Food and Agriculture Organization of the United Nations

BRIEFING NOTE

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Addressing sustainable crop production priorities in National Adaptation Plans

Overview

Sustainable crop production intensification, here defined as the integration of biological and ecological processes into cropping, optimization of the use of non-renewable inputs and improvement of farmers' knowledge, faces particular threats from climate change. Although crop production systems are already responding to challenges to seed systems, horticultural practices, genetic diversity and the management of pests and soil health, there is a need for better coordination between policymakers, farmers and other intermediaries to provide more timely, relevant technological and knowledge inputs to adapt to medium- and long-term climate change scenarios. Drawing on the United Nations Framework Convention on Climate Change (UNFCCC) Least Developed Countries Expert Group (LEG) *National Adaptation Plans Technical Guidelines* and the Supplementary Guidelines *Addressing agriculture, forestry and fisheries in National Adaptation Plans*, this briefing note identifies the entry points at the national level to plan and budget for adaptation actions for the crop production sub-sector to respond to medium- and long-term climate change threats.

Key messages

1. Integrating crop production adaptation priorities into NAPs aims to build resilience and alleviate the socio-economic impacts of climate change on agriculture-dependent households.
2. The long-term adaptation of crop production systems and livelihoods to climate change involves increasing yield to meet the food supply and nutritional needs of populations, producing varieties adapted to specific local conditions and promoting more diversified and sustainable agricultural practices.
3. Laying the groundwork for integrating crop sector priorities into NAPs involves assessment of existing formal and informal seed systems, agricultural infrastructure and land use potential for crops, as well as existing capacities for breeding or reintroducing climate-resilient varieties.
4. An enabling environment should be created for the implementation of assessed capacity development needs for all stakeholders for the development and adoption of technologies to adapt to climate change.
5. Capacity development should enhance the existing capacities of extension services and incorporate new extension tools such as Farmer Field Schools and other participatory learning approaches. Additionally, national and sectoral planners need to be sensitized to planning needs, the implementation of early warning systems for the monitoring of crops, pests, weather and soils, among others, to ease the decisions made at farm level.
6. Successful implementation of sustainable crop production intensification practices depends on defining indicators that measure resilience and productivity at both farm and sub-national levels. Given that farmers are key actors in adoption of climate-resilient techniques, careful attention should be paid to how to build farmers' knowledge into NAPs.

Introduction

Crop production is a vital source of revenue for 40 percent of the economically-active population globally (FAO, 2011). In developing countries, this proportion is much higher. Significant challenges threaten the production of crops for food and income. Given the projected population growth over the next 40 years, crop production needs to double to meet demand (FAO, 2011). This places additional stresses on achieving food security especially in marginal areas and developing countries. At the same time, there is increasing recognition that agricultural intensification must be accompanied and reinforced by approaches that reduce environmental degradation and properly manage ecosystems.

Climate change adds a particular set of challenges to providing food for a projected population from 6.9 billion (2010) to 9.2 billion people in 2050 (FAO, 2011). The most crucial of these include increased temperature, changes in precipitation patterns, increased frequency of climatic variability and extreme events, increased atmospheric carbon dioxide and increased sea level rise and salinity (Willis, 2017). These have implications especially in parts of the world dependent on key crops such as maize, rice or wheat. Subsistence farmers in developing and least developed countries are particularly vulnerable.

Around 85 percent of developing countries mention agriculture and/or land use in their Intended and Nationally Determined Contributions (INDCs/NDCs), while 99 countries mention crop production as a priority concern (FAO, 2017). The reduction of crop yields and shifts in crop production patterns due to climate change have potential ripple effects not just on individual livelihoods, but on households, enterprises and regions. These bring about changes in socioeconomic systems around issues of equity, social protection and gender relations. Wider implications on water and land use, crop production value chains and the maintenance of sustainable food systems also demand a coordinated approach that could be a sustainable way to build resilience at the household level. Planners at the national and sub-national levels must be equipped to take into account the particular challenges faced by the crop production sub-sector, such as capacity needs of relevant stakeholders. Data and monitoring systems should be enhanced to meet the challenges of planning and budgeting adaptation options while sustaining food production with population growth. This briefing note shows how the NAPs process provides a framework for the adaptation planning needs and priorities of the crop production sub-sector to be integrated into national-level planning policies, strategies, mechanisms and climate budgeting.

