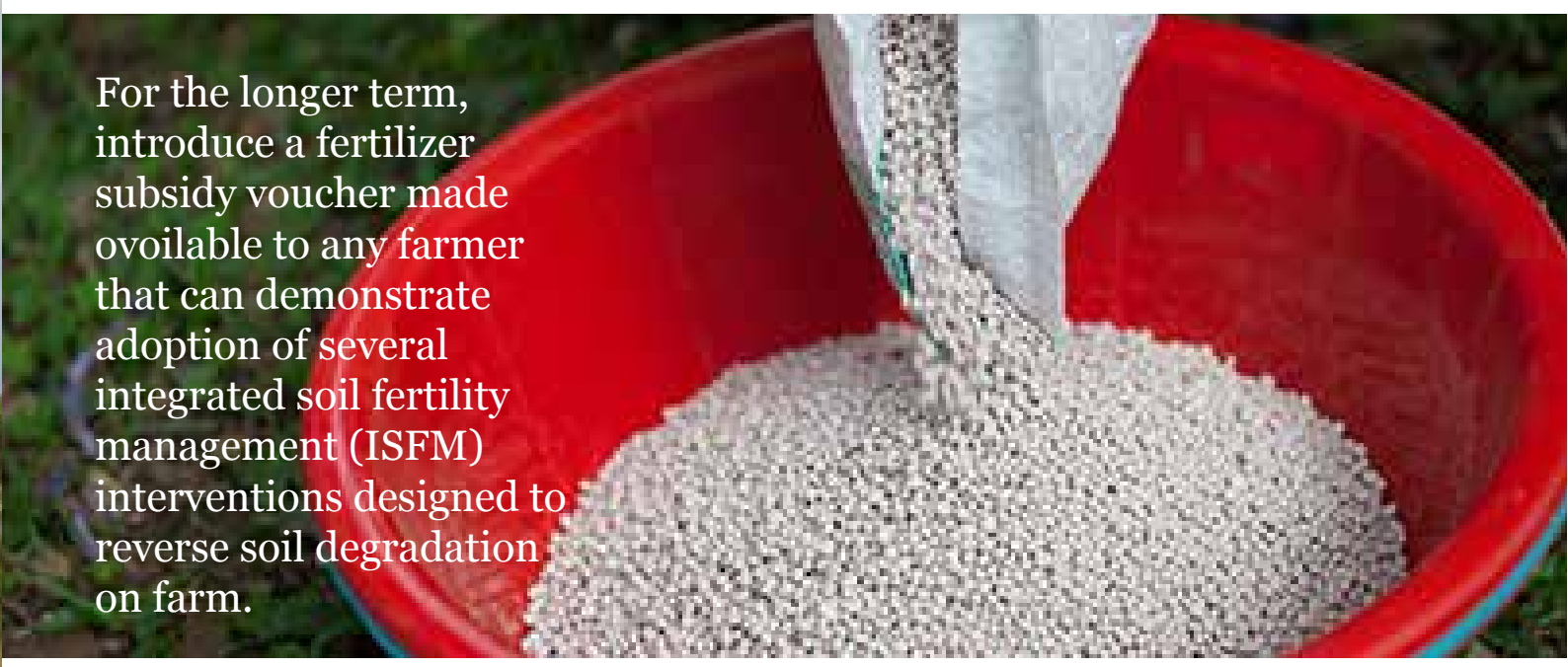

Key Policy Points:

1. **Access to inputs** through subsidy/voucher support programs (as in the Farm Inputs Subsidy Program (FISP)) is essential for food and nutrition security, and the generation of income by Malawian smallholder farmers. These programs allow farmers to access NP fertilizer in a timely manner and at affordable cost. However, they require substantial government expenditure, and so it is crucial that they are implemented efficiently. There is need to a) source appropriate nutrients, b) ensure those inputs are delivered and accessible to farmers before planting rains arrive in November and c) be deployed with relevant management information.

2. **Appropriate fertilizer:** Support widespread access to high-analysis NP fertilizers such as urea and 23:21 compound, delivered by October. Combine P-fertilizer with a complementary subsidy voucher comprising seed of suitable grain legumes (according to agro-ecology/farmer interest/end use). In locations where other nutrients such as S or Zn are deficient, support access to 23:21 + 4S and compound fertilizers with Zn. Facilitate the establishment of blending plants that can provide the required fertilizer formulations.