Overview of the NAPs process

The NAPs process was established under the UNFCCC as part of the Cancun Adaptation Framework. This process enables countries to formulate and implement NAPs as a means of identifying medium- and long-term adaptation needs and developing and implementing strategies and programmes to address these needs (UNFCCC, 2012). Undertaking such a process at the national level also allows planning and implementation to be linked to global means of financing such as the Green Climate Fund Readiness and Preparatory support programmes.

The supplementary guidelines Addressing agriculture, forestry and fisheries in National Adaptation Plans (NAP-Ag) were formulated to provide agriculture sector-specific NAPs guidance (FAO, 2017a). They provide a framework for supporting developing countries to:

- **Build adaptive capacities and resilience** by reducing the vulnerability of the agriculture sector to the impacts of climate change.
- **Address agriculture** in the formulation and implementation of NAPs.
- **Enhance the integration of adaptation** in agricultural development policies, programmes and plans.
- **Enhance coherence with global frameworks** (Sustainable Development Goals, UNFCCC, Paris Agreement, Convention on Biological Diversity) and national commitments (e.g. NDCs).
- **Formulate a basis for effective and sustainable investments**, including future financing for implementation of adaptation options (adapted from FAO, 2017a).

Both the UNFCCC and NAP-Ag guidelines are built around four Elements of the NAPs process. These are comprised of: (i) recommended steps and building blocks towards laying the groundwork and addressing gaps; (ii) preparatory elements including assessing vulnerabilities and reviewing adaptation options; (iii) implementation; and (iv) reporting, monitoring and overview. A NAPs process is country-driven, iterative rather than prescriptive and best conducted as a gender-sensitive, participatory and fully-transparent process.

Key vulnerabilities and adaptation considerations for crop production

The main physical effect of rising temperatures expected with climate change is the variation of the photosynthesis efficiency rate of different crops, which could lead to a reduction of yields or total crop failure. These consequences depend on a number of factors: the magnitude of these changes, availability of biophysical resources and the level of agronomic management (e.g. management of field-crop production). Factors such as an extended growing season could increase the frequency of the breeding cycles of insect populations, which could harm crops. Biological processes below the ground will also be affected by climate change. High temperatures could accelerate organic matter decomposition and decrease nitrogen-fixing activities of legume species which will negatively affect soil health. The water requirements of some crops may also increase due to high temperatures, especially in water-scarce regions. Agricultural practices that are heavily dependent on rain-fed agriculture are especially vulnerable to climate variability and change. It is predicted that maize production in southern Africa could decrease by 30 percent by 2030, while in South Asia the loss is estimated at 10 percent (Lobell *et al.*, 2008).

In the context of these risks and vulnerabilities, it is necessary to have a system of production of annual and perennial crops that would be managed sustainably and profitably while meeting the needs for food, feed, energy and fibers. The challenge lies in intensifying production while adapting to and preventing the impacts of climate change. The sustainable crop production model[1] (FAO, 2011) recognizes the need to maximize production per unit area while reducing negative environmental impacts. This can be done through: (i) the management of biodiversity and ecosystem services; (ii) adoption of new varieties or even changing to different crops; (iii) rapid development and dissemination of plant protection guidance in order to preserve the environment for future use (see **Box 1**).

Box 1

Efficient use of resources through greenhouse production systems

Unpredictable rainfall, water scarcity, increased pests and diseases due to high temperatures and soil degradation have compromised farmers' livelihoods, forcing many to migrate in search of opportunities to generate incomes and sustain their families' basic needs.

Figure 1 – Tomato production in Santa Ana, El Salvador.

Farmers in the mountainous areas of **El Salvador** and **Honduras** invest in wooden low-cost greenhouses for vegetable production in areas where there is limited availability of land and water, obtaining high yield growing vegetables under protected agricultural systems. They use limited resources efficiently, optimizing the use of pesticides and fertilizers and introducing biological control agents.

Located between 700 to 1 500 meters above sea level, the environment is suitable for vegetable cultivation under greenhouses eliminating the need to invest in costly cooling systems.