3. **Good management:** Promote the provision of information and expanded training/awareness opportunities for farmers to experiment with applying fertilizers to maize and legumes according to fertilizer '4R' principles on parts of their farm where responses are most assured, and by managing weeds.

4. **Sustainable:** For the longer term, introduce a fertilizer subsidy voucher made available to any farmer that can demonstrate adoption of several integrated soil fertility management (ISFM) interventions designed to reverse soil degradation on farm. This should be linked to programs of increased awareness and training on the use of ISFM.

5. **Procurement:** Procurement and distribution of fertilizer should be gradually transferred to the private sector to improve cost efficiencies. In countries where the private sector is fully engaged in these activities, the subsidy program is more successful.

1. Why Fertilizers Matter

Experience has clearly demonstrated that greater sustained use of NP mineral fertilizers in Malawi is key to raise the productivity and sustainability of smallholder maize-legume systems. Provision of subsidized fertilizer in the FISP was estimated to have raised maize production in Malawi by around 0.5 million t of grain each year during the late 2000s. This greater availability and use of fertilizers on maize has improved local food security and national self sufficiency in Malawi.

The high cost of maintaining input support programs means that there is compelling interest to ensure the fertilizer supplied is used as efficiently as possible. Currently, use efficiencies are low -around 7-14 kg of maize grain is produced per kg N applied, compared with the 20-30 kg of grain that is readily achievable. The more efficient use of fertilizers in Malawi will reduce the cost of fertilizer imports and raise the returns and benefits from subsidy programs for the country ariCI its people.

Returns to fertilizer use could be easily raised by 30 to 50% from current low levels by the timely supply and targeting of fertilizers to maize and grain legumes. An additional 50 to lOO% gain in returns could be achieved by the widespread and routine us~ of basic principles of crop management by farmers, including improved control of weeds and (fo ~he extent possible) the use of organic inputs. This is increasingly essential in Malawi as farms continue to become smaller and it becomes ever more urgent for resources to be used efficiently to maintain food security.

The result of these interventions will be sustainable growth in agricultural productivity in Malawi and a wider mix of food crops grown and used. This will lead to improved household nutrition, as well as income generation if production is above household requirements; all without raising the quantity and import costs of mineral fertilizers.

2. Principles Behind Fertilizer Use

a. Soil fertility and fertilizers:

Fertilizers work in Malawi: Malawian smallholder farmers have been producing staple food crops for many generations. Most soils in Malawi remain inherently fertile, although they are increasingly depleted of organic matter and certain nutrients such as N, P and S. Farmer practices in organic matter management and the cycling of nutrients on farm are insufficient, and external supplies of mineral fertilizers are necessary to maintain and increase crop production. In most cropping situations, and with the relatively favorable rainfall patterns that prevail in Malawi, farmers can obtain good responses to fertilizer inputs.

Different crops need different fertilizers: Fertilizer needs are very different for a cereal such as maize than for grain legumes. Maize requires large amounts of N for good growth and high yield, while grain legumes can fix most of their N but frequently respond to additions of P to the soil.

Standard N recommendations of 69 or 92 kg N/ha have been available for maize in Malawi since the 1990s, depending on the soil type and end use for the crop. Additionally, more recent research findings have shown that excellent maize yield responses can also be achieved from modest rates of N fertilizer (around 30 kg N/ha), although such rates can add no more than 800 kg/ha to grain yields. N fertilizer for maize has been an integral part of subsidy support programs (Starter Pack, the Targeted Input Program (TIP) and FISP) since the late 1990s. Fertilizer recommendations for grain legumes are less developed and fertilizers specific to legumes are lacking, but the use of P is widely indicated.

Types of fertilizer: Since maize requires N in large amounts, it is often most cost-effective to target to maize a concentrated N fertilizer such as urea. Urea does have shortcomings since it does require careful timing of its application to coincide with sufficient moisture in the soil. In addition to N, other nutrients that are often beneficial for maize include P and S. These nutrients are supplied by a widely available basal fertilizer, the NP compound 23:21+4S. This is a balanced P source that is particularly appropriate for maize grown in mixtures or rotations with legumes, as the P will have residual benefits for legumes. It is also appropriate for acidic soils if P is unavailable due to fixation. Another source of P is the concentrated type, triple superphosphate (TSP), which is available from local or regional sources. In specific locations in Malawi, certain soil types are low in Zn, which can be identified through distinctive white striping in maize leaves and a maize yield response to compound fertilizers that contain Zn.

The new formulation 23:10:5+1Zn, 6S is one such source of Zn that is appropriate for such locations, especially if P deficiency is not an issue.

Targeting fertilizer: Most legumes usually respond to P, while some specific legumes (such as groundnut) require a lot of Ca. Fertilizers targeted to one crop in a rotation or intercrop will often have residual effects on following crops. Compost and manure applications also have both direct and residual benefits and can be applied in combination with mineral fertilizer.

Nutrients need to be targeted to where responses are known (through farmer and extension experience) to be likely based on previous history of crop response and soil tests. The location and management history of fields on a farm affect fertilizer needs and response. Best responses are generally found on fertile home and mid fields with histories of good management. By contrast, modest or nil response to fertilizer are found on shallow soils, hill slopes, outfields depleted of nutrients, and striga-infested fields. It is also rarely cost-effective to apply fertilizer to nutrient-rich fields on dimba wetland margins because nutrient supply there is already high.

b. How farmers can get more from fertilizers:

Raising the efficiency of fertilizer use: Smallholder farmers can improve the efficiency of use of mineral fertilizers by routinely employing the basic principles of good fertilizer management, known as the Fertilizer 4Rs, along with adequate timely weeding. Through such approaches, the efficiency of use of N fertilizer for maize can easily be raised from current levels of around 10-15 kg grain/kg N applied, to well over 25-30 kg of grain.

The Fertilizer 4Rs: The Fertilizer **4Rs** refer to the need to ensure farmers access the **right source** of fertilizer for their crop and soil, apply it at the **right rate**, at the **right time** in relation to crop development and growth, and in the **right place** close to the plant and on or in the soil. These basic principles are well established from research and are widely known in extension services and by leading farmers, but are not always fully appreciated or applied by many farmers. For example, although practice varies considerably from year-to-year and place-to-place, many farmers apply their basal fertilizer to maize more than two weeks after planting rather than at or just after planting. There is also a general tendency to top dress with N fertilizer at stages of crop development that are too late (such as around taseling) for the crop to use the fertilizer to produce additional grain yield. Urea is often applied on the soil surface (rather than in small holes in the soil) and so subject to volatilization losses. Helping farmers to understand the benefits from the **4Rs** and the trade-offs with other needs and options, such as their use of labor on other activities, is essential. As well as the optimal **4Rs**, it is important that farmers appreciate second best but still helpful options. If, as is common, fertilizers arrive late, then farmers need contingency 4Rs that stress the need to apply late arriving fertilizer straight away, or if it is far too late, to save it for the next season.

Lower rates give higher use efficiencies: The standard N recommendations of 69 or 92 kg N/ha are appropriate for maize crops produced from improved (hybrid) seed grown on quality soil with good management in seasons

with adequate soil moisture. Modest rates of around 30 kg N/ha will allow N fertilizer to be used even more efficiently in producing maize grain; important especially when N fertilizer is scarce or is only obtainable at market prices.

Weed well: Inadequate weeding is a common feature of maize cropping in Malawi, in large part because labor can be short due to competing activities with other food crops or when farm labor is employed in ganyu. Around 25% of farmers weed their maize just once or not at all, while just over 60% weed twice (which is commonly considered the minimum necessary to successfully manage weeds). Although farmers may start to weed on time, they may still weed parts of their fields later than necessary, subjecting their crops to competition for nutrients and water, and reducing yields. Additionally, parasitic weeds (principally Striga asiatica, which is widely found in some areas in Malawi) damage maize, reducing its response to fertilizer. Weeding twice at appropriate times (2-3 weeks after planting and around 6 weeks) can easily raise grain yields by over 50% and double the efficiency of N use compared with a single weeding. Gains from adequate weeding are even higher in dry seasons when insufficient soil moisture and nutrients combine to reduce yields. Thus, raised awareness on the importance of adequate weeding, and help to farmers to do timely weeding are simple ways to greatly raise returns to fertilizers and increase maize production, especially in dry years.

Fertilize good fields: The response to fertilizers is usually not the same for all fields on a farm. Both research and farmer experience indicates that in many cases the best returns from mineral fertilizer inputs with maize and some legumes like soybean and groundnut come from more productive fields with a history of significant use of organic residues and fertilizers. Crop yield responses and efficiencies of fertilizer use may be higher on fields that have deeper loamy soils and a history of good crop husbandry, including legume use, applications of organic matter, and fertilizer inputs. Farmers can be encouraged to target fertilizers to their crops growing on the more responsive fields and to explore opportunities for improved management to enhance the quality of all fields over several years.