1 This term covers a range of approaches that focus on integrating biological and ecological processes into cropping, optimizing the use of non-renewable inputs, and improving farmers' knowledge, including agroecology and climate-smart agricultural strategies (FAO, 2011).

Figure 2 – Greenhouses for tomato production in Santa Ana, El Salvador.

The standard size for a low-cost greenhouse with a duration of three to five years is 600 square meters. A total cost including structure, plastic, netting, fertilizer-irrigation system and labour for construction is approximately USD 12 per square meter for a total investment of USD 7 200. Netting and plastic are used to prevent insects and diseases that affect vegetable crops, thereby optimizing the use of agrochemicals. A drip irrigation system is installed to address the limited availability of water. Farmers obtain 12 tonnes of high-quality tomatoes per greenhouse in six months, generating roughly USD 8 400 to improve their livelihoods and gain better access to food, healthcare and education.

The implementation of climate-resilient crop production systems intersects with a range of interventions already being implemented in the crop production sub-sector towards the goal of healthy agro-ecological systems. These include:

- **Identifying the limits and opportunities of existing seed systems.** The use of quality seeds and planting material of well-adapted cultivars is a pre-requisite to making agricultural systems resistant and resilient to the most common effects of medium- and long-term climate change threats.

- **Increasing genetic diversity at farm level to improve resilience.** Farmers have long used local varieties and landraces that, although less productive, have good potential for adapting to changing climate conditions. There is a need to support the promotion and development of varieties with functional and useful characteristics, keeping in mind that projected climate change adds an additional level of stress to their adaptive capacities (see **Box 2**).

- **A horticultural production system (HPS)** is akin to a value-chain approach and can help in planning for climate change adaptation. A HPS takes into account the contribution of a rich and wide range of species, including indigenous vegetables, to the maintenance of a balanced food regime and builds in the cost of transportation and conservation measures. One benefit of a HPS approach is that it connects urban and peri-urban centres of circulation. It can assist in highlighting issues such as access to seeds, research on indigenous cultivars and differential access to technologies (e.g. drip irrigation) on a national scale.

- **Integrated Pest Management** approaches address the challenges of pest management while keeping a necessary balance amongst a few key variables. These include the need to keep pest populations low enough to prevent major losses, optimizing the use of pesticides to economically-justified levels and reducing negative impacts on human health and the environment.

- **Soil management.** Intensive crop production can lead to nutrient loss and soil degradation. However, fertilizers are often expensive or inaccessible to farmers in many parts of the world. A key objective of soil management is to encourage the introduction of nitrogen-fixing legumes into existing production systems by extension agencies and development partners. This includes promoting the cultivation of legumes in multiple cropping systems and the inclusion of shrubs and trees to enhance the recycling of nutrients originating in deeper soil layers.

- **Conservation Agriculture.** This approach is based on the concept of minimum disturbance of the soil between different crop cultivations. The purpose of conservation agriculture is to maintain soil organic matter, soil structure and overall health. Crop rotation and soil cover are commonly-applied interventions and utilize a wide range of plants species, annuals and perennials to enhance crop nutrition and to improve the resilience of the agricultural production system.

Box 2

National Adaptation Plans and genetic resources

Figure 3 – Maize collection at the International Maize and Wheat Improvement Center (CIMMYT) genebank.

An estimated 8 000 species of plants have been used for human and animal food production (RBG Kew, 2016). Additionally, another 5 000 species have been identified as potential sources of genes for breeding programmes. This diversity is particularly important because it constitutes a reservoir from which more climate-resilient cultivars can be developed.

The genetic material of the world's major crops and their wild relatives are currently conserved in the gene banks of the Consultative Group for International Agricultural Research

(CGIAR) centres and national and international gene banks, representing a good investment for adapting to climate change. The genetic resources stored in these gene banks are held in trust under the auspices of the Food and Agriculture Organization of the United Nations (FAO) through an agreement with the International Treaty on Plant Genetic Resources for Food and Agriculture and are available for consultation on the World Information and Early Warning System on Plant Genetic Resources for Food and Agriculture (WIEWS).

These resources are freely available for research, breeding and training purposes. The plant traits for adapting to future climate scenarios can be sourced from these resources. The Voluntary Guidelines to Support the Integration of Genetic Diversity into National Climate Change Adaptation Planning (FAO, 2015) helps to identify clear goals for conservation and the use of genetic resources for food and agriculture as part of the overall national adaptation planning processes in countries.

- **Sustainable mechanization.** Increasing productivity per unit of land is an important strategy for reducing the yield gap projected with climate change. Sustainable mechanization approaches are based on facilitating access to small machinery combined with Conservation Agriculture approaches to allow for the efficient management of land preparation activities and a reduction of harvest losses.

- **Creating enabling environments.** Policies tackling the socio-economic context for crop production play an important role in particular for gender and youth involvement in crop production (see **Box 3**). These include increasing access to credit by reducing the transaction costs, setting affordable prices for inputs and identifying approaches to strengthen farmers' access to land and other productive inputs in ways that incentivize them to make long-term investments.

Box 3

Impacts of climate change on the gender gap in crop production

In **Uganda**, a drought in 2008 caused losses of approximately 3 percent of the value of all food and cash crops that year. In 2011, the country suffered economic losses of about 16 percent of the total annual value of these food crops, cash crops and livestock. If no action is taken on climate adaptation, it is estimated Uganda could lose up to USD 1.5 billion on food crops, due to climate change impacts.

This has knock-on effects on other levels of society, including livelihoods. Women are involved in the production of food crops while the production of income-generating crops is dominated by men. According to UN Women, the gender gap in Uganda's agricultural productivity is 13 percent which equates to losses of 1.6 percent of the agricultural gross domestic product. Women therefore have lower access to assets and resources to build resilience in the face of climate change. Adaptation actions addressing the crops sub-sector in Uganda must therefore tackle existing inequalities that will be exacerbated with climate change.

Sources: National Environment Management Authority, Uganda (2008); UN Women and World Bank, cited in FAO and UNDP, 2017.

- **Investment in education for farmers** is important especially in developing countries where extension services are limited. Investment in research institutions are also key to technology-generation for medium- and long-term adaptation to climate change.

- **Decision-making tools for farmers and agriculture planners.** Tools for monitoring the weather and its effects on crops help farmers to make informed decisions that minimize negative climatic effects on crop production and guide them in planning on seasonal and long-term bases. Such tools include the Crop Calendar that provides timely information about seeds as well as information on planting, sowing and harvesting periods of locally-adapted crops in specific agro-ecological zones. The Horticulture Cultivars Performance Database HORTIVAR provides information on crop species and varieties linked to prevailing climatic conditions in a given location.

Many of these existing strategies are adaptation options. Part of the NAP process is to understand the costs and benefits of an option in relation to another. There is a need for well-structured adaptation and planning policies at the national level to account for these risks within existing or new tools in a systematic way.

Recommendations/ Response options

National governments have the potential to create an enabling environment for the implementation of tested adaptation options through policies and institutional coordination mechanisms. This will ensure robust and effective flows of information horizontally and vertically to accommodate new needs in the following areas: knowledge (up-to-date climate information, integrated models, downscaled models, farmer and indigenous knowledge); capacity (diverse stakeholders); coordination (national, provincial and local levels); monitoring and reporting; and finance (domestic, international, private sector). In line with the framework of a NAPs process (UNFCCC, 2012; FAO, 2017a), the following are some ways in which risks and vulnerabilities within the crop production sub-sector could be integrated into the national adaptation planning process:

Element A: Laying the groundwork and addressing the gaps

This element focuses on contextualizing adaptation planning in the sub-sector. This includes taking stock of ongoing sub-sectoral adaptation activities and assessing capacity development needs. An objective of this step is to facilitate the involvement of relevant stakeholders in the process of ensuring the integration of crop production sub-sector priorities in NAPs.

- **Take stock of existing vulnerability and risk assessments, knowledge, methodologies and the capacity and institutional gaps, policies, plans**

and investment frameworks in the sub-sector. Seeds are the foundation of farming. Thus, the assessment of risks and vulnerabilities of the existing national seed systems is crucial to understanding its weaknesses and strengths. This information will be the basis with which to design effective adaptation strategies to overcome issues in the systems' adaptive capacities. Formal and informal seed systems need to be taken into account, in order to ensure a better fit with local agricultural contexts. Agricultural infrastructure, such as the availability of irrigation systems or machinery, are important assets for adapting to climate change.