Grow more legumes: Related to this, the wider incorporation of a range of legume options as intercrops and in rotation with maize will raise soil fertility, the availability of soil nutrients, and maize productivity, and provide legume grain for home consumption and market sale. Legumes produce residues with 3-5% N content, supplying around 20-50 kg N/ha to a subsequent crop

of maize, helping raise maize yields and reduce the need for N fertilizer. Legumes with copious vegetative growth such as pigeonpea provide even more N as well as soil-quality improvement. In Malawi, maize grown in rotation after longer duration pigeonpea and pigeonpea mixtures with groundnut ('double up' legume systems) have been shown to respond to N fertilizer inputs by an additional 35-125% compared with continuous sole-crop maize.

A widening range of grain legume options is available for different agro-ecologies, cropping niches on farm and end uses. The 'double-up' systems involving intercrops of two legumes with complementary types of growth, such as a longer duration pigeonpea and viney species of climbing bean or spreading cowpea in mixed stands with determinant (bushy) groundnut or soybean, provide substantial amounts of organic matter and N to the soil. Short duration varieties mostly produce grain/pods (e.g. early varieties of groundnut, soybean and bean), with modest soil-improving properties beyond rotational diversity, but they do still provide dietary, market and drought-avoidance benefits.

There are also agroforestry improved fallow legumes and green manure legumes available that offer major improvements to severely depleted fields, although they can be challenging for farmers to adopt. These have a role in some circumstances, especially where farmers have major difficulties with exhausted fields and have some labor to spare, but require substantial support on seed and management expertise to help farmers to use them effectively.

Fertilize the legumes as well as maize: Legumes frequently benefit from P fertilizer applied to them and the use of P on legumes should be considered. Farmers will also find that the residual benefits from P fertilizers on legumes also help their maize and further improve returns to fertilizers employed on maize.

Consider inoculating some legumes: Soybean types that are not promiscuous are highly likely to respond inoculation. Provision to farmers of information on how to use the inoculant, and ensuring the availability and use of high quality inoculant would contribute to improved yields and improved soil fertility. However, since currently there is no capacity in Malawi to produce and supply inoculants, this can be considered for investment in the future, perhaps through linkages with the 'N2Africa' project that works in Malawi and the region.

Add organic matter: As throughout tropical agro-ecosystems, adequate soil organic matter is essential for long-term sustainable productivity in Malawian maize-legume systems. Organic inputs add the carbon needed for effective soil biological processes, soil structure, water holding and help to retain some nutrients in the soil so they can be available to crops when required. Practices that add organic matter to the soil through composting, the direct application of compost to fields and the good use of in **situ** cereal and legume crop residues of mixed quality will help raise the efficiency of fertilizer use and the re-cycling of nutrients.

3. Fertilizer Support Needs and Actions

a. Improve fertilizer supply chain:

Timely delivery: Fertilizers need to be delivered fast, well before the start of the cropping season. It is essential that farmers receive their fertilizers by late October at the latest since a 4- week delay may reduce yields by 30%. The procurement of fertilizer, its delivery to dealers and the provision of vouchers to farmers all need to be done on time (during May for delivery of fertilizers and August for vouchers), and this means that adequate resources must be allocated on time and managed well. This one change alone could improve yield gains from current quantities of fertilizer by 30 to 50%.

Source and deploy the right types of fertilizer: Previous emphasis on importing the cheapest source of N (i.e. urea) has led to emerging deficiencies of other nutrients. These deficiencies need to be rectified through sourcing fertilizers that include S, P or Zn as well as the concentrated N fertilizers. The fertilizers require to be delivered to dealers in areas with known deficiencies of those nutrients. Consider the more widespread use of compounds such as 23:21+4S, or periodic use of ammonium sulfate (available in neighboring countries such as Mozambique for rice), to address needs for S. Malawi used to have some capacity to blend fertilizers in-country. It will be easier to ensure the right fertilizer blends are available if the country can establish appropriate blending plants.