Therefore, assessment of national infrastructural assets will help to lay the foundation for prioritization of further action to redress infrastructural gaps. A third area is studies of land use potential, which will be crucial to understanding where different crops can be planted under different climate change scenarios. These assessments need to cover food security issues and the nutritional needs of the population, as well as collate relevant policies and laws related to all plant production systems (e.g. horticultural systems, plantations).

- **Address capacity gaps and weaknesses in adaptation planning in the crop production sub-sector.** Capacity needs for addressing climate-induced risks and vulnerabilities range from individual and organizational levels to the enabling environment. In turn, individuals, organizations and enabling environments can be assessed for the strength of technical and functional capacities (FAO and UNDP, 2018). For example, developing the new varieties needed to ameliorate future climate change risks on crops is an essential technical capacity for national agencies engaged in plant breeding. Countries need to assess the availability of human resources and expertise required to establish and maintain breeding programmes. Where programmes lack the necessary expertise to develop new varieties, the reintroduction of adapted landraces and varieties from countries with similar agro-ecological conditions is a recommended pathway for adaptation to climate change. There is a need to develop capacity to disseminate the seeds of new varieties and promote their use by farmers.

  While inputs for a baseline capacity assessment already exist in activities conducted by the national extension services for the sub-sector, consultations with a variety of stakeholders can help to identify perspectives that might be missing from extension services. At farm level, it may be necessary to address gaps in the adoption of new practices and technologies. Farmers may need to be trained in the early detection of pests and diseases.

Element B: Preparatory elements

This element focuses on analysing climate change scenarios, risks and vulnerabilities in the crop production sub-sector and identifying, selecting and prioritizing medium- to long-term adaptation options. These can be generated in consultation with stakeholders, both public and private, to ensure that clear information on climate change impacts and strategies on the sub-sector are reflected in sectoral NAPs and national planning processes.

- **Identify, select and appraise adaptation options in the agriculture sectors.** This step involves selecting the methodology and criteria for appraisal of adaptation options. The choice of methodology and criteria depend on overall planning strategies. A strategy for a long-term adaptation plan could be based on technologies that build resilience to climate change at the plant and soil levels. For example, the system could be based on regenerating and/or improving soil health while bringing diversity in the crops that are cultivated under a well-managed water supply. The mapping of risk areas and analysing how plant diversity would change in those areas has also been deployed effectively to address the dual goals of building resilience and sustainability while closing the yield gap. Economic tools such as Cost Benefit Analysis then can be used to identify and appraise adaptation options.

  National breeding programmes are another suite of policies that can support the production of new varieties well-adapted to climate change. To increase the resilience of the system to a wide range of climate change scenarios, these adapted varieties could be integrated in cropping systems that would combine a wide range of plant varieties and species, both annuals and

perennials, while applying Conservation Agriculture (CA) principles (see above). This could be strengthened by the *in situ* conservation of crop wild relatives and wild food plants that represent a source of desirable genes, nutritional enhancement and food diversification.

Considering that poor-quality soil is a significant limiting factor to any agricultural production system, particularly in areas where the lack of financial resources often limit access to agricultural inputs, in such cases nitrogen-fixing legumes and CA strategies are recommended for regenerating and improving soil health. As with new technologies, the uptake of new techniques would improve if extension services and farmer organizations were involved in supporting farmers through the transition. At the national level, the implementation of CA strategies can be facilitated by policies supporting sustainable mechanization (e.g. facilitating access to small machinery through the implementation of policies such as reduction of importation taxes; enabling farmers or farmer groups access to credit for purchase of equipment; encouraging the importation of more suitable farm equipment such as tractors).

No crop production system is viable without a good water management system. Accessibility to small irrigation systems such as drip irrigation through lines of credit designed for small- to medium-sized farmer operations is an important policy priority. In addition, the use of techniques of water conservation in countries where the rainfall is concentrated in one or two months during the year (such as the zaï pit conservation farming method in Burkina Faso) should form part of sustainable water resources management strategies to be considered.