Expand fertilizer delivery mechanisms: Timely deployment of the right sorts of fertilizer to large numbers of farmers can be facilitated if the fertilizer dealer network can be expanded. Efforts to widen the involvement of input dealers in programs such as FISP should be considered, by relaxing requirements and raising incentives to be involved.

b. Provide more flexible subsidy vouchers:

Flexible maize fertilizer voucher: In FISP, two vouchers are currently provided to a farmer; one for a 50 kg bag of 23:21+4S and a 50 kg bag of urea, plus a second for maize and legume seed. More-flexible vouchers would allow farmers to obtain inputs more suited to their needs over a period of years.

A flexible maize fertilizer voucher can include 23:21+4S and urea, and include other fertilizers periodically (say once in 3-4 years for each farmer) to address emerging deficiencies, e.g. a compound containing Zn and ammonium sulfate for S.

Legume seed and P package voucher: The area planted to legumes in Malawi needs to triple and the yields to double. Better and more-widespread use of P can easily raise yields by over 20%. Farmers will also need more seed of the more-suited grain legume crops and varieties according to agro-ecological adaptation and farmer interest. This will require commitment from government programs (along with private and NGO partners) to further promote seed production of appropriate legumes, and distribute seed for evaluation and retention by farmers in extension programs and NGO projects. A dedicated voucher for legume seed and P fertilizer can be included in FISP.

Herbicide for maize: Given the benefits from better weeding of maize, but the difficulties farmers face in doing adequate weeding, include a maize herbicide voucher and training on weed management in FISP or related programs. Few farmers have experience with using herbicides, so training on their appropriate safe use in current cropping systems that include susceptible crops such as legumes, cucurbits and tobacco, and access to application equipment, will be essential.

Conditional universal subsidy: More generally for the long-term, incentives need to be put in place to encourage farmers to use inputs and practices that will contain and reverse land degradation in Malawi's densely populated farming areas. A scheme can be considered that will allow farmers to qualify for subsidized fertilizer provided he/she adopts several ISFM-enhancing investments. These would include a minimum (say 30%) of farm land planted with legumes, use of P on legumes, use of composts and manures and perhaps demonstrated management of other related problems such as Striga infestations and soil erosion. Such approaches would link subsidy programs such as FISP to information and education on building soil production capacity, which is detailed next.

c. Provide soil fertility management information:

Awareness and support: Additional support is needed to provide the latest soil fertility management information to farming communities. Much broader provision of appropriate information on fertilizer use and management is needed for farmers. There are many ways of doing this that can make a big impact collectively. Basic early awareness programs on long-term ISFM can be implemented in standard schools, with more advanced programs run in farmer field schools (FFS) and other extension initiatives. Information can be communicated on time through a wide range of media and venues including radio/TV broadcasts, newspapers, schools, churches and mosques, various community groups, and the internet.

Technology factsheets: The soil fertility technology factsheets being developed in projects like Africa Rising-Malawi need wide distribution to FISP fertilizer dealers, NGO projects, and extension services for them to use with lead farmers, farmer groups and in FFS.

Training and farmer experimentation programs: Training (by soil fertility research and extension projects, and in FFS) can be supported so it can be conducted more widely. Fertilizer dealers can be trained on ISFM and encouraged to provide information and factsheets to farmers when they collect fertilizer inputs. More opportunities for farmers to experiment with and learn about ISFM and fertilizer use need to be put in place through extension institutions and projects. Good farmer practices can be identified and then support given to spread information about these through extension efforts to support community based experimentation and knowledge sharing in farmer groups and FFS.

d. Support extension services on integrated soil fertility management:

Help extension to do a good job: Government extension services are widely distributed in Malawi and have much to offer farmers on fertilizer management. Extension staff require updated training in farmer-to-farmer extension, the training and making use of agro-dealers, as well as more operating resources and staff to implement ISFM educational programs with many farming communities.

Training on fertilizer 4Rs: Extension can conduct wider training and awareness on the fertilizer 4Rs to address gaps in farmer knowledge. Topics may include a) the timely use of appropriate types of mineral fertilizer, and their good management in combination with early weeding and rotations, to ensure good returns for these inputs, b) awareness that soil improvement from growing more (doubled up) legumes in the farming system and from organic sources such as composts are essential to ensure returns to fertilizer inputs, and c) advice on how and when to best split the applications of fertilizers.

Target the fertilizers: Promote the targeting of fertilizers to better fields to get the most from N and P fertilizers. The limited amounts of mineral NP available through support programs may be best targeted to these fields to ensure good returns. Extension need to be orientated on these spatial management opportunities that are quite new (having only recently been fully recognized from on-farm participatory research) and work with farmers to implement them.

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