- **Review integration of climate change adaptation in the agriculture sector in development planning, including national, subnational and sectoral plans.** National and sectoral policies and laws could be reviewed to ensure that adaptation priorities of the crop sector are integrated. One area of focus is the review of quarantine procedures to prevent the entry and establishment for new pests. An example includes the fall armyworm, which was first detected in Central and West Africa in 2016 and spread rapidly across Africa and other regions. Emergency measures addressing the sudden onset of pest appearances could be accompanied by strengthened regulation on seed systems. For example, controls could be placed to reduce seed multiplication and the size of the seed bank in the soil to reduce the prevalence of invasive species. National institutions could promote the sustainable use and conservation of indigenous varieties and wild relatives which are not only well-adapted to local conditions but can also be source of genes for breeding programmes. The knowledge of all relevant stakeholders, from smallholder farmers, to farmers' organizations and national institutions, should be leveraged in these policy reviews.

Element C: Ensure appropriate priority for the agriculture sector in national adaptation planning; improve capacity for planning and implementation in crop production sub-sector

The focus of this element is on developing strategies for inclusion of adaptation options in the NAPs and enhancing capacities to implement adaptation actions in the crops sub-sector. Based on the assessments conducted, specific adaptation strategies can be designed with the chosen model of crop production.

- **Developing long-term capacity development strategies** A capacity development plan is necessary for stakeholders to keep pace with evolving climatic conditions and ensure the continuous development of technologies and strategies to address the impacts and opportunities of climate change in the long term. A national approach could ensure more comprehensive coverage of long-term capacity building efforts. This would imply a national assessment of the adaptation options and the existing capacities to implement them (see Element A).

  The first level of training would be done for farmers. Some of the key needs include developing farmers' capacity to adopt existing climate change adaptation practices as well as new technologies and innovations.

Farmers should also be helped to understand ecosystem functions to support the scaling-up of ecosystems-based approaches. Where they exist, extension services, given their access to a wide network, can play a role in the capacity development of farmers and farmers' organizations and can serve as a connector between new practices and farmers.

Where these services are absent, which is the case for many developing countries, the gap can be bridged by implementing Farmer Field Schools (FFS). FFS are founded on an approach to community education based on the principles of experimentation, learning-by-doing and cooperation. FFS can help farmers to integrate practices based on agrobiodiversity, CA, mechanization and better water management into existing crop systems. It could also implement long-term demonstration plots to show the cumulative benefits of these approaches on soil health and crop production. In Indonesia, FFS were converted into "climate field schools," with training on how to incorporate climate information within farm decision-making processes (Winarto *et al.*, 2008). Beyond the farmers and actors working directly with them, other members of the chain will need capacity development to support sustainable mechanization efforts, establishment of curricula for tractor repair and building small field equipment locally.

- **Enhanced capacity for coordination, monitoring and financing adaptation in the crop production sub-sector**
  As recommended in the NAP Technical Guidelines, it is necessary to have political support to implement relevant regulatory, policy, institutional, accountability and legislative frameworks to help make the necessary changes. One area for enhancement could be the monitoring of climate change impacts, data analysis and assessment of adaptation options as well as coordination of different actions by a range of stakeholders. Monitoring should be carried out at all levels including at farm level, specifically engaging farmers in crop surveillance systems so that they can report on changes they observe in patterns of pest appearances. All actors from research institutions and academia, national and local government institutions, Non-governmental organizations (NGOs), community–based organizations, farmers' organizations, women's and youth organizations are part of the process of monitoring, reporting and data analysis needed for effective planning.

  The successful implementation of capacity development assessments, actions and their monitoring depends on access to funding. Capacities should be built to access programmes that target country preparedness for adaptation in the agriculture sectors include the Green Climate Fund (GCF), the World Bank's Climate Investment Funds, the Global Environment Facility (GEF) and the International Fund for Agriculture Development (IFAD), as well as bilateral funds. The country's coordinating bodies on development and climate finance (for example the GCF-National Designated Authority (NDA) and UNFCCC focal point), should be sensitized to the adaptation priorities developed by the crops sub-sector.

- **Promote coordination and synergy at the national and subnational levels.**
  Given the wide scope of data collection, assessments, implementation and monitoring of adaptation actions for the crop production sector, there is a strong need for coordination at the national level. The Ministries of Finance and Planning play a key role in raising finance and making the relevant funding available. Ensuring the right prioritization of actions requires coordination between ministries of the sub-sectors contributing key technical inputs to policies and actions, such as the ministries of Agriculture, Environment, Land and Water, Industry, Higher Education, Research and Development, and Rural Development. At the same time, provincial-level representation of these agencies also need to be sensitized to NAPs processes, in order to ensure the coherence and harmonization of priorities and monitoring targets with national ones.

Element D: Reporting, monitoring and review

The focus of Element D is on developing effective monitoring and review of systems to assess progress, effectiveness and success in implementing adaptation actions related to the crops sub-sector. It also focuses on effective outreach and communication of information to relevant stakeholders. The complexity of climate change and uncertainty around its actual, rather than predicted, impacts requires an adaptive

management approach to both monitoring and knowledge-sharing.

- **Prepare for monitoring and evaluation in the agriculture sector.** Sustainable crop production intensification is knowledge- and management-intensive. Given the complexity of climate change, flexible monitoring and evaluation processes are most valuable. Smallholder farmers and planning institutions alike will need to adapt constantly and re-strategizing will be required. Preparatory support includes putting monitoring systems in place, defining indicators and clarifying institutional responsibility for monitoring, evaluation and knowledge-sharing.

  Adaptation actions should be monitored through indicators that are defined early on in a NAP. This will involve collaboration with research institutions, universities and statistical agencies to evaluate the level and effectiveness of the implementation. Measures of effectiveness at the subnational level – for example trade, gender gap, productivity – must be balanced by the qualitative and quantitative evaluation of impacts at the farm level. These could include indices of resilience, nutritional balance, gender equality and poverty reduction constructed for farming households and agriculture-dependent populations. Once monitoring systems are in place and indicators defined, institutional responsibilities for collection and update of monitoring data should be clarified. If there is a lead institution responsible for NAPs coordination, sectors and agencies should define clear roles for liaison with this institution.

- **Outreach and communications for iterative assessment of NAPs effectiveness.** Climate change requires increased capacity of farmers to make short- as well as long-term planning decisions and choices of techniques and technologies. Knowledge and strategies developed need to be constantly assessed for continued effectiveness under different conditions. Communication is also needed to ensure no weak links between parts of the system within which an intervention is being implemented. For example, beyond policies that address climate-resilient varieties, pest management and fertilizer control, strengthened communications and dissemination systems that target the marketing and commercial aspects of crop supply chains are equally important for ensuring that these remain responsive and aligned to NAPs objectives.

  Successful adaptation practices often depend on knowledge generated by learning-by-doing. The sharing of experiences, skills and knowledge by farmers through participatory methodologies have an important role to play in encouraging experimentation and farmer-to-farmer exchange, a platform that has also been provided through Farmer Field Schools. Farmers knowledge is an important resource for iteratively updating the NAPs to increase the adoption of relevant, more efficient adaptation actions and planning mechanisms.

Conclusions

Crop production in the face of climate change is a priority concern for many countries as it has wide-ranging impacts across livelihoods and national and regional economies. At the same time, some efforts are already in place to adopt sustainable methods to improve yields, diversity and seed systems and ensure the long-term plant health. These efforts should also take into consideration the actions taken by other sub-sectors, especially those related to land use and water provision, to ensure that adaptation actions are not in conflict with one another.

The NAPs process provides a framework for understanding how these priorities can be integrated into broader processes of planning. Assessments, for example of seed systems, need to include all parts of the system, including aspects of distribution and capacity for implementation. Prioritization of adaptation actions requires a long-term adaptation strategy that covers diversification of risk, breeding capacities, support for new farm technologies and infrastructure, protecting farmers' livelihoods as well as regulatory and emergency response mechanisms to address pests and declining yields. While access to funding is important, coordination should address monitoring of crops as well as knowledge exchange and communication between farmers, extension services, field schools, research and breeding institutions, and provincial and national planning agencies. In addition, monitoring the effectiveness of the implementation should be undertaken.

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Integrating agriculture in National Adaptation Plans

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United Nations Development Programme
www.adaptation-undp.org/naps-agriculture
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Germany's Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)
www.bmu.de/en

International Climate Initiative (IKI)
www.international-climate-initiative.com

For more information, please contact FAO-NAPs@fao.org.

